WARGAMING

Practitioner's Guide

Mirosław Wnorowski

DOCTRINE AND TRAINING CENTRE OF THE POLISH ARMED FORCES

WARGAMING
Practitioner's Guide

Mirosław Wnorowski

Bydgoszcz 2022

Translation:
Aneta Wilewska

Proofreading:
Graham Longley-Brown

Cover design:
Łukasz Gutowski

Typesetting and desktop publishing:
Łukasz Gutowski

Cover illustration:
based on www.pixabay.com

ISBN 978-83-66731-30-1 (online)
ISBN 978-83-66731-29-5 (print)

Publisher:
Wydawnictwo Centrum Doktryn i Szkolenia Sił Zbrojnych
im. gen. broni Władysława Sikorskiego
ul. Szubińska 105
85-915 Bydgoszcz, Poland
e-mail: wydawnictwo.cdissz@mon.gov.pl
https://cdissz.wp.mil.pl/en/pages/dtc-publishing-office/

Printing and binding:
Drukarnia Wydawnictw Specjalnych
ul. płk. Kazimierza Leskiego 5
01-485 Warsaw, Poland

Edition I, Bydgoszcz 2022

In 2019, Doctrine and Training Centre of the Polish Armed Forces started its adventure with wargaming. The level of ambition set by the superiors was the achievement of the Polish Armed Forces' capability to organize such projects at the strategic, operational and tactical levels. When undertaking activities aimed at building these capabilities, first the literature on the subject was explored, then the knowledge and experience of experts, both in the country and abroad, were used. As awareness was built and new skills were acquired, confirmed by the organization of war games, the idea of developing this publication emerged.

All of this would not have been possible without the help and commitment of many people. At this point, I would like to especially thank all those who supported us both while discovering the world of wargaming and writing the guide itself. First of all, my sincere thanks go to Professor Rex Brynnen of McGill University in Montreal, who, in accordance with the principle of diversity he propagates, helped to understand that in the world of wargaming there is a place for everyone. I would also like to thank the entire team involved in the development of the guide's assumptions, including in particular Cpt (N) Paweł Podgórny from the Polish Naval Academy in Gdynia. Additional special thanks go to Graham Longley-Brown for his help with the English version.

Finally, I would like to mention my superiors at the General Staff of the Polish Armed Forces and Doctrine and Training Centre of the Polish Armed Forces. It was their openness to new ideas and understanding that made it possible to complete the work on the guide. Thank you.

Mirosław Wnorowski

TABLE OF CONTENTS

źródło: Combat Camera Poland

Introduction

Decision-making games, including war games, are one of the tools that can be used to support decision-making processes. The history of conducting professional war games in the armed forces dates back to the 19th century, when officers in the Prussian army were taught tactics using the game *Neues Kriegsspiel*[1] by Georg Vinturinus. The game, unlike earlier ones such as *The Kings Game* by Christopher Weikmann or *War Chess* by Johann C. L. Hellwig, allowed to simulate the movement of units, their destruction and the operation of logistics. On a tide of Prussian military successes, war games became very popular in many European countries and beyond. In Poland, they were disseminated by the French military mission at the beginning of the 20th century (Caffrey, 2019). In times of great wars, war games were successfully used both to verify operational plans and to train cadres. After World War II, during the Cold War years, war games continued to flourish. They were commonly used to play out a potential conflict between superpowers.

Due to the geopolitical changes at the end of the 20th century and the general relaxation in international relations prevailing in the world, war games receded into the background. The ability to conduct them has been gradually degraded. Currently, NATO treats wargaming as a priority capability that needs to be restored as soon as possible. In order to meet the requirements of the modern security environment, a non-standard approach in this area must be demonstrated. Wargaming capabilities should be used at all levels of decision-making, both military and non-military.

The Polish Armed Forces also recognized the need to use war games as a potential tool to support decision-making processes. Doctrine and Training Centre of the Polish Armed Forces, implementing a campaign under the patronage of Chief of the General Staff of the Polish Armed

[1] A classic CoA (Course of Action) war game, usually a two- or three-sided game, with rigid adjudication (based on strictly defined rules) or semi-rigid adjudication (taking into account the controller's decisions based on his own experience and opinion of subject matter experts).

Forces, called *NUP2X35*, the essence of which is a debate with the broadly understood civilian community and operational environment, and whose aim is to identify and analyze trends and factors in the Polish security environment out to 2035, has organized a series of projects bringing this theme closer. War games were the subject of a scientific seminar entitled *The use of war games in the decision-making process* organized in cooperation with the Faculty of Political and Security Sciences of the Nicolaus Copernicus University in Toruń and the webinar entitled *War games as a tool used in the decision-making process when combating military and non-military threats*, organized with the participation of McGill University (Montreal, Canada), Defense Academy of the United Kingdom (Shrivenham, UK) and LBS Consultancy (Chippenham, UK). A large part of the session *Strategic Analysis and Operations Research Methodology* of the GlobState IV conference was also devoted to war games (Lis & Reczkowski, 2022).

As a consequence, a need was generated to develop a document systematizing knowledge about decision-making games for the needs of the armed forces. This guide has been developed in response to the identified need. By definition, it contains basic information, and its main goal is to present the main elements and the process of preparation and execution of war games. The source of knowledge for the preparation of the document was a systematic review of the literature on the subject and lessons learned from the observations of participants in the organization and conduct of war games. The first part of the document presents the history of decision-making games, their elements, classification, and possible use in the armed forces. The next part describes the process of preparing a war game, including its mechanics, scenario, adjudication, and data collection and analysis mechanisms. The problems related to the development of game tools, such as the board, are also presented. The last part of the document presents examples of different war games based on the same input data.

CHAPTER 1

THE ESSENCE AND OBJECTIVES OF WAR GAMES

source: Combat Camera Poland

Definition of war games

There are many definitions of war games in the literature. The definition contained in the American doctrine *US Joint Publication 1* (Joint Chiefs of Staff, 2017) indicates that a war game is a kind of simulation of a military operation involving two or more opposing sides (forces/troops), using specific rules, data and procedures designed to represent a real or assumed situation. As defined in *The Art of Wargaming. A Guide for Professionals and Hobbyists* by Peter Perla (1990), a well-known theoretician and practitioner of war games, a war game is a warfare model or simulation, not involving real forces (troops), in which the sequence of events affects the decisions made, and at the same time, the decisions made affect the actions of the participating players representing the opposite sides. In *Fundamentals of War Gaming* by Frank McHugh (1966) we can find a definition according to which a war game is a simulation of selected aspects of a military operation, conducted in accordance with established rules, data and procedures, the purpose of which is to collect lessons from the decision-making process or to develop information necessary to make decisions, in possible real situations. In *Red Teaming Guide* (Development, Concepts and Doctrine Centre, 2012), a war game is defined as a scenario-based warfare model in which the outcome and sequence of events affect, and are affected by, the decisions made by the players. *Wargaming Handbook* (Development, Concepts and Doctrine Centre, 2017) defines a war game as a decision-making technique that provides structured but intellectually liberating safe-to-fail environments to help explore what works (winning/succeeding) and what does not (losing/failing), typically at relatively low cost. According to the publication, a war game is a process of adversarial challenge and creativity, delivered in a structured format and usually assessed or adjudicated. War games are dynamic endeavors where players make decisions. In its course, players should also take into account all possible factors, in addition to the actions of the opposing side, that may hinder the implementation of the plan. For the purposes of this document, a definition has been adopted that fully reflects the essence and characterizes war games:

A war game is a tool that provides a structured, safe-to-fail and reliable environment for conducting research on the possibility of making decisions based on incomplete data (Herman et al., 2009). Participants in war games can make decisions and actions that even they would not have predicted if not for the game environment (Perla, 1990).

War games use qualitative research methods (Burns, 2015) to reveal ideas, problems, and insights that would otherwise not be easily achievable through the use of quantitative research methods. It is a tool for creating analyses, conclusions and observations (Schelling, 1986).

The essence of war games is the interdependence of decisions made by players, which can occur sequentially (players make decisions alternately) or simultaneously (decisions are made at the same time) (Dixit & Nakebuff, 1991).

Although the term "war game" in its meaning directly indicates an armed conflict, at present this term is used very widely, also in relation to decision-making games implemented outside the military area, e.g. in politics or business (Gilad, 2008).

Benefits and limitations of war games

War games have many advantages. They make it possible to play scenarios and take risks without endangering human life or interrupting the continuity of the organization's (command's, staff's) work. They introduce an element of competition with the opponent. War games (Lartigue, 2008; Bartels, 2019) allow:

1. To create experiential learning opportunities. They enable players to make mistakes and learn from them in order to avoid them. They limit players' excessive trust in their own decisions.

2. Broad intellectual training. They provide an environment in which players learn about limitations and resultant problems, analyze and compare possible solutions.
3. Gathering ideas from a large number of participants. They enable collecting expert opinions needed to build and verify a model of the analyzed phenomenon.
4. Verification of doctrines and plans. They allow to identify incorrect assumptions, elements omitted in the planning process.
5. Identification and analysis of challenges. They allow to identify possible developments based on the players' reactions.
6. Developing inter-institutional awareness. They allow to understand different points of view and limitations resulting from e.g. the scope of organizations' activities or communication between institutions.
7. Appreciating the role and strength/importance of the sides (opponent). Based on the analysis of possible reactions, they enable players to assign and verify the proper meaning to the identified factors and actions taken.

With this in mind, it is important to remember that war games are only a problem-solving tool. They allow to discover and define new, previously unspecified factors and conditions of action and allow 'what if' questions to be asked. Like any tool, war games have limitations (Development, Concepts and Doctrine Centre, 2017):

1. They are not the solution to all problems. They are not the goal in itself, but a tool to achieve the goal.
2. They allow for the identification of the possible development of the situation, but it should be remembered that each identified decision path is built on the basis of the assumed model of the analyzed phenomenon, which is only an approximation of reality.
3. The results obtained cannot be treated as the only indicator to introduce changes in the organization, environment, etc. The results of games are usually qualitative. In the case of quantitative results, a single event, such as a game, cannot be the basis for drawing absolute conclusions.
4. They do not answer the question: 'what will happen?', but suggest what may happen.
5. Their quality depends largely on the participants, their commitment, knowledge and experience.

Player selection is essential to the gameplay. In the case of professional games, the participants, as in the case of exercises, should have the appropriate qualifications and experience. The aim should be to ensure maximum realism in this respect. Nevertheless, even in an optimal situation, i.e. with the full involvement of key personnel (specialists, decision makers), we should remember about the unfavorable phenomena that may occur during the game. The conviction of one's own expert knowledge and experience may cause participants to reject the obtained results as unreliable or even ridiculous. The Dunning-Kruger effect (Świeży, 2010), according to which incompetent people do not notice their low level of ability and are unable to correctly assess the level of ability in others, should be particularly taken into account. In addition, war games are prone to unintentional falsification of results, e.g. due to the career pressure of individual people involved in the game and when the results confirm the theses previously put forward by the game sponsor (Longley-Brown & Curry, 2019).

History of game theory

Since the inception of social sciences, researchers in the field have tried to understand and describe in an orderly manner the causes and courses of conflicts. One attempt was *Theory of Games and Economic Behavior* by Neumann and Morgenstern (1944). In 1960, Thomas Schelling, in *The Strategy of Conflict* (Schelling, 1960), presented game theory as a unified concept within the social sciences. He focused primarily on resolving multilateral non-zero-sum games. He put forward the thesis that interactions between players can be explained using the theory of non-cooperative games (Kostecki, n.d.).

Schelling's work on conflicts and nuclear weapons proliferation was particularly important for the security system. He developed the concept that within the game, players arrive at a solution/strategy without communicating with each other, relying only on each player's expectations of what other players expect them to do (Grimes, 2016). Schelling also included an analysis of global conflicts in *Strategy and Arm Control* (Schelling & Halperin, 1961) and *Arms and Influence* (Schelling, 1966).

The theories developed by Schelling (The Royal Swedish Academy of Science, 2005) were influenced by John Forbes Nash, who proved that in all games with a finite number of pure strategies there is an equilibrium point (Nash, 1950). This was an important achievement since it took into account a wide spectrum of conditions under which the equilibrium point (Nash equilibrium point) occurs for the entire class of non-cooperative games, i.e. those with n number of players with a negative, zero or positive sum (Murphy, 2016). The Nash equilibrium point is a fundamental concept in game theory. Simply put, no player can increase their payoff by unilaterally (that is, without changing the strategy of all other players) changing their strategy (Płatkowski, 2012). Nash Equilibrium is a pair of strategies in which each player's strategy is the best response to the other player's strategy. There can be several Nash equilibrium points in any game.

Elements of game theory

Game theory can be defined as a mathematical theory of competition and cooperation situation, which aims to establish criteria for rational decision-making for two or more sides in a situation of complete or partial conflict of interest, i.e. in a situation where the participants show a tendency to implement different goals (Roszkowska, 2007).

For a game to occur, the following elements must be present (Pietraś, 2012; Haman, 2014):

1. Players – there must be at least two entities/players interacting in some way.
2. Interests – the players should have their interests and know them well and, where possible, know the interests of the other side.
3. Strategies – game participants must have strategies of action. It is assumed that there are usually at least two strategies in a game, i.e. one of them concerns possible cooperation between players, while the other – a potential conflict. A set of strategies is assigned separately for each player.
4. Actions – in pursuit of a goal, all players take certain steps, actions. Actions determine outcomes.

5. Outcomes – the outcome of a game is the result of the adopted strategies and actions taken by the players. By assigning appropriate values to individual outcomes, players are able to make rational decisions.
6. Rules – players' actions and behaviors are restricted by rules of the game that are imposed from the outside and followed.
7. Rationality – players act rationally, which in game theory means that they know the hierarchy of their preferences, they strive to maximize expected utility, i.e. to achieve their goals to the maximum in a situation in which other players behave exactly the same. Rationality, according to the assumptions of economics, sometimes may mean not maximizing profits (utility), but minimizing costs (losses).

