

A Proposal to Model Wargames in the MDA Framework

Leandro Ouriques

*Programa de Engenharia de
Sistemas e Computação, COPPE
Universidade Federal do Rio de Janeiro
Centro de Análises de Sistemas Navais
Marinha do Brasil
Rio de Janeiro, Brazil
ouriques@cos.ufrj.br*

Geraldo Xexéo

*Programa de Engenharia de
Sistemas e Computação, COPPE
Departamento de Ciência
da Computação, IM
Universidade Federal do Rio de Janeiro
Rio de Janeiro, Brazil
xexeo@cos.ufrj.br*

Carlos Eduardo Barbosa

*Programa de Engenharia de
Sistemas e Computação, COPPE
Universidade Federal do Rio de Janeiro
Centro de Análises de Sistemas Navais
Marinha do Brasil
Rio de Janeiro, Brazil
eduardo@cos.ufrj.br*

Abstract—This work aims to define meaningful actions that players can take in a wargame. Starting from the premise that wargames are (serious) games, we wondered if a wargame and its actions could be well modeled as a game. We looked at formal approaches and decided to model wargames in MDA since this framework analyzes the actions in games as mechanics or dynamics. The proposed model links emotions with instincts that may arouse in players with mechanics and dynamics from wargames. Afterward, we indirectly evaluated the model through a survey among wargames experts. Although most research participants agree with the suitability of the proposed mechanics and dynamic, they suggested other actions that players could perform in wargames. The model matched most emotions and instincts selected by the participants and the results allowed us to improve the model mainly in mechanics and dynamics. An important contribution of this work is to recognize the emotions and instincts that are triggered by the dynamics and mechanics of wargames. The participants' answers on instincts agree with our understanding from the literature, but their answers on emotions contradict some views on wargames. Many participants indicated that wargames can evoke fear, anger and sadness, but wargames have limitations to arouse these emotions in players. Most military see wargames primarily as training activities. However, few participants find enjoyment in wargames.

Index Terms—wargames, serious games, MDA, mechanics, dynamics, aesthetics

I. INTRODUCTION

Wargames reflect a decision-making process between opposing forces, i. e., exercises in interaction and interplay of human decisions [1]. The most important issue in wargames is not about winning or losing, but players' decisions [1] [2]. The central dynamics of any wargame lie in the flow of information and decisions among players [3], which induce insights and learning. Since we know that decisions result in players' actions, we must understand what actions players can undertake.

Therefore, this work aims to define meaningful actions that players can take to build their strategies in wargames. In this case, the military uses wargames as didactic and analytical tools to stimulate learning in their planning activities. We also propose to model these wargames' actions in a conceptual model using the MDA framework [4], which classifies actions

as mechanics or dynamics. In addition, we analyzed the players' emotional responses to complete the model. Thus, the Wargame MDA model can be used in new wargame designs to evoke specific emotions and instincts and highlights the appropriate actions to fulfill the educational goals through the games.

A. Wargames

Wargames are commonly described as warfare models or simulations, not involving actual military forces, whose sequence of events is affected by and, in turn, affects decisions made during those events by players representing the opposing sides [1]. Wargames deliver a greater understanding of conflict and better decision-making and also contribute to training better decision-makers. They are an opportunity to test assumptions and manage risks, without risking lives in military operations [5].

A wargame combines history, science and game, building a playable simulation of military action [2]. Wargames usually have at least one map, playing pieces representing military units, and a set of rules. Players have to grasp how to use their resources, move their units most efficiently, and how to position and use their units to destroy the opposing units, to achieve pre-defined victory conditions [6].

According to Longley-Brown [5], wargames are enjoyable, challenging and engaging environments. They must be interesting and playable enough to disrupt players' inherent disbelief, and, in result, open their minds to an active learning process. Learning opportunities arise during game design, gameplay and post-game analysis [1]. They also must be accurate and realistic enough to ensure that such learning is informative and not misleading [7].

