GAMING THE IRRATIONAL

Connections 2021 Working Group 3 Report

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Executive Summary

Introduction

We have a challenge in our analysis of operations, one that games are well suited to examine. But we often ignore this challenge in our games because it is very hard to include. It is what we call the “irrational.” We might also call it the unexpected, the awkward,1 or the embarrassing. It can also be the introduction of the human, the bureaucratic, the organizational, or even the sinful into events.

Events happen all of the time that disrupt the expected flow of operations, and when these events do happen, they often change the very nature of the operation. Examples of the irrational include:

- Fratricide: blue on blue, and blue on white. Accidental and deliberate.
- Criminal acts such as Abu Ghraib
- Insider threats
- Accidents or mistakes
- Insurrections
- Poor leadership
- Incomprehensible or deliberately vague orders or mission statements
- Rivalries, jealousies, and other difficulties between people or organizations
- Morale
- Battlefield friction, confusion, and chaos

And that is only at the operational and tactical levels of war. It also happens at the strategic level. Historically we have seen many examples of things not quite going as they should. Hitler’s interference on the Eastern Front (and many other orders). Napoleon’s insistence on maintaining the Continental System. And the tendency, much disliked by military folk, of the Clinton and other administrations of micro-managing strike targeting.

No matter what your political beliefs, we have seen in recent years situations where strategic guidance and orders can become incoherent or chaotic. In addition, there is the use of misinformation at scale to create changes not only in how society perceives reality, but also force politicians to act on or react to that artificial reality.

This is the reality of warfare in the modern age. In virtually every conflict we have been involved in during that past several decades the irrational or awkward has played a role in shaping that conflict. Models and simulations, which tend to be based on physics and doctrine have little hope of incorporating these irrational elements into their predicted outcomes. Mostly because no one who sponsors or runs them would ever be able to admit that such things might happen and affect the course of conflict. Games, however, because they are both played and controlled by people, have a much better chance of including some of these elements.

1 “awkward” = situations that tend to generate replies of “that would never happen!” “that’s against doctrine/rules/law/orders” and “we can’t admit that might happen, ever!” Of course those events do actually happen, and people get in trouble when they do.
Our working group
In this working group we discussed the problem of including counter-factual, irrational, or awkward elements in game play. While there are simple solutions such as “put it in as an inject” what we were really looking for was:

- a discussion of how to shape the game, and player behavior, so that these events emerge organically from the game play
- how to include characters in the game who are manifestly “different” from the accepted liberal/neo-conservative internationalist approach that typically informs Western foreign policy in games.
- Adjudication of actions that encourage miss-behavior in games, from counter-factual2 propaganda to deliberate spoofing and other shenanigans. This would include insider threats, supply chain attacks, and other actions that corrupt the decision process from the inside.
- How to deal with common, but often ignored, elements such as morale, fratricide, fog of war,3 and battlefield chaos on a standard player/controller game.
- How to deal with politically sensitive topics such as Congress, lobbyists, and other sensitive issues so as not to generate real-world blowback from the game.

This is obviously a huge topic that has many aspects to it. In the following sections we summarize the two general approaches our participants took toward the topic. For more detail, or specifics, see the individual papers attached to this introduction.

The meaning of irrational
Our discussion, and papers, divided into two general ways to think about the problem:

- Irrational taken literally as “not rational.” This tended to lead the discussion into areas of definitions, game theory, and ways in which the players in a game make decisions. We could also call this the game or player centric view of the problem.
- A sweeping interpretation of the problem to include items, issues, and behaviors that are socially liminal, emotionally charged, politically difficult, or just plain crazy. Especially behaviors that violate the “polite” acceptance of a neo-conservative, liberal, western, interpretation of behavior between individuals and societies that has emerged as a consensus value during and after the Cold War. This tended to lead the discussion far afield into areas that would not easily fit into the idea of “not rational.”

2 By “counter-factual” we don’t mean military deception or communications intrusion. That is included in the “chaos of war” at the tactical level. Instead we are referring to large-scale information campaigns directed at social structures and populations designed to change the accepted underlying reality and in turn affect the strategic calculus of political decision-makers.

3 Note that we are not just talking about double blind here, rather how do you incorporate the chaos of misunderstanding where you are, what you are supposed to be doing, what other units are supposed to be doing, and where the enemy is and what they are doing. This goes to the larger chaos that occurs when units come into contact.
These two approaches worked well in the discussion, with those concerned with the literal interpretation holding ideas about how players are, or are not, rational in their decision-making, while the other approach broadened the discussion to areas, such as who to include in the game and how to simulate media, that were not strictly “rational” or “irrational.”

These two different approaches we characterize as “player centric irrationality” and “problem centric irrationality.”

**Player centric irrationality**

This approach is captured in the papers “Irrationality in Operational Gaming,” by John Hanley and “ and “Wargaming Irrationality: A practical approach,” by Roger Mason. Justin Peachey’s paper “Gaming the Irrational: What do we mean and how might we achieve it,” sits has elements of both player and problem centric irrationality. We are not going to review the paper’s arguments in this summary, for that you can read the actual papers. Instead we will focus on the discussion that occurred between the authors during the working group.

The core argument in the player centric approach is that there are well defined ways of understanding rational choice and these can be applied to understanding player actions and options. One topic that was brough up was using Confrontation Analyses⁴ to understand the underlying rationality of situations. Confrontation analysis has players iteratively work through their objectives and goals, while trying to eliminate dilemmas created by conflicting goals. While Confrontation Analyses is related to game theory, the focus is on identifying dilemmas between the players and how those dilemmas might get resolved. It can also be seen as a highly formalized way of executing a game with moves focused on creating or resolving dilemmas.

And it was a game theoretic approach that dominated this side of the conversation. The general concept was to understand how to get the players to behave in irrational ways. One was was to potentially stress the players, thereby affecting their decision-making and Observe Orient Decide Act (OODA)⁵ loop. While this may be a bit questionable, and certainly might make the players uncomfortable, messing with the players directly was discussed as a way to affect their rationality. This might include things like sleep deprivation, an uncomfortable environment, lack of food water or coffee and incompetent support. One person during the out-brief said that in one of their games they did not give the players representing the victims in a disaster food or water unless it was supplied to them in the game. While the effect of such approaches on the players’ morale is worrisome it does reflect the player-centric approach toward understanding and finding tools to manipulate the rationality of the players’ decisions.

Another issue that was raised during the discussion is emotional attachment. How do you inculcate in players the attachment that might be present in the real world. A strike against Hawaii represents a loss of communications, firepower, or logistics from a rational, practical, point of view, but it also is

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someone’s co-workers, house, family, and home. That sort of attachment can be difficult to replicate in games, but it affects the rationality of the decision.

**Problem centric**

The idea of emotional attachment to a situation overlaps with the problem-centric approach toward this problem. The paper that best describes this approach is Ed McGrady’s “You Can’t Do That! Putting the awkward, irrational, and just plain stupid into games.” Here the emphasis is on what we include or leave out of games. Not just from the player perspective but from the overall perspective of what the game is about. Primary examples would be effective media play, political considerations, emotions, loss of situational awareness, and events such as malfunctions and blue-on-blue.\(^6\)

In this version of irrationality asks us to look at a lot of things that we don’t normally include in games. Examples include:

- Media and social media play and the effect (or lack of effect) on player decisions.
- Panic and unit morale
- Random acts such as firing on friendly forces or accidentally firing on civilians.
- Deliberate crimes and actions that can be considered crimes (i.e. the role of lawyers in operational and strategic games).
- Congressional and other political play.

Needless to say the poster child for this problem is Trump. Simulating Trump in serious, professional, games represented a challenge. If an individual did it they would be accused of caricature while if he was managed by control the game would be open to political criticism or lack of accuracy (by both sides). It was also hard to predict his actions in any given circumstance. This lack of predictability, combined with political sensitivity, is at the heart of the problem-centric approach.

It basically says: we worry all the time about how accurate our games, models, and simulations are but we deliberately avoid including many of the key drivers for actual outcomes. This can range from no including Congressional play in procurement games to avoiding drivers like civilian casualties or war crimes (like Abu Ghraib) that affect our ability to operate in a complex environment.\(^7\)

During the discussion the player-centric approach countered that many of the concepts included as a problem were actually a failure to understand the underlying logic of the individuals involved. The North Korean ruling Kim family was one example. It is essentially a criminal enterprise with its own internal logic, economics, and ideology that guide decisions every bit as much as neo-conservatism guides our foreign policy. Likewise Trump has his own internal measures for what success or failure means and those drive his logic. It is not that the decisions are irrational, they are logical within the structures where they operate.

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\(^6\) Blue-on-blue is a friendly shooting at another friendly. Blue-on-white is a friendly unit firing on civilians.

\(^7\) And there are very good reasons why many of these factors are not included in games. But the games are still inaccurate without them.
This is somewhat different when you move from the operational and strategic to the tactical scales. Here the idea of the irrational has been worked on continuously ever since Jim Dunnigan introduced the idea of “panic” and “pinning” into tactical games.\(^8\)

**Conclusion**

The overall conclusion from the working group and the papers has to be that designing game mechanics to incorporate the irrational in games is a very difficult challenge. There are no simple solutions as many of the required effects involve convincing the players of something.

Whether that is convincing them to make a decision based on emotions, or a social media feed, pulling players that deep into the suspension of disbelief is difficult. It is made even more so by the players strongly held personal, ethical, or political beliefs which can get in the way of immersion into the game role.

The good news is that there are ways to use game theory, and similar formal models, to understand some of these effects. It is also possible, at the tactical level, to adopt hobby game techniques to approximate many of the tactical issues with communications, misdirection, morale, and emotion.

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\(^8\) Here “panic” means loss of tactical control by the player over the unit. “Pinning” represents loss of control due to enemy fires and generally reflects the units has “gone to ground” and cannot move or shoot. Pinning is a common mechanic in tactical games.
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Irrationality in Operational Gaming

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The Context
This working group will explore the differences between our game designs and the real world that is the result of our failure to deal with the irrational. By irrational we mean the broad category of events where someone does something against their objective self-interest, or established norms. We also include situations where we choose to ignore the uncomfortable variables for political, ethical, or doctrinal reasons.

There are examples from almost every war. When someone shoots down an airliner in the middle of battle. Or when Abu Ghraib derails years of political groundwork. Or when we assume leaders who will behave rationally in making decisions at the strategic, operational, and tactical levels of war. When adverse information is released about a commander. When troops in contact get confused and lose their position and start driving off in the wrong direction. All of these have effects in the real world that are rarely included in our games.

These gaps occur in game play, where players are unable or unwilling to mimic real-world behavior. They also occur in our designs, where we fail to include the possibility of real-world options occurring. How many future force games include Congressional play, for example?

Abstract
Gaming the irrational raises the question of what rational behavior is. Game theory and games motivated by game theory provide insights regarding rational behavior in both structured games used in experiments and operational games. Contrasting game theory and behavioral theory suggests many ways in which play will be other than normatively rational, and raises some questions regarding the rationality of doctrinal joint planning process in Joint Publication 5-0. In their efforts to go beyond mathematical game theory, Thomas Schelling made advances in appreciating mixed-motive situations and Nigel Howard developed theory and techniques for including dynamic, emotional, and irrational behavior by building upon decision dilemmas exposed by game theory. Since games have played such a big role in the development of artificial intelligence, and AI in electronic games, these theories and experimental evidence suggest limits of rationality for autonomous AI. Game designers have a wide variety of opportunities to explore other than rational behavior in both highly structured and free-form games.

Introduction
Operational gaming involves bringing decision makers or their surrogates with differing interests together in a simulation of a “real-world” contingency for the purpose of aiding decision making, planning, or policy formulation. It is useful in the development of strategy, campaigns/operations, and tactics. It affords “a practice field for the acquirement of skill and experience in the conduct or direction of” responses to the
contingency, “and an experimental or trial ground for the testing of” plans. Operational games seek to complete unknown information about the rules that players use in the game, how the context and the details of the contingency affect the play, and provide insights into likely outcomes from pursuing particular courses of action. Rather than a complete set of instructions for all possible courses of action, strategy in operational games involves accomplishing intended goals with available means. Though having origins in war games, operational gaming is used to address social contingencies such as pandemics, commercial decisions, and preparing strategies for all forms of competition and cooperation. The discussion below applies to more than gaming war, and therefore, this paper will use the more general term operational gaming.

“In order for a game to be successful, the players must enter, wholeheartedly, into the spirit of the play.”

In addressing rationality, we first need to dispense with cheats, triflers, and spoil-sports. A cheater pretends to be playing the game, but violates the rules to gain an advantage. A trifer recognizes the rules, but not the goals of the game. A spoil-sport ignores the spirit of the game by recognizing neither the goals or the rules, thus ‘shatters the play-world’ and robs play of its illusion. A premise is that the players are invested in the spirit of the game. Otherwise, they are playing a different game with a different basis for judging rationality.

Behaving rationally in playing golf is relatively straightforward in the context of pursuing self-interest, given that the player solely determines the outcome of each stroke. Play in games where the outcome of interactions between an offense and a defense, like basketball or baseball, also fits norms of rationality (subject to cheats, spoil-sports, and triflers) in that the game is zero-sum: a success for one side is a defeat for the other. However, few two-sided games in real life are zero sum, and going beyond two-sides creates a host of opportunities for coalitions and side-payments.

John von Neumann and Oscar Morgernstern developed game theory employing mathematical constructs believing that “the foundations of economics and of the main mechanisms of social organization – requires a thorough study of the “games of strategy”. The rules of the game include not only the move and information structure and the physical consequences of all decisions, but also the preference systems of all of the players.

Von Neumann and Morgenstern recognized that, “There is no point in using exact methods where there is no clarity in the concepts and issues to which they are applied.” Game theory is often criticized for the stringency of its formulation and artificiality of its economic assumptions. John von Neumann and Oskar Morgenstern’s theory required precise definition to admit computation. In requiring precision, they

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10 Ibid, 1.9.


14 von Neumann and Morgenstern. 4.
highlighted and structured Platonic ideals embodied in formal models of the clarity one would like to have as opposed to the shadows that we have to interpret. Nonetheless, the theory established an exceptionally useful framework for examining rationality and shortfalls in human ability to behave rationally. A bit of game theory highlights features that if changed result in an essentially different game (such as information conditions) and provides useful frameworks for those designing, conducting and analyzing games. Game theoretic solution concepts are based upon the players taking normatively rational action.

A game theory primer for gamers

Game theory provides an “elaborate mathematical development centered solely in the social sciences.” It begins with utility theory to provide an approach for quantifying the value of known, certain outcomes for each individual.16

Types of games

... I naturally said to him [von Neumann], since I am an enthusiastic chess player, “You mean, the theory of games like chess.” “No, no,” he said. “Chess is not a game. Chess is a well-defined form of computation. You may not be able to work out the answers, but in theory there must be a solution, a right procedure in any position. Now real games,” he said, “are not like that at all. Real life is not like that. Real life consists of bluffing, of little tactics of deception, of asking yourself what is the other man going to think I mean to do. And that is what games are about in my theory.”17

Reflecting their interest in economic and social coalitions from living through the turmoil of the 1930s in Europe, von Neumann and Morgenstern distinguished between “inessential” games in which coalitions and side-payments between partners play no role, and “essential” games where they do. Inessential games include two-person, zero-sum games where one person gains what the other loses, and two-person, non-zero-sum non-cooperative games where the sum of the outcomes for the players is not zero, making them not strictly competitive, and where mutual gain is always a possibility, but no pre-play communication between players is permitted. In repeated plays of the second type, observing the other player’s choices provides a means for signaling within the game, but no other messages may be sent.

Essential games include two-person cooperative games where pre-play messages are transmitted without distortion, all agreements are binding and enforceable by the rules of the game, and a player’s evaluations of the outcomes are not affected by the pre-play negotiations; and n-person games where going beyond two people allows for the formation of coalitions.18 Where assumptions about pre-play negotiations or other communications not affecting the evaluation of outcomes are too strong, one can revise the formulation of

16 Individual decision making where the probability distributions for alternative outcomes are known is characterized as risk and uncertainty where the probability distributions are unknown. Risk and uncertainty require extensions to von Neumann’s and Morgenstern’s utility theory. Ibid, 13.
18 Luce and Raiffa devote a chapter to each of these topics, along with critiques.
the game to explicitly include negotiations and communications, thought coding written and verbal language, expressions, and behavior are a challenge for any quantitative method.

**Information conditions**

The information that each player, and game controllers and umpires, have performs a determinative role in game theory to the point that changing the information conditions changes the game. The information conditions address what information is available to each player at every stage of the game, what is the role of a player being informed about the other player’s strategy, and about the entire theory of the game.\(^\text{19}\)

**Complete information:** To “divide the difficulties” of assuming otherwise, von Neumann and Morgenstern assumed that the subjects under consideration “are completely informed about the physical characteristics of the situation in which they operate and are able to perform all statistical, mathematical, etc. operations which this knowledge makes possible.”\(^\text{20}\) Incomplete information is where this assumption does not apply.