Decision-making/war games occur wherever decisions are made. Game theory is a relatively young field of science and still requires a lot of research in order to develop knowledge and systematize it. In the literature, it is often referred to as an art instead of a science (Dixit & Nakebuff, 2009). This term is particularly appropriate when the environment under research contains many variables and complex relationships between them. As a result, building a mathematical model describing this environment is difficult or even impossible. Therefore, we should be aware that the results obtained as part of a war game are often qualitative in nature and their interpretation using game theory is not possible (e.g. determining the equilibrium point, i.e. indicating the most optimal strategy for the players).

Game theory dilemmas

Game theory tries to explain the behavior of players during the game, their relationship between preferences, which can be convergent or divergent. Considerations concern the rational actions of players (available strategies) that can improve or worsen the general situation or cause a conflict. These decisions consist in choosing between two (three, four, etc.) strategies (opportunities). This alternative generates a problem, a dilemma – how to proceed and which choice is the best. In game theory, there are many dilemmas describing the problem of choice. They include

e.g. (Malawski et al., 2004; Binmore, 2017): the prisoner's dilemma, the game of chicken, the assurance game, the traveler's dilemma (Jacko, 2009), the tax dilemma (forcing behavior), the Cournot duopoly (determining the production volume). The most widespread include:

1. The prisoner's dilemma – the problem of trust – describes a situation where the pursuit of maximizing individual benefits leads to unfavorable solutions for each of the players. The dilemma presents the situation of two prisoners accused of committing the same crime. The prosecutor has only circumstantial evidence and the outcome of the proceedings depends primarily on the testimony given. In return for giving explanations, admitting guilt and incriminating a fellow prisoner, each of the accused receives a proposal to reduce the sentence or avoid punishment. Two decisions are possible for each of the inmates – cooperation (silence, "keeping your mouth shut") or competition (giving evidence against a fellow prisoner and reducing or avoiding punishment). For the above decisions the following payoffs are possible:
   1 – reward/release (no possibility to prove guilt),
   2 – accusing the environment of cooperation with the judiciary,
   3 – reduction of punishment (sentence),
   4 – punishment (full sentence).
   The result of the prisoner's dilemma is that individually rational choices can lead to collectively irrational outcomes. The optimal solution for both prisoners would be to remain silent and thus obtain the minimum sentence or release. However, from the point of view of each of the accused, it would be most profitable if only one of them confessed, giving evidence incriminating the other. Then only the second one will be punished. As a consequence of this thinking, they both give evidence incriminating the other, thinking that this is the best solution for each of them.
   There are two ways to deal with the prisoner's dilemma:
   a. encouraging to cooperate – rewarding those who cooperate, and consequently punishing the uncooperative;
   b. creating a reputation system in a given environment – guidelines on who can and who cannot be trusted.

   The above-mentioned solutions have their rational justification in the situation when the prisoner's dilemma is played once. In an

iterative game, the choice of strategy for individual players and how the justice system conducts the game (incentives or penalties for cooperation or lack thereof) will depend on the strategy adopted by the opponent in the previous round and whether the next round will be the last (Haman, 2014). In that case, choosing the optimal strategy will be extremely difficult. In the literature (Pietraś, 2012), possible solutions to the iterated prisoner's dilemma include: avoiding participation in conflict situations, changing the attitudes of decision-makers and focusing on achieving social rationality, and establishing power over the participants of the game.

2. The game of chicken (also named hawk–dove) – the problem of competition – describes a situation where both sides do not cooperate and simultaneously strive to achieve the same goal. An example of this game is when two people start driving a car at high speed in opposite directions while on a collision course – whoever brakes or swerves first is the "chicken" and loses. The game is about competing for a scarce good (not about how you can work together to get the best outcome, as was the case with the prisoner's dilemma). There are two strategies here – "chicken" and "bold". The game's loss is a collision, and the reward is when both drivers swerve. At the same time, the temptation in the game is the moment when one of the drivers swerves and there is no collision.

   The main problem of the game of chicken is concession allocations – players A and B want to achieve something. In order to win anything, the players must also take into account the interests of the other side – hence the reward is a situation in which both players swerve in order to avoid the collision. The game is about a situation where a common interest coexists with opposing preferences for action.
3. The assurance game (also named stag hunt) – the problem of choosing between safety and cooperation – describes a situation where each player is prompted by the system to cooperate. The goal of the game is to coordinate actions for a better result. The game was described by Jean Jacques Rousseau, who depicted two people going hunting. Each of the hunters can individually choose a stag or a hare but hunting a stag is possible only with the other hunter's help. Each hunter makes a decision without knowing the other person's decision. If one side chooses a stag, they must cooperate with the

other, or they will fail. They can catch a hare alone, but it is worth far less than a stag. This is an important analogy to the problem of social cooperation. When there is no cooperation, the result may not be achieved or is worse.

CHAPTER 2

THE USE OF WAR GAMES

source: Combat Camera Poland

War games in the armed forces

While game theory is primarily applied to economics, it can also be applied to any other field where people interact and follow certain rules. A classic example is the prisoner's dilemma. To put it simply, the prisoner's dilemma can be used to illustrate a strategy game depicting the arms race between the US and the USSR (Próchniak, 2017) during the Cold War. The great powers were spending huge sums on armaments. The strategic goal of each player was to have greater military potential and gain advantages. This situation can be illustrated by the following payoff matrix:

USA \ USSR	Disarmament	Armaments
Disarmament	10, 10	-50, 20
Armaments	20, -50	-20, -20

Figure 1. Payoff matrix of a strategy game describing the arms race between the US and the USSR
Source: author's own study

According to the values assigned to individual actions of the players, in a single run of a game, the most likely solution for both players will be the continuation of armaments. They will incur the associated costs (-20, -20), however, in this way they prevent the loss of a possible advantage if one of them decides to disarm and the opponent continues to arm (20, - 50 or -50, 20). However, the optimal solution for both players is a situation in which they do not incur the cost of armament (10, 10).

Another example of the use of game theory in the analysis of armed conflicts is the consideration of the remilitarization of the Rhineland by Germany in 1936, the occupation of the Falkland Islands by Argentina in 1982, or the Cuban Missile Crisis, which took place in 1962 after the USSR had deployed missile installations in Cuba, as examples of the game of chicken (Haman, 2014). Game theory does not analyze the causes of conflict, but it allows for the search for an optimal solution. Although it has limitations resulting primarily from the possibility of mathematical modeling of the game environment, players do not make decisions

completely randomly. As Dixit & Nakebuff (2009) put it, "strategic thinking is the art of outdoing an adversary, knowing that the adversary is trying to do the same to you".

Taking into account the game theory, various types of games can be assigned to operations conducted by the armed forces. Considering the course of military conflicts and military operations, they can be classified as (Longley-Brown & Curry, 2019):

a. armed conflicts – non-cooperative zero-sum games;
b. peacekeeping and peace support operations – semi-cooperative (non-zero-sum) games or non-cooperative zero-sum games;
c. humanitarian operations – cooperative or semi-cooperative (non-zero sum) games.

Characteristically, non-cooperative zero-sum games are most often used for the needs of the armed forces – the payout means the loss of the opponent. In reality, semi-cooperative non-zero-sum games are the most common.

The type of war game is determined by the expected outcome. The type of game that gives the most likely answers to the questions specified by the game sponsor should be used. In other words, the analysis of the problem and the requirements of the game sponsor are the main factors determining the type of game and its course. The design team chooses the type or combination of game types that will best support the achievement of its goals.

War games as an element of planning

The Polish Armed Forces, as an element of the state's defense system, perform the tasks specified in the Constitution of the Republic of Poland. They conduct analyses of the security environment and the operational environment allowing for the development of strategies for action – adequate to the changing environment. Modeling (description) of the security environment is complex and contains many variables affecting the determination of the best response (strategy) to the situation. The modeling typically uses both traditional and scenario-based planning methods.

In traditional planning, building a strategy is a formalized process that takes into account analytical data describing the environment and the strengths and weaknesses of the organization (Obłój, 2001). This approach assumes a process of visioning, analyzing and making strategic choices, and turning them into programs and plans. After the implementation of the above, the original vision is reviewed and verified, which is an impulse to restart the planning process (Krupski, 2007).

The scenario-based approach consists on the description of the analyzed object or system, taking into account the maximum number of factors influencing them, and defining development opportunities and emphasizing the reality of given decision-making situations, which in turn gives a set of possible alternatives of the future (Daszyńska-Żygadło, 2011). Scenario-based planning assumes that there is intractable uncertainty and ambiguity in any given situation. A strategy leading to success can be developed only by being fully aware of it and accepting it (Olszyńska, 2011).

When comparing traditional planning and scenario-based planning, it can be seen that in the case of traditional planning, it is assumed that the environment in which the organization will operate in the future will be similar to the present one and will not change significantly. The variables to be analyzed are known and countable, or their occurrence can be predicted in some way. In addition, the relationships between these variables are disclosed and described statistically. The essential context of traditional planning is that what is happening now is the result of actions in the past. Accordingly, the possible future is built as a consequence of the present. It is a passive approach, adaptive to reality (Gierszewska & Romanowska, 1994).

With scenario-based planning, the basic assumption is that nothing will be the same in the future. According to this concept, there are variables in the organization's environment that we know may appear, but we are unable to predict when and with what force they will occur. In addition, there are variables whose occurrence we cannot predict. The environment is subject to dynamic changes. The future is uncertain and cannot be clearly described. Stochastic models and qualitative analyzes are used to analyze the future. The essential context of scenario-based planning is that the present is the basis for creating the future. It is a proactive posture (Gierszewska & Romanowska, 1994).

Taking into account the specificity of the decision-making process in the armed forces, which is very often based on incomplete or unverified data, it seems reasonable to support it through scenario-based planning. This planning is useful at all levels of command, especially at the strategic and operational level, where non-military factors become as important as military factors. A tool supporting the development and verification of plans (scenarios, models, programs, etc.) created in a complex, unpredictable environment are war games, which, unlike exercises, enable the search for new, non-standard solutions. War games, especially CoA games, are widely used within NATO as part of operational planning at all levels of command.

Classification of war games

War games can be classified according to various criteria.

1. Purpose:
   a. didactic games – used for teaching, improvement and verification of skills and competences;
   b. research games – used for research and analysis of specific solutions and systems.

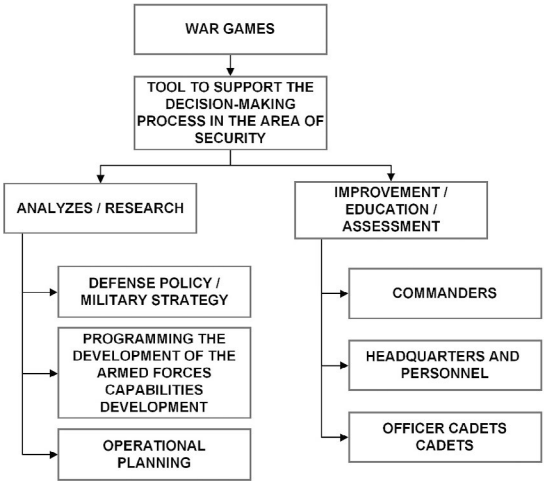


Figure 2. Purpose of war games
Author's own study based on Longley-Brown and Curry (2019)

2. The technique/methodology used:
    a. seminar games – usually conducted in small groups of several people. They are formalized, argument-based discussions between experts. The games are played according to a specific scenario, and the players are forced to make decisions and face the consequences. They use arguments to present ideas for solving the problem. Typically, the goal of seminar games is not to solve a specific problem, but to obtain opinions, conclusions, a model, structure, necessary for further research by the game sponsor. Their aim is also to enable a better understanding of phenomena and problems occurring in the played environment. Therefore, it is advisable to involve decision-makers in the game. Typically, seminar games are not structured in rounds/turns. After the players are introduced to the game environment (situation), there is a discussion/brainstorming, which the facilitator directs in such a way that the problems are considered in a specific order, while maintaining the consequences of the decisions or actions taken. Seminar games, unlike scenario-based discussions, primarily contain cause-and-effect interaction of the decisions made. Seminar games are one-sided or 1½-sided games. Adjudication can be semi-rigid but tends towards free;
    b. matrix games – have fixed rules that define what actions players can take. During the game, players, based on the arguments they present, fill in a matrix that allows to draw together conclusions, observations and decisions made during the game. Matrix games require participants to present specific solutions and supporting arguments. The opposing side presents counter-arguments and a discussion ensues, leading to a settlement. In order to make the gameplay more plausible, an element of randomness is often introduced in the game, e.g. in the form of a dice roll. In-game debates are time-limited to allow for multiple rounds. Thanks to this, players have the opportunity to face the consequences of their decisions. Matrix games are most often two-sided or multisided. Adjudication can be semi-rigid but tends towards rigid;

c. course of action (CoA) war games (Dowództwo Wojsk Lądowych, 2007) – the most commonly used form of wargaming during the planning process by headquarters at all levels of command. Course of action wargaming is a systematic method for analyzing a plan to visualize the potential ebb and flow of an operation. It is used to compare and test scenarios and allows 'what if' questions to be asked.
   A course of action war game is based on a specific scenario that players become familiar with as they play. The scenario directs the course of the game, and the playing teams solve specific problems, striving to achieve the imposed goal.
   Course of action war games are usually two-sided or multisided. Adjudication tends towards rigid;
d. inductive games – they are used early in the concept development process, and make use of open-ended brainstorming throughout the game to obtain data, and after analysis, an outline of the concept is created;
e. deductive games – they consist in testing general ideas for solving a problem during the game. Observations collected during the game serve to support or disprove the initial hypothesis;
f. scenario planning games/alternative futures games – they boil down to examining the problem in the context of a specific scenario. The gameplay is based on the analysis by two or more participants probable future scenarios and identifying the key factors that make a given scenario plausible;
g. Disruptive Technology Assessment Games (DTAG) (Allied Command Transformation, n.d.) – players work out an action plan based on a scenario at least twice. Firstly, using currently available solutions, both technological and doctrinal, and then modern technologies not previously considered. The solutions developed by the playing teams in both rounds are compared;
h. Concept Development Assessment Games (CDAG) – a variant of DTAG games, however, in this case, concepts are the subject of consideration. Players discuss each element of the concept in turns, taking into account different perspectives. Unlike DTAG, players usually play within one team.