Perla [1] argues that wargaming can be a powerful learning tool since emphasizes human interaction and role-playing. Sabin [8] reinforces that wargames certainly derive considerable benefit from being fun. Although Blunt [9] warns that there are obstacles to translating fun into learning settings. Haggman [10] questioned whether fun is really useful in a learning process. He says the idea that wargames should be

fun is contentious in professional wargaming and constructive satisfaction must be intrinsic motivations to players.

B. Are wargames games?

At the beginning of our work, we wondered if wargames were really games, and why. Some military dislike the word game since it concerns the entertaining aspect connected to the competitive settings [2]. To answer this question, we must first consider that games are studied in academia as belonging to two classes: games in general and serious games.

The main purpose of generic games is entertainment or simply fun. Games we have played since childhood are included in this classification. Serious games are generally defined as games whose main purpose goes beyond providing entertainment, having a practical effect such as learning, marketing, etc. [11].

A game is an activity among two or more independent decision-makers (players) seeking to achieve their objectives in some limited context [12]. Players' actions are constrained by rules. Games can be exploited for learning because of their engaging nature, which is a direct and natural consequence of them being fun [11]. All games require players to learn something and, if possible, have fun doing it. At least, the rules of play must be learned [12].

Wargames have a scenario, players, objectives and rules. The scenario abstracts a real or fictitious situation. Players are disposed in opposing forces and make their decisions strategically to accomplish their objectives. Rules limit the intentions of combat or movement.

The use of games in education is centered on the concept of game-based learning [13]. Serious games allow players to not only learn but also demonstrate and apply what they have learned. Serious games have been used in the military, business, government, education, and health care.

Games have been applied to a wide range of military problems [14]. The military is the largest source of funds for serious games. These games let players get fast feedback on the consequences of their actions without the cost of errors in the real world [12].

C. MDA Framework

There are some formal approaches proposed to understand games and describe their elements [4], [15], [16]. The MDA framework stands for Mechanics, Dynamics, and Aesthetics [4] and, it was built upon these three levels of abstraction.

Mechanics are the basic actions by which the game is played [17]. Dynamics describe the run-time behavior of the mechanics acting on player inputs over time [4]. Dynamics are related to the game's context, constraints, choices, chance, consequences, competition, and cooperation [18]. Aesthetics describes the desirable emotional responses evoked in players when they interact with the game system [4].

D. Related Works

This section first lists works, especially at the SBGames proceedings, which used the MDA framework to analyze game designs.

Two works analyzed existing game design methods, including the MDA framework with different purposes. Pereira and Fragoso [19] proposed an iterative method for developing analog games. Zaffari and Battaiola [20] intended to integrate academic knowledge in game design with the professional tools of the game industry. They sought to bring together artifacts such as High Concept and Game Design Document with game design theories.

Kusuma et al. [18] used the MDA framework with an educational purpose to analyze articles on gamification. They broke down the gamification models to understand how game elements have acted in a learning process.

Kritz et al. [21] built a Game Mechanics Ontology mainly based on the mechanics' category presented in BoardGameGeek.com according to the formal concepts from the MDA framework. Their purpose was to show that a set of terms usually known by players can lead us to better understanding how players perceive the games' components. This set of mechanics could also support the development of a game design.

Some works explored aesthetics in games. Lundgren et al. [22] examined several gameplay properties that can affect the player's experience such as rules consistency, chance, varying strategies, game balance, and limited playtime. De Souza et al. [23] evaluated the aesthetics of a game developed by themselves from players' perceptions. The results show that players had a bad feeling about the game and misunderstood game objectives. The authors concluded that the game's aesthetics caused these results and identified opportunities to improve the game. Finally, Dillon [17] investigated how emotions and instincts can interact to enhance the gaming experience. MDA has been commonly used to model games, but Dillon [11] also used MDA to model serious games.

In addition, we looked for works in previous SBGames proceedings, whose main subject was wargames. We only found one work from Duarte and Uhlmann [24], which pointed out that military forces and the government have been using wargames to study tactics and strategy. They also briefly discussed the recent legacy of wargames and describe wargames components, such as the map, cardboard counters, charts, tables, and rules systems.