**Perfect information:** Where at every point of time during the play of a game each player with a decision to make knows all of the previous moves of the other players when making a move. Chess is an example of a game with perfect information.\(^\text{21}\) Simultaneous moves where previous moves are known provides ‘almost perfect’ information. Lacking perfect information, players need to randomize their decisions to achieve the best outcomes.\(^\text{22}\)

**Imperfect recall:** In games like Bridge players decide upon their bids not knowing the contents of their partner’s hand. Games involving teams representing a player may not know of moves other teammates have made or the information on which those moves were based. In games with imperfect recall, players may need to make a random choice of strategy at the beginning of play, so that the actions of their agents will be properly correlated. In games with perfect recall, randomizing decisions can be deferred until actual decision points are reached. Mixed strategies of this kind with on-the-spot randomizations are called ‘behavioral strategies’ in the literature, and are far easier to work with, both in theory and practice, than general mixed strategies.\(^\text{23}\) Imperfect recall leads to ‘direct signaling’ in Bridge as opposed to ‘inverted signaling,’ or bluffing, in Poker.\(^\text{24}\)

Game theory primarily treats exogenous uncertainty from random processes as ‘nature’s moves.’ For calculation, it treats the associated probabilities as known. Decision theories make greater distinctions between decisions under ‘risk’ where probabilities are known, and uncertainty where the probabilities are more subjective.\(^\text{25}\)

**Game-theoretic forms**

The theory provides for three forms to represent a game: extensive, strategic (or normal) form, and the characteristic function. The first level of application of game theoretic analysis is in the selection of which way to represent the game.

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\(^{19}\) von Neumann and Morgenstern. 47.

\(^{20}\) Ibid, 30.

\(^{21}\) Ibid, 51.

\(^{22}\) Ibid, 183-184 and Shubik. 1982, 37.

\(^{23}\) Shubik. 1982, 37-38.

\(^{24}\) von Neumann and Morgenstern. 54

\(^{25}\) See Luce and Raiffa.
Extensive form

Modeling games in extensive form captures the timing of the players’ moves relative to relevant events and representations of what the players knew about other's choices when they selected their move. Figure 1 illustrates two simple games in extensive form involving players Red (R) and Blue (B) making sequential moves in 1a, where Blue knows Red's choice when making its move, and “simultaneous” moves in 1b, where both sides select their move without knowing the other's choice.26 For simplicity, these games represent Red having three and Blue having two alternatives, one “branch” representing each alternative. A move involves choosing one of the possible alternatives.

A strategy in game theory means a complete description of how a player intends to play a game, from the beginning to the end. “The test of completeness of a strategy is whether it provides for all contingencies that can arise, so that a secretary or agent or programmed computer could play the game on behalf of the original player, without having to return for instructions.”27 In policy making and the military the term course of action (COA) represents following one path down the game tree. COA is used below to avoid confusion with other concepts of strategy.

The alternatives are numbered and the outcomes indicated with subscripts relating to the player’s choice of that alternative; e.g. O_{ij} indicates the outcome should Red select COA i and Blue select its COA j. The payoffs to Red and Blue are indicated similarly by R_{ij} and B_{ij} respectively. The payoffs are the value (utility) of the outcome to each player.28 Should the value of all outcomes be equal and opposite for Red and Blue (i.e. R_{ij} = - B_{ij} for all Red COAs i and Blue COAs j), the game would be zero-sum. In general, though some situations, such as winning or losing a duel, may be usefully modeled as a zero-sum game, the more considerations involved in the outcome, the less valuable modeling the game as zero-sum is likely to be.

Figure 1b also illustrates two ways for representing simultaneous moves, and the information available to players when they chose their next move. The bubble (ellipse) around the positions at which Blue selects its move indicates that Blue does not know which move Red has selected when it makes its choice. The set of points enclosed is called an information set.29 For simultaneous moves the information set consists of one point. The lower figure is an alternative representation of Blue with one information set that shows it is the equivalent of the players choosing simultaneously among their alternatives.

In a game with more than two players, the sequence of player alternatives and moves is represented adding to the detail above. Nature and game adjudicator (umpire) decisions are treated similarly to a player, representing their adjudications as moves in the game.

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26 Game theory assumes that each player knows the other the other players' possible courses of action and evaluation of outcomes, which rarely occurs in actual circumstances. Some work has been done on evaluating games with misperceptions. The analysis is challenging enough, and may be sufficient for the purposes of the model without going to this level. The purpose of the analysis determines the level of complexity required.
27 Shubik. 1982, 34.
28 von Neumann and Morgenstern includes a method for expressing the utility of an outcome to an individual player as a specific quantity. However, this method is difficult to employ, and is made conceptually and practically much more difficult when attempting to quantify a single utility for multiple players representing different organizations or groups of individuals.
29 Shubik. 1982, 42.
Figure 1: Games in extensive (tree) form

The positional form is a variant of the extensive form useful for reducing redundancy in the many games such as *Checkers, Chess* or *Go* where pieces can reach the same physical positions through various sequences of moves and the history of the game is not relevant to the play. A directed graph, network structure, allowing different lines of play to merge is one way to capture the moves in such a game. Since the positions of the pieces are used to evaluate future moves in machine learning and artificial intelligence, the positional form may save computations. This form resembles a flow diagram for a computer program. As with computers, loops can result in moves of infinite duration. Chance and simultaneous moves can be treated as before, but all nodes with multiple incoming edges are assumed to have the same information. Most positional games in the literature have perfect or almost perfect information. Also, players may make a different choice when re-arriving at a node, complicating the enumeration of strategies. “Stationary strategies’ are where the player uses selects the same alternative at each opportunity to move. In games like *Monopoly* arriving at a position leads to a ‘spot payment,’ which when summed up leads to ruin or survival. The chance events associated with the roll of dice make the game stochastic.30

**Strategic Form**

If the focus of the analysis is on strategy and payoffs, representing a game in strategic form may be more useful than the extensive form. A two-person game in strategic form (also called the normal form) is represented as a two-dimensional matrix. Each player represents a dimension, requiring games with three players to be drawn as cubes, and games with more than three players being even more challenging to illustrate. Figure 2 illustrates the same games as figure 1, but in strategic form.

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30 Adapted from Shubik. 1982, 48-57.
Figure 2: Game in strategic, or normal, form

Going to the strategic from the extensive form loses many details of the move sequence and information structure. However, the strategic form of these simple games shows the importance of intelligence of the other players move. Blue has many more COAs available when acting with knowledge of Red’s COA than without that knowledge. Here the strategies, or COAs, available to Blue going from the simultaneous to the sequential game go from selecting either COA 1 or 2 to selecting among eight along the lines of (1,1);(1,2);(1,3), which means Blue selects 1 if Red selects 1; Blue selects 2 if Red selects 1; Blue selects 3 if Red selects 1, etc. In general, the number of Blue’s strategies is the number of its alternatives raised to the power of number information sets at the point of choice. Transitioning from a multi-move game in extensive form to one in strategic form requires careful book keeping. Accounting for all of the combinations of possible COAs in games with many moves is daunting and produces very large matrices.

Characteristic Function

In considering cooperation among more than two players in his original work on game theory in 1928, Von Neumann formulated the notion of a characteristic function that assigns a value to every coalition that can be formed in a game. Table 1 illustrates such a game with three players. \( V(i) \) indicates the value that player i could achieve acting alone. \( V(ij) \) indicates the value that players i and j could achieve acting together in a coalition. \( V(123) \) indicates the value that all three players could receive if they all participated in a coalition. The characteristic function is a pre-solution, as matters of how the players should share the gains from a coalition require further analysis. This form leaves behind all questions of tactics, information, and physical

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transactions to deal with essential features of n-person problems. This form must be modified or abandoned when strategic questions cannot be separated from coalitional questions.\textsuperscript{32}

Table 1: Game in characteristic form

<table>
<thead>
<tr>
<th></th>
<th>V(1) = 1</th>
<th>V(2) = 1</th>
<th>V(3) = 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>V(12) = 4</td>
<td>V(13) = 4</td>
<td>V(23) = 7</td>
<td></td>
</tr>
<tr>
<td>V(123) = 11</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Solution concepts

In introducing their theory of games and economic behavior, von Neumann and Morgenstern devoted careful attention to their meaning of a solution concept.\textsuperscript{33} Game theoretic solution concepts involve mathematically complete principles of ‘rational behavior’ for the participants in a social economy to derive general characteristics of that behavior. To allow mathematical treatment, ‘rational behavior’ involves maximizing individual ‘utility,’ as formulated for the theory. The definition of a solution “must be precise and exhaustive in order to make a mathematical treatment possible. The construct must not be unduly complicated, so that the mathematical treatment can be brought beyond the mere formalism to the point where it yields complete numerical results. Similarity to reality is needed to make the operation significant. And this similarity must usually be restricted to a few traits deemed “essential” pro tempore – since otherwise the above requirements would conflict with each other.” Recognizing the difficulty of finding principles valid in all situations, von Neumann and Morgenstern sought to find solutions for some special cases.

The concept of a solution “is plausibly a set of rules for each participant which tell him how to behave in every situation that may conceivably arise.” These rules account for the irrational conduct on the part of others in the sense that irrational conduct produces less utility for that participant than rational behavior would have. Using utility, the solution summarizes how much the participant under consideration could get by behaving ‘rationally,’ recognizing that more could be obtained if other participants behaved irrationally.

Ideally, the game would lead to a solution that had just one set of payoffs.\textsuperscript{34} In his 1928 paper von Neumann proved that two-person, zero-sum games have a saddle-point where the minimizing the maximum (the minimax) that one player receives equals maximizing the minimum (the max-min) that the other player receives. Realizing this point may require randomizing between two strategies rather than adopting a single strategy. But this solution only occurs in two-person zero-sum games.

Moving on to two-person variable sum, then to more than two people (which allows cooperation against the third party – leads to multiple sets, and sets of sets, of feasible payoffs for each player.\textsuperscript{35} A dominant strategy is where one player can achieve their goals no matter what other players do presents an obvious choice. However, that rarely occurs. Nash equilibria, named after John Nash, where no player can improve their position given the other players’ choices is another common aspect of a solution, but multiple Nash equilibria

\textsuperscript{32} Shubik. 1982, 129.
\textsuperscript{33} von Neumann and Morgenstern. 31-45.
\textsuperscript{34} Economics calls the set of payoffs an imputation.
\textsuperscript{35} The mathematics of game theory involves set theory more than other forms of mathematics.
in a game are not uncommon.\textsuperscript{36} In general, though concepts for solutions to all types of games exist, as one moves from two-person, zero-sum games the possible solutions are not unique and additional rules for what constitutes a solution must be added, which limits the solution to cases where that set of rules applies.\textsuperscript{37}

To summarize, game theory solutions are mathematical constructs. Game theoretic solutions deduce the set of outcomes that are consistent with the embedded assumptions about individual and group behavior.\textsuperscript{38} “As long as the logic is sound, a solution cannot be wrong per se. However, a solution can be irrelevant in the sense that it fails to provide reasonable normative advice and is of little use in predicting behavior.”\textsuperscript{39} Game theorists understand that “multi-person games cannot be properly analyzed or solved until adequate information is provided about the social climate – in particular, about the possibilities for communication, compensation, commitment, and trust. Given this sociological information, one can proceed to the selection of a suitable solution concept.”\textsuperscript{40} An accurate criticism of game-theoretic solutions, as with other mathematical models, is that this may not be possible without far more detailed knowledge than is usually available, and then the solution applies only to the narrow set of conditions modeled, as those are the specific causes that determine the outcome.

**Classic 2x2 non-constant-sum games**

Because $2 \times 2$ games are relatively few in number and can be used to illustrate several of the paradoxes involving the relationship between individual isolated and interactive behavior, they are frequently used in experimentation.\textsuperscript{41} Some of the $2 \times 2$ games have been given names. Classic among these games are the prisoners’ dilemma, the battle of the sexes, and the game of chicken.

Prisoner’s dilemma is a game where two completely rational individuals might not cooperate, even though cooperation would produce a better outcome. The story that goes with the game is that two members of a criminal gang are arrested and imprisoned. The prisoners are separated with no means of communicating with the other. The prosecutors lack sufficient evidence to convict the pair on the principal charge, but they have enough to convict both on a lesser charge. Simultaneously the prosecutors offer each prisoner a bargain. Each prisoner is given the opportunity to either betray the other by testifying that the other committed the crime, or to cooperate with the other by remaining silent. The possible outcomes are:

- If R and B each betray the other, each of them serves two years in prison
- If R betrays B but B remains silent, R will be set free and B will serve three years in prison (and vice versa)
- If A and B both remain silent, both of them will serve only one year in prison (on the lesser charge)

In strategic form the matrix is as shown in table 2 with representative payoffs.

\textsuperscript{36} Formally, an equilibrium point is "a vector of strategies such that no one player, regarding the others as committed to their choices, can improve his lot." John Nash formulated this solution concept in his doctoral dissertation, so it is commonly called the Nash equilibrium. Shubik. 1982, 240.

\textsuperscript{37} Shubik. 1982, 365-366 provides useful table summarizing solutions and their characteristics.

\textsuperscript{38} Shubik. 1975, 91.

\textsuperscript{39} Ibid, 276.

\textsuperscript{40} Shubik. 1982, 24.

\textsuperscript{41} There are 78 strategically different 2x2 games with no ties in individual preferences. There are about $65 \times 10^9$ strategically different 3x3 games.
Table 2: Prisoner’s dilemma payoff matrix

<table>
<thead>
<tr>
<th>B remains silent</th>
<th>B betrays R</th>
</tr>
</thead>
<tbody>
<tr>
<td>R remains silent</td>
<td>-1, -1</td>
</tr>
<tr>
<td>R betrays B</td>
<td>0, -3</td>
</tr>
</tbody>
</table>

The game demonstrates where choosing what is individually rational provides other than what may be considered a socially rational outcome. The only non-cooperative equilibrium for the prisoner’s dilemma is for both to betray each other, since that is the least bad outcome given that neither knows what the other will do. The prisoners would be better off with cooperation.

In the battle of the sexes a man and a woman must agree on one of two possible activities (such as which movie to see) where their preferences differ. If they do not agree, they do neither activity, but are unhappy with each other. Table 3 shows a payoff matrix of the value to them for going to her movie, his movie, or disagreeing and not going out.

Table 3: Battle of the sexes payoff matrix

<table>
<thead>
<tr>
<th>Choose her movie</th>
<th>Choose his movie</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choose her movie</td>
<td>2, 1</td>
</tr>
<tr>
<td>Choose his movie</td>
<td>-1, -1</td>
</tr>
</tbody>
</table>

In the game of chicken two hot-rodders drive towards each other on a collision course. If they stay on course, they both crash. If one veers and the other stays on course the later “wins” and the former is the chicken. If both veer their mutual shame cancels out. Table 5 shows representative payoffs.

Table 4: Game of Chicken payoff matrix

<table>
<thead>
<tr>
<th>Stay on course</th>
<th>Veer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stay on course</td>
<td>-10, -10</td>
</tr>
<tr>
<td>Veer</td>
<td>-5, 5</td>
</tr>
</tbody>
</table>

Experimentation provides some insight into the relevance of various solution concepts. Game theory provides a theoretical framework for extending experimental psychology to interpersonal and social relations. The theory provides constructs that sharpen concepts of “conflict and co-operation, trust and suspicion, power of bargaining, balance of bargaining advantage, and equity ...” 

norms of behavior. “The game theory is extremely useful in setting up the game, but the running of the game is our means to explore behavior.”

Von Neumann began his explorations into game theory by illustrating a completely rational solution to a zero-sum game. Thus, from experimental data on zero-sum games one can draw conclusions about how the actual behavior of people departs from rationality in a completely competitive situation. However, “Even at the level of two-person zero-sum games context and professional training appear to be relevant.” An early PhD thesis of R. I. Simon (1967) utilized business school and military science majors playing a two-person, zero-sum game with three scenarios for the quantitatively same game. One scenario was based on business, one was military and one was abstract. Different results were obtained in all instances.” That said, “The pure strategy saddle point when it exists provides a reasonably good prediction of how people behave.”

An extensive literature exists on cooperation in repeated plays of the prisoner’s dilemma. Other experiments used different communication conditions (no communication, communication, reversible decision, and non-simultaneous decisions) and three orientations (cooperative emphasizing joint maximization, individualistic where each player was told to look out for himself, competitive where each player was made to feel that he played against the other). Results of the experimentation demonstrated the value of communication and performing a trusting act in achieving cooperation, though betrayal continued to occur in all communication conditions. Players’ orientations also significantly affected their choices, as did the presence of an “obnoxious” person present as an observer.

One set of experiments involved showing students the payoff matrices of the three classical games without descriptions of the choices and having them assign the three names to the matrices. There appears to be some support that “numbers tell a story” for the battle of the sexes but little for the prisoner’s dilemma or the game of chicken. After the students were told of the names of the games, they for the most part agreed that the names were “reasonable.” But the percentage of correct guesses indicated at best a fairly weak association. Experiments changing the name of the prisoner’s dilemma have produced different levels of cooperation and betrayal.

Interpersonal comparison

The three games above have symmetric payoffs for the players. Experiments routinely demonstrate that payoffs that are not symmetric, though strategically equivalent in having the same equilibrium point (such as multiplying one player’s payoffs by 100), affects choice as players compare their payoffs to others rather than choosing what strategy guarantees their best outcome. Choosing based upon the difference in payoffs changes a two-person, non-zero-sum game into zero-sum.