3. Number of sides:
    a. one-sided games – in a one-sided game, players belong to one or more groups operating within the same side, i.e. taking into account one perspective of looking at the problem. In the course of the game, prepared scenarios or injects are used that change the initial conditions or situation in the game, causing players to re-analyze their thoughts, perspectives or decisions related to the problem being analyzed.
    A variation of one-sided wargaming is a two-sided simulated[2] game. The main difference between one-sided games and 1½-sided games is scenario injects that are created as the game progresses, based on the actions and decisions made by the players;
    b. two-sided games – in a two-sided game, players are divided into opposing cells (e.g. BLUE and RED). Each cell responds to the actions and decisions of the other cell based on pre-established rules of conduct. A control cell adjudicates the interaction of the actions and decisions of the playing cells. The outcome of the interaction informs subsequent gameplay. A control group may also use scenario injects to alter the general scenario and achieve the goals set by the sponsor;
    c. multisided games – they involve more than two sides and are generally conducted in the same way as two-sided games. The rules of conduct in multi-sided games tend to be much more complex than in two-sided games due to the number of possible interactions between cells representing the actions of different players.
4. Representation of force elements:
    a. kinetic games;
    b. non-kinetic games (representing 'soft' factors).
5. Command level of the games played:
    a. strategic games;
    b. operational games;
    c. tactical games.

[2] The other side is played by the controller team. In the literature, this type of game is referred to as a 1½-sided game.

6. Degree of computerization:
    a. manual games;
    b. computer-assisted games;
    c. computerized (simulation) games.
7. Round/turn length (duration of each side's action):
    a. short-term games – including single minutes in the cyber domain or hours in tactical operations;
    b. medium-term games – including days of fight or operation phases;
    c. long-term games – covering months or years.
8. Representation of time:
    a. games with sequential/linear representation of time – showing chronological course of events with the preservation of time units;
    b. games with a cyclical representation of time – showing an iterative process;
    c. games with or without time jumps.
9. Scenario type:
    a. games with a pre-determined scenario – the game is conducted according to a strictly defined scenario, any possible deviations are corrected by a facilitator;
    b. games with an open-ended (evolving) scenario – the scenario has an outline and is treated freely; in case it evolves in an unintended direction, it is not corrected.
10. Game outcome:
    a. zero-sum games – one player wins as much as the other players lose (e.g. in the case of a collision of potentials in games such as CoA);
    b. non-zero-sum games – the above condition is not met.
11. Order of decision making:
    a. games in strategic (normal) form – describe situations in which players make decisions simultaneously, without knowledge of the decisions of other game participants;
    b. games in extensive (developed) form – describe situations in which players make decisions sequentially, at successive intervals of time, having specific information about the decisions of other players (and their own) made previously.

12. Possessed knowledge:
    a. games with complete information – players have full information about the possible outcomes of the game (they know their possible payoffs and the possible payoffs of other players). In addition, they have information about the sets of possible player strategies/actions;
    b. games with incomplete information.
13. Possibility of forming coalitions:
    a. cooperative (coalition) games – when actions in the game are assigned to groups (coalitions) of players. Achieving the best outcome in the game is possible only in cooperation with other players;
    b. non-cooperative games – when the actions in the game are assigned to individual players. Obtaining the best outcome in the game depends on the actions of the player himself.
14. Sets of available actions and strategies:
    a. finite games – when a set of strategies available to each of the players is finite (e.g. checkers or chess – each piece has an assigned set of allowed moves);
    b. infinite games – when a set of strategies available to players is infinite (e.g. the rules of the game allow to acquire completely new tools or permit unconventional use of the tools players already have).
15. Number of actions performed:
    a. games with a finite time horizon – the rules of the game specify the maximum number of rounds/turns;
    b. games with an infinite time horizon - the rules of the game do not specify the maximum number of rounds/turns, and the game ends when the assumed goal is achieved, e.g. obtaining a specific number of points or defeating the opponent.
16. Repeatability:
    a. single games;
    b. multiple (iterated) games.

CHAPTER 3

THE ELEMENTS OF A WAR GAME

source: Combat Camera Poland

The elements of a game are: (1) game participants – the design team and players, (2) game mechanics, including rules and procedures, (3) scenario, (4) adjudication, (5) analysis (including the data collection process), (6) databases. Figure 3 shows the dependencies between the elements of a game during its preparation (dashed lines) and during its conduct. The central element are the players, whose decisions and actions are subject to evaluation and at the same time they can influence the changes in the scenario and, consequently, the provision of necessary information from the database.

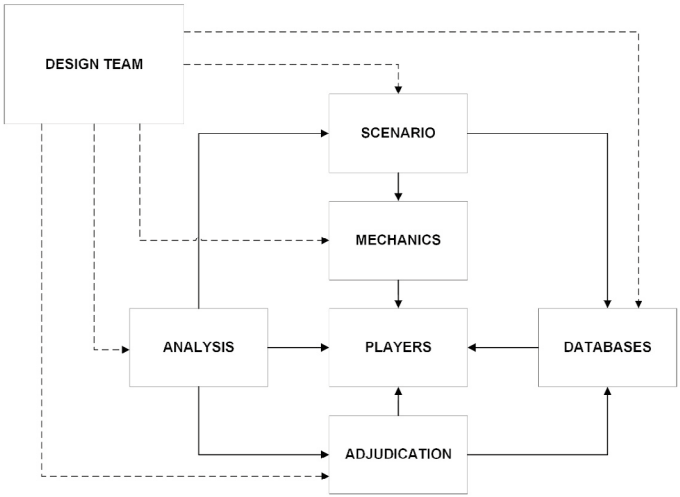


Figure 3. The elements of a war game
Source: author's own study

Game participants

1. Design team
   The design team is the team necessary to plan and run a war game. Its structure and composition are determined by the sponsor and the director, who are the initiators of the game and develop its basic assumptions and goals. The team's composition can be modified as needed and limited to a few people, provided that the assumed goals of the game are achieved. The overriding principle is to appoint

only those people who are necessary to the team. As part of the preparation of war games, especially those conducted on a large scale, the design team may include: sponsor, director, designer, developer, analyst, controller/adjudicator, facilitator, info manager, database manager, Real Life Support (RLS) manager, Information Communication Technology (ICT) manager, military and non-military operations manager.

a. Sponsor – responsible for generating a problem to be wargamed. He is responsible for clearly defining the objectives, tasks and scope of the war game. The game sponsor plays a particularly important role in the process of preparation and execution of the war game. He is usually a high-level decision-maker and his involvement and participation in the whole process translate directly into the involvement of players and the results obtained. At the beginning of the entire project, it is necessary to define the rules of cooperation with the sponsor, i.e. how he intends to interfere in the process of preparing the game and its course. The sponsor communicates with the design team through the game director.
b. Director – responsible for organizing, synchronizing, planning and performing tasks as part of the preparation and the conduct of the game. He is the main link between the design team and the game sponsor. The main task of the game director is to operationalize the goals of the war game agreed with the sponsor, for which he is responsible. The tasks of the game director include:
   - appointing a design team and managing its work;
   - ensuring, in coordination with the main analyst and the sponsor, the achievement of the game's goals and answers to research questions;
   - acceptance of documents produced by members of the design team;
   - training of design team members;
   - game verification (validation), organization of trial games;
   - proper selection of players and the conduct of the game;
   - preparation of a post-game report.

c. Designer – responsible for translating the goals of the game, agreed by the game director and approved by the sponsor, into a feasible project, and for developing game mechanics. The designer must be supported by all members of the design team, in particular by the adjudicator and the analyst. When developing game mechanics, he must take into account the method of obtaining data for analysis. The designer's tasks include:
   - participation in the development of the problem description, game objectives and research questions;
   - analysis of previous games in terms of their possible use;
   - development of a game design taking into account its mechanics and enabling the acquisition of data necessary to prepare the report;
   - defining the documentation necessary to be performed by the design team;
   - identification of tools for use in the game and after its completion required for data analysis.

d. Developer – creates and refines the products required to run the game. The developer translates the idea, the concept developed by the designer into real products. He is responsible for providing and/or developing the necessary tools to conduct the game. The developer's task is to ensure proper playability, i.e. enabling players to act intuitively in the game. Developer tasks include:
   - identification of products, data necessary to obtain from the sponsor;
   - development of products and materials for players;
   - determining the game environment requirements, e.g. required logistics, requirements for ICT systems and databases;
   - managing the game testing process.

e. Analyst – produces a post-game analytics report that should address the research questions and issues identified by the sponsor. The analyst is responsible for the organization of the collection system for data, observations, comments and observations of the players. Analyst's tasks include:

- development of a data collection mechanism and related documentation;
- participation in the development of models/simulations used during the game;
- close cooperation with the adjudicator to ensure that players' actions can be assessed;
- participation in the game testing process;
- active in-game acquisition of data and its analysis;
- development of the post-game report and its archiving.

f. Controller – plays a key role in the game. He steers the game, the subsequent rounds/turns of the participating sides, controlling the time regime. He settles disputes arising from the course of the game. In the event that the gameplay deviates from the core of the wargamed problem, he reacts by correcting the prepared scenario. He is responsible for achieving the assumed goals of the game.
In the adjudication process, the adjudicator is responsible for determining the outcomes of player decisions. Its tasks include, among others, collecting data and making the necessary calculations.
The tasks of the controller/adjudicator include:
   - development of adjudication rules and verification of the project in terms of its playability;
   - acquiring expertise on the wargamed problem and subject matter experts (SMEs) for the control team[3], and managing the team;
   - training of members of the control team;
   - adjudication based on accepted principles;
   - participation in data analysis and report development.

g. Facilitator – responsible for running the game. He introduces the players to the game, explains the rules, controls the course of the wargamed scenario. The role of the facilitator can be combined with the role of the controller. The facilitator's tasks include:
   - participation in the development of game mechanics and the scenario;

[3] In the case of large-scale war games, the control team should be expanded to include SMEs in various fields, e.g. SMEs in operating in individual operational domains.

- introducing players to the game situation;
- controlling the course of the game, including the order of wargamed problems and time.

h. Info manager – responsible for establishing information flow procedures during the game. He manages access to information during the game. The tasks of the info manager include:
   - development of information flow procedures during the game;
   - in the case of using ICT systems in the game, granting access rights to the appropriate directories/information exchange sites, issuing guidelines for configuring player accounts – depending on the roles performed;
   - cooperation with the analyst in the development of data collection tools.

i. Database manager – prepares and manages the database(s) used during the game.

j. Real Life Support (RLS) manager – responsible for game support in terms of logistics, including administration and service for participants.

k. Information Communication Technology (ICT) manager – responsible for the preparation and operation of the tools supporting the game in terms of the ICT technologies used (IT system, VTC system, simulation system, command support system, etc.).

l. Military and non-military operations manager – responsible for the proper mapping and implementation of mechanisms for using combat systems (capabilities) in the game environment, and implementation of civil-military cooperation mechanisms.

Figure 4 presents the roles of individual game participants in the process of preparing and conducting the game. The dependencies between individual elements are marked with arrows. Their functioning should be focused on collecting materials to perform an analysis of the problem defined by the sponsor. During the game, the analyst (analyst team) must stay in direct contact with the other members of the design team in order to make changes to the scenario, if necessary, provide information to the players or take into account the requirements of the game during the adjudication.

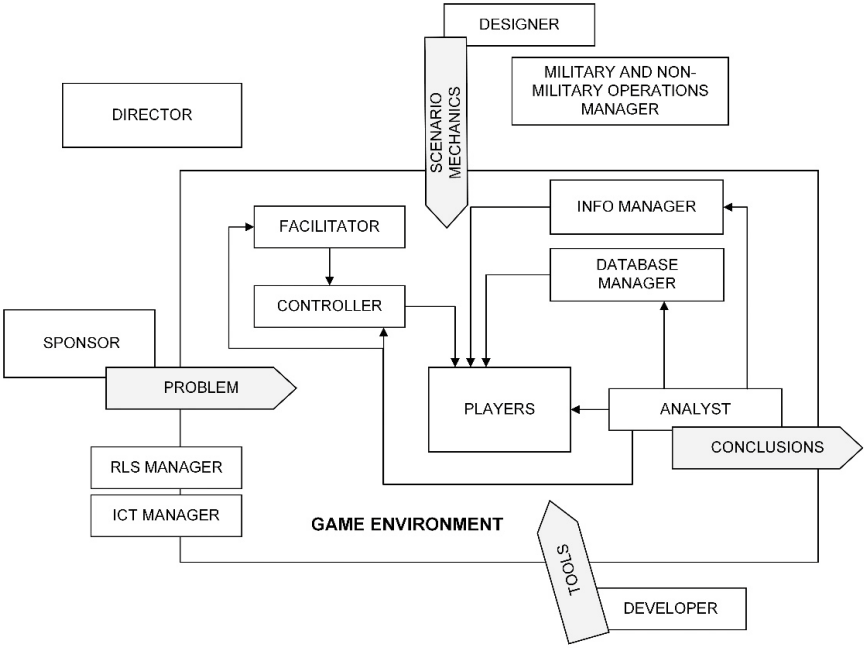


Figure 4. Role and place of design team members
Source: author's own study

2. Players
   Players are the most important participants in the game. They should be carefully selected in terms of expertise, ensuring the appropriate substantive level of the game and achieving the assumed goals. It is essential that players show a high level of involvement in the game. It is desirable that the players be volunteers. Player actions and decisions should be watched and archived as the main source of data for analysis. Players usually play in teams/groups (color-coded) representing:
   a. friendly or allied forces (e.g. BLUE);
   b. the opposing forces (e.g. RED);
   c. indigenous (local, national) security forces (e.g. GREEN);
   d. armed non-state actors (e.g. ORANGE);
   e. organized (including transnational) criminal groups (e.g. BLACK);
   f. civilian population or neutral actors (e.g. BROWN);

g. national and international political organizations and diplomats (e.g. YELLOW);
h. humanitarians, international organizations and non-governmental organizations (e.g. WHITE).