Our work differs from those ones cited above because we had not only used the MDA framework to analyze the design of wargames, but we also evaluated the proposed model among subject matter experts to ensure its suitability. More research on wargame design is needed in Brazil, especially as an educational tool.

II. METHOD

Starting from the premise that wargames are (serious) games, this work aims to define meaningful actions that players could take in wargames to support a wargame design. We looked at formal approaches and decided to model wargames in the MDA because this framework analyzes the actions in games as mechanics or dynamics.

First, we gathered possible actions that players can take from wargames artifacts. Next, we selected a small but significant set of actions and classified them into mechanics and dynamics. We also indicated emotions and instincts that would arouse in players during wargames. Then we build a Wargame MDA model according to the literature to correlate these mechanics and dynamics with those emotions and instincts.

Afterward, we indirectly evaluated the chosen elements and the model itself through a survey among Brazilian military officers with knowledge or interest in wargames. Then we analyzed participants' answers and comments, and we improved the Wargame MDA model from the survey results. Finally, we compared the wargame model from the literature with survey results and discussed our findings.

A. Mechanics and Dynamics

We intended to identify core mechanics and dynamics to describe a wargame. First, we sought to identify actions that players could take in wargames. We analyzed the mechanics and dynamics of retro and indie games [17], a library of game mechanics used as a design and analysis tool [15], and the game mechanics ontology [21].

Next, we looked for actions cited in studies that described wargames artifacts [6], [7], [10], [25]–[36]. Table I summarizes the actions mentioned in the studies.

TABLE I
SUMMARY OF WARGAMES ACTIONS IN REFERENCES

Results	Actions
13	attack
11	move
10	defend
8	maneuver
7	destroy
6	control, deploy
5	detect, protect, withdraw
4	combat, disrupt, reach, reinforce
3	advance, arrange, engage, occupy, supply, surround, sustain, talk
2	allocate, capture, confront, conquer, converse, enclose, place, pursue, retreat, search, seek information, stand, stop, threat, warn, write
1	access, ambush, break away, catch, chase, communicate, concentrate, counterattack, cover, dispose, escape, exploit, express, force back, help, hide, hinder, identify, infiltrate, intercept, interfere, investigate, locate, obtain information, overwhelm, overrun, perceive, posture, read, rearrange, recover, reorganize, resist, resupply, retire, retrain, rotate, run, stay, share experiences, strike, submit information, surveil, support, threat, trust, turn, turn around, wait, withstand

B. Aesthetics

Aesthetics in games describes player's emotional responses. The analysis of emotions is not an easy task. It is not clear, at least in academic terms, what these responses actually describe: enjoyment, moods, emotions, pleasures, or something in between [15]. This understanding can be applied to instincts

as well. There is no agreement on which, among all possible emotions and instincts, are the basic ones [17]. But there are some efforts conducted to minimize this disagreement [37].

Some simplified approaches identify only two emotions: happiness and sadness [38]. The psychologist Paul Ekman categorizes seven basic emotions that the human face can express: anger, contempt, disgust, enjoyment, fear, sadness, and surprise [39], [40]. Ekman's research was recognized even by the Dalai Lama of Tibet, who requested a project to develop an atlas of emotions, a kind of map of basic emotions, situations that usually trigger emotions and behaviors motivated by emotions [41].

We use the 6-11 framework [42] to identify the emotions and instincts observed in players during wargames. This framework is usually associated with the MDA framework. The 6-11 framework focuses on six emotions (fear, anger, joy, pride, sadness, excitement) and eleven instincts (survival, self-identification, collecting, greed, protection, aggressiveness, revenge, competition, communication, exploration and color appreciation). These emotions mostly agree with Eckman's research [37]. Only the excitement was not explicitly evidenced in his research.

C. Wargame MDA model

We chose a small set of actions from literature (Table I) to model wargames. We identified move, combat, deploy, communicate and search as mechanics. Maneuver, advance, pursue, detect, attack, defend, withdraw, escape, arrange, reinforce, talk, share experiences, read and write would represent dynamics.