43 Shubik. 1975, 92.
44 Ibid, 245.
45 The earliest of these was a 1952 RAND paper on the Flood and Dresher experiment of 100 plays of the game; Poundstone. 1992, 106-116.
46 Rapoport. 218-222.
47 Shubik, Martin. 2001. The Uses of Teaching Games in Game Theory Classes and Some Experimental Games. COWLES FOUNDATION DISCUSSION PAPER NO. 1289, New Haven: Yale University, 10.
48 Ibid, 11.
Cooperative games and coalitions

Three-person nonconstant-sum games provide many ways to form coalitions and divide the proceeds of coalitions that are formed. The characteristic function describes the value of each possible coalition and feasible divisions of the proceeds. Game theory provides many possible solutions for dividing the proceeds, making these games a rich source for experimenting with the merit of the various solutions. In general, when the set of feasible divisions is large, players select a feasible solution. The smaller this set, the less often players select a feasible solution.49 Even given numbers for outcomes, most players cannot identify solutions that allow feasible compromises when the set of possibilities is too small, resulting in irrational outcomes.

Some Implications for game design, observation, and analysis

Game theory can be employed at high-church, low-church, and folk levels.50 High-church game theory is found in publications such as *Mathematics of Operations Research*. Low-church game theory employs simplified features of game theory to explore the logic of particular contingencies. Folk-level game theory is at the level of the narratives that go with these classic 2x2 non-constant-sum games that allow win-win and lose-lose solutions.

All three have had impact. But it is the third which has caught the imagination of the public. These classical games suggest that game designers, controllers, and analysts should employ folk-level game theory to address fundamental features of narrative used in the scenario framing the contingency under study. Is it a situation where trust is required to accomplish the best outcomes for the players? Is it a case where cooperation is required, recognizing that one party will accept the other obtaining a greater gain, or both will lose possible gains? Is it a situation where not losing means dying? One test of rational play is whether the players choose to accept worse outcomes rather than make the required compromises.

Of course, one must have the information to understand what the player considers a worse outcome. Many examples of individuals selecting other than ‘objectively’ rational behavior exist. One recent example is young Koreans choosing *shibal biyong* “fuck-it expense” as a means to vent their frustration with their future prospects, a trend that applies to other nation’s millennials.51

Contrasting Game Theory and Behavioral Theory

Game theory contrasts with and is complementary to the models employed in behavioral theories that deal directly with the shadows (table 5).52 Contrasting game theory and behavioral theory allows one to see the plethora of mechanisms that may lead to behavior in operational games that is not normatively rational.

*Table 5: Game and Behavioral Theories*

<table>
<thead>
<tr>
<th>Game Theory</th>
<th>Behavioral Theories</th>
</tr>
</thead>
</table>


52 Shubik. 1975, 156-180.
Rules of the game contrasted to laws and customs of society

Game theoretic solutions employ a homo-economicus who seeks to maximize individual payoffs, as measured by utility theory. Often this is interpreted as financial returns. However, one can as easily employ deontic logic concerned with obligation, permission, and societal norms as the measure of utility. Suicide bombers may rationally maximize their utility employing such logic. Not understanding the deontic logic of adversaries is one obvious reason for believing their behavior to be irrational. If cultural and institutional factors play a role, the game design must model them explicitly. Play inconsistent with cultural and institutional factors may be considered irrational. In the construction of operational games, following the game theory approach of explicitly modeling cultural and institutional factors is recommended.

External symmetry contrasted to individual detail: control and context

External symmetry refers to those features of players on the outside environment that are assumed to be the same to all. Thus, one could swap the players in the game without affecting outcomes. Internal symmetry refers to actual structures in the game model.

Like participants in structured experiments, often students, individuals playing in operational games “come equipped with social conditioning, language and memory of individual experience. When they come to an experiment [or operational game] their memories and conditioning cannot be wiped out.” In their work on game theory Shapley and Shubik suggested that the condition of “external symmetry” be made explicit in game models. This condition indicates that unless explicitly modeled otherwise, all aspects of the players are assumed to be the same. In fact, they never are. At best the designer can suggest that as a first order approximation the individuals are sufficiently similar.

When little in the way of context is provided, the influence of differences in wording instructions is magnified. The scenario and instructions to players will frame perceptions and judgments of players in games. Should the game designers believe that players are not behaving rationally given the objectives of the game, they should first look to the context they provided.

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53 Shubik. 1982, 16.
Details of the setting are essential in developing tact, discussed below.

**Socialization**

Game theory presumes that players tastes and beliefs are represented in the formalization of the game. Socialization addresses the extent to which nationality, family, and group loyalties of the players affect the play of the game. Game design and instructions to players should be clear about whether the players are to simulate a personality acting in their own self-interest, or the norms of an institution and provide them with guidance on those norms if the players are not familiar with them. The analysis should consider whether the play represents the sides as unitary rational actors, as merely following organizational processes whether or not they are applicable to the contingency, or are playing bureaucratic politics. The bureaucratic politics model often fits Title 10 games.

**Role Playing**

Game theory does not involve role playing. The operational game designer and producer is always confronted with having to find players that can represent the role that they are to play in the game. Ideally, to enhance the validity of the simulation, the participants in operational games will be either actual decision makers or their direct representatives, and subject matter experts where inviting players from competing institutions is not appropriate.

The role of the players in simulating specific individual or institutional decision makers can affect perceptions of rationality for acting in one’s self-interest. Differences in policies between different political parties demonstrate the large differences in what is considered to be self-interest. Where uncertainty regarding policies exists, including players with different perspectives on the same team can expose the implications of those policy differences. The game helps expose the extent to which competing policies are rational in the sense of accomplishing desired objectives.

**Goals of the Players**

“In a game theory model, the goals are assumed to be known and fixed. Furthermore, the motivations and involvement of the players are such that the goals are immutable and are pursued relentlessly. This must be contrasted with a behavioral world in which the goals are only partially defined at any time. They may become sharper in definition or possibly more vague.” Aspiration levels play a role. Just as the Chinese have had success in enforcing their claims in the South China Sea, success in pursuing goals has changed their levels of aspiration. Alternatively, challenges may expose the player to be more of a “satisficer” as conditions for satisfying self-interest are reduced.

In this regard, operational games may assist in clarifying issues and suitable, feasible, and acceptable goals; what constitutes rational action and a “win?”

**Personality and other personal characteristics**

Under external symmetry, game theory treats the players as rational, utilitarian, without quirks. If understanding players’ personalities is important to the game, running various personality tests before using players in the game would add much rigor. The experimental gaming discussed earlier demonstrates that

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54 For a description of these models see Allison, Graham T. 1971. *Essence of Decision: Explaining the Cuban Missile Crisis*. Boston : Little, Brown, and Company.

personalities and personal objectives affect the play of the game. Some players are willing to ‘pay to play’ in the sense of being recognized for their play is more important than the stated goals of the game.

**Intelligence**

The role of intelligence in the sense of knowing other players’ courses of action was commented upon earlier. Here, the issue is that game theory treats players as having essentially limitless and costless computational ability. The player’s memory is unbounded and faultless. In operational games, control should be cognizant of limitations of the players, particularly if the game moves are complicated in the sense of many decisions, and complex in the sense of many interactions. Games can be valuable for identifying individuals who have talent and a sense of coup d’œil as candidates for positions of greater responsibility.

**Learning**

In game theory, the game is fully specified for the purpose of analysis. Thus, any learning that occurs must be modeled in the game. John Harsanyi and others worked on games with incomplete information where players learned from playing the game. Harsanyi employed “Bayesian” players whose beliefs about the play of others updated as the game proceeded.\(^{56}\) Adding subjective probabilities to the game further complicated game analysis, presenting enormous difficulties in identifying relevant rational solutions to real problems. However, it was a step toward a dynamic theory of games.

Operational games are also exceedingly valuable in helping to understand the structure of wicked problems and enhancing logical tact and military talent through recognition primed decision making. Among other features, how one addresses wicked problems depends on how one frames the problem, and solving the current situation just sets up the next phase of the problem.\(^{57}\) Permanent ‘solutions’ do not exist to situations involving armed conflict or sustained competition.

Tact implies touch, the most powerful of human senses. Tactics imply contact. Carl von Clausewitz picked up on Immanuel Kant’s notion of logical tact, contrasting people using common sense as opposed to “people of science” using conscious reasoning. The later are capable of conceiving of rules in the abstract before their application, and the former are skilled in the application of rules in concrete settings.

> For Kant concrete settings activate within the obscurity of the mind what he calls “logical tact,” with which “reflection presents the object from numerous different sides and produces a correct result, without being conscious of the acts that are going on inside the mind [Gemüt] during the process.” Directed immediately toward the object, tact, or logical tact, is an operative function that takes multiple points of view on the sensory input, weighs them against each other, and offers a single result. While decision appears to emerge spontaneously, it is in fact the product of a mass of subconscious judgments. Due to its orientation directly toward the object and due to the hard work of the subconscious, logical tact, for Kant, is a superior means of reasoning in empirico-practical

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Kant illustrates the non-conscious mind by imagining “an organist who is improvising a fantasia with all ten fingers and both feet, while, at the same time, he is carrying on a conversation with someone standing next to him. In such a situation the piece will often be of such high quality that the organist would wish he had been able to write it down in notational form. Yet, Kant continues, if he had attempted to sit down at his desk with a quill in his hand, he would have been unable to write down anything of the quality of the fantasias he could perform when improvising at the organ.”

Developing such skill requires practice. Judgment involved in logical tact comes from experience of trial and success, the repeated interaction of conscious mind with the empirical world. “A correct understanding, a trained judgment, and thorough reason constitute the entire range of intellectual cognition: especially if it is also judged as a skill for promotion of the practical, i.e. for the promotion of purposes.”

Kant regards the “ability to look to the future as the necessary condition for all praxis and all human endeavors.” He defines this empirical ability as “the expectation of similar cases.” This foresight allows enables the planning of future actions with a high degree of accuracy. “It does not, however, involve any rational consideration of cause and effect, “only the recollection of observed events as they usually follow on after the another, and repeated experience produces a skill in this regard.” This skill works for stable phenomena, but logical tact is required to deal with greater complexity.

General Gerhard Johann David von Scharnhorst was a Prussian general who established the Prussian Militarakademie and its approach to military science in the early nineteenth century. He is credited with developing the modern general staff system. A follower of Kant’s work on epistemology, Scharnhorst believed in the power of intuition and his duty to develop it through education.

Carl von Clausewitz was a student of Scharnhorst and a colleague in battle. Kant’s influence on Clausewitz even greater than on Scharnhorst. Clausewitz follows Kant in distinguishing between two kinds of decision making: “rational deliberation or “critical judgement” and subconscious, seemingly spontaneous judgment.”

Here the activity of the understanding leaves the field of rigorous science, i.e. logic and mathematics, and becomes, in the larger sense of the word, an art, i.e the ability to find in a confused mass of elements and relations the ones that are most important and essential.

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59 Ibid, 72.
60 Kant quoted in Engberg-Pedersen, 73.
61 Engberg-Pedersen, 74.
62 Kant quoted in Engberg-Pedersen, 74.
63 Ibid.
For Clausewitz, “the tact of judgment is a fast subconscious operation of the mind that with lightning speed sorts through a field of infinitely small and manifold objects and quickly dismisses the unimportant noise. For Clausewitz, tact is first and foremost a faculty that makes heuristic decisions that are immediately transformed into effective action in a concrete situation.”\textsuperscript{66} The commander’s ability to include obscure representations rapidly allows solving problems that exceed the capabilities of the conscious mind. For Clausewitz, logical tact is an essential skill to manage the state of war.

So, how does one develop logical tact? For Clausewitz, experience in war was most effective. Absent that, the history of warfare provided useful insights. However, both Scharnhorst and Clausewitz were critical of how military histories generally glossed over mistakes and difficulties faced by the commander. Clausewitz, in debunking von Bülow’s and Jomini’s concepts of fixed rules of war based upon geometry emphasized factors that fog, friction, chance, and the dominant role of moral factors in war. To understand these, one needed to study concrete historical situations and all documents from the conduct of campaigns that one could obtain to look at the scenario from as many perspectives as possible.\textsuperscript{67}

Augmenting the study of previous battles and campaigns were staff rides where officers could explore the terrain and imagine ranges of possibilities of what might have happened.

Clausewitz criticized parade drill and staged exercises that did not incorporate the friction, fog, and fatigue of actual operations and expose troops to danger. Only war could provide the full realism, but the closer exercises with troops could simulate these features, the more valuable they would be.

And then were mental exercises not in the field involving the study of maps to formulate and rehearse concepts for future operations and games played upon those maps.

Games
The games of the late eighteenth century imitated rigid formations and formalized tactics of the era.

\textit{During the late half of the eighteenth century there developed in Prussia an increasing emphasis on warfare as an exact science – as a branch of mathematics resembling geometry. ... This gave rise to what was called the “vogue of military mathematics.” It was axiomatic that above all a military leader must be a great calculator. ... Von der Goltz [considered an outstanding general of the 19th century] said of this period:}

\textit{... a true strategist of that epoch did not know how to lead a corporal’s guard across a ditch without a table of logarithms. ... Battles were no longer fought from motives of}

\textsuperscript{67} Engberg-Pedersen.78.
\textsuperscript{68} Ibid, 136-140.
patriotism, but for art’s sake, and it was deemed preferable to forego victory that to achieve it by unscientific methods.

It was inevitable that the games created during this period tended to reflect the mathematical thinking and theories of warfare then prevalent.\(^\text{69}\)

The mathematician and natural scientist Johann Christian Ludwig Helwig’s in 1870 published a game with the title *Versuch eines aufs Schachspiel gebaueten taktischen Spiels von zwey udn mehreren Personen zu spielen* (Attempt at a Tactic Game Based on Chess to Be Played by Two or More Persons). He published a second edition in 1803. His was the first game to have pieces representing aggregations of men, use terrain features, and employ umpires to determine the outcome of combat.\(^\text{70}\) The game was essentially an extension of chess expanding the board from 64 to 1,617 squares and retaining rules based upon concepts of fixed, geometrical rules of war which the game was to make visually manifest.\(^\text{71}\) Numerous rules made the game difficult to play. The purposes of the game were both for entertainment and to teach the rules which he believed to be “truths of the art of war,” which led to a list of rules, “whose truth is confirmed by the game.”\(^\text{72}\)

The engineer officer and military writer Georg Venturini in his *Beschreibung und Regeln eines neuen Krieges-Spiels, zum Nutzen und Vergnügen, besonders ame zum Gebrauch in Militair-Schulen* (Description and Rules of a New War Game for Usefulness and Enjoyment, but Particularly for Use in Military Schools, sought “to teach young soldiers the often difficult doctrines of the art of war as though through experience.”\(^\text{73}\) His 1798 game was also and a chess-like board, but the first to employ particular terrain, the Franco-Belgian border, on the game board. He also stressed logistic calculations in the game rules. Rather than teaching known rules, Venturini intended players “to get an overview of the connections, the causes and effects of the great events of war in a single glance, and through the experience on the small scale [im kleinen] to derive the possible consequences of the first causes of also on the great scene of the world.”\(^\text{74}\) Attempting to offer a realistic simulation of the state of war around 1800 resulted in large sets of rules that made these games difficult to play.

The primary function of simulation to Clausewitz was to educate the tact of judgment that made “the discovery of truth, i.e., the correct judgment, almost into a habit.” He saw the invention of such games “as a further degeneration of the ill-conceived notion that the art of war is a calculation of maneuvers, as in a game of chess.”\(^\text{75}\) Emphasizing the differences between Kant’s theoretical and practical reason, calculations made at a desk contributed to correct judgement, but the skill of a commander is measured in logical tact. He and his colleagues saw little value chess-like games that sought to teach formal rules as opposed to develop the coup d’oeil that comes with military genius; the mental eye that allows commanders to make correct judgments subconsciously in situ as contingencies arise. As with structured field exercises, games


\(^{71}\) Engberg-Pedersen. 124.

\(^{72}\) Ibid, 123.

\(^{73}\) Ibid, 124.

\(^{74}\) Ibid, 125.

\(^{75}\) Ibid, 140-141.
needed to address chance, fog, and friction and engage the emotions of officers if they were to be effective in developing the tact of judgment needed on the battlefield.

A public servant in Bohemia, Johann Ferdinand Opiz, was the first to design a game employing chance in the outcome of actions; Das Opiz'sche Kriegsspiel, ein Beitrag zur Bildung künftiger und zur Unterhaltung selbst der erfahrensten Taktiter (The Opiz War Game, a contribution to the Bildung [self-cultivation] of Future Tacticians dan to the Entertainment of Even the Most Experienced Tacticians). His son published the game in 1806 following the death of his father. A young officer in the Austrian Army, Baron Frelich, with whom Opiz had often played the game in encouraging its publication first lauded the realistic depiction of the terrain:

*What a difference! What incomparably more important, far superior advantage compared to chess!*—which admittedly practices the mind immensely in reflection, but in no way teaches the soldier the various and often mind-boggling impediments in an operation.*

He then turned to its simulation of chance, capturing the concept of friction that Clausewitz was beginning to develop at this time:

*What gives your game the greatest resemblance to a war operation is this: that the result of the players’ dispositions does not always turn out according to their will, but often according to the less advantageous chance of the roll of the dice.—This singular feature of your game is a first-rate original thought, which lends your game a certain degree of perfection in a really useful way.—For this is how it is in real war. The dispositions of even the most experienced and daring commander are not always carried out to the letter, rather the effects of mutual fire and thousand other chance occurrences often impact the dispositions and lead to a wrong or even disastrous result.*

Beyond impact of firepower, Opiz’s game addressed the capture of prisoners, desertion, and the success or failure to advance in mountainous terrain. If one force’s artillery attacked the opponent’s forces led by the commanding general, a sum of two on the dice meant that the general was wounded and twelve that he was killed. If the attack was carried out by infantry, an even sum killed the general while an uneven sum left him wounded.