In some types of games[4], both RED and BLUE teams may represent the same side, e.g. friendly forces. Figure 5 shows a variant of the positioning of the players and the design team during the game. The dashed line indicates the separation of individual teams. During the game, team representatives meet only at the moment of evaluating the decisions made. The exchange of information between individual cells during the game should only take place based on specific rules and should be supervised by the info manager.

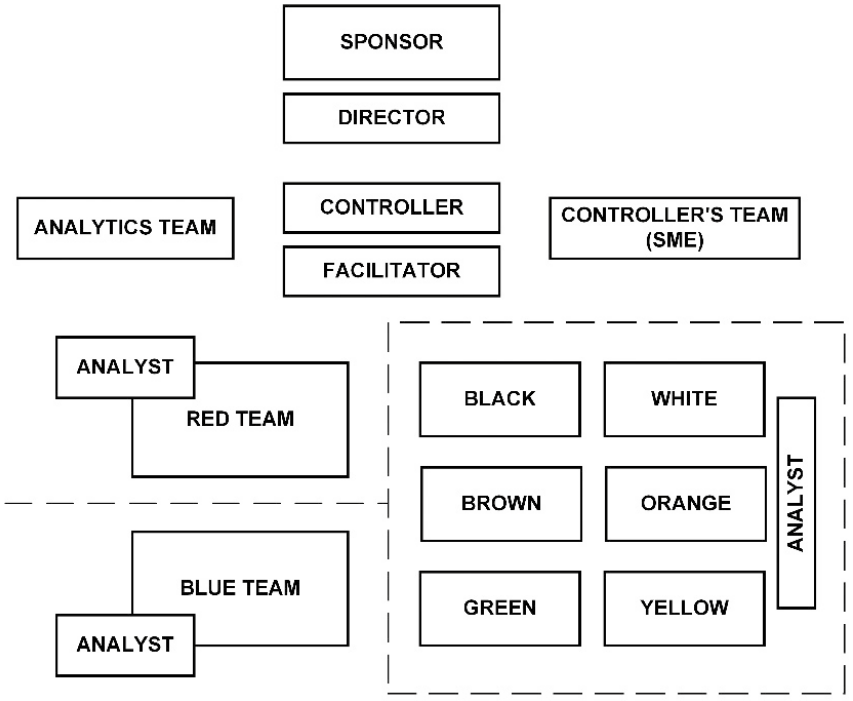


Figure 5. A variant of the positioning of the players and the design team during a war game
Source: author's own study

[4] For example, in a simulation, where the plan is analyzed independently by two teams.

3. Game mechanics
   Each game has rules that describe how the game is played, including the order in which players make moves, what actions are allowed, and how they are assessed. They all make up the mechanics of the game. The mechanics depend on many factors and, above all, it is determined by the type of war game used. The mechanics of the game, taking into account the definition of war games contained in Chapter 1, can be depicted as in Figure 6.

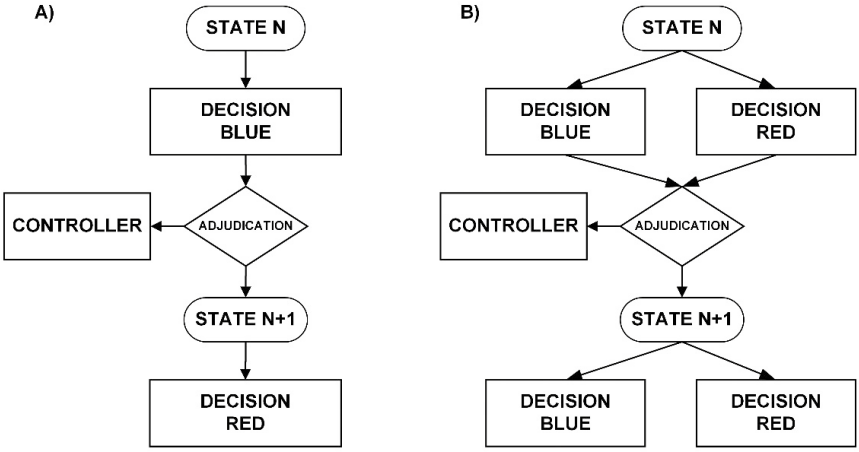


Figure 6. War game mechanics:
A) with sequential decision making (extensive form)
B) with simultaneous decision making (strategic form)
Source: author's own study

Considering the initial state of the game as state 0, which is the responsibility of the RED team, generating a dilemma for BLUE, it can be assumed that one complete round of the game, in the case of sequential decision making, consists of BLUE's action, RED's counteraction and BLUE's response. In that case, each side will be responsible for generating 2 game states. Each side's action within a round is usually referred to as a turn.

In the case of decisions made simultaneously, a full round of the game involves taking one turn by each of the game participants. The possible course of subsequent rounds and turns is shown in Figure 7.

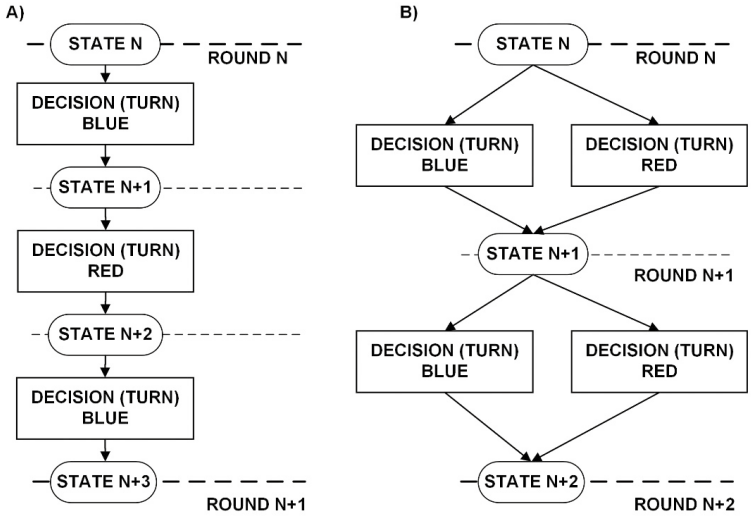


Figure 7. The course of a gameplay
A) with sequential decision making (extensive form)
B) with simultaneous decision making (strategic form)
Source: author's own study

Depending on the assumed goal of the game, the scenario can be played through (Dowództwo Wojsk Lądowych, 2007; Krajacich, 2021):

a. time analysis – hour by hour, day by day; month by month, etc.;
b. analysis of operation phases;
c. analysis of key tasks;
d. analysis of the adopted area of operations in terms of occurring events;
e. analysis of key events sequence;
f. analysis of directions of action.

The mechanics presented earlier is directly applicable to such types of games as simulation or matrix games. In other types of games, it will be subject to modifications. For example, in DTAG games, in the first round, task and problem analysis and action planning are carried out simultaneously by at least two independent teams. Then, in the second round, the teams return to the initial state and run the decision cycle again, taking into account additional technological factors. Figure 6 shows the mechanics of a DTAG game.

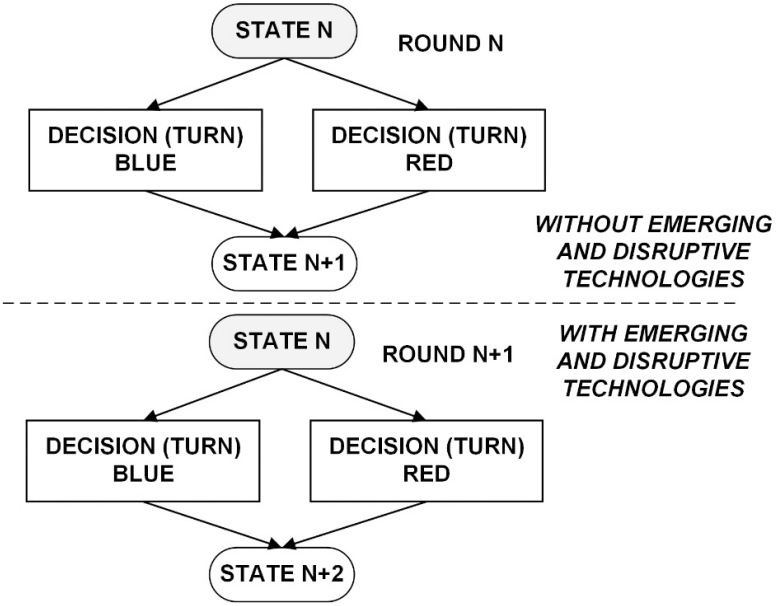


Figure 8. The mechanics of a DTAG game
Source: author's own study

When designing the game mechanics, it should be taken into account that any attempts to reliably represent reality can significantly complicate the rules of the game, affect its length, and thus discourage and reduce the involvement of players in its course.

Scenario

The game scenario is a prepared narrative that provides the background to the research problems identified by the sponsor. The scenario should ensure a multi-faceted approach to the conducted analyzes and research and the achievement of the assumed goals. Hence, the key issue for the development of the scenario is the proper definition (at the initial stage) of the research problem to be wargamed. To achieve this, two fundamental mistakes must be avoided (Silverman, 2009):

1. failure to distinguish the real problem from what is currently functioning in the social sphere – debates, media, conversations, opinions;
2. too broad definition of the research problem – it is impossible to explore everything with one game.

A good war game scenario should combine many factors. It should make it possible to understand how the connections and relations between external factors, trends and internal conditions that may generate threats or opportunities. Individual factors may escape attention in the conducted analyses, while in combination with others, they may become crucial to achieving the assumed goals.

Scenario planning should start with organizing knowledge related to the game and dividing it into two categories: elements that we think we know, and elements that remain in the area of probability and uncertainty (Schoemaker, 2007). Known elements, including lessons learned and identified trends, allow for making preliminary assumptions regarding the possible development of the situation. It should be remembered that some phenomena tend to change in certain periods. By adding elements of uncertainty to the adopted assumptions, potential opportunities for future development are generated.

In order to design a game well, the designer must first of all isolate himself from the influence of the opinions and views of authorities (sponsor, decision makers) and ask himself two fundamental questions (McGrady & Perla, 2019):

1. What do I think about the wargamed problem?
2. Why is the situation this way and who profits from it?

The answers to the above questions can help design the game mechanics, its scenario, rules and interactions between the players. In addition, regardless of the designer's knowledge of the project, there are common rules that should be taken into account when developing a scenario:

1. conflict – wherever there are scarce goods, it is very likely that there will be a conflict between the players;
2. discrepancies between individual and group goals – it is important to keep in mind that individual goals depend on the position held and do not necessarily coincide with the goals of the organization;
3. history – it should be remembered that history has a tendency to repeat itself and maybe the solution to the problem already exists.

An exemplary scenario development methodology, modified for the purposes of war games, is shown in Figure 9.

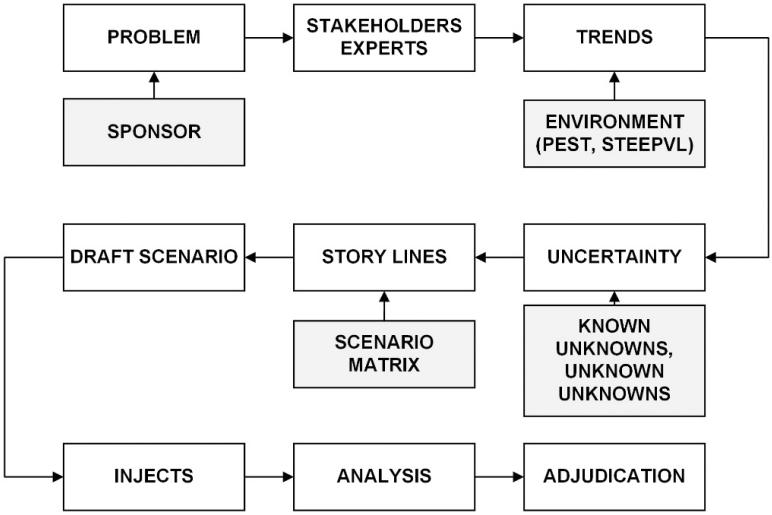


Figure 9. An exemplary scenario development methodology
Source: author's own study

The methodology for developing a game scenario includes the following (Koehler & Harvey, 2007; Kononiuk, 2011; Schoemaker, 1995):

1. Defining the problem
   A decision problem cannot be defined too generally. When playing many scenarios with a wide range of issues, there are risks of too superficial analysis of the game subject and the inability to generate possible developments due to the influence of too many factors (variables). When choosing a research area, three questions can be used: what is possible?, what is feasible?, what is desirable?
   The choice of the research area cannot be absolute, i.e. closed. During the game, other factors not originally included in the scenario, but important from the point of view of the considered problem, may occur.
2. Identification of stakeholders and subject matters experts
   Identification of stakeholders allows to determine who will be interested in participating in the game, what their behavior has been so far, and what their interests are. SMEs support the construction of the scenario so as to maintain its reality. The group of SMEs should be heterogeneous.

3. Identification of trends
   It is necessary to determine the influence of trends (positive, negative, neutral). When identifying trends, we can use, for example, the PEST analysis (checklist of: political, economic, social, and technological factors) or STEEPVL analysis (checklist of social, technological, economic, ecological, political factors, values, and legal factors).
4. Identification of unknown factors (uncertainties)
   Particular attention should be paid to unknown factors that can shape the future. Their potential impact on reality should be determined. It is important to realize that among the unknown factors there may be those that we can expect – unknown that we know, and those that we do not expect – unknown that we do not know.
5. Developing story lines
   One method of constructing the plot is to select two key uncertainties, variables from a predetermined set, and build a matrix specifying the possible development of the situation for each of them. Figure 10 shows a situation where the maintenance of alliance cohesion and the increase in the aggressiveness of the potential adversary's policy were indicated as variables. As a result, four different solutions were obtained – variants of the development of the situation that can be used during the game.