Although destroy, disrupt and protect were well cited in the articles, we did not select these actions because we understand that attack would already include destroy and disrupt, and defend would include protect.

We did not select control because this action has an unclear meaning. Control can be a mechanic or a dynamic relying on the context. Control is defined as mechanics when the player occupies or influences an area [21], [35]. Control is defined as dynamic when the player acts on a specific area or a domain [10], [30].

We did not select sustain and supply because a wargame can be designed without logistical issues. Some simple wargames omit logistic considerations altogether and assume that all antagonists remain supplied throughout the engagement. Although the supply dimension does not have the same effect as sweeping maneuvers and decisive attacks [7], we understand that it can have a critical impact on military operations.

The MDA framework describes that mechanics support dynamics in gameplay and dynamics generate aesthetics. Emotions naturally arise in gameplay. Emotions and instincts can trigger each other. Instincts, in turn, will force the player to act in the game, ultimately showing how the whole aesthetics can be linked to actual dynamics and mechanics. Fig. 1 correlates all these elements in a Wargame MDA model. We selected at least two dynamics to represent the behavior of each mechanic. Each group of dynamics is associated with an instinct.

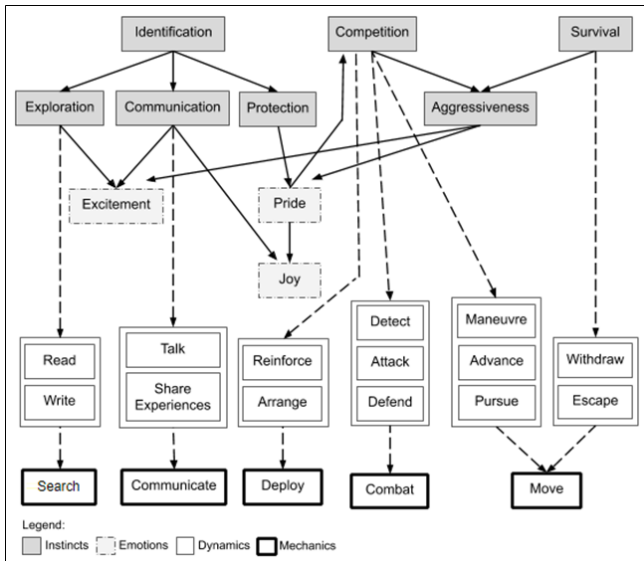


Fig. 1. Wargame MDA model according to the literature

Wargames' literature guided our decisions to define which elements we put into and excluded from the model. We understand that every conflict simulation must necessarily model movement and combat. This move–fight sequence has remained dominant, especially in simpler wargames. The most basic activity that units undertake is to move across the map [7]. Move mechanics can take on many behaviors, but we choose only the dynamics we judge are the most significant to simplify the model.

Mechanics usually fall into combat and procedures for playing the game [43]. Combat is probably the most complex element in warfare, since it includes several physical and psychological variables that make it hard to encompass using any analytical or modeling technique [7]. We suggest simplifying the combat, indicating that it basically involves detecting the enemy, attacking, and defending.

Players often spend most of their time deciding how to deploy and employ forces in wargames [44]. Some games allow players to reinforce units to adjust the strength of opposing forces [6].

Communicate and socialize ideas are purposes for wargaming [45]. Wargame is primarily a communication instrument to examine strategies, share ideas, perspectives and experiences. We chose talk and share experiences as dynamics to represent the communication mechanic. But other forms of oral or gestural communications could also be considered.

Wargame also includes searching for information about the scenario, the enemy and the setting. We chose read and write as dynamics to represent the search mechanic. Military intelligence takes these activities to get information in warfare.

After we have built the Wargame MDA model, we can summarize that the arrangement and the maneuver of units identify the wargames. These actions prepare combat between the opposing forces. Combat uses many tactics and methods,

such as detection, attack, advance, defend, withdrawal, movement, engagement, as well as communication [26], searching for information, sustaining and supply their resources.

The extreme complexity of the war phenomenon can explain the analysis of wargame aesthetics since war is a dangerous environment where various instincts emerge in the military. War is chaotic, full of unknowns, and generally governed by chance [46].