Frelich goes on to describe a game where the sudden realization of an improbable event transformed the battle. He goes on to comment on how the difficulties that he found in the game reminded him of actual events during his recent campaign in Italy. He recommends that military academies purchase the game because it allows military instructors “to make the theoretical lectures on basic principles, rules and elements of comprehensible to the students in that it shows and proves everything to them as if *it had been performed in praxis and presented to the senses.*”

Opiz anticipated “Black Swans” in making the improbability of an event inversely proportional to the vastness of its effects. Frelich in capturing *theoretical reason transcending into practical reason* noted:

*Since in the game you cannot always put your faith in your experience and fearlessness, but must leave your dispositions to chance, you also learn the perniciousness of the ever-

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76 Ibid, 128.  
77 Ibid, 131.
changing, unpredictable fortunes of war, you become more cautious in your dispositions, you calculate every possible movement, and slowly with good books readily at hand, you play your way effortlessly (spielend) [in the process of playing] into somewhat of a tactician, who with time not only learns to comprehend more easily the episodes and events of the vast scene of Mars,—but who can also prepare small operations himself.—I assure you that many ideas that would otherwise have appeared obscure, became clear to me on your board.  

In describing his caution, Frelich describes his discovery of maximizing the minimum in a zero-sum game, a technique employed by machine learning to avoid catastrophes given incomplete information.

Contingency and probability were emerging as new paradigms of war. “More than a theoretical aid that visualizes concepts, the game offers practical training in contingency, so that players learn to comprehend the state of war better and to act in it more effectively. … Read backward from the material objects themselves to the ideas they manifest, the games constitute a material history of intellectual perception of war.”

In 1811, Baron George Leopold von Reisswitz, filling a position as a War Councilor at the Court of Breslau in Prussia to address tactical questions following the departure of Carl von Clausewitz, developed a game that would spare future officers the need to conduct tactical rides to the scenes of recent battles because the war game “could conjure” the battles “into his room,” along with, “the remaining, eternally memorable battle theaters of Silesia, in order to maneuver variously with … figures on them.” The history of the success of the Baron’s game with the royal family and his son Georg Heinrich Rudolf Johann von Reisswitz success with Chief of General Staff General Karl von Müffling in establishing war games in the German and other militaries is well recorded elsewhere and will not be repeated here. However, war games were always but one epistemological method in a broader campaign of learning.

Campaign of Learning
As has been suggested, operational games have a history of exposing wishful thinking leading to more realistic goals and courses of action for obtaining them. They are exceedingly valuable in a campaign of learning involving study of the details of contingencies of interest, modeling and analysis, games, and introducing prototype concepts and technology into fleet and field exercises and operational experiments.

Understanding the practicality and limitations of the epistemology of each theoretical and practical method led Scharnhorst, his followers, and successors to employ a campaign learning, illustrated in figure 3 described by Ferrand Sayre in 1910.

78 Ibid, 131.
79 Ibid, 132.
Coding
Coding involves specifying relationships and data for calculation. Interpreting semantics and words, and ensuring that the words are as good as the deed present coding problems not only in game theory and gaming, but more generally in any mathematical treatment of politics, international affairs, negotiation, war, and social sciences in general. “Much of the confusion and misapplication of game theory has been caused by the failure to perceive that the formal theory of games makes no claims to having solved the critical problem of how to represent verbal acts as moves.”

Militaries create and train to rigid procedures for written and verbal orders to turn words into action. Game theory highlights these coding challenges. Coding human behavior into combat models is opaque, if explicit at all.

Primarily Dynamic
Sun Tzu remarked noted that “speed is the essence of war,” and Carl von Clausewitz commented on the major psychological effect of speed that would help provide secrecy as well. However, in game theory and other mathematical treatments the players have all of the time that they need to consider alternatives and calculate probabilities. Von Neumann and Morgenstern understood the limitations and challenges in making the theory dynamic: “We repeat most emphatically that our theory is thoroughly static. A dynamic theory would unquestionably be more complete and therefore preferable. But there is ample evidence from other branches of science that it is futile to try to build one as long as the static side is not thoroughly

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82 Shubik. 1975, 15.
84 von Clausewitz. 198.
understood.” Von Neumann went on to address dynamism in his work on neural networks and computers that could replicate themselves. This led to a major branch of artificial intelligence research and development, and anticipated the discovery of the workings of DNA and RNA in organic cell reproduction. Dealing with the timing of actions in operational games helps one understand both the importance of move sequences and challenges of representing them in models and simulations.

Is Joint Planning Doctrine Rational?

The doctrinal Joint Planning Process recognizes the wicked nature of military operations in calling for “operational design” to provide “an iterative process that enables the commander’s vision and mastery of operational art to help planners answer ends—ways—means—risk questions and appropriately structure campaigns and operations in a dynamic OE [operational environment].” John Schmitt, a college professor and Marine Corps Reserve officer, contributed to joint planning doctrine adopting operational design in the 2006 version of Joint Publication 5-0 as part of mission analysis to “understand the problem and the purpose of the operation and issue appropriate guidance to drive the rest of the planning process,” and course of action development.

Doctrinally, war gaming is a principal method for assessing alternative Courses of Action (COAs) in the Joint Planning Process (JPP). This step in the Joint Planning Process follows the decision to initiate a plan, mission.

Schmitt and Kline have documented that commanders and their staffs rarely have the time (or interest) in gaming multiple adversary COAs in the preparation of any single contingency plan even when conducting deliberate planning, and in actual crises often have time only to rehearse their concepts mentally. The authors’ experience at a combatant command is that higher authority prescribes the main planning scenario, and the staffs involved in planning for large contingencies have time to explore only a few variations of the many prescribed planning assumptions.

Joint doctrine notes that, “some JPP steps or tasks may be performed concurrently, truncated, or modified as necessary, depending upon the situation, subject, or time constraints of the planning effort.” However, it cites as example the difference between contingency and force planning. Based on the time available, it calls for staffs to prepare alternative COAs for the adversary’s most likely and most dangerous potential COAs, along with a set of criteria for assessing those COAs. Knowing what the adversary could do to achieve its objectives, and which is “most dangerous” is often difficult to discern before conducting games, as the

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85 von Neumann and Morgenstern. 44.
88 Joint Chiefs of Staff. 2020. III-45.
90 Deliberate planning is the planning in anticipation of a potential future contingency and distinguished from the Crisis Action Planning that occurs when actually facing a contingency.
91 Joint Chiefs of Staff. 2020. III-11.
92 Ibid, III-23, 32, 45, 52.
adversary must consider difficult tradeoffs often not apparent without more careful analysis from its perspective.

Rather than tasking staffs to come up with multiple COAs, Ross, Klein, et. al. (2004) recommend a Recognitional Planning Model (RPM) as a more natural and faster way to arrive at adequate, feasible, acceptable, distinguishable and complete courses of action. A major distinction between the traditional Military Decision Making Process (used by the U.S. Army and Marine Corps) and the Commander’s Estimate process (used by the Navy) is that the commander provides the initial COA for analysis, rather than the staff generating alternatives for the commander to consider. Also, alternative COAs, if needed, are derived in overcoming problems discovered when assessing the initial COA, rather than arbitrarily creating multiple COAs. The analysis shows that “the commander’s knowledge, training, and experience generally help in correctly assessing a situation and developing and mentally war gaming a plausible COA, rather than taking time to deliberately and methodically contrast it with alternatives using a common set of abstract evaluation dimensions.” The RPM process also involves fewer steps and in evaluations has reduced planning times by 20-30 percent with no apparent loss in effectiveness of the resulting plan. Recent doctrinal publications are adopting some aspects of the RPM process.

A key feature of both the doctrinal and RPM processes is the importance of who participates in the war gaming. Earlier versions of Joint Pub 5-0 stated that ideally, “the individuals who were deeply involved in the development of the COAs” should participate in gaming. More recent versions are less explicit. Where those involved in the planning and operations are not participants in the gaming, some means for efficiently transferring the experience derived by the gamers to the planners and commanders is needed. Joint Pub 5-0 dropped the distinction between deliberate and crisis action planning beginning with the 2017 version. As Clausewitz noted: a person who reasons well in front of his desk is completely lost if the same method of reasoning is transferred to the battlefield. The commander and staff that attempt to employ theoretical reasoning in situations where time does not permit, and have not developed trained their practical judgment to arrive at a correct appreciation of an ongoing battle intuitively are in danger. They will lose the initiative to a force that can take correct actions more quickly. Working through contingencies in detail using gaming before facing the actual situation primes the judgment to make correct decisions. However, suggesting that gaming alternative COAs has a place in time-sensitive situations is mistaken.

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94 Ibid, 6.
95 For example, see TRADOC Pamphlet 525-5-500, The U.S. Army Commander’s Appreciation and Campaign Design. Version 1.0, 28 January 2008 and the discussion of operational design in JP 5-0, Chapter IV.
97 Engberg-Pedersen. 80.
Beyond Game Theory
Game theory represents the epitome of Kant’s theoretical reason. “Rational choice theory” reaches its fullest development in game theory.”

Given the limitations of game theoretic solutions and the absence of dynamism, Thomas Schelling and Nigel Howard pursued extensions.

Tacit Communications
Recognizing the limitations of the assumptions of game theory and focused on situations involving mixed motivations for competition and cooperation, Thomas Schelling sought to extend game theory into a theory of interdependent decision. He experimented with situations where the players had common or differing interests, and where they could not communicate or could explicitly bargain. He found that even without communication people could “often concert their intentions or expectations with others if each knew the other was trying to do the same.” Schelling concluded that in situations where collaboration is advantageous, even where conflict of interest is also present but where direct bargaining is impossible, tacit agreements will take place, provided the two parties can seize on some prominent, preferably unique feature of the situation, which one has reason to believe the other will also seize upon. Also, significantly, the impossibility of explicit bargaining precludes quantitative compromises, typical of the results of haggling. Even with explicit bargaining, the ‘solutions’ that people arrive at involve some special feature of the situation, such as status quo ante. Rather than a continuous range of possibilities from most to least advantageous for either side, people are better able to recognize qualitative rather than quantitative differences that are lumpy and discrete.

Using game theory, repeating a 2 x 2 game once produces an 8 x 8 matrix of strategies. The size of the matrix grows dramatically with each repetition of play. Providing the players with a large matrix of strategies to decide on their course of action is not the same as having them repeatedly play the game, where their play provides a form of tacit communication.

Recent research shows that human’s ability to detect patterns stems in part from the brain’s goal to represent things in the simplest way possible, balancing accuracy with simplicity when making decisions. Errors in making sense of patterns are essential to getting a glimpse of the bigger picture, as when looking closely at a pointillist painting, and then stepping back to get a sense of the overall structure. This theme of balancing the level of detail to arrive at an appropriate scale for identifying patterns is a common theme in language, play, gaming, mathematics, and studying emergence in complex adaptive systems.

Confrontation Analysis
To get beyond game theory’s treatment of rationality as “pursuing fixed, given preferences within a fixed given frame,” Nigel Howard studied what he called “move theory” and “drama theory” that allowed for

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100 Ibid, 57.
101 The repeated Prisoner’s dilemma has multiple equilibrium points, all of which are rational solutions. Shubik. 1982, 259.
changes in attitudes, beliefs and objectives to take place within the game. Working with colleagues and the British Army, led to the development of Confrontation Analysis and its application to operations other than war.\textsuperscript{103}

Howard recognized that both games and drama involve role-playing and leisure activities that illuminate life. He chose the word drama to emphasize the dynamic nature of his theory allowing the players to change their value systems and their views of reality. Also, the ‘characters’ are emotional and irrational while participating in rational debate. They attempt to change each other’s preferences and behavior, and alter the rules of the game as it proceeds. The characters common assumptions about what is possible changes. Where games end with a victor and a loser, “drama ends when none of the characters has anything left to hope for or to fear.”\textsuperscript{104}

Howard focuses on equilibria notions from game theory. The end of a drama is characterized by a stability of expectations, which may be represented either by happy or tragic endings. “A tragic ending is stable because the characters’ fears have been realized and hopes destroyed; a happy ending is stable because character’s hopes are realized and fears banished. In either case, they have neither hopes or fears.”\textsuperscript{105}

Howard focused on mixed-motive situations, similar to Schelling, involving peace support and what we now call gray zone confrontations (e.g. South China Sea). The role of a commander in winning a confrontation in the sense of getting his position genuinely accepted involves driving the characters to change their positions, to “direct and orchestrate” these tendencies until a full resolution is reached. “The important thing about the collocation of reason and evidence is not that it is impartial or disinterested – in the sense of having nothing to prove. That is not the case. Its importance is that, if effectively presented, it compels belief in what it aims to prove.” The parties involved “need to be brought into a state of contentment with a future that consists of fulfillment of the commander’s mission. They may, of course, be in various states of discontent and conflict regard to other matters, particularly details.”\textsuperscript{106} The aim is to bring a broad degree of peace and order, not to settle every issue.

Drama theory needs game theory. Should negotiations, through words or acts, fail, communications cease, and positions become set, game theory again prevails. Also, drama theory uses the dilemmas produced by game theory to analyze, predict, and understand the pressures on characters to change their positions, preferences, and common reference frame. The logical derivation of drama theory shows how:

- \textit{Initially we suppose that characters see their common reference frame as fixed, and hence see themselves in a game. This is because they have assumed this frame for purposes of communication and for the time being, cease to question it.}

- \textit{As the characters see themselves in a game, they try to behave rationally in the game-theoretic sense. This brings them up against game theoretic dilemmas.}


\textsuperscript{104} Howard. 68.

\textsuperscript{105} Ibid.

\textsuperscript{106} Ibid.
● The dilemmas then cause the characters to feel positive and negative emotions. The emotions felt depend on the dilemmas the characters face and the ways to deal with them.

● Emotions may cause them to behave irrationally (i.e. not optimally), change their preferences, or search for new cards [means] to play or new characters to introduce. By these means, dilemmas may be eliminated.

● As an alternative, the characters may solve their dilemmas by changing their positions.

● A general alternative to these methods of dilemma-elimination is deception. Instead of becoming irrational or changing preferences, cards, or positions, characters may pretend to do so. Note that deceitful persuasion changes the common reference frame just as much as non-deceitful persuasion.

● What makes deceit attractive for one character creates disbelief in another. Such disbelief must be overcome to effect desired change in the common reference frame. To overcome it, characters construct logical arguments, show evidence, and appeal to generally accepted standards.

● Characters’ arguments cannot be value-free; to make sense, arguments generally must assume pursuit of some common interests or objectives. If objectives are not shared, arguments based upon them will seem insincere or unappealing. Characters are thus led to construct rational arguments in the common interest.

● Successful arguments of this kind have the effect of building up the preferences and attitudes of a supercharacter formed by an alliance of the characters. Individual characters’ preferences do not become the same as the supercharacter’s, but become such that solving subcharacter confrontations becomes a mechanism causing the supercharacter to function as a character.

● The supercharacter generally will be a character in a larger dilemma, in which it too tries to behave rationally and so confronts dilemmas.

Starting from the assumption that characters try to be rational within a fixed frame, drama theory sows how they are led to behave irrationally and change the frame, so creating the possibility of rational behavior at a higher level. This is the deep sense in which drama theory depends on game theory.  

Howard goes on to identify a set of dilemmas that must be addressed to arrive at a stable solution. The Confrontation Analysis Handbook lists these as Persuasion, Trust, Co-Operation, Threat, and Rejection Dilemmas.  

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107 Ibid, 70-72.
Figure 4 illustrates the six phases of Confrontation Analysis. The game begins by identifying the principal parties (characters) involved and identifying the actions that the players are currently taking to set the scene. Each character then expresses its position by supporting, rejecting, or expressing indifference to each of the other character’s actions. The characters then state their intentions if nothing changes, allowing for proposals to change behavior should others change. This begins to identify dilemmas to be addressed. The characters then express doubts over whether other characters are willing or able to follow through on their stated intentions, identifying more dilemmas. A software routine may be used to identify the dilemmas. This completes the build up for a move. Each team then explores ways to address the dilemmas identified and proposed new actions for the next move. The game continues until dilemmas are resolved or confrontation turns into conflict.

Figure 4: The six phases of Confrontation Analysis

To learn the technique by teaching it, Stephen Downes-Martin, Bob Klein (a skilled teacher with no game experience), and I taught a six-session, 90-minute course at the Osher Life-Long Learning Institute at the University of Rhode Island for interested senior citizens. One student was a former diplomat, others had led commercial enterprises, and several were interested citizens with no subject matter experience. None were experienced gamers. The subject chosen for teaching the technique was what next following the U.S. dropping out of the Joint Comprehensive Plan of Action for Iran’s nuclear program. The students formed teams for the U.S., Israel, Iran, and Europe. The instructors played China and Russia. Figure 5 illustrates the initial build-up for the first move. Following four, very credible, moves by the participants, they chose to look at offshore wind farms as another illustration of the technique – to illustrate its possibilities for domestic confrontations on all scales. The student teams spent many hours outside of the course working on their actions for their next move and strongly requested similar courses in the future. They learned how difficult confrontation resolution can be and to appreciate possible consequences should conflict occur. The technique demonstrated its pedagogical value for employing theoretical reason to sharpen the intuition.
When is artificial intelligence rational?

Games and game theory have provided a basis for both developing artificial intelligence, and the use of artificial intelligence in computer games.