	Increased alliance cohesion	Divergent interests of member states
Cooperative policy of the adversary state based on trade relations	No possibility of economic blackmail	Weakening of individual states in bilateral relations
Confrontational politics, increased aggression of a potential adversary	Deterrence, proactive attitude	Possibility of isolation of individual states, regional conflict

Figure 10. Scenario matrix
Source: author's own study

The selected scenario should create an internally consistent, credible description of the development of events that explains how the current state of reality passes into possible future states.

6. Developing a draft scenario
   At the next stage, the selected scenario should be confronted with all trends to identify those that are favorable or potentially negative. Particular attention should be paid to weak factors and unpredictable events that may change the picture of the scenario.
7. Development of scenario events
   It consists in developing specific events that fit into the plot of the scenario. The plot should contain all previously identified uncertainties. Where the same phenomenon is explored multiple times, individual games should cover alternative futures rather than variants of the same scenario.
8. Development of requirements for further research and analysis
   During the development of the scenario, it may be necessary to conduct further in-depth analyses, e.g. in terms of identified trends and their correlations.
9. Identifying possible indicators, assessment (adjudication) rules
   Adjudication rules and assessment indicators should be identified by experts. As far as possible, they should be objective, developed on the basis of quantifiable data, understandable for players and allowing for obtaining data for later analysis.

Adjudication

Adjudication (deciding on the consequences of decisions made, dispute resolution) is an essential element of decision/war games common to all types. It fulfills several essential functions in the game (McGrady, 2020):

1. keeps the game within the framework of the developed scenario – each scenario has its limits;
2. allows to direct the actions of players in order to achieve the assumed goals of the game;
3. allows to react in the event of unforeseen circumstances, e.g. by issuing orders from senior superiors.

The following types of adjudication can be distinguished:

1. rigid – based on strictly defined rules;
2. semi-rigid – using an outcome from strictly defined rules as a starting point for discussion by players and SMEs;

3. free – based on the knowledge and experience of the controller (control team), and the expertise and experience of SMEs;
4. minimal/consensual – based on the expertise and experience of the controller (control team, SMEs) and discussion between the sides of the game, in which they strive to agree on a common position.

Irrespective of the agreed method of adjudication, it should be borne in mind that the decisions of the controller will be affected by the following external factors.

1. Goals (motivation) of the players – during the game it may happen that the decisions made by the players are rational and could be a solution to the currently considered problem, but ignore the goals of their participation in the game, such as:
   a. verification of plans/concepts – the aim of the game should be to consider, evaluate plans, concepts as a whole;
   b. training – the game should enable participants to improve, e.g. in terms of implementing procedures or making decisions;
   c. discovering new ideas/problems – the aim of the game should be to identify factors that have not been visible or considered unimportant so far;
   d. entertainment;
   e. other (e.g. negative motivation – forced participation in the game).
2. Rules, game mechanics – rules should be applied wherever possible. Lack of rules can lead to irrational decisions or actions.
3. External context (geographical, political, historical, etc.) – when making a decision, the controller should be guided by the rules found in the real world.
4. Scenario (history) – the controller's decisions should ensure the development of the game situation in accordance with the adopted scenario.
5. Player characters (actors) – decide what is allowed and what is not, what abilities and skills they have.

In addition, decisions made during the game will be influenced by the controller himself, his experience, character, prejudices. The above has been illustrated in Figure 11.

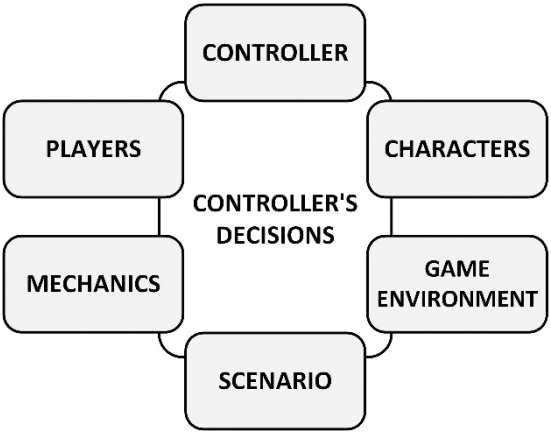


Figure 11. The influence of external factors on the controller's decisions
Source: author's own study

Data collection and analysis

During the development of the game project, it is necessary to take into account the data collection mechanism. For the data collection and analysis process to be effective, a data collection and analysis plan should be developed. It should ensure that data is collected in a structured manner using appropriate people and techniques. In the above-mentioned plan, the variables that will be acquired must be specified, as well as their measures. The type of variables obtained will have consequences for the selection of the appropriate analytical technique for their processing.

Data analysis is usually divided into three phases (Allied Command Transformation, 2021):

1. descriptive analysis of individual variables;
2. analysis of relationships between variables;
3. analysis of patterns with many variables.

Once the variables necessary for capture have been identified, the tools that will enable this (e.g. simulation system, observation sheet) and the test sample should be identified. Subsequently, training of data collection personnel is necessary. During the game, data should be collected in accordance with the above-mentioned plan, and all other

information, observations, in particular conversations conducted by players, arguments quoted, reactions to situations occurring in the game, should be documented.

The following categories and data analysis techniques can be used to prepare a data collection and analysis plan, data acquisition and subsequent analysis (Allied Command Transformation, 2017):

1. Data structuring techniques – identify and organize facts, issues and ideas. They involve decomposition, visualization, organization, and grouping as a way to break down data into its component parts. Data structuring techniques are used for capturing ideas and as a basis for further work. As part of data structuring, the following can be distinguished:
   a. mind mapping;
   b. concept mapping;
   c. rich picture.
2. Creative thinking techniques – they allow to look at the problem from a different perspective and break out of stereotypes, knowledge commonly used in the organization of the sponsor. They allow new ideas or novel combinations of ideas to be generated. In addition, they enable overcoming prejudices and trigger creativity. As part of creative techniques, we can distinguish:
   a. brainstorming;
   b. reverse brainstorming;
   c. brainwriting;
   d. starbursting;
   e. six thinking hats;
   f. creative combinations.
3. Diagnostic techniques – used to support problem analysis or the development of alternative solutions. They focus on testing hypotheses, and assessing evidence. They are often used to identify or diagnose potential problems. As part of the diagnostic techniques, we can distinguish:
   a. SWOT (strengths, weaknesses, opportunities and threats) analysis;
   b. PMI (plusses, minuses, interesting) analysis;
   c. five why's;
   d. key assumptions identification;
   e. quality of information check;

   f. outside-in thinking;
   g. surrogate adversary/role play;
   h. alternative futures analysis.
4. Challenge techniques – also called contrarian techniques. They can appear in different versions as: self-criticism, criticism of others, and criticism by others. They consist in challenging current thinking and existing solutions, examining the problem from a different, often opposing point of view. As part of the challenge techniques, we can distinguish:
   a. devil's advocacy technique;
   b. team A/team B analysis;
   c. pre-mortem analysis;
   d. what-if analysis.

CHAPTER 4

GAME TOOLS

source: Combat Camera Poland

When preparing war game tools, the developer must consider three essential elements: space, time, and the sides of the game and the interactions between them.

Space

The basic tool in the game is the board. It allows the visualization of the game space and creates an environment for communication between its participants. The board should contain only those elements that are important to the players. Therefore, it is necessary to properly prepare it, taking into account the type of game and its purpose.

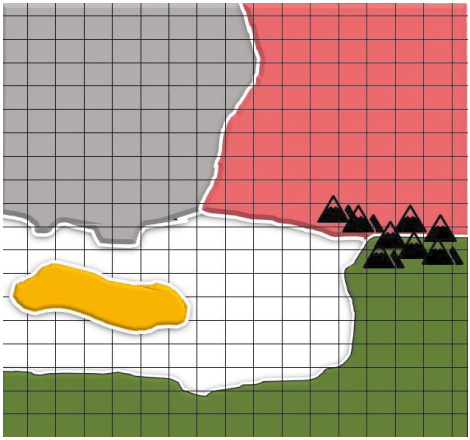


Figure 12. Game board
Source: author's own study

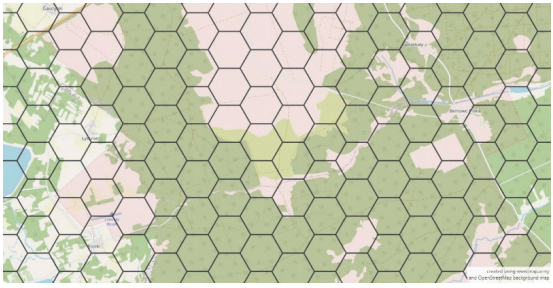


Figure 13. Game board
Source: author's own study based on www.map.army [May 15, 2022]

Figures 12 and 13 show game boards, taking into account the level at which the game is played and its goal. Figure 12 shows a game board, the aim of which is to illustrate the overall operational situation in the game, while Figure 13 allows to simulate the actions of players at the tactical level.

A game board can be made using: any map, fields, zones, graphs, diagrams, models.

1. Any map (physical, political, etc.) with a grid, lines limiting the moves that can be made by players. The selection of the map scale and the grid limiting the players' moves will be of particular importance in the case of CoA games, in which the depiction of the terrain, including its accessibility parameters, directly affects the ability of the players to perform actions. In the simplest case, commonly available maps can be used, e.g. with UTM (Universal Transverse Mercator) or WGS-84 (World Geodetic System 1984) grid. Figure 14 shows a game board with a UTM grid overlay.

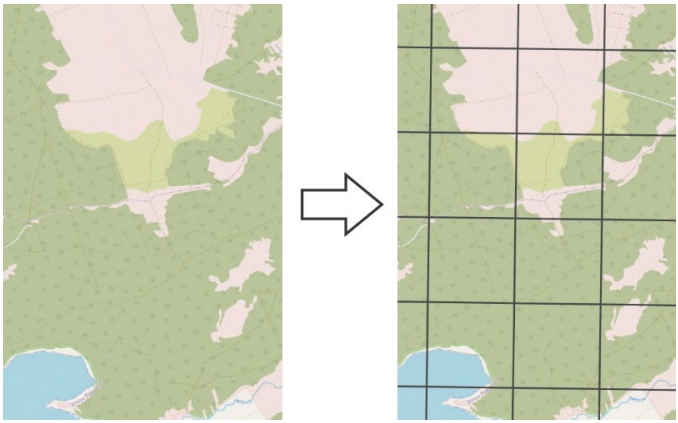


Figure 14. Preparation of a game board
Source: author's own study based on www.map.army [March 7, 2022]

Figure 15 shows two examples of a game board: with the WGS-84 grid and with the grid in the form of regular hexagons. The use of a standard grid (in this case, WGS-84) may cause difficulties in visualizing the movements made by players, e.g. while maintaining an appropriate level of game realism. If a unit is moved, it may still be in the same field on a board despite performing an action. However, in the case

of moving a unit to an adjacent field, it would actually have to move a distance that is impossible according to the rules of the game. The use of a grid of regular hexagons allows units to be moved in each of the six directions by the same distance, i.e. by one field of the same size.

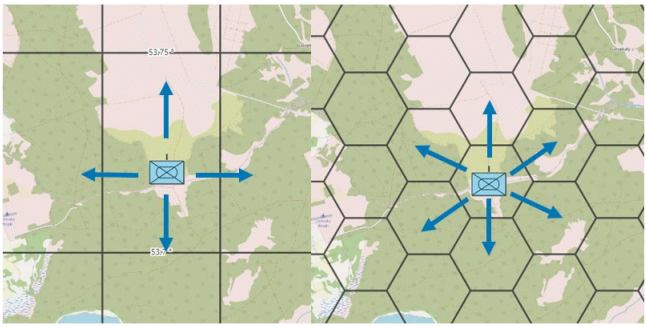


Figure 15. Influence of grid selection on players' ability to make moves
Source: author's own study based on www.map.army [March 7, 2022]

2. Fields, zones
   Figure 16 shows a game board with irregularly shaped fields. This type of depiction is most often used when the game is played at a higher level, e.g. strategic, and the actors in the game represent, for example, states or international organizations. During the game, the processes taking place and the ways of making decisions, are considered rather than the actual, real operation of individual elements.

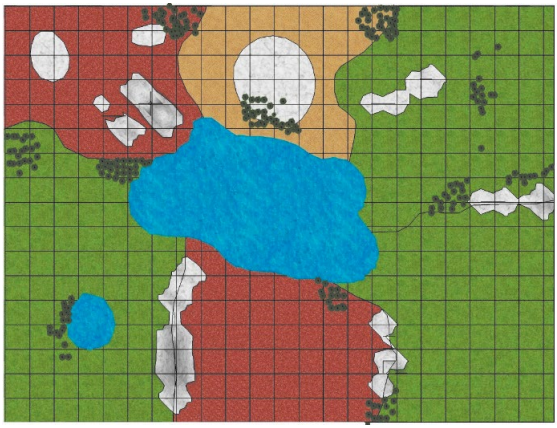


Figure 16. Game board with zones
Source: author's own study

3. Graphs, diagrams, models
   Figure 17 shows a game board with a diagram enabling a detailed analysis of the processes taking place and the actions taken. This type of visualization is particularly useful when the game environment is a space domain or cyberspace and the actual representation of this environment is impossible due to its abstractness. In addition, they make it possible to visualize and make a detailed time analysis of the ongoing processes and actions in the game.