Self-identification instinct arises in the military since they will be trained through wargames to occupy positions that they are willing to achieve in their careers. Thus, wargames create empathy in players for their role-playing [47].

Competition is a central feature of most wargames [48]. Games' ability to challenge the competitive spirit refers to the presence of emotion during wargaming [10]. The instinct for self-preservation (survival) rapidly asserts in combat operations [6]. Survival and competition may require players to decide on more aggressive strategies. But competition may trigger pride when engagements result in victories.

Afterward, players awaken the exploration instinct to know the setting and are concerned with protecting their troops. Communication instinct arises since players must define strategies and make decisions.

We do not consider that wargames arouse collecting, greed, revenge, and color appreciation instincts. Collecting and greed are usually related. But wargames do not involve looking for resources or objects. Players may appreciate the colors on the map, but they would not be focused on that. Revenge is related to anger. We did not choose anger either. Wargames are limited tools for stimulating anger in players. Wargaming provides a harmless setting in which players could face some of the war's challenges. But fear, danger, losses, the unexpected, and fatigue will still be missing — omissions that must never be overlooked [1]. We understand that this view remains valid.

Since the risk of death is not present in wargames, we consider that wargames do not evoke in players the fear of getting hurt or dying, the anger against an enemy, and the sadness of losing partners. Although we consider that excitement, pride and joy emerge in wargames.

Players must feel proud and excited when they properly fulfill missions or attain a goal [49]. Excitement also comes when players explore the setting and cooperate to achieve goals. Often both opposing players will correctly analyze the situations in a general sense. But skillful players differ in how they apply their analysis through tactics or techniques. This condition may provide an exciting play [6]. Finally, a well-designed wargame should be somewhat enjoyable, so player's focus would not be solely entertainment but specifically designed learning [25]. Joy can come from individual pride and communication between participants.

D. Instrument

We intended to validate the elements chosen to build the Wargame MDA model and, consequently, the model itself. We chose the survey research method to conduct the evaluation. A survey can be described as obtaining data or information

about characteristics, actions, or opinions of a certain group of people, which represents a target population, through an instrument, usually a questionnaire [50].

Survey participants were military officers with knowledge or interest in wargames from the Brazilian Armed Forces (Army, Navy, and Air Force). The survey was created on Google Forms and first was released to officers known to the authors. The officers kindly forwarded the survey to their co-workers at the authors' request.

The participants answered questions that asked which suggested mechanics, dynamics, and aesthetics would represent wargames. We did not mention in the survey that we had built a wargame model. We used this strategy to avoid biasing the survey. We did not want the participants to soon agree with the elements we had chosen to build the Wargame MDA model without properly thinking about the answers.

The survey had five sections. The first section has a statement that contextualizes the academic research in the military environment and explains its motivation and purpose. The statement also explains the concepts of mechanics and dynamics according to the MDA.

The second section reinforces the definition of mechanics in the MDA and analyzes the mechanics of wargames.

- **Q1:** Are the following mechanics enough to represent the possible actions of the players in wargames: move, combat, deploy, communicate and search (for information)?
- **Q2:** If the previous answer was not "Strongly Agree", what other mechanics could represent the players' actions in a wargame?

The third section reinforces the definition of dynamics in the MDA and analyzes the dynamics of wargames.

- **Q3:** Are the following dynamics enough to represent the behavior of the mechanics during a wargame: maneuver, advance and pursue; withdraw, and escape; detect, attack and defend; arrange, and reinforce; talk and share experiences; read and write?
- **Q4:** If the previous answer was not "Strongly Agree", what other dynamics could be noticed during a wargame?

The participants must also answer Q1 and Q3 on a Likert Scale with five options ranging from Strongly Disagree (1) to Strongly Agree (5). Q2 and Q4 are open-ended questions.

The fourth section explains the aesthetics definition in the MDA and indicates that aesthetics will be analyzed using the 6-11 framework.