Continuing his work in set theory, von Neumann’s development of game theory followed Ernest Zermelo, Emile Borel, and others’ efforts seeking mathematical approaches for determining a method of play better than all others in chess and other games without any reference to psychology. Computer advances and Alan Turing’s writings on “thinking machines” led to a conference at Dartmouth College in 1956 where the term artificial intelligence (AI) was coined. One prominent view defines artificial intelligence as “the study and construction of rational agents,” thus establishing the connection to game theory when multiple agents are involved. Early work on AI explored neural nets and machine learning. By 1959, Arthur Samuel had developed a machine that could beat him at checkers using game theory and clever techniques. As the speed of computations has increased, computers have been used to experiment on better ways of playing games.

Working on the Defense Calculator in 1952, John Holland and his colleague Arthur Samuel found that the computer opened possibilities for exploring models far beyond what could be done with pencil, paper, and an adding machine. They aimed to write programs that could learn as their calculations explored

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112 This account is from Holland.
alternatives, that would allow them to tell the computer what to do without telling it how to do it. Holland attacked the problem through the metaphor of neural nets while Samuel developed a technique he named Machine Learning. Following the work of von Neuman and others on chess, they chose to look at board games; in this case *Checkers*.

Rather than following the neural net approach of trying to understand how humans make decisions, Samuel chose to focus on winning strategies. The novelty of his approach was in identifying and assigning weights to features of the game (e.g. pieces ahead, kings, penetration), anticipating the opponent’s moves, looking ahead several moves to adjust the weights assigned to match a future state of the game, and work towards a minimax outcome, minimizing the maximum damage that the opponent can inflict. Bootstrapping by having the checkers player play against itself was an additional technique. By 1959 he had produced a program that could beat him at checkers. Though computational capacities and speeds have increased geometrically consistent with Moore’s Law, Samuel’s technique provides the foundations for current Machine Learning.

Computer competitions have determined better schemes for playing an iterated *Prisoner’s dilemma* and test ideas for teamwork in general agent systems. BUILDING ON THE SUCCESS OF IBM’S Deep Blue, programs on commercial software now can defeat even the most talented human chess players. Recently, Google’s AlphaZero has outperformed both humans and other programs in playing the games of *Go, Chess, and Shogi* (a Japanese form of chess) as efforts to apply machine learning to a broader range of subjects have accelerated. Unlike previous prototypes like AlphaGo, the program iterates using the rules of the game rather than attempting to mimic natural, human game play. However, changing the rules mid-game flummoxes the program.

To address games where no best strategy exists, such as *rock-paper-scissors*, imperfect information, actions that pay off only after many moves, continuous play rather than alternate turns, and a large action space, AlphaStar took on the challenge of playing StarCraft II. Beginning with strategies derived from human play and using a set of reinforcement learning, Long-Short Term Memory and other techniques, AlphaStar was able to defeat top human players. Like Samuel’s checkers player, AlphaStar discards risky strategies to find approaches that are least likely to go wrong, thus improving the safety and robustness of AI systems. The final AlphaStar agent employs a Nash distribution of the most effective mixture of strategies discovered. The intent is to apply these techniques to the “fundamental problem of making complex predictions over very long sequences of data appears in many real-world challenges, such as weather prediction, climate modelling, language understanding and more.”

Though AlphaStar has outperformed some of the best StarCraft II players, AI has had major successes in “inessential” games, while making some progress on games that have some of the features of “essential” games. AI is enjoying a third wave of enthusiasm after having had successes in the 1950s and a resurgence in the 1980s. Many are skeptical over whether it can

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move beyond “narrow” AI for well-specified problems to more general AI for more wicked, complex problems.116

Multi-agent artificial intelligence (AI) systems, imitation and reinforcement learning, and adversary training in Generative Adversarial Networks (GANs) compute minimax solutions for zero-sum games and Nash equilibria for non-zero-sum games.117 Such developments have led to a growing literature in “algorithmic game theory” addressing topics such as game playing, social choice, and mechanism design. Recent directions in mechanism design address resistance to manipulations enabled by anonymous internet connection.118 Designing auctions employs inverse game theory where the game is designed around the behavior of rational participants.

Artificial intelligence is an essential aspect of commercial video games. Rather than attempting to beat the human player, the objective for this AI is to provide virtual competition in a way that enhances a player’s experience. To do this in a way that players do not notice, the AI must provide proper reactions to specific stimuli. One of the most widely used techniques is call the Finite State Machine (FSM) algorithm. The game designer anticipates all the possible situations that an AI could encounter, and then specifies a future state as a reaction to each situation. Thus, the AI reacts to the human with pre-programmed behavior. Many successful games such as Battle Field, Call of Duty, Tomb Raider, and Super Mario use FSM AI. In using this technique, the game designer is essentially using the game-theoretic extensive form to program the game. This technique provides predictability. Other games, such as Civilization where players compete to develop a city in competition with an AI doing the same thing, uses a Monte Carlo Search Tree (MCST) algorithm that randomizes among possible responses to overcome the repeatability aspect of FSM and make the game more enjoyable. Deep Blue used MCST to consider possible moves and the opponent’s responses through several iterations, select the most promising, and then repeat the process following the opponent’s move. Essentially, this approach randomizes among possible responses when the set becomes too large to anticipate. Video game developers are cautious when randomizing as the play of the game to avoid unexpected AI behaviors that could impair the experience of a human player.119 A technique used in Alien: Isolation adds another level of a Director AI whose job is to keep the game enjoyable, and an Alien AI as the virtual opponent. The Director controls the information that the Alien has about the human player to affect the Alien’s behavior. Some games are incorporating neural nets, GANs, and other techniques to allow the AI and the player to learn through iterative play. This work transfers to the real world as games like Grand Theft Auto have been used for instrumental purposes to provide a safe and realistic environment for testing self-driving car algorithms.120 Also, Assassin’s Creed has been used to develop scenes to help train AI algorithms,  

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and *Minecraft* has been used to conduct research into machine learning. As massive-multiplayer online role-playing video games become a prolific source for “big data,” both video gaming and AI development will contribute to each other.\textsuperscript{121}

AI provides powerful techniques for discovering and matching patterns. However, deceiving AI is conceptually straightforward, as one only needs to provide deceptive patterns or data for the AI to train upon. Also, whether AI can ever provide normatively rational solutions for essential, mixed-motive game situations and the kinds of dilemmas that game theory exposes is unlikely. It may help humans explore the solution space, but cannot be relied upon for automated action. Efforts to apply AI in autonomous decision should begin with understanding the character of the game underlying the competition and cooperation in the contingency. Should modeling the game as zero-sum be adequate, the data used in training the AI be valid, and the game rules stable, AI should perform well. As with von Neumann and Morgenstern’s quest for game-theoretic solutions, AI is likely to provide normative solutions appropriate for the real world only in special cases. Given AI’s conscious use of data, how can AI be expected to have logical tact – reliance on concrete circumstances rather than averages?

**Back to examples in the context**

*In war more than anywhere else in the world things happen differently to what we had expected, and look differently when near, to what they did at a distance. With what serenity the architect can watch his work gradually rising and growing into his plan. The doctor, although much more at the mercy of mysterious agencies and chances than the architect, still knows enough of the forms and effects of his means. In war, on the other hand, the commander of an immense whole finds himself in a constant whirlpool of false and true information, of mistakes committed through fear, through negligence, through precipitation, of contraventions of his authority, either from mistaken or correct motives, from ill will, true or false sense of duty, indolence or exhaustion, of accidents which no mortal could have foreseen. In short, he is the victim of a hundred thousand impressions, of which the most have an intimidating, the fewest an encouraging tendency. By long experience in war, the tact is acquired of readily appreciating the value of these incidents; high courage and stability of character stand proof against them, as the rock resists the beating of the waves. He who would yield to these impressions would never carry out an undertaking, and on that account perseverance in the proposed object, as long as there is no decided reason against it, is a most necessary counterpoise. Further, there is hardly any celebrated enterprise in war which was not achieved by endless exertion, pains, and privations; and as here the weakness of the physical and moral man is ever disposed to yield, therefore*

only an immense force of will which manifests itself in perseverance, admired by present and future generations, can conduct us to the aim. 122 von Clausewitz [Bold added.]

The context called for examining how to introduce irrationality into games, such as shooting down air liners, violations of national and international laws, behavior inconsistent with higher objectives, and confusion. Indeed, game designs generally attempt to exclude the features common to actual war in an effort to focus on desired objectives. Blue firing on Blue is common in war and field/fleet exercises, but never seems to appear in combat models and games. Introducing “irrational” behavior into games is easy. One needs only to amplify the already incomplete information that players bring to the game and include imperfect information, select players that do not share the same tastes (preferences) and beliefs (expectations of likely outcomes) required of a team,123 introduce chance Black Swan type events as Opiz did, or present players with the kinds of dilemmas illustrated in game theory and Confrontation Analysis. A question is whether games should.

The primary distinction between a “training or educational” and an “analytical or research” game is the intended objectives along the hierarchy of learning in Benjamin Bloom’s taxonomy of educational objectives (figure 6). They both involve individual and institutional learning, with research games being a bit more ambitious. In general, educational games should seek to achieve the levels of learning sought by research games.

Many may consider making the game simulation more representative of the real world as interfering with the “clean” learning objectives of the game. An alternative view is not including such features provides false expectations and false learning of both what players should do and how the overall system will perform. Do we conceive of educational games as Helwig did in teaching known truth, or in terms of Opiz and the Reisswitz’s Kriegsspiel in teaching logical tact?

At a minimum, efforts to enhance the logical tact of the players and the organization employing the game should distribute the players in teams as they would occur in actual operations, and require them to develop communication skills that deal with the coding challenges of language. But that is the topic of another working group.

About the Author

John T. Hanley Jr. earned a doctorate in operations research and management science at Yale University, writing his dissertation on war gaming. A former U.S. Navy nuclear submarine officer and fleet exercise analyst who employed military modeling to conduct campaign analyses, he used gaming extensively during his service with the first eighteen Chief of Naval Operations Strategic Studies Groups as an analyst, program director, and deputy director. He also served as special assistant to the Commander in Chief, U.S. Forces Pacific, in the Office of the Secretary of Defense (Offices of Force Transformation, Acquisition, Technology and Logistics, and Strategy), and as deputy director of the Joint Advanced Warfighting Program at the Institute for Defense Analyses. After serving as director for strategy at the Office of the Director of National Intelligence, he retired from government in 2012 and is now a non-resident research scholar at the U.S. Naval War College.

122 von Clausewitz, 193.
Figure 6: Bloom's taxonomy

Wargaming Irrationality: A practical approach

Roger Mason

Abstract
Determining rationality and establishing a basis for rational behavior has intrigued philosophers since the time of Aristotle. These questions become more challenging to determine when applied to complex systems such as warfare. Establishing a baseline for rationality is difficult in a domain where heroism, cowardice, logic, and irrational behavior are constantly appearing and evolving. To understand the possible parameters of rationality, it is essential to examine the theoretical definitions for logical behavior. This analysis can provide a foundation for understanding irrational behavior and its manifestations in warfare. The wargaming domains of operations, command and control, psychological factors, and design parameters are where these insights can be applied. By employing various wargame design techniques, it is possible to introduce a form of irrationality in gameplay. The manifestations of irrationality appear as forms of emergent behavior arising from interactions within a complex adaptive system. This approach offers a practical method for modeling irrationality in wargaming.

Introduction
What is rationality and how do rational people act? This is a question that has intrigued philosophers since Aristotle. Aristotle, in his Nicomachean Ethics, observed that humans are different from animals because they exhibit reason (Aristotle, 2000). Kant proposed that practical agents exercise a capacity for theoretical and practical reason. Kant believed behavior and actions that are universally recognized as rational come from the ability to reason. (Kant, 1998).

What is rationality? Broadly speaking (and with less circularity than might appear), it involves thinking and behaving reasonably or logically, and it comes in several guises. Rational beliefs are those that are internally consistent, and rational arguments are those that obey the rules of logic (Cole, 2020). What happens when beliefs are not internally consistent and do not obey the rules of logic?

One of the best examples is warfare. The arena of human conflict provides another level of complexity to the question of rationality. Activities that are personally dangerous and involve the potential destruction of other persons and things might be considered rational and even heroic — or highly irrational, or a combination of the three.

Throughout history, warfare has been a persistent reality and the subject of intense study. Wargames were developed as a tool to model conflict. Alon describes wargames as models that employ “analytical, logical process that considers opportunities and risks vis-à-vis success, cost versus benefit, and possible unintended consequences” (Alon, 2002).

If wargames allow us to simulate conflict, can they be used to model irrationality in warfare? To answer this, we must define what type of wargame we are talking about. Is this wargame designed to provide an irrational opponent for problem-solving? Is the objective to design a game offering problem-solving
within a system prone to irrational conditions? Will the design assumptions define a context for rational behavior in gameplay?

This article will explore scientific definitions of rationality. We will investigate the manifestations of irrationality in theory and in actual warfare. Finally, we will offer practical recommendations for modeling irrationality in games.

Rationality
It is paradoxical that some of the simplest and easiest concepts to understand are the most difficult to describe. Albert Einstein once asked, “How on earth can you explain in terms of chemistry and physics so important a biological phenomenon as first love?” (Dukas & Hoffman, 1979). So it is with rationality. Salmon stated, “People are called rational if we think they reason well; arguments are called rational if we think they are logically correct; and logical principles are called rational if they are canons of correct logic” (Salmon, 2005). True enough; but what precisely are we referring to when we make these "calls"? The "canons of correct logic" are clear on paper, but what do we mean, more precisely, when we say people "reason well"?

Most people can agree on what thoughts, actions, and decisions appear rational, but it is hard to explain what makes this true. Nickerson observed, “Rationality may be used to convey different ideas by different people and by the same people in different contexts. It is safe to assume that some people who use the word would be able to give only a vague explanation of what they mean by it.” One solution is to consider theoretical models of rationality (Nickerson, 2008).

Theories of Rationality
There are many theories designed to explain rationality. These theories also consider decision-making and actions as manifestations of rationality and logical choice.

Rational Man Theory
In its strong form, rational man, or rational actor theory maintains that people are consistently rational, self-interested, and seek to optimize outcomes. Jonathan Swift had a point when he wrote Alexander Pope that he, Swift, rejected the idea (translating from the Latin) that "Man is a rational animal" and would go only so far as "an animal capable of reason." Additionally sometimes actual people act altruistically, even if they suffer a net material loss doing so. We can use "Rational Man/ Rational Actor" as a heuristic device, or a statistical one. This theory suggests there are four indicators of rationality.

• Knowledge of the problem
• Clear preferences
• Ability to optimize
• Indifference to logical equivalence

Knowledge of the problem means rational decision-makers have clear pictures of the problems before them and their choices. The indication of preferences means this rational person has ordered the alternatives in terms of value. The ability to optimize demonstrates the skill needed to calculate and develop the optimal course of action. Once our hypothetical rational person has adopted a course of action, he can exhibit indifference to logical equivalents. (Heath, 1974).
Rational Choice Theory
The economic theories of Adam Smith (1982) and Thomas Hobbes (2019) were the source of rational choice theory. In their analyses, rationality is choosing an action that is the best alternative given the decision maker’s knowledge. Rational choice theory indicators for rationality include:

- The actions examined are based on unbiased and systematic estimations of costs and rewards.
- The reward must outweigh the cost.
- The action will continue until the value of the reward falls below the value of the cost.
- The decision-makers will employ their resources to optimize their rewards.

Rational Choice Theory holds that individuals use rational calculations to make rational choices (Ganti, 2021). The rationality of the decision-maker is assumed, so costs and rewards are the basis for choice selection, and rewards must outweigh the cost. If the reward value falls below the cost, then action will cease. The decision-makers will employ their resources to optimize their rewards (Levin & Milgrom, 2004).

Game Theory
Von Neumann and Morgenstern developed game theory as a model of interaction between and among rational players. The theory suggests that each individual player’s payoff is contingent on the decisions or strategy of their opponents (Von Neumann & Morgenstern, 1944). According to game theory, the choices of each player will affect the outcomes for all players. Rational choice theory is a basic component of game-theoretic models, which assume that decision-makers choose the best action according to their preferences. (Dehdashti, Fell, Obeid, Moreira, & Bruza, 2020).

Bounded Rationality
Herbert Simon originally proposed the theory of bounded rationality. Simon also theorized that decision-makers are essentially rational and value rationality as a — or the — basis for choice. In Simon's analysis, decision-makers employ the following steps in their decision process:

- List and evaluate all possible behaviors
- Determine the possible outcome from each alternative.
- Balance any negative consequences against the possible payoff.

Simon believed that decision-makers, while searching for alternatives, rarely have complete knowledge of the alternatives. Decision-makers will select the choice they judge to offer the greatest utility or the least penalty, whatever the level of accurate knowledge that is available to them (Simon, 1957).