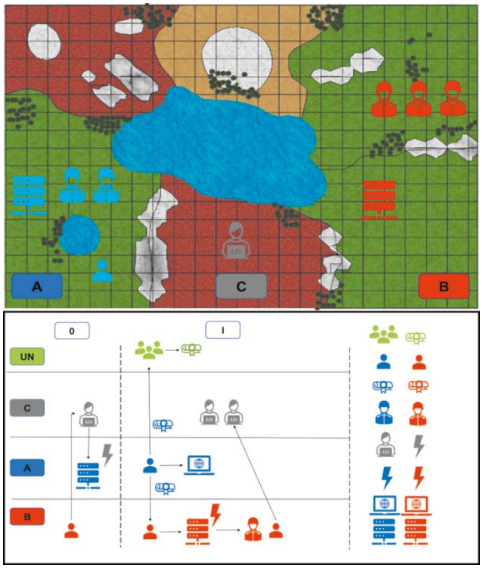


Figure 17. Game board with a diagram
Source: author's own study

Time

The chronology of events in war games can be represented (Dymarczyk, 2007) in two ways.

1. In a linear, sequential (synchronous) manner
   In a synchronous representation of events, each element occurring in time is treated as a single event that passes and causes specific effects and consequences. All elements in time occur in a certain order one after the other.

2. In a cyclical manner (e.g. in relation to recurring processes)
   In a cyclical representation of events, time can be inscribed in a circle and have no beginning or end. A characteristic element of this approach is the return to the initial state. In this case, each element in time can occur in parallel with the others.

In addition, within a game, the chronology of events may include time jumps.

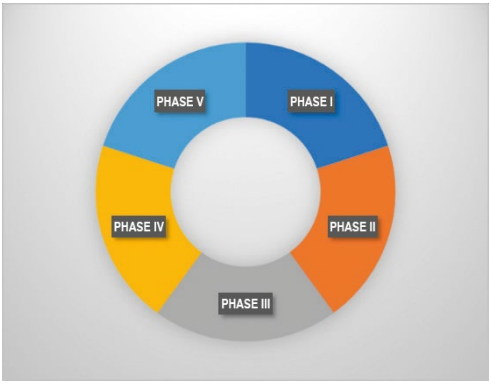


Figure 18. Cyclic representation of time
Source: author's own study

Sides of a game and the interaction between them

Representation of the game sides should enable unambiguous identification. Figure 19 presents examples of types of weapon systems (forces) present in the game. The graphics contain only basic information about the type of military equipment. The level of detail that should be taken into account when creating a game depends on the goal and the level at which the game is played. For example, in the case of games at the strategic level, the visualization will primarily serve to show what capabilities and tools the players have at their disposal. However, in the case of games played at the tactical level, it is necessary to visualize the value of capabilities.

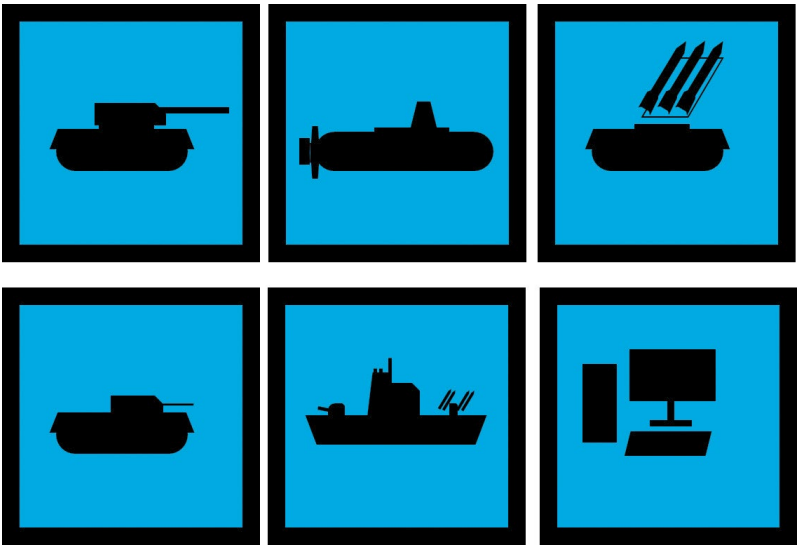


Figure 19. Representation of game elements
Source: author's own study

Interactions between players/sides are one of the most difficult elements to perform during game preparation. It fundamentally affects the adjudication during the game. In CoA games, the actors appearing in the game are usually assigned actions and capabilities along with their value/potential. These can be both offensive and defensive capabilities. Figure 20 shows an armored unit with an example of assigned attack values, including its range, defense, displacement and ability to cross terrain. It should be borne in mind that assigning additional parameters to players in the game can significantly complicate its rules and requires proper preparation of the board.

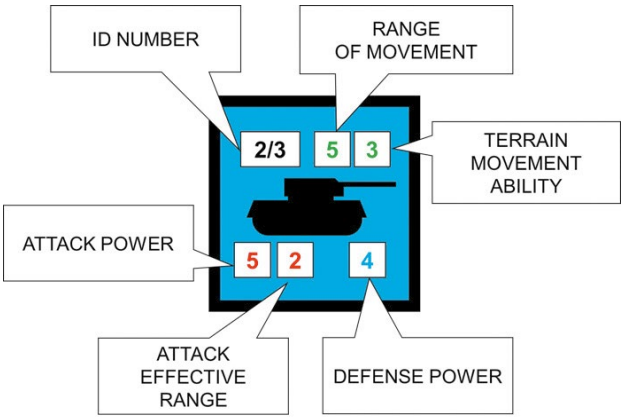


Figure 20. An example representation of possessed capabilities, possible actions
Source: author's own study

In the case of kinetic actions, the result of the clash of the sides is most simply obtained by comparing the potential of the units involved in the clash. Figure 21 shows the aggregation and comparison of the potential of RED and BLUE units. Depending on the mechanics of the game, the potential may be aggregated, e.g. only within units of the same type or within all of the player's units involved in the clash. The obtained results are an approximation and may not fully correspond to the results possible to be obtained in simulation systems based on more detailed data or with the results of real combat operations. It is essential that players are aware of this.

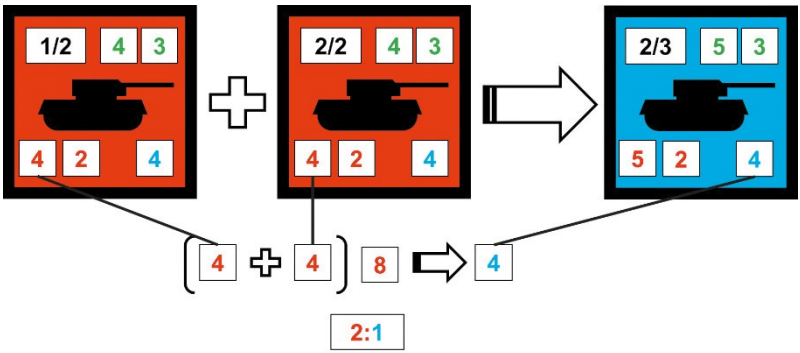


Figure 21. Capability aggregation on RED attack
Source: author's own study

In some solutions, in order to make interaction in the game more realistic, an element of uncertainty is introduced in the form of a dice roll. Figure 22 shows a variant in which the green color marks the required number of dots to be rolled with two 6-sided dice for the assumed effect – victory/defeat to become a reality in the game. Referring to the case shown in Figure 21, RED would have to score at least nine in one throw to be successful.

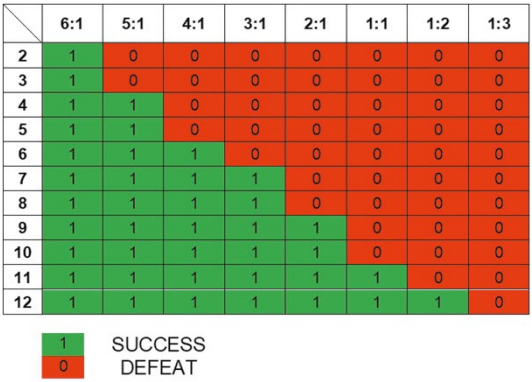


Figure 22. Probability of a successful attack with a given force ratio
Source: author's own study

In the above solution, only the sum of the dice thrown is evaluated. In the event that the capabilities of the actors/units in the game do not have assigned values, the use of dice also makes it possible to assess the effectiveness of the impact, including non-kinetic, as well as to illustrate the potential risk, e.g. related to the process of acquiring new weapons.

CHAPTER 5

THE PROCESS OF PREPARATION AND EXECUTION OF A WAR GAME

source: Combat Camera Poland

Process model

The process of preparing and conducting the game includes 7 stages:

1. Stage I – commissioning, carried out by the sponsor in consultation with the design team, including:
   a. defining the game's goals and expected effects;
   b. identifying the research problem;
   c. development of a schedule for the preparation and execution of the game.
2. Stage II – designing, carried out by the design team, mainly the designer, including:
   a. operationalization of the game's goals and expected effects;
   b. identification of tools necessary to conduct the game and the analyses;
   c. development of the concept of the organization and course of the game, including the initial scenario.
3. Stage III – preparation, carried out by the design team, including:
   a. preparation of tools to execute the game, taking into account game mechanics and scenario;
   b. providing organizational support for the game (logistics, administration);
   c. providing technical support for the game (including ICT systems, command and control support systems, etc.);
   d. preparation of a mechanism for collecting and analyzing data, and conducting research;
   e. development of game documentation.
4. Stage IV – testing, carried out by the design team, including the conduct of internal tests of game mechanics and supporting tools.
5. Stage V – conducting a trial game, carried out by the design team, includes tests and demonstration of the expected course of the game with the participation of the sponsor.
   Stages III through V are part of development. Within this process, the design team will prepare, develop and test mechanics, scenario, tools, data-collection mechanism repeatedly, and move between these, going back to re-design elements of the war game after testing them.
6. Stage VI – game execution is the essential stage of the process, conducted with the participation of the players and all game participants.

7. Stage VII – analysis and archiving, carried out by the design team, mainly the analyst. This stage should be carried out in parallel with the other stages, which will enable proper preparation and conduct of analyses.

A general diagram of the process of preparing a war game is shown in Figure 23. Gray arrows indicate the feedback flow, thanks to which the game should be subject to a continuous process of change and improvement. The red color means that the lessons and observations from these stages will be used in the preparation of the next games.

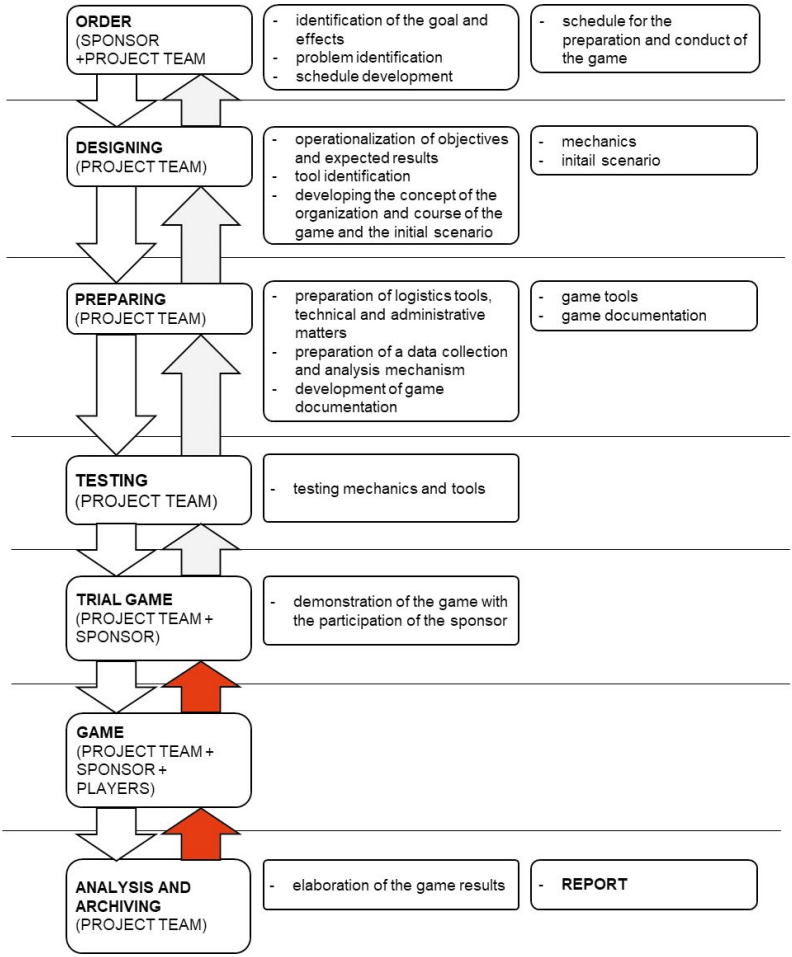


Figure 23. The process of preparation and execution of a war game
Source: author's own study

Below are examples of war games: seminar and matrix at the strategic level. All cases are based on the same materials, including the scenario. As mentioned earlier, the choice of the type of game depends on the goal defined by the sponsor.

Seminar game

1. Game preparation
   a. Board

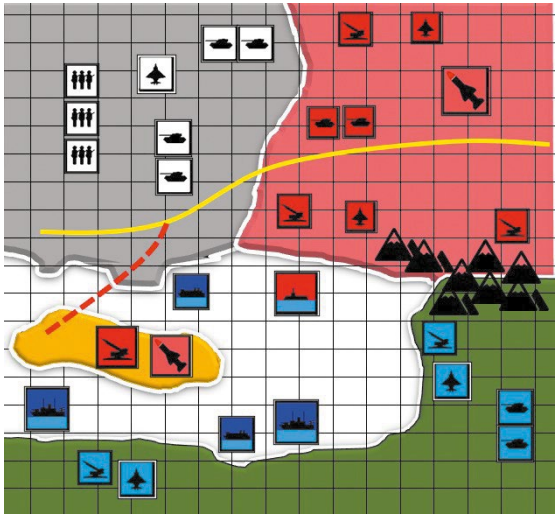


Figure 24. Seminar game board
Source: author's own study

   b. Scenario
      – PHASE I (round I)
        RED, under the national development program, started the simultaneous implementation of many infrastructural projects. They started the construction of...
      – PHASE II (round II)…
2. Game execution
   a. The game is conducted in three twenty-minute sessions – rounds (depending on the stages of the scenario).

b. At the beginning of each round, the board is displayed, and the players are given a scenario and analyze it.
c. Considering each of the stages of the scenario, the players indicate the resulting implications, possible necessary actions, decisions and their justification.
d. The players write down the implications, necessary actions, decisions and their justification on index cards, and then stick them in the table:

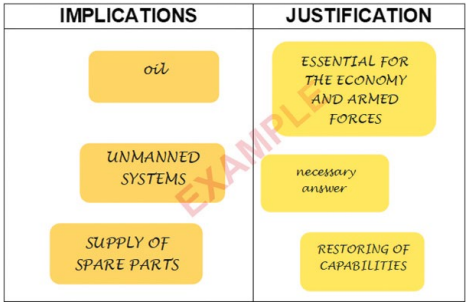


Figure 25. Implications table
Source: author's own study

e. After indicating all the implications, they are put in the table taking into account the dimensions of the security environment according to the PMESII[5] categorization.