- **Q5:** What emotions arouse in players during a wargame?
- **Q6:** What other emotions could be observed in a wargame?
- **Q7:** What instincts emerge in players during a wargame?

Q5 has six answer options. Each one indicates an emotion in the 6-11 framework. Q6 is an open-ended question. Q7 has eleven answer options. Each one indicates an instinct in the 6-11 framework. Q5 and Q7 also emphasize that the participant can check more than one answer.

The fifth section asks for information about the participant. The eighth question asks what armed force the participant belongs. The ninth question asks the participant's last role in a wargame. The tenth question offers the participant to comment on the survey. The eleventh question asks the participant's rank, nickname, and email. Thereby we could contact them if we have any doubt about their answers or comments. Participants are not required to answer these last two questions.

E. Research Protocol

- 1) Gather data from survey answers
- 2) Analyze answers to indirectly check if the participants agreed with the Wargame MDA model
 - a) Examine participants' suggestions on mechanics and dynamics
 - b) Examine participants' suggestions on emotions and instincts
- 3) Check if it was necessary to improve the Wargame MDA model
 - a) Include and correctly classify the most suggested mechanics and dynamics
 - b) Establish a criterion for emotions and instincts. If one had been selected by at least 40% of the participants, then it would be maintained or included in the model, otherwise, it would be removed or refused

III. RESULTS

The survey was answered by 122 participants between November 2019 and February 2020. Participants comprised 31 officers from Army, 53 officers from the Navy, and 38 officers from Air Force. Regarding their last role in a wargame, 38 officers were controllers, and 84 were players.

In Q1, 63.1% of participants agreed that proposed mechanics are representative, 24.6% were neutral, and 12.3% disagreed. Fig. 2 shows Q1 results. Participants suggested in Q2 about 60 actions that players could perform in wargames. Many suggested actions would be better defined as dynamics according to the MDA. But we recognize that would be too demanding for the participants to correctly classify the action as mechanics or dynamics since they must not have known these academic game concepts.

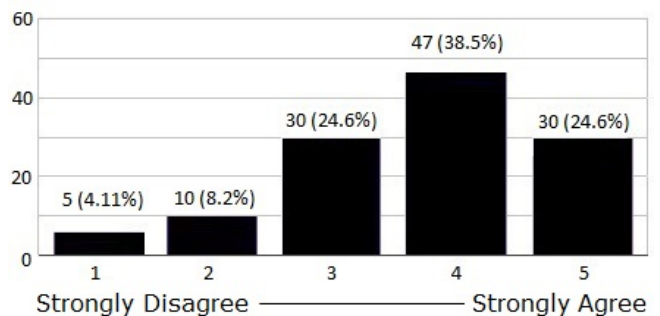


Fig. 2. Q1 results - agreement with suggested mechanics

In Q3, 70.5% of participants agreed that proposed dynamics are representative, 18.0% were neutral, and 11.5% disagreed. Fig. 3 shows Q1 results. Participants also suggested in Q4 about 60 actions as wargames dynamics. But many suggested dynamics were different from those suggested mechanics in Q2. Table II lists the mechanics and dynamics suggested in Q2 and Q4, respectively.