Irrationality
If we've established a serviceable idea of rationality, what, then, is irrationality? Lisa Borolotti states, “Irrationality ensues when judgement, suppressed by emotions, is false and gives rise to actions that are not justified by the situation” (Bortolotti, 2015). “Irrationality is the deviation from rational choice.” (Dehdashti, Fell, Obeid, Moreia, & Bruza, 2020). Animals capable of reason are not always reasonable, and our objective is to insert the real-world element of irrationality into wargaming. We will consider irrationality in military decision-making, manifestations of irrationality, and a brief case study.
Irrationality and Military Decision-making

Most of the research on irrationality focuses on individuals making decisions. Military conflict is much different. Military decision-making is a corporate activity. This activity ranges from senior strategic planners to tactical decision-makers, all making simultaneous and overlapping decisions. It is impossible to track every decision and evaluate its apparent logic or irrationality, but Kai suggests that irrationality in military decision-making is the results of biases, including such well-documented ones as:

- Overconfidence bias
- Confirmation bias
- Disconfirmation bias
- Availability bias
- Anchoring bias, and
- The Sunk-cost fallacy

The greater a decision maker’s expertise, the greater the possibility of overconfidence. Decision-makers seeking data to confirm their beliefs risk confirmation bias. Disconfirmation is the flip side, where decision-makers demand more stringent evidence for hypotheses they do not agree with. Availability bias is the tendency to think that examples that come readily to mind represent common phenomena, so we frequently estimate probabilities based on our experiences, or news reports or what those around us often bring to our attention. Hence the expression from the age of JAWS (1975) "shark-attack threat" for people's tendency to overestimate the number of shark attacks since the very few that happen get a great deal of publicity, or, far more seriously, Americans' overestimating the danger of child abduction by strangers or middle-class children getting shot at school (Kai, 2016).

The anchor bias is the inclination to rely on your initial information for subsequent decision-making; and the Sunk-cost fallacy motivates people to provide additional investments to prevent the loss of what has already been spent ("throwing good money after bad" in business, "doubling down" in gambling — and tragic decisions to continue wars of mutual attrition since "So many lives have been lost already") (Kai, 2016). Knighton further observed that the detailed analysis and planning involved in military decision-making “could induce biases that affect the decision-maker’s perception of risk”; with all that careful preparation, what could go wrong? (Knighton, 2004).

Do biases impact a person’s concept of utility and their perception of rationality? Kahneman and Thaler discovered examples of biases regarding future rewards that affect a person’s perception of utility (Kahneman & Thaler, 2006). With so many potential biases at so many levels of decision-making we should not be surprised, even when many lives are at stake, by instances of irrational behavior.

Manifestations of Irrationality

In warfare, a simple approach to evaluating irrationality begins with consideration of the conflict terrain. By terrain, we are referring to total milieu in which decision-makers operate, how they make decisions, and how these decisions interact. Starting from there we can see seven manifestations of irrationality in warfare.
It is contextual.
Decisions and actions that can appear irrational may have differing levels of rationality based on their context. In 554, Byzantine strategy at the battle of Volturnus would have appeared entirely irrational to the Goths. The Byzantine General Nares appeared to place his army in a very vulnerable position. He divided his army into two wings and left a large gap in the center of his lines.

The Byzantine strategy takes on a different flavor when we discover that the Heruli mercenaries assigned to the center of the Byzantine line had deserted just before the battle. Nares may have put too much trust in the Heruli, but he had not irrationally intended a gap. Such issues of context in rationality have been described as ecological rationality. This occurs when the rationality of a decision is based on the context or environment where it occurs (Goldstein & Gigerenzer, 2002). “Context appears to dramatically influence human decision-making” (Rosati & Stevens, 2010).

It is dynamic and synergistic.
Irrational decisions often appear at peak moments of stress and uncertainty. These situations are dynamic because of their complexity, the number of interactions, and other variables. The switch from logical to irrational can occur quickly, and irrational decisions — especially when not recognized as irrational — are also synergistic as they can influence the behavior and decisions of others.

The dynamic nature of the interactions, uncertainty, and sudden changes in the surrounding environment can diminish a decision-maker’s ability to optimize decisions. Research at the University of Pittsburgh indicates that “anxiety diminishes rule-based guidance of behavior, leading to performance bias, and increased error propensity in decision-making under conflict” (Wood, Bondi, Delarco & Moghaddam, 2016).

Environmentally sensitive
Decision-makers in stressful situations are susceptible to environmental changes. Warfare is the application of force and movement designed to overwhelm an enemy and control the relevant environment. Changes in the environment of the battle provide a level of uncertainty that complicates decision-making. Dean and Sharfmax call environmental change competitive threats. They observed that “the environment (competitive threat), the organization (external control), and the strategic issue (uncertainty) jointly effect the level of procedural rationality. Strategic decision-making procedures were most rational when competitive threat and external control were limited, and problems were not uncertain” (Dean & Sharfmax, 1993).

Relative to the agent
Rationality is relative to the agent and the observer. The relativity of rational decision-making is where explanatory models fail to account for irrational behavior. Historic campaigns that resulted in an agent’s disaster can be explained in rational terms. Crassus believed the logical route for invading Parthia involved marching through the Mesopotamian desert. Napoleon had strong motivation and rational arguments for invading Russia. Hitler believed that holding the Stalingrad pocket was the rational choice to achieve his military goals on the Russian front.

Rationality is relative to the agent because decision-makers are prone to overlook the biases that influence their reasoning. Bartolutti determined that irrational beliefs can “only be ascribed against a general background of rationality.” She also observed that people with delusions can “seem to be
genuine believers and the behavior explained in intentional terms” (Bortolotti, 2005). While such actions may appear irrational, the agent’s intentions may be more than just loosely connected random actions.

**Sensitive to framing and feedback loops**

Framing is a type of cognitive bias where decision-makers evaluate information based on how it is presented. Tversky and Kahneman suggested that “a decision problem is defined as the acts or options among which one must choose, the possible outcomes or consequences of these acts, and the contingencies or conditional probabilities that relate outcomes to acts.”

Once a problem has been framed and, thereby, options necessarily limited, the issue becomes how people will reason their ways to finally make choices among the options. Some researchers suggest that there are two differing systems for reasoning, intuitive and deliberative. “The intuitive system is responsible for fast processes that are affective, emotional, and automatic, while the deliberative system is responsible for slower processes that are more analytical, rational, and calculating in nature” (Guo, Trueblood, & Diederich, 2017). An intuitive choice may be unavoidable given time constraints, and it may well be a correct choice; but it is not grounded in reason and hence literally not rational; a decision from deliberation may be skewed by various biases, and also irrational.

Boud and Molloy define feedback as a learning process designed to “appreciate the similarities and differences between the appropriate standards for any given work, and the qualities of the work itself, in order to generate improved work” (Boud & Molloy, 2013). Feedback loops can help to confirm accurate or inaccurate information.

A feedback loop interprets data based on the recognition of an outcome. This interpretation informs future decisions. When based on faulty information they can also result in a cascading effect of irreversible tipping points called runaway feedback loops. These can result in illogical choices (Crisp, 1987).

In early 1942 the German decision to dig in and hold during the 1941 Russian counter offensive helped to stabilize the Eastern Front. When the Sixth Army was trapped at Stalingrad Hitler cited the earlier success as the rational for not retreating. As the situation become more critical Hitler insisted the problem was a failure to hold defensive positions. Hitler’s faulty feedback loops led to a catastrophic failure.

**Determined by the Outcome**

The evaluation of rationality in warfare is often connected to outcomes. A high-risk gamble may appear to be heroic, brilliant, or a stroke of genius if successful. A failure may be considered foolish or irrational. In 1519 Cortes burned his expedition’s ships upon his arrival at Veracruz. The expedition successfully reached Mexico City. Cortes’s rationality would have been questioned if the invasion had failed.

**Irrationality on the Battlefield**

One of the most irrational attacks in warfare is the battle of Missionary Ridge during the American Civil War. This brief case study illustrates the manifestations of irrationality. It involved decision-makers from the army commander to individual soldiers. Before the battle there were definite questions about the logic of the attack.

Colonel John Martin recalled,
“Stronger grew the conviction that the attempt would be made and stronger grew the conviction of its utter madness and folly. I could not believe that any courage, however desperate, could carry the height bristling with a hundred pieces of artillery, and defended by a force nearly, if not quite, as large as ours. But I felt that however fearful the risk of utter defeat, the attempt would be made, and I shuttered [sic] as I looked down the lines of brave men and thought how many of them would that day sleep their last sleep” (Martin, 1869).

As the attack progressed, the synergy of the decisions impelling forward movement spread from the leading elements throughout the entire army. The attackers were environmentally sensitive as they climbed the ridge. They realized there were places of relative safety as they continued to move uphill. The attackers experienced direct feedback indicating an approach to the main defensive line on the top of the ridge would be possible (Sword, 1995).

To the commanding generals, the attack appeared completely irrational and destined for failure. The evaluation of irrationality changed with the successful outcome. Since irrationality is so common in warfare how can we introduce it into wargaming?

**Introducing Irrationality into Wargames**

Warfare is a dynamic system of decisions, actions, and consequences neither 100% rational nor irrational. Information is often uncertain and outcomes are in question. The problems of logic and irrationality become even more elusive when introduced into games. Mandler assumes "that rational agents in games best respond to the actions taken by irrational agents by staking "out a middle ground that avoids the extreme rationality assumption that all agents play their best responses" on the one hand, "and the position that the consequences of irrationality are so unforeseeable that rational agents must always adopt actions that are always optimal regardless of how irrational agents play" (Mandler, 2014).

A wargame that stimulates irrational decision-making is challenging to design. The players will lack the historic decision biases that made the original choices illogical. The easiest way to simulate irrational behavior is to introduce factors that alter the game. The factors which stimulate irrational-like decisions or actions can be more than just a detailed random events table. This involves limiting and varying the types and numbers of irrational changes/conditions that appear in the game.

One solution is the identification of domains where logic, reason, and irrational behavior are most obvious. These domains are found in most military wargames, and it is possible to simulate irrationality by modifying or manipulating them. The domains can be organized into operational, command and psychological effects, and design parameters.

The operational group includes movement and combat. How the units will move and fight during the simulation. Command and control determine the simulated commander’s ability to manage their units. Psychological factors define a unit’s ability to retain cohesion and stay engaged.

The design parameters can be divided into four groups. (1) The scenario sets the narrative framework for the game and establishes the design boundaries. (2) The order of battle establishes which units will appear and when this will occur in the game. (3) Injects are the environmental changes introduced into the game. (4) Time represents when and how game time will be manipulated.
Operational
Two essential operational factors in warfare are movement and combat.

Movement
In combat, units move with a variety of purposes, from advancing to engage, to retreating, to reorganizing. In historic battles units unexpectedly move forward to engage or retreat based on a combination of factors. A combination of reasons and actions result in outcomes that sometimes appear irrational.

A good example occurred at the battle of Gettysburg on July 2, 1863. Sickle’s III Corps unexpectedly advanced forward from the main Union line leaving it exposed and nearly cut off. This movement left a large hole in the Union defenses. Whether this was poor decision-making or irrational behavior, the impact was the same. The unexpected advance nearly resulted in the defeat of the Union Army. This type of behavior can be modeled by selectively or randomly causing units to move or remain in place.

Combat
A variety of factors can influence the effectiveness of combat units. These factors can influence irrational behavior by individual units or leaders. Armies that are superior in size may suddenly lose combat strength causing defeat (Ex: the 1942 British surrender of Singapore). Inferior forces sometimes stage successful attacks. These attacks may be a combination of bravery or surprise but may also involve irrational decision-making.

Such factors can be simulated by enhancing or degrading combat capabilities. These changes can be triggered by a variety of factors such as positional (location in the simulated battlespace) or injects in the scenario. Movement and combat are critical, but they rely on control of your forces and maintaining morale and unit cohesion.

Command and Control, and Psychological Effects
Most wargames allow the players control of their unit’s movement and action. An associated factor is the ability to maintain the morale and cohesion of units. Both factors are sensitive to irrational behavior. A good example is the Battle of Guilford Courthouse, fought on March 15, 1781. Despite careful training and preparations, the American militia’s morale failed.

At the first sign of British regulars, the militia fled without firing a shot. The British also lost control when their forces broke ranks to chase the fleeing colonists. Their artillery began firing into the melee causing numerous friendly fire casualties. Both sides suffered from illogical and irrational choices.

Command and control
Command and control is the ability to direct the actions of units. This can include causing units to move toward or away from the enemy. It may also cause units to freeze in place.

Psychological Effects: Morale
Morale is a combination of factors, including unit cohesion and the ability to rally units that have panicked or become disrupted. The loss, maintenance, or improvement of morale can result in actions
that might otherwise be impossible. It is possible to impact rational choice patterns by influencing/manipulating morale.

**Design parameters**
Design parameters involve the introduction of predetermined conditions or events into a game.

**Scenario**
The scenario is the narrative portion of a wargame’s design framework. Decision points where the game environment or the conditions or capabilities change can be written into the scenario narrative. In the battle of the Tenrau in 1942 the Japanese continued to make frontal attacks until their forces were largely destroyed. To the American defenders, the attacks appeared irrational and were only possible due to the morale of the Japanese attackers and the code of *bushido*. These conditions could be part of the scenario for a game.

**Order of battle**
Unanticipated changes in the order of battle can be the results of illogical decision-making. As Nelson approached at Trafalgar, the van of the French fleet continued sailing away, leaving the battle behind them. Such unanticipated changes to the order of battle can suddenly reorder and redefine the limits of rational choice.

**Injects**
Injects are the points where factors influencing rationality can be introduced into the game.

**Time**
Scientific research indicates that people’s approach to decision-making changes as they have less time to make decisions. Under pressure to make an immediate decision, people tend to become less risk adverse and prone to take chances (Kahneman & Tversky, 1979), which can result in irrational or illogical decisions. Game time can be modified at the micro and macro-levels. In game systems employing action points, adding or removing points influences how many actions can take place in a game term. At the macro-level, events in the game can be used to add or subtract game-terms allowing for more or less time to meet the conditions for victory.

**Applying Irrational Factors to Game Play**
The three-domain approach provides design and game play opportunities where irrational or illogical factors can be introduced. A game designer should carefully consider the impact of each factor to avoid the tidal wave effect resulting in an illogical design. There are four methods for applying these factors to a game. These systems can be included individually or in combinations.

**Conditional**
Conditional factors are situations where a specific condition tips an environmental change. An example is locations in the game space. If a certain objective is captured or lost, changes impact the combatants.

**Alternate Combat Results**
Alternate combat results are common in games employing different types of units or styles of attacks. (Ex: attacks involving armor, siege attacks). Alternate combat results can include factors of irrationality.
Cards
Cards are a useful system for making changes to game play. They can cause immediate changes or provide a capability that can be deferred and played at the moment of greatest advantage.

Chits
Chits are similar to cards, but they are limited in how much data they can provide. They typically offer one data point, like activating a single unit in combat.

Action Points
Action points represent limitations on how many actions a player can take. They are an artificial representation of time and decision-making. The ability to take actions can be altered by adding or subtracting their availability. This can be useful in triggering decision options and behaviors that would otherwise be illogical or irrational.

Irrationality and Emergence
As previously stated, it is impractical to imagine a rational player who can produce irrational game play. It may be possible to take illogical actions, but the effect will be temporary and uneven. If the purpose of the wargame is to model conflict, it is crucial to consider that even history’s most irrational decision-makers had moments of rationality.

However evil, clearly not every decision Hitler made was irrational. If they had been, the Germans would not have nearly conquered Europe, North Africa, and Russia. The intellectual problem was that at crucial points, Hitler made increasingly irrational decisions that doomed the German war effort.

To model irrationality, we should consider it as a factor of the game and not an imperative. One possibility is to treat irrationality as emergent behavior. The widely-used term "emergence" can be defined as phenomena arising out of interactions within complex adaptive systems. Goldstein describes emergence as, “The rise of novel and coherent structures with patterns and properties during the process of self-organization in complex systems. Emergent phenomena are conceptualized as occurring on the macro-level, in contrast to the micro-level components and processes out of which they arise” (Goldstein, 1999).

Emergence is undoubtedly attainable in games. In a very different context, Holland notes, “We can contemplate emergence in another guise if we turn to a seemingly unrelated arena, board games. Agreement on a few rules can give rise to extraordinarily complex games” (Holland, 1998) Shannon suggested that a conservative estimate for possible chess moves was $10^{120}$ (Shannon, 1950). If nearly unlimited complexity is possible with something as simple as chess, it should certainly be feasible in a wargame.

I believe this can work for modeling irrationality in wargames. The domains of operations, command and control/psychological factors, and design parameters offer a broad source of options for introducing irrational appearing actions. When combined with independent decision-making, the number of potential interactions dramatically increase.

The result is a more substantial or dynamic emergence. This can be defined as “the appearance of emergent structures or higher levels of organization or complexity which possess truly new properties that cannot be reduced, even in principle, to the cumulative effect of the properties and laws of the
basic parts and elementary components” (Fromm, 2005). The effect of emerging irrationality will involve changes to the players' decision environment throughout the game.

By gradually introducing irrational conditions and behaviors, it is possible to control their influence on the game. During a storm, the impact of individual waves is not catastrophic. The dynamics of a storm involves environmental changes with the wind influencing wave action in seemingly random patterns. Instead of a random event that suddenly introduces an illogical outcome, we can produce a seamless and dynamic environment influenced by irrationality.

Ashby noted, “The configuration of a system at any given moment is defined as the set of numbers which are the values of the variables” (Ashby, 1947). The changes can vary between a tidal wave (ex.: all units within two hexes of the enemy panic and retreat six hexes) and tidal surges (disorganized units do not rally until next turn).

The result is a game environment promoting a seamless landscape of uncertainty. Exercising independent decision-making with the backdrop of emergent irrationality prevents the possibility of anticipating outcomes. In his study of strategic irrationality in games, Basu observed that a person playing a strategy begins by assuming everyone is rational until they are revealed to be irrational (Basu 1986). An even deeper level of analysis is possible with players attempting to determine if the emergent behavior is irrational, purposeful, or a mistake.