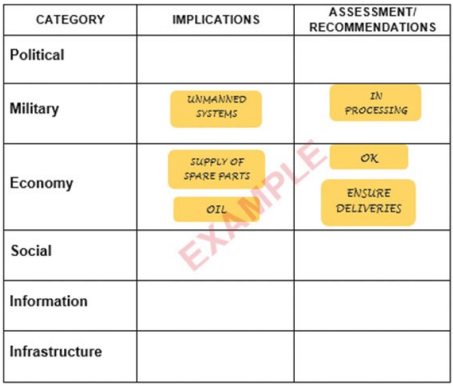


Figure 26. Analysis of players' decisions according to the PMESII categorization
Source: author's own study

[5] PMESII – Political, Military, Economy, Social, Information, Infrastructure. A variant of PMESII analysis is PMESII-PT. In addition to the above, Physical Environment and Time are considered.

f. After sticking all the implications in the right areas, they are evaluated by the participants of the game. In the case of generating specific recommendations/capabilities, they are written down in the ASSESSMENT/RECOMMENDATIONS column – they are decisions made in the first round.
g. Another round is then played. Players analyze the next phase of the scenario and indicate implications/recommendations as in the previous round, taking into account previously made decisions.

3. Final arrangements
   a. The facilitator directs the discussion to achieve the intended goal of the game.
   b. During the game, the analyst participates in the work of the team, and takes notes necessary to prepare the game report on an ongoing basis.
   c. During the discussion, all thoughts and ideas are collected, including those deviating from the assumed direction.

1½-sided matrix game[6]

1. Game preparation
   a. Board

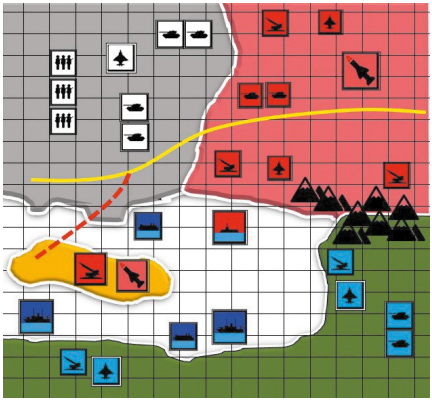


Figure 27. 1½-sided matrix game board
Source: author's own study

[6] The RED team is being played by the facilitator. The RED team makes ad-hoc decisions throughout the game based on the development of the scenario.

b. Scenario
   - PHASE I (round I)
     RED, under the national development program, started the simultaneous implementation of many infrastructural projects. They started the construction of...
   - PHASE II (round II)…

c. Attributes – represent the capabilities that players have or can acquire, actions that can be performed. During the game, attributes are used to graphically represent the reality that exists in the game.

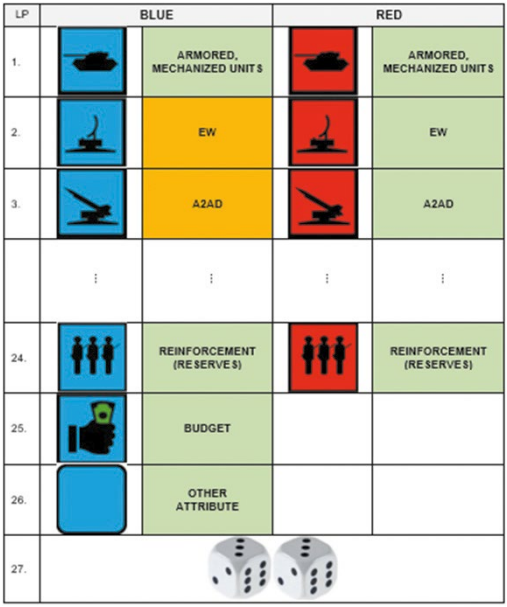


Figure 28. Table of attributes available to players
Source: author's own study

d. Player's card – contains all the necessary condensed information about the attributes and budget funds.

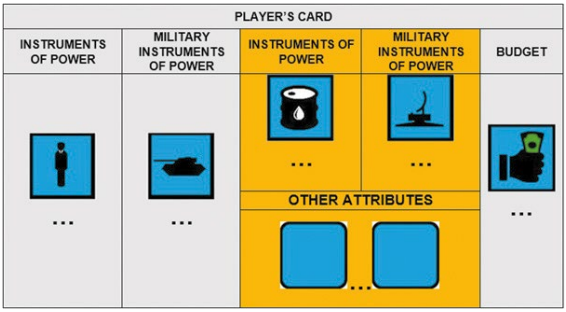


Figure 29. Player's card
Source: author's own study

e. Matrix – the most important element of the game; allows to collect data, conclusions, and solutions proposed by players necessary to analyze and develop a game report.

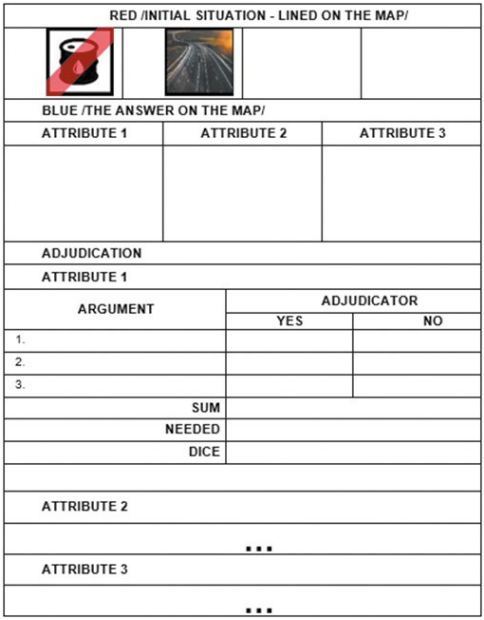


Figure 30. Game matrix
Source: author's own study

2. Game execution
   a. The players are assigned to the BLUE team. They act as the representative of the armed forces in the National Security Council.
   b. At the start of the game, the players receive:
      – scenario;
      – cards with the attributes they have (marked green in the table in Figure 28);
      – cards with financial resources, for which they can acquire new attributes during a turn (marked orange in the table in Figure 28);
      – blank cards which can be used to acquire other attributes not included in the table (using budget cards);
      – a player's card with all the items listed above.
   c. The facilitator introduces the situation based on the scenario. He performs turn 0 based on the developed assumptions, i.e. introduces the players to the situation and makes RED's move.
   d. In response to the facilitator's action, BLUE perform a turn:
      – they suggest responding using the attributes they have; within one turn (response), BLUE can use no more than three attributes; for this purpose, they lay out the proposed attributes on the game board and present a matrix filled in with arguments for the proposed solution;
      – in order for the proposed action to materialize in the game, each attribute laid out is subject to evaluation in terms of its possible use;
      – the evaluation is made using the matrix taking into account the element of randomness;
      – BLUE enter into the matrix up to three arguments "for" the applied solution in relation to each of the attributes; the arguments used must be relevant[7]; they are subject to evaluation and in case of negative verification may be rejected;
      – taking into account the above data, BLUE players roll two dice; to get the ability to use the attribute, it is necessary

[7] Due to the fact that these are immeasurable values, they are subject to assessment by the controller.

to roll at least 7 (58.3%); at the same time, each argument "for" increases the probability of its use by +1, i.e. players must roll 1 point less; similarly, each argument "against" makes it necessary to roll 1 point more.

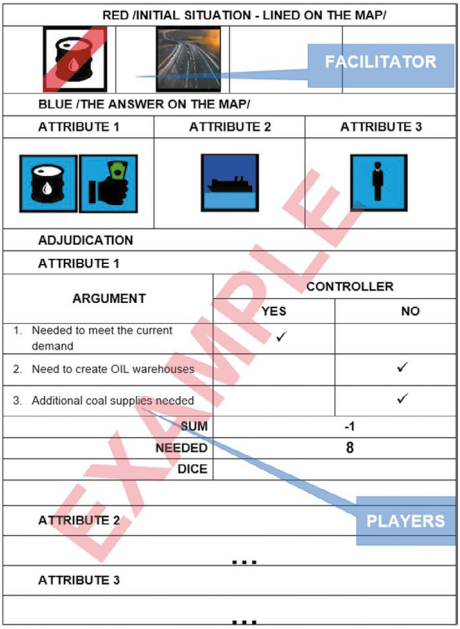


Figure 31. Example of filled-in matrix
Source: author's own study

3. Final arrangements
   a. The facilitator directs the discussion to achieve the intended goal of the game.
   b. During the game, RED's response (performed by the facilitator) can be freely modified with additional attributes.
   c. During the game, the analyst participates in the work of individual teams, and takes notes necessary to prepare the game report on an ongoing basis.
   d. During the discussion, all thoughts and ideas are collected, including those deviating from the assumed direction.

2-sided matrix game

1. Game preparation
   a. Board

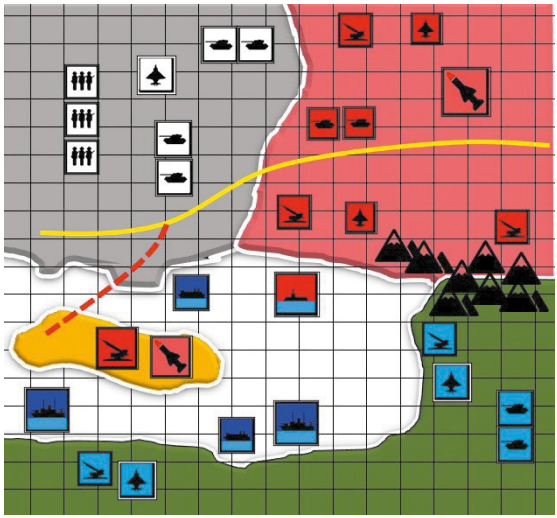


Figure 32. 2-sided matrix game board
Source: author's own study

   b. Scenario
      – PHASE I (round I)
        RED, under the national development program, started the simultaneous implementation of many infrastructural projects. They started the construction of...
      – PHASE II (round II)…

c. Attributes

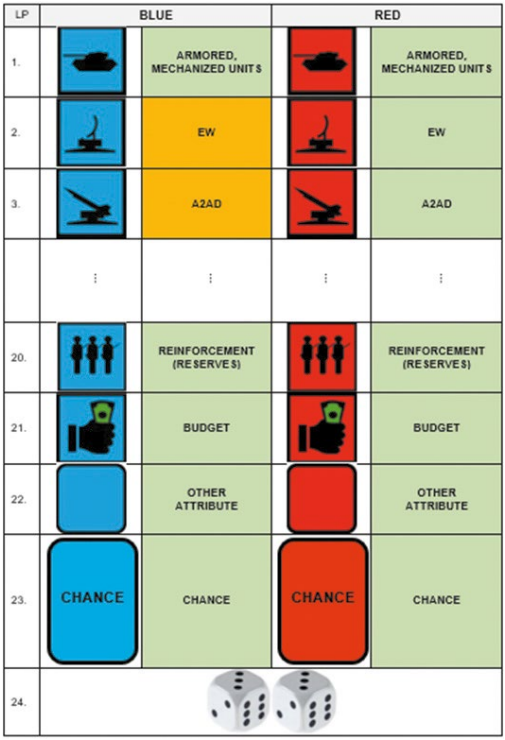


Figure 33. Table of attributes available to players
Source: author's own study

d. Player's card

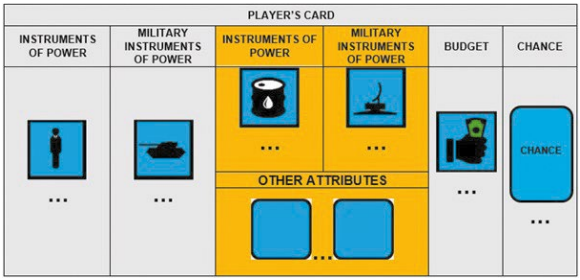


Figure 34. Player's card – BLUE
Source: author's own study

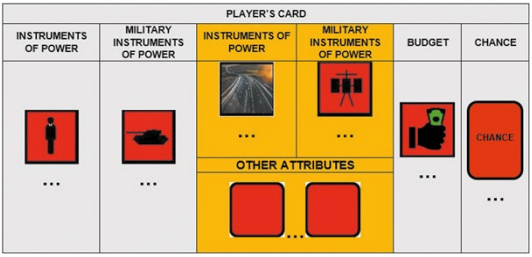


Figure 35. Player's card – red
Source: author's own study

e. Matrix

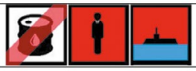
ROUND 0			
ATTRIBUTES:			
			
REACTION – BLUE:			
ATTRIBUTE 1	ATTRIBUTE 2	ATTRIBUTE 3	
ADJUDICATION:			
ATTRIBUTE 1			
BLUE ARGUMENTS	CONTROLLER YES/NO	RED COUNTER-ARGUMENTS	CONTROLLER YES/NO
SUM			
NEEDED			
DICE:			
ATTRIBUTE 2			
...			