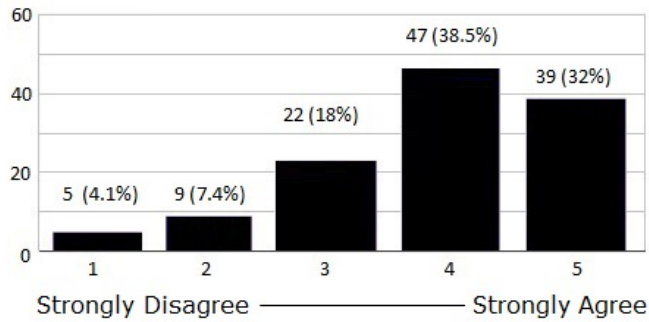


Fig. 3. Q3 results - agreement with suggested dynamics

TABLE II
MECHANICS AND DYNAMICS SUGGESTED IN THE SURVEY

Results	Mechanics	Dynamics
5	supply	conceal
4	defend	deter
3	position, watch	counterattack, defend, patrol, watch
2	attack, carry, control, evacuate, logistics, mislead, plan, recover, support	attack EW, communicate, escort, slow up, stand
1	assess damage, assess risks, block, choose area, choose unit, compare fighting power, complete, create unit, decide, delegate, detach unit, detect, dispose, escort, establish directives, fire, float, give orders, identify, insert information, inspect, interdict, involve, joint units, land, monitor, navigate, negotiate, neutralize, overcome, patrol, prepare, rearm, receive data, recognize, reinforce, repair, replenish, restore, resupply, search, shelter, sustain, sweep, take off, throw, umpire, wait	anticipate, arrange, assess damage, attract, avoid, back off, bomb, clarify, confuse, consume, deceive, delay, destroy, disperse, fix, flank, follow, give order, hide, induce, influence, intercept, interdict, make flexible, mislead, monitor, neutralize, not act, overwhelm, paralyze, persuade, plan, press, rearrange, receive info, receive orders, relocate, replan, reposition, rest, retract, send info, share plans, supply, support with fire, sweep, synchronize, undermine, wear out

The most indicated emotions in Q5 were excitement (87.7%) and pride (73.0%). These results match the emotions chosen to build the Wargame MDA model (Fig. 1). Only 38.5% of participants indicated joy. This result may indicate

that players see wargames primarily as training activities. The number of participants who indicated fear (36.9%), anger (54.9%) and sadness (26.2%) exceeded our expectations since wargames have limitations to arouse these emotions in players. Perla suggested that fear, danger, fatigue will still be missing in wargames [1], and we agree with this view yet. Fig. 4 shows these Q5 results.

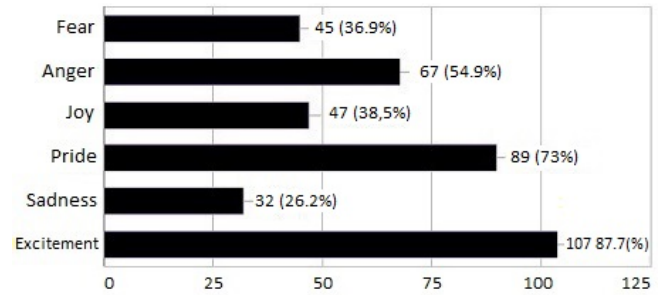


Fig. 4. Q5 results - emotions aroused in players

Table III lists the emotions indicated in Q6. We can even discuss whether some of these are really emotions. For instance, we understand that doubt and uncertainty are present in wargames, but they are not considered emotions.

TABLE III
EMOTIONS SUGGESTED IN THE SURVEY

Results	Emotions
13	anxiety
10	doubt
5	frustration, insecurity
4	deception
3	apprehension, regret, uncertainty
2	confidence, hesitation, indifference, mistrust
1	alert, apathy, arrogance, boredom, concern, confusion, courage, delusion, despair, disappointment, dismay, distrust, emotional intelligence, envy, euphoria, excitement, fatigue, greed, hate, impatience, indecision, indignation, mission accomplished, nervousness, nonconformity, perplexity, persistence, precipitation, relief, revenge, scepticism, shame, strangeness, superb / pride, surprise, tiredness, vanity

The most indicated instinct in Q7 was competition (87.7%). Protection (62.3%), aggressiveness (59.8%) and survival (53.3%) were well-chosen instincts. Less than half of participants chose exploration (45.9%), identification (44.3%), and communication (43.4%). The least chosen instincts were revenge (27.0%), greed (16.4%), and collecting (15.6%). Finally, only two participants chose color appreciation (1.6%). Fig. 5 shows these Q7 results.

We consider that eleven instincts were suitable to meet the survey objectives. Therefore, we did not create a question to ask what other instincts could be aroused in wargames.