The use of emergence provides a flexible platform to introduce irrationality into games. This allows the wargame to move from a formulaic demonstration to a dynamic environment with unpredictable outcomes. This type of game offers the players a more lifelike battlespace and useful game experience. Holland noted that, “Board games are a simple example of emergence or great complexity from simple rules or laws” (Holland, 1998).

**Conclusion**

Understanding irrationality must begin by defining what is rational and logical, and employing one of the theoretical descriptions of rational choice can help establish an anchor point for logical choices and decisions. As a person moves farther away from the anchor they begin to exhibit increasingly illogical choices. The choices manifest themselves in various ways, in different locations, and with unpredictable outcomes.

The mid-point between rational choice and irrationality represents a fulcrum where the decision-maker must balance. As they make decisions, the seesaw will tip depending on their position. Some decision-makers will remain firmly on the end at rationality, resulting in stability with little movement. Some may vary their decisions. As they move toward irrationality the seesaw will begin to move. This is not a black and white contrast of pure logic and illogical choices but a palette of subtle shades where irrationality emerges as part of a dynamic environment.

Sometimes the appearance of irrationality coincides with a critical decision point resulting in disaster. An irrational choice may also come at the time of an unexpected opportunity, leading to victory. Instead of being illogical, the (lucky) decision-maker becomes a daring risk-taker who selected the perfect moment to act.
The question of what is rational is one of the great philosophic questions of humankind. There is nothing simple about it, and even just trying to model irrational choices and behaviors within a wargame is a tall order. The best we can do is approximate the appearance and effects of illogical choices. Fortunately, modeling irrationality in wargames is possible by employing the phenomenon of emergent behavior.

About the Author

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Gaming the Irrational:
What do we mean and how might we achieve it?

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Abstract
In this paper we briefly explore a specific definition of irrationality related to gameplay. We note how the failure to include these types of decisions in games adversely affects our ability to model reality effectively. We then briefly explore two methods to include these effects in games and propose some questions to consider to address this gap in wargaming.

Introduction
Wargames save lives. To do so, wargames provide a synthetic environment for players to explore potential alternate pasts, presents, and futures. Wargames abstract or remove key parts of the world to allow players to focus on the key features that a game seeks to represent. But what are the downsides of this approach? Well, for some historical games, this may mean that players have an outsized view of what is possible. In other historical games, it leads to anachronous behavior or over the top “win conditions” that lead to less-than-optimal play.

And yet, in many of the wargames run by DOD, this type of behavior does not occur. The author has previously met uniformed officers who were serious high achieving officers who would play commercial games in this manner. So, what is different? Why don’t we have players in our wargames who do things in game like Nazi Germany did on the Eastern Front during World War II, commit war crimes regularly in our games like at Abu Ghraib, or more simply, represent the challenges inherent in the POM cycles, etc. In our wargames, players often play seriously (and at least from their perspectives, optimally). So, if that is the case, how can we as the wargaming community include the irrational, the confounding, and the downright confusing actions that are part of reality in our games? And does it matter?

125 https://acoup.blog/2021/04/30/collections-teaching-paradox-europa-univeralis-iv-part-i-state-of-play/
126 See for example https://www.reddit.com/r/ShitCrusaderKingsSay/
127 Ibid.
Does it Matter?

Let’s tackle the second question first (after all, it’s easier). The simple answer is that yes, we should care. War is a human endeavor. In the future, if war is fought by machines only, maybe then war will follow perfectly defined axioms, all fighters will be perfectly rational (i.e., act completely consistently to achieve some utility function) and perhaps wars will never even be fought (maybe losing a war is worse than the outcome of capitulating prior to war). Until then, though, we are stuck with the wetware that we have. Kahneman and Tversky’s work, Thaler’s work, Suessstein’s work all point to the fact that, at best, we humans exhibit bounded rationality. Due to limits in resources such as time, humans may make sub-optimal decisions to achieve their stated goals.

So, given that humans struggle to act perfectly in accordance with a set of goals, we should not expect that a group of humans will be able to do so. And yet, in many of our games, a small group of human decision makers generally act rationally to achieve some strategy. This blinds us to the potential Black Swans that future leaders may encounter. While not every game can predict these potential outcomes, our goal should be to include surprising, shocking, or confounding actions that appear irrational when possible in our games.

How Should We Do It?

Including these types of actions in our games can be a challenge. So let’s think about the ways that we can include these outcomes in our games. It’s worth thinking about what we are shooting for before we go off “willy nilly” just trying to include the irrational in our games. So, what are we looking for? Well, broadly we want to do the following:

*We want to include actions in our games in which players appear to act in some way that is contrary to their goals or act in ways that appear to be outside the norm for their roles.*

Under this assumption, there are two ways that we can achieve this outcome from our game design:

1. First, players may appear to other players as taking irrational actions even if they are acting in their own best interests within the game.
2. Next, players may act in some way that is legitimately against their interests. After all, they are only human.

We will briefly explore methods to achieve each of these as a method to address our larger approach.

Subverting Player Expectations within the Game

As part of gameplay, players are asked to enter the magic circle. In other words, game designers ask players to buy into the game and enter a flow state in which they happily join in the game’s fantasy. In

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128 Summarized nicely in Thinking Fast and Slow.
131 “The magic circle is the area within which the rules of the game apply, a special space, ideally but not necessarily demarcated by the rules within which play occurs. It need not be a physical space, but can instead be
this case, an enterprising game designer can use the trust in the game system to build seemingly irrational behavior into games. The key is to ensure that all players believe that they are playing the same game while instead assigning different win conditions to each faction. In other words, in this case the irrationality will be built into the rules of the game. The key will be to keep those rules hidden from players.

As a partial example, consider the popular video game *Among Us*. In this game, four to fifteen players are assigned to a location as a combination of crewmates and impostors. The impostors are assigned a different goal than the crewmembers. Instead of seeking to complete missions, impostors seek to kill crewmembers or cause critical failures in systems that the crewmembers seek to repair. As a social deduction game, players are aware of the game structure and walk into the game expecting to be betrayed. However, if a game designer were to keep that information hidden, certain actions by the impostors would be distinctly irrational to the crewmembers.

So, how would we go about doing something like this in our wargames? Perhaps the most simple method to address this would be to design an emulation game in which every faction is provided with a different win condition; game control could design the original game brief to indicate that all players are working toward the same goals. However, the game would be designed to reward players for different win conditions unbeknownst to the players.

Just “lying” the players in the briefing will be insufficient for intelligent players. If every group is part of the game intro and then separately given a “hidden” win condition, intelligent players will assume that every group has a hidden win condition. In other words, to ensure that this approach works, a game designer will need to do a lot of work to ensure that all players believe that they are playing the same game while instead focusing them on very different win conditions. This requires several parts for game execution:

1. A belief by each team that they know both their goals and the goals of the other teams; and
2. An actual set of goals/win conditions that are surprising in some way to each team.

The easiest way to achieve this is to “lie” to players; however, that limits the ability to replay and may adversely affect the trust between control and players if done poorly. So, what are some other options?

**Getting Players to Act against Themselves**

If we want to avoid the issue of explicitly manipulating players and risking the loss of player buy in, a game designer can instead try to engineer opportunities for players to act against their own interests in the game. To do this, facilitators and designers need to create emotional responses in players during gameplay. As noted by others, humans do not exhibit full rationality in multiple ways. Commercial games, such as *Diplomacy*, make use of this fact to create emergent behavior in players that falls short of perfectly rational decisions. So, how do they do it? Broadly, they appear to approach it as follows:

1. Achieve buy in to the game from the players.

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132 See *Thinking, Fast and Slow* for some ideas about which biases may be exploitable.
2. Leverage the types of personalities playing the game\textsuperscript{133,134}
3. Create narrative moments where the players Type 1 systems overwhelm Type 2 (through strong emotions, time restrictions, or some other type of scarcity.\textsuperscript{135})

Let’s briefly breakdown each of these steps. First, to achieve this type of outcome, we need to build an engaging game. Many times, the one off nature of makes this harder for DoD wargaming. After all, most research games may be playtested once. So, how can we do this? Well, the trite but easy answer is to build a game that caters to what the players see every day for mechanics and has a believable story that players are willing to buy in to play. That’s likely easier said than done, but perhaps can be improved with a little playtesting and a lot of good work in the design phase.

Next, we want to leverage the types of personalities in games. This is much harder to do in non-hobby gaming. Most players are playing to win in a serious game instead of playing to express themselves or just have fun. However, we can still leverage the personalities noted. To do so, we need to create a shortage of a key resource and force players to react. Instead of thinking things through, our game should create a shortage of time or create a strong emotional reaction. Under these assumptions, our players do not have the capability to engage their long term, rational planning that they normally would use. Instead, they will react within the context of the game. Experienced Diplomacy players in the hobby gaming world are quite familiar with this approach. Setting up a situation in which others feel betrayed or blindsided creates a strong reaction in many players. In turn, players then are willing to make “sub-optimal moves” to regain control or assert independence as part of the game.

Putting it Together

Broadly, we see two ways to achieve irrational play in our games. The first requires a game designer to build the irrationality into the rules or deceive players. However, in this case, players may either rebel if they feel they are being manipulated or may choose to interpret the rules in some other manner. This suggests that we should instead make the irrational part of emergent gameplay. While likely more effective (because the players believe it to be their idea), this is much harder to engineer. It requires more deliberate planning from the game designer or facilitator and a much lighter touch. The downside here is that while it may lead to the behavior we desire, it is much, much harder to guarantee.

About the Author

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\textsuperscript{133} \url{http://www.diplomacy-archive.com/resources/god/two.htm}
\textsuperscript{134} \url{https://magic.wizards.com/en/articles/archive/making-magic/timmy-johnny-and-spike-2013-12-03}
You Can’t Do That!
Putting the awkward, irrational, and just plain stupid into games

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Abstract
In this paper I describe a real problem in our games: we don’t take into account things that are difficult, embarrassing, or just plain awkward. Unfortunately these significantly affect the accuracy of our games when they are left out. These range from media and Congressional play to mistakes and war crimes. While there are very good reasons for omitting these problems in many games, leaving them out is a significant source of inaccuracy in games as well as models and simulations. There are ways to include them, but for some areas, like media play, convincing the players to behave as if the problems were real can be quite difficult. Most of these difficulties occur in strategic and operational level games. In tactical games we have many mechanics from the hobby industry that we can adopt to manage these problems. We describe the challenges for three major areas: media, politics, and tactical irrationality. We also propose solutions to problems in each of these areas.

Introduction
I’m going to make a statement: all of our games are wrong. And in fact our games continue to be wrong in some very fundamental ways. And if I told you why they are wrong, you wouldn’t, or couldn’t, correct them. I’ll predict that you like your games wrong. Which is strange because we talk so much about our games being inaccurate.  

When we think about whether a game is “right” or “predictive” we tend to think about the narrow field of predicting the warfight. We want to understand kinetic conflict. And to do so we feel we need good or better physical models of the systems involved. We want the most realistic physical models possible. So, we can tell who will win or lose.

Likewise there is perennial issue of the players in professional games. Should anyone be used to play the threat? Or should it be just those intelligence analysts steeped in the ways that the threat does things? Some ask: “shouldn’t it be those with the cultural ties to the threat?” So they can emulate the

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136 Something that I believe we should stop doing. It’s foolish for the first thing people hear about wargaming is its limitations. At least lead with the advantages.
way in which the threat thinks. In the end this comes down to how well the players are representing the threat. And we want that done as well as possible.

Then there is the issue of repetition. Some feel that playing games over and over is important in order to smooth out any biases or issues that one set of players, or one set of courses of action, may have introduced into the game. There are all the challenges inherent in this approach, with comparison between instances of a game, the role of players, and other factors.

But we very seldom ask how well we represent our own decision-making in games. We assume that whoever we place into the role, especially if they have done that job in the real world, will fit well into the world of the game and make realistic decisions. That the game decisions will mimic those that we would find in the real world.

We also fail to account for the kinds of real-world pressures those “blue” or own-side decision-makers face. They want to look good. They often have someone looking over their shoulder. Many times they are not the actual person making the decisions. Sometimes they get mad, go off the rails, or just plain don’t do what you expect.

We worry so much about everyone but ourselves, we miss the biggest challenge to realism in our games: ourselves. In fact I contend that the primary reason our games are not predictive is that we fail to emulate how the “blue” side behaves, decides, and acts in the real world. Instead we have an idealized representation of the complex, messy, and confusing thing that is the US national security decision-making process. At all levels.

Let’s take a look.

Take pandemic gaming, since it’s a recent example. For many years the Department of Health and Human Services, along with the Department of Homeland Security, have been developing pandemic preparedness plans. As part of both the development process games were used both to understand the plans and to build training and socialization across agencies and throughout the government. Resistance to vaccination, unruly behavior, and other shenanigans were part of that process. I know, I ran pandemic games for HHS many years ago.

But what we never, ever, counted on was that the shenanigans would come from the White House.137 No did we predict that the communication errors that were identified in the 2001 anthrax attacks repeat themselves in a pandemic outbreak.138 Because the CDC and HHS had built a communications strategy that was supposed to be aligned. At least until it all got upended by the Trump administration.

Even with the best of conditions it is difficult to train politicians on the political trade-offs involved in the early phases of pandemic response. The COAs are all bad, and no one wants to make a clear decisions for fear of what will happen if they are wrong, and the blame you will receive is staggering even by DoD standards. And if they are playing in the game the political leaders have little incentive to deviate from the center-rationalist model of governance that has emerged as the standard in most of the world.


138 CDC communications
However when you look at what actually happened when we had a pandemic, almost all of the center-
rationalist tropes, and the rationalist assumptions of decision-making, went out the window. Instead political, social, and media factors dominated, along with personalities and relationships. And this has little to do with Trump himself. Sure he was a little less “standard” than most, but even now there are elements at work in the Biden administration’s response that reflect the political, social, and media factors influencing pandemic decisions. We don’t tend to make decisions based on rational data when we are in a pickle. And most games are built around situations where we are in a pickle.

And if you think a pandemic is a pickle, try a general shooting war with a nuclear-armed, peer, competitor.

At all levels, from the strategic to the tactical, these irrational factors are difficult to put into professional games. They are difficult for very good reasons, but just because they are difficult does not make them any less important.

I break down the challenges into the following categories:

- Media, including social media
- Politics, from organizational politics, service politics, to national, partisan, politics.
- The irrational. From emotion to confusion, from the strategic to the tactical, it can be simulated in wargames, but we don’t see it demanded in wargames.

I’ll discuss each of these factors in turn. My focus is on understand them across the spectrum of gaming, from the tactical to the strategic. I will also discuss them from the perspective of “how we do it now” and the effect that doing it badly has on our game results.

Throughout this I’ll refer to the “rationalist model” for foreign policy. You could also read this as the mainstream or academic approach to foreign policy that balances hard and soft power to achieve a relatively safe and stable world (for trade). Both liberal internationalism, realist, and neoconservative approaches have as their basis a desire for a stable internationalist structure that is governed by rules and laws where everyone behaves themselves. This is not necessarily the only way to approach things, as Russia clearly demonstrates. Biases, beliefs, ambitions, and strange goals can creep into how we deal with the world, and often they produce some rather surprising results. The rationalist model would reject inclusion of such behaviors into a foreign (or domestic) policy since they do not necessarily equate to anyone’s obvious advantage.

Of course there are other models of foreign-policy-making than the strictly rationalist model. There are also the organizational process, bureaucratic, groupthink, prospect/loss aversion, and the cognitive/psychological approach. But I am neither a political scientist nor interested in these nuances.

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139 Ok, he was way less than “standard” but I’m trying to be nice here so as not to upset those who still support him. But, see, for example: https://www.nytimes.com/2020/04/24/us/politics/trump-inject-disinfectant-bleach-coronavirus.html
in this paper. I am sure there is something interesting in delving deeper into the relationship between these models and our games, but here I’m just outlining a general problem.

The fundamental question in this paper is: Why are we wedded to the rationalist approach, when all the evidence is that decision-making is a lot crazier than that?

In other words, we keep imposing economic sanctions, under a rationalist approach, and then wondering why they don’t work. That is one example. Another example is the constant desire to “signal” to other entities that our intentions are serious and they should behave. Which never seems to work very well. We see these in our games, but we don’t quite know what to do with them when they occur. And we seldom seek to understand whether they should occur and whether our games are wrong if they don’t.

Simulating the media

Media play influences decision-making at all levels of warfare. However, because the effect is in the decision-makers mind, we as game designers have to find some way to put into the decision-makers beliefs and considerations that the media play matters.

Simulating media in games is generally done one of several ways:

- **Have actual media play media.** This is probably the gold standard but it still has a failing. The media you usually get to play are reporters with interests in national security, and so they are already partially or fully incorporated into the rationalist model for foreign policy. And, truthfully, they don’t really influence the politicians as much as many of the other influencers and personalities in the media. Simulation of those other media players is not usually included as part of the actual media play. A lot of professional media training falls into this category: how to manage an interview from a serious reporter. Even with media training there is less of a focus on media personalities that are seeking to embarrass, discredit, silence, or otherwise manipulate you, your organization, and your image.

- **Have players play the media.** Most reasonably aware players can simulate one source of media or the other, but they will have less credibility. This is more common with matrix games where player roles can be multiform and fluid. The challenge with this method is that it relies on the players to describe the media effects, and the other players to care.
  
  - A sub-option of this category of play is to use some sort of accounting mechanic to reflect the players standing in the media. An example would be to remove some freedom of actions from players with a “bad” media reputation while rewarding others with additional ability to act when they had a lot of public support. But this is really a hack: you are getting the player to care about something that the media effects, not the media itself.