Figure 36. Game matrix
Source: author's own study

2. Game execution
   a. The players are assigned to the BLUE and RED teams. BLUE act as the representative of the armed forces in the National Security Council, while RED act as the commander-in-chief of the RED's armed forces.

b. At the start of the game, the players receive:
   - scenario;
   - cards with the attributes they have (marked green in the attribute table in Figure 33);
   - cards with financial resources, for which they can acquire new attributes during a turn (marked orange in the attribute table in Fig. 33 and in the player cards in Fig. 34 and 35);
   - blank cards which can be used to acquire other attributes not included in the table (using budget cards);
   - CHANCE cards, which can be used by the players to present counter-arguments during the game;
   - a player's card with all the items listed above.

c. The facilitator introduces the situation based on the scenario. He performs turn 0 based on the developed assumptions, i.e. introduces the players to the situation and makes RED's move.

d. In response to the facilitator's action, BLUE suggest responding using the attributes they have. Within one turn (response), BLUE can use no more than three attributes. For this purpose, they lay out the proposed attributes on the game board and present a matrix filled in with arguments for the proposed solution;

e. In order for the proposed action to materialize in the game, each attribute laid out is subject to evaluation in terms of its possible use. The evaluation is made using the matrix taking into account the element of randomness;
   - BLUE enter into the matrix (Figure 36) up to three arguments for the applied solution in relation to each of the attributes; RED, after getting acquainted with the proposed solution, if they have a CHANCE card, similarly give no more than three arguments „against"; each argument „against" acknowledged by the controller resets one argument „for" of the playing team; the arguments „against" do not have to relate directly to the arguments „for", but to the proposed solution;
   - taking into account the above data, BLUE players roll two dice; to get the ability to use the attribute, it is necessary to roll at least 7 (58.3%); at the same time, each argument

"for" increases the probability of its use by +1, while each argument „against" reduces the probability of its use by -1;
- in case the arguments „against" are rejected by the controller, for each rejected argument, a CHANCE card is taken away from the team; when a team is deprived of all CHANCE cards, it loses the right to evaluate the solutions proposed by opponents, i.e. the probability of making a free and real move by the opponent increases.

f. If the move did not materialize, the attributes are returned to the players. If a budget card was used to gain an attribute that was not achieved, the team loses it.

Conclusion

War games have advantages that predispose them to be widely used in the armed forces. They provide an environment for research into the possibility of making decisions based on incomplete data, and war game participants can make decisions and actions that even they would not have predicted without the wargaming environment. They are a tool for creating analyses, conclusions, and observations. In addition, taking into account the advantages of war games and their limitations, games provide an effective tool for conducting analysis and training. They can complement education and training processes and develop creative thinking among participants at an early stage of education, trigger initiative in action, and enable the assessment of personality traits and predispositions of individual players.

A critical element in the process of preparing a war game is choosing the right type. It should be tailored to the problem under consideration, as defined by the sponsor. It is important to be aware that there are many types of war games, and each of them allows to analyze different types of problems in different ways. For example, CoA games work very well at the tactical level when simulating operations. On the other hand, at the operational or strategic level, where other aspects, including non-military ones, may play an important role, CoA games may not fully provide an analysis of the key factors influencing the development of the situation. For a specific decision problem, there is no clearly assigned tool in the form of a specific type of game that will work best in a given case. In addition, before choosing a solution, it is necessary to analyze whether conducting a war game is justified. Perhaps other available solutions, e.g. conducting simulations, or expert discussion, are more adequate and will allow for better results, taking into account lower costs of organizing the entire project (Longley-Brown & Curry, 2019).

The literature on the subject (Perla, 1990) indicates that the design and execution of war games are more of an art than a science. Nevertheless, in the process of preparing a war game, it is reasonable to use elements of

game theory. It allows to build and analyze a decision-making model based on rational premises in order to select the optimal player strategy. Even taking into account that the analyzed model is only an approximation of reality, the mere fact of the existence of various decision paths raises the awareness of game participants and demonstrates what decisions can be made and what the resultant consequences may be.

The development of war games may contribute to a better understanding by the players of the mechanisms and phenomena occurring in the armed forces and within the entire state security system. Thus, they are a tool for analyzing and improving the functioning of the armed forces and interaction with other elements of the security system.

References

Allied Command Transformation. (n.d.). *Disruptive Technology Assessment Game 'DTAG': Handbook V0.1*. https://www.innovationhub-act.org/sites/default/files/docs/DTAG%20handbook.pdf

Allied Command Transformation. (2017). *The NATO Alternative Analysis Handbook* (Second Edition).

Allied Command Transformation. (2021). *NATO CD&E Handbook: A Concept Developer's Toolbox*.

Bartels, E. (2019, November 19). *Getting the most out of your wargame: Practical advice for decision-makers*. War on the Rocks. https://warontherocks.com/2019/11/getting-the-most-out-of-your-wargame-practical-advice-for-decision-makers/

Binmore, K. (2017). *Teoria gier*. Wydawnictwo Uniwersytetu Łódzkiego.

Burns, R. S. (2015). *War Gamers' Handbook a Guide for Professional War Gamers*. Defense Automated Printing Service.

Caffrey, M. B. (2019). *On Wargaming. How Wargames Have Shaped History and How They May Shape the Future*. Naval War College.

Daszyńska-Żygadło, K. (2011). Planowanie scenariuszowe – próba systematyzacji pojęć. *Zeszyty Naukowe Uniwersytetu Szczecińskiego*, 38, 385-396.

Development, Concepts and Doctrine Centre. (2012). *Red Teaming Guide* (Second Edition). UK Ministry of Defence.

Development, Concepts and Doctrine Centre. (2017). *Wargaming Handbook*. UK Ministry of Defence.

Dixit, A. K., & Nakebuff, J., B. (1991). *Thinking Strategically: The Competitive Edge in Business, Politics, and Everyday Life*. W.W. Norton.

Dixit, A. K., & Nakebuff, B. J. (2009). *Myślenie strategiczne. Jak zapewnić sobie przewagę w biznesie, polityce i życiu prywatnym*. OnePress.

Dowództwo Wojsk Lądowych. (2007). *Planowanie działań na szczeblu taktycznym w Wojskach Lądowych: DD/3.2.5*.

Dymarczyk, W. (2007). Kultura organizacyjna – temporalne implikacje. In K. Konecki & P. Chomczyński (Eds.), *Zarządzanie organizacjami. Kulturowe uwarunkowania zarządzania zasobami ludzkimi* (pp. 77-98). Wydawnictwo Uniwersytetu Łódzkiego.

Gierszewska, G., & Romanowska, M. (1994). *Analiza strategiczna przedsiębiorstwa*. Polskie Wydawnictwo Ekonomiczne S.A.

Gilad, B. (2008). *Business War Games*. Red Wheel/Weiser.

Grimes, W. (2016, December 13). *Thomas C. Schelling, master theorist of nuclear strategy, dies at 95*. New York Times. https://www.nytimes.com/2016/12/13/business/economy/thomas-schelling-dead-nobel-laureate.html

Haman, J. (2014). *Gry wokół nas. Socjolog i teoria gier*. Wydawnictwo Naukowe SCHOLAR.

Herman, M., Frost, M., & Kurz, R. (2009). *Wargaming for Leaders: Strategic Decision Making from the Battlefield to the Boardroom*. McGraw Hill.

Jacko, J. (2009). Niektóre ontologiczne rozstrzygnięcia teorii gier na przykładzie dylematu podróżnika i dylematu więźnia. *Zagadnienia Naukoznawstwa*, 3-4, 429-441.

Joint Chiefs of Staff. (2017). *Joint Publication 1: Doctrine for the Armed Forces of the United States*. https://irp.fas.org/doddir/dod/jp1.pdf

Koehler, D. J., & Harvey, N. (2007). *Blackwell Handbook of Judgment and Decision-Making*. Wiley-Blackwell.

Kononiuk, A. (2011). *Metoda scenariuszowa w antycypowaniu przyszłości na przykładzie Narodowego Programu Foresight „Polska 2020"* [Doctoral dissertation, Uniwersytet Warszawski].

Kostecki, R. P. (n.d.). *Wprowadzenie do teorii gier*. Uniwersytet Warszawski. https://www.fuw.edu.pl/~kostecki/teoria_gier.pdf?msclkid=5938eda5bbbd11ec947748b0f0e0e610

Krajacich, C. (2021). *COA Analysis & Wargaming*. United States Naval War College.

Krupski, R. (2007). *Planowanie strategiczne w warunkach niepewności*. Wałbrzyska Wyższa Szkoła Zarządzania i Przedsiębiorczości.

Lartigue, L. J. (2008). *Wargaming and the Interagency*. U.S. Army War College.

Lis, A., & Reczkowski, R. (Eds.). (2022). *Security Environment in the (Post) Pandemic World and its Implications for the Conduct of Military Operations, GLOBSTATE, Vol. 4, Issue 2*. Doctrine and Training Centre of the Polish Armed Forces.

Longley-Brown, G. L., & Curry, J. (2019). *Successful Professional Wargames: A Practitioner's Handbook*. Lulu.com.

Malawski, M., Wieczorek, A., & Sosnowska, H. (2004). *Konkurencja i kooperacja. Teoria gier w ekonomii i naukach społecznych*. Wydawnictwo Naukowe PWN S.A.

McGrady, E. (2020, August 10-14). *Adjudication: Theory, Practice, and Swags – Mostly Swags* [Conference session]. Connections US, Quantico, Virginia, United States.

McGrady, E., & Perla, P. (2019). *Chapter 17. The top 10 things that make a good wargame designer*. In G. L. Brown & J. Curry (Eds.), Successful Professional Wargames: A Practitioner's Handbook (pp. 271-294). Lulu.com.

McHugh, F. (1966). *Fundamentals of War Gaming*. Government Printing Office.

Murphy, R. P. (2016). *Pojęcie równowagi Nasha w teorii gier*. Instytut Edukacji Ekonomicznej im. Ludviga von Misesa.

Nash, J. F. (1950). Equilibrium points in n-person games. *Proceedings of the National Academy of Sciences of the United States of America, 36*(1), 48-49. https://www.jstor.org/stable/88031?origin=JSTOR-pdf

Neumann, J., & Morgenstern, O. (1944). *Theory of Games and Economic Behavior*. Princeton University Press.

Obłój, K. (2001). *Strategia organizacji*. Polskie Wydawnictwo Ekonomiczne S.A.

Olszyńska, A. (2011). *Przydatność planowania scenariuszowego dla funkcjonowania przedsiębiorstw logistycznych*. Logistyka, 5, 1200-1206.

Perla, P. (1990). *The Art of Wargaming*. Naval Institute Press.

Pietraś, Z. J. (2012). *Decydowanie polityczne* (1st ed., 4th re-ed.). Wydawnictwo Naukowe PWN S.A.

Płatkowski, T. (2012). *Wstęp do teorii gier*. Uniwersytet Warszawski.

Próchniak, M. (2017). *Teoria gier. Historia teorii gier*. Szkoła Główna Handlowa. https://web.sgh.waw.pl/~mproch/Z_ekonomia_menedzerska/em_1.pdf?msclkid=a3b04ccabbc311eca4b33919aa4da2c9

Roszkowska, E. (2007). *Modelowanie procesów decyzyjnych oraz procesów negocjacji za pomocą kompleksów reguł*. Wydawnictwo Uniwersytetu w Białymstoku.

Schelling, T. C. (1960). The Strategy of Conflict. Harvard University.

Schelling, T. C., & Halperin, M. H. (1961). *Strategy and Arms Control*. Twentieth Century Fund.

Schelling, T. C. (1966). *Arms and Influence*. Yale University Press.

Schelling, T. (1986). The role of war games and exercises. In A. Carter, J. Steinbruner, & C. Zraket (Eds.), *Managing Nuclear Operations* (pp. 426-444). The Brookings Institution.

Schoemaker, P. (1995). Scenario planning: A tool for strategic thinking. *Sloan Management Review*, 36, 25-40.

Schoemaker, P. J. (2007). Forecasting the scenario planning. The challenges of uncertainty and complexity. In D. J. Koehler & N. Harvey (Eds.), *Blackwell Handbook of Judgment and Decision-Making* (pp. 274-296). Wiley-Blackwell.

Silverman, D. (2009). *Interpretacja danych jakościowych*. Wydawnictwo Naukowe PWN.

Świeży, M. (2010). *Metapoznawcze aspekty nabywania umiejętności*. Uniwersytet Jagielloński, Wydział Filozoficzny Instytut Psychologii.

The Royal Swedish Academy of Science. (2005). *Advanced information on the Bank of Sweden Prize in Economic Sciences in Memory of Alfred Nobel, Robert Aumann's and Thomas Schelling's contributions to game theory: Analyses of conflict and cooperation*. https://www.nobelprize.org/uploads/2018/06/advanced-economicsciences2005.pdf

Table of figures

The publication updates and systematizes the current state of knowledge, using the author's practical experience in organizing and conducting decision-making games. It can be an important tool that will ensure better understanding and critical thinking in the decision-making process in many areas at various levels of the Polish Armed Forces and more broadly in the state defense system.

Lt. Gen. Dr. Piotr Błazeusz
1st Deputy Chief of the General Staff of the Polish Armed Forces

---

The publication clearly and reliably presents and systematizes knowledge about war games. Its potentially popularizing character should be emphasized and positively assessed. A compact publication that reliably describes and organizes the subject of war games is very much needed on the Polish publishing market, especially since it is written in a simple and accessible way.

Prof. Bartłomiej Michalak
Nicolaus Copernicus University, Toruń, Poland

Wydawnictwo
Centrum Doktryn i Szkolenia Sił Zbrojnych

ul. Szubińska 105
85-915 Bydgoszcz
wydawnictwo.cdissz@mon.gov.pl
www.cdissz.wp.mil.pl

ISBN 978-83-66731-30-1 (online)
ISBN 978-83-66731-29-5 (druk)