- **Control brings the media.** This can be done one of several ways:

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140 Since I am no expert in the complexities of academic foreign policy analysis I will simply refer you to some references: [https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7978756/#CR14](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7978756/#CR14) (has a good summary of the topic). A general overview can be found in Morin, Jean-Frederic and Jonathan Paquin. *Foreign Policy Analysis: A Toolbox* (2018)
Control has media representatives within control who watch the play and develop media injects.

Control develops pre-scripts media injects.

Control, as Control or through subject matter experts, again imposes some sort of accounting on players for their media image. Indiscriminate precision bombing will result in increased civilian casualties, and that can result in top down political pressure to ease up on the bombing. Making players pay a penalty for ignoring the pressure would be an accounting mechanic.

- **Modeling.** Using one mechanic or the other populations can be modeled. Give them some objectives, likes, and dislikes and apply judgement to how they would react to player actions. It’s not a perfect simulation, but it’s something. Unfortunately this has difficulties:
  - Getting someone, anyone, to agree on an actual population model.
  - Interfacing the model with the players. “We strike the village.” “You cause 100 excess casualties in the village.” ---Ok---now put that into the model and develop a reason why the players know that the population in that province likes them 10% less this year. Polls take time, months, to do. Without feedback players will just assume the increase in attacks is an increase in attacks.
  - Putting up with the challenges of time and effect. Population perceptions tend to move slowly except in some extraordinary circumstances. Especially in the positive direction (it’s easier to convince people to hate you by punching them in the face than it is to get them to like you by handing out candy). This means that, within the scope of an operational or tactical game, player actions may have minimal effect, and may be washed out altogether by an adverse result. This can make all the fuss not worth all the trouble.
  - **Ignore the media role all together.** What can you do. If you can’t get media players, and you don’t have time for elaborate social models, you do the best you can with the occasional inject. Particularly for operational and tactical games.

I have found that the biggest challenge with representing media in games is to get the players to actually care about it. In the real world they have an entire wrap-around that goes with any decision. How they will look now and in history (the dramaturgical perspective), how the decision will affect their supporters and power relationships, and how the decision will affect their ability to get other things done, their chance of getting a job after they serve, things that may matter more to them. Games tend to focus players on only one problem, the fight in front of them, without replicating the long-game of how this all might work out in the end.

So, does this make your game unrealistic? I contend it does. Let’s continue with our pandemic theme. In a pandemic game media play can be an important way to frame the overall response. Is the government competent and reassuring, or off their game and dangerously incompetent? When media stories, for example, don’t match between different parts of the government, say the White House, CDC, and HHS, then the media begins to assume that the government’s response itself is not coordinated. Or that the different agencies do not have a common picture (actually, a pretty good assumption). The media response to lack of coordination can whipsaw back into the administration and create the opposite effect: a lockdown on information and a single point of contact for the media. When that happens, the stories begin to appear about the CDC being “suppressed” by the White House.
and HHS. Again, undermining confidence in the response. Of course this is a no-win situation, but one that the decision-makers are going to have to deal with, one way or another.

The lack of realistic media play at the strategic level completely upends the actual decision-making process. When strategic decisions are made domestic politics plays a significant role. Without the feedback coming from core constituencies, and the disagreements that may occur, players are left to take the path that they think is the best one based on their experience and understanding. For senior players this means that they get to do something they would never get to do in the real world: make a rational trade-off without the worry about how they are going to look in the news tomorrow.

It may be rational to take that action, but the press, people, political advisors, and lawyers won’t let you.

Even with a robust set of reporters playing in a strategic game, all that tends to give us is a “Greek chorus” of media that say what would be happening in the stories of the day. Not how it could change the lives of the principal actors forever.

At the operational and tactical levels lack of a media feedback loop allows for the continuation of operations and behaviors that might otherwise be stopped due to strategic, and political, considerations. In addition to having to deal with the complexity of embedded reporters, tactical and operational commanders have to think about how their actions might get reported on to the wider community, and how that will affect the overall course of the operation. The “strategic corporal” is an example of this. But incorporating the effect of a really bad interview into a company-level simulation of a disaster response is difficult, if nothing else because the senior commanders may simply ignore it in the game.

So in all of our games I’d simply ask: where are the organizational, media, framing, social, and legal feedback loops that go with everything else occurring in the game? And, if cyber is becoming more of a thing, how do you create an effective information environment without those feedback loops?

And don’t tell me you have them, unless you can tell me how you get the actual players to care about them in the same fashion that the real-world decision-makers care about them.

**Political decision-making**

Go ahead, tell me how you are building a game to design the future force structure. Having the players make build trade-offs, seeing how that affects the overall budget, balancing between services, and, maybe, comparing what you come up with to what the threat is doing. A great game of understanding what the future force will look like?

Nope.

I have designed many future force games. I have seen more than I have designed. And not one time did any of the games include either as a player, or a consideration, the biggest influence on what the future force will look like.

Congress.

Now you can argue that the games are designed to influence Congress and therefore should not take Congressional consideration into account. But, if that were the purpose wouldn’t you rather play a
game where you got a better understanding of what would happen to your force once it went up to the Hill? So you could argue against whatever cunning plan Congress had? You know: better informed?

There are simple and understandable reasons why professional games done for government tend not to include Congressional play. The fallout from Congress finding out, for example.141

But just because it is not politically feasible does not mean that our games are automatically realistic because its omitted. In fact, of all the categories of things omitted from games that makes them unrealistic, I’d say that Congressional play, including the staffs and hearing process, is the biggest single offender. With media following a close second.

I told you that you would not want to make your games realistic. And this is why.

But it’s not just Congress, all sorts of political factors are routinely underrepresented in our games.

A good example is pacing. In reality, especially in recent years, what happens in the public sphere is incremental, careful, and contained. Violence is contained by competing political considerations, even when both sides desperately hate each other. Changing something, digging a canal or building a space shuttle, goes through large numbers of political and bureaucratic hurdles before anything is executed. The upshot of all this is that a realistic game, even a political policy game, is a game that is

- Highly detailed
- Focused on the technical aspects of the issue
- Incremental
- And slow to change

This is not a recipe for an action-packed and entertaining game. Take the challenge in Taiwan, for example. The Chinese have increased incursions into Taiwan’s airspace.142 This is the kind of thing you’d put in your scenario to see where the conflict would go. Well...it’s not going anywhere very fast. Taiwan usually just issues a stern warning.143

Ah, but you can easily contend that this sort of stuff doesn’t matter much, because that is not what we are trying to understand. We are trying to understand how to fight and win the wars, operations, or battles, let the politicians deal with the politics.

141If you doubt the interested that can be generated by a game covering a legitimate set of political questions, just ask the Transition Integrity Project (http://transitionintegrityproject.net/).

142 https://www.nytimes.com/2021/01/24/world/asia/china-taiwan-strait-exercise-biden.html and then there was this recent incursion: https://www.npr.org/2021/06/15/1006921645/china-sends-a-record-28-militaryoplanes-into-airspace-controlled-by-taiwan

Well, first of all there is the whole issue of strategic games. How are you going to build realistic strategic games if the pressures on the players don’t represent the pressures they have in the real world?

Now there is a difference between achieving game objectives and achieving game realism. In a realistic game between China and Taiwan not much might happen. That seems to be where we are now. But in a game where you wanted a cross-strait attack to occur, your objectives conflict with the reality of how slowly and carefully things move.

The degree to which political decision-making is involved in the details, and the degree to which domestic politics comes into play, is routinely discounted in games. Because the political fallout for failure is high, most rationalist leaders will become involved in the details to ensure that their decisions are not affected by a lack of knowledge. At the same time the political pressures, including the media pressure, significantly affect decisions. These forces operate not just on US decision-making, but also allied, partner, and adversary decisions. Just differently (especially for adversaries).

We can characterize political pressures on the decision-makers as:

- Social identity/Dramaturgical. This can range from whether a President will get re-elected, or seen by history as a great leader, to an officer in charge of a unit considering the pressures they are under from their commander, their service, and their family. It also goes to how people want to present themselves to the world – their dramaturgical persona.
- Legal. Legal issues surround every decision a leader makes in the US and many allied countries.
- Reputational. This would include the press and overall view that the media and public have of the actions that are taking place. This can apply as much to a battalion commander as an entire country.
- Authority. Decision maker’s authority to make decisions can be perceived different depending on where they are in an organization. Even in a situation where they have defined authority within the organization to make a decision, they may be strongly influenced in the decision by other organizational factors. A common example is that a leader may not want to make a controversial decision without getting buy in, or at least mollifying, those parts of the organization that will be adversely affected.
- Political. What will the impact of the action be on the key constituencies of those making the decisions? This goes both for elected and unelected leaders. The service chiefs, for example, have political considerations and constituencies as well.

144 While there is a lot of literature on leadership and teams, the diversity of the space for decisions and the influences for decisions is not robustly represented in the literature which seems to divide between decision-making in the sense of how you make rational decisions, and leadership.

The irrational

After the media and the political we come to the irrational. Why distinguish them? Because for decisions-makers at all levels the rationalist model can break down. People don’t always do what is in their immediate best interest. Sometimes decision-makers fail to understand what is happening.

For example, if you have a great C3 plan with multiple inputs and an all-knowing, all-seeing set of ISR (intelligence, search, and reconnaissance) capabilities sending information back to the operations center, you are hoping that the guys in the ops center notice the important stuff and can figure it out in time to act coherently. With some frequency the key decision-makers will latch onto the wrong information, be distracted, or have other issues to deal with during the critical times when they should be understanding what is going on and making rational decisions. We seldom ask in our games whether we are effectively simulating this confusion.

One way to understand whether we are including the right kind of chaos in our games is to compare game outcomes to real world events. I’d ask when was the last time in a game you saw any of the following occur?

- Blue on blue (i.e. engaging a friendly)
- Blue on white to include white ships hit, or civilian casualties
- Bad information passed between echelons?
- A unit defending against a threat that wasn’t there (i.e. “we have missiles inbound” when it’s just a flock of birds).
- Accidents and mistakes. This is a catch all for mistakes that don’t involve shooting at something.
- Illegal acts. Specifically war crimes like Abu Ghraib.
- Logistics issues, such as ammunition being switched for cleaning supplies? Often blamed on cyber in a game, but more likely to happen by accident.
- Rear area and force protection mistakes. Such as locating information regarding nuclear weapons, along with passcodes and other security details, being published on the open web.
- Tactical units “panicking” and running off in directions that you did not expect? Especially units that get lost.
- Breaking. Morale is a concept that factors heavily into considerations of pre-1900 games, but diminishes as we move into the 20th century and is totally absent from current discussions. However unit morale, or the modern word “cohesion,” is an important factor in casualty absorption rates and combat effectiveness degradation. In modern combat a “broken” unit is degraded to the point of combat ineffectiveness and is removed from the line, it does not simply “run away” the way they did in Napoleonic warfare.

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146 This sounds a lot like the OODA loop – except we are mainly interested how people mess up the orient-decide portion of the loop. https://en.wikipedia.org/wiki/OODA_loop


These and other factors are not often seen in games. Why?

- It’s difficult to simulate in games. In the same way that it’s difficult to simulate the media it’s hard to put the right kind of pressures on the players to get them to behave in strange ways.
- It undermines trust in Control. If as a controller I suddenly push to players an attack that isn’t there, then the next time they won’t trust me. Games involve relationships, and the control/player relationship is built on fairness and trust. Some of these elements undermine that trust.
- It takes away agency from the players. Players need to be able to control what they are given in the game. For the controller to then suddenly take that control away leads to the “why don’t you just play the game instead” mentality. Sure, it can be done in small amounts, but do a lot of it will result in the players giving up.
- It requires some degree of modeling in the game to be believable. What is the probability in a brigade movement that a platoon gets lost for a while? A company? What is the probability that any given company will get lost? We typically don’t have very good data values for these probabilities, which means we exclude them from consideration. (Though we might if we recorded events in training and exercises.)
- As we get further down the chain of command, to individual ships, aircraft, vehicles, and soldiers, the chance that something causes them to disregard or “update” orders increases. In other words, to use Dunnigan’s terminology, to panic. As with larger unit’s random processes are not a very good simulation of the potential behavior of panicked units. A ship isn’t going to do random stuff, but it could fire on a ship its escorting by mistake. But if we don’t assign a random chance for a random action, Control is going to be accused of taking control of the game.

Since these concepts are hard to implement in games they are often ignored. They also represent relatively “rare” events that can have limited effect on the overall operation. Though the definition of “effect” may vary depending on whose point of view it is.

There are several ways we have to include them if we want to, but none are inherently very satisfying:

- **Panic.** We can expand Dunnigan’s original concept of a random set of actions in any number of ways. We can have random tables of effects that we will see in various circumstances. Sometimes we might get a blue-on-blue and others it might simply being a radar breaking.
- **Pinning.** This is the technique I use the most. When ground forces are taking concentrated fire then they may decide that they will hit the ground and wait out the firestorm. While they won’t take casualties, they won’t be doing a lot either. This is a good way to give the opposing player an effect, without overkilling the targeted unit. It also is a good reflection of the delays and timing of a deadly modern battlefield, where not everyone is moving and shooting all the time.

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150 Fortunately, it was a CWIS firing on a battleship: [http://billgx.com/2019/10/autonomous-friendly-fire/](http://billgx.com/2019/10/autonomous-friendly-fire/)

• **Context dependent actions by Control.** This differs from the general concept of panic in that we are now specifying a specific context for the event. If there is an air battle, we can have blue-on-blue. If there are strike operations on mainland targets there will be a certain number of civilian casualties. In Panic all units are affected randomly, here some units are affected depending on what they are doing.

• **Morale.** While, as we noted earlier, this concept is tied to pre-20th century warfare it can still apply to modern combat just with other names. Most combat simulations of ground actions have some sort of system for establishing combat effectiveness based on losses of personnel and equipment.

• **Random selection.** This can range from chit pulls to the hobby technique of randomizing a player’s control over individual units. This works well for simulating the chaos of decision-making and orders delivery but it does not incorporate a lot of the other factors like mistakes and misunderstandings. It is, in my experience, difficult for players who are not hobbyists to understand how to manage the process, and their units, when they don’t have full control of them.

I don’t have a “best practices” on this problem. My preference is to acknowledge the problem, and select the best technique that fits what I’m trying to do at the time.

**So what?**

So, we don’t take into account a lot of things when it comes to games. Things that in the real world are actually pretty important. There are ways to incorporate some of these things, like confusion and misunderstandings, while others like the role of the media, public opinion, and political pressure are really hard.

There are, of course, many things that we ignore or gloss over in games, and this may just be another one on the list.

But if we do, we need to acknowledge that our games are in fact ignoring a substantial factor in how reality works. In particular, budget or procurement games that ignore the influence of Congress are likely to get the incentives, priorities, and realities quite wrong with respect to what is actually possible. But, right now, we really don’t talk much about these things.

What I’m really suggesting: that we talk more about how these irrational forces influence our games. We admit that we are falling short, and think about what that means. Maybe we could even worry less about things like probability of kill and a little more about some of the big challenges to warfighting, like not being allowed to fight with all our resources.

There are also some practical things we can do:

• **Build tactical games that reflect the actual vagaries of the battlefield.** Even having injects or events that just “occur” randomly during the game will be something the players understand, and we can easily script ahead of time.

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152 I would also say that we don’t do this in our fancy computer simulations either, but I don’t want to start that fight.
• Factor in the effects of fires on tactical units and the psychology and physiology of their ability to fight. This is particularly important in a CBRN environment where forces are going to be in MOPP gear and definitively not having a good time.\textsuperscript{153}
• Think about including a lawyer in any operational or strategic game. They, after all, will have a lot of influence on what forces can, and cannot, do.
• Include mechanisms for civilian casualties, and penalties for generating civilian casualties. Or at least remind the players they are generating them.
• Include media and information operations play, and design mechanisms where they can have an effect. An example would be a “political” score which allows players to get stuff done. If that falls then they can do less.

Getting players feedback on the complexities of modern warfare is difficult. Introducing the complexities of morale, panic, and mistakes is possible, but hard to sell to players. But all of them are where our games become realistic. We should put as least as much effort in including these effects as we do the engineering and technical adjudications that we often focus on.

About the author
Dr. McGrady writes, speaks, and teaches on the design of professional games. He is an adjunct senior fellow in gaming at CNAS, teaches and manages game design courses for MORS/Virginia Tech, and runs a business devoted to using games and game techniques to bring innovative experiences in new areas. In the past Dr. McGrady built and directed a team of 10-20 analysts at CNA devoted to the design and execution of professional games. Dr. McGrady has written, taught and presented on the topic of games and their use in organizational and individual learning. He has designed and run games for many different clients ranging from the White House to the Department of Agriculture. Dr. McGrady has also built a team at CNA devoted to chemical and biological response operations, including domestic response operations. Dr. McGrady has deployed as an analyst with US Forces in Haiti during operation Uphold Democracy, onboard USS Nimitz for Desert Storm and with operational E-2C squadrons. Dr. McGrady holds a Ph.D. in Chemical Engineering from the University of Michigan. He has published extensively in the Chemical Engineering, physics, and national security literature and is widely cited for his work on the mathematics of aggregation and fragmentation.

\textsuperscript{153} CBRN: Chemical Biological Radiological and Nuclear. MOPP: Mission Oriented Protective Posture – your CBRN suits.