After we had analyzed the answers, we concluded that Wargame MDA model must be improved. First, we reviewed

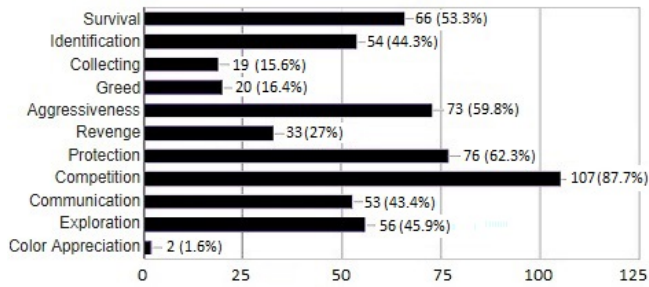


Fig. 5. Q7 results - instincts emerged in players

the mechanics and dynamics from the literature, and we identified the most suitable ones from Table III.

Participants suggested some dynamics that express the communication mechanics. They probably had already played seminar wargames because this format focus on player interaction, which involves persuasion and negotiation [24].

Sustain mechanic was included because many participants indicated that wargames should address logistical issues. Participants also warned that detection dynamics is more related to search mechanics rather than combat. Table IV shows the mechanics and dynamics resulting from the entire analysis.

TABLE IV
MECHANICS AND DYNAMICS GATHERED FROM LITERATURE AND SURVEY

Mechanics	Dynamics
combat	attack, counterattack, defend, fire, support
communicate	clarify, conceal, deter, deceive, influence, negotiate, persuade, press, share, synchronize, talk
deploy	arrange, choose unit, dispose, position, reinforce, relocate
move	advance, back off, disperse, escort, escape, evacuate, maneuver, mislead, pursue, slow up, stand, withdraw
search	detect, inspect, identify, monitor, patrol, sweep, watch
sustain (logistics)	assess damage, carry, consume, supply

Next, we reviewed emotions and instincts. Survey results showed that the seven most chosen instincts match the instincts included in the Wargame MDA model (Fig. 1). Few participants chose the other four instincts of the 6-11 framework.

We kept the instincts but exchanged some emotions in the model. Survey results showed that participants did not feel joy during wargames, although they stressed that they may feel angry; thus, we replaced anger with joy in the model. Fig. 6 shows the Wargame MDA model updated from survey results. We only included the main dynamics from Table IV to simplify the model.

IV. DISCUSSION

The participants’ suggestions for other mechanics and dynamics were very similar. They probably had a hard time understanding and abstracting these game concepts. After the research, we figured out that if the first question explained the

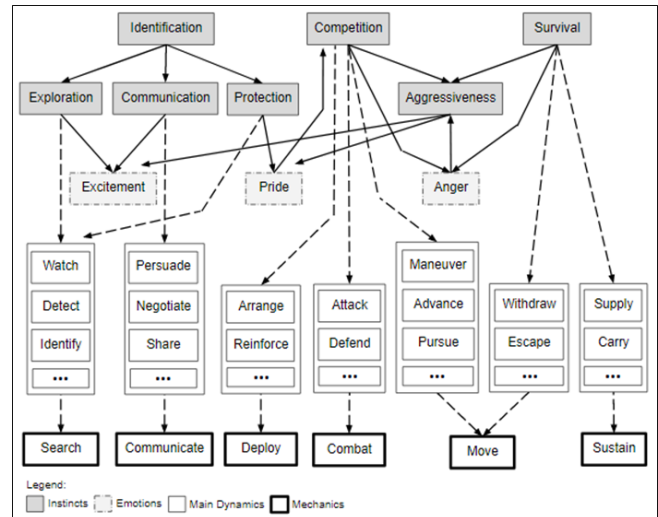


Fig. 6. Wargame MDA model according to the survey

concept of dynamics and the next question explained that the dynamics could be grouped into mechanics, then the answers about proposed mechanics and dynamics would have a greater agreement.

A Brazilian Navy Commander understands that perceiving emotions in a game or any situation is a human characteristic. But he emphasized that controllers must suppress players’ emotions in wargames. Military leaders should be guided by reason, assessing the cost-benefit their decisions would have in the real environment. Players’ decisions and actions must be made based on planning rules, regulations and international conventions. Emotional interference is not allowed. The participant added if he was a wargame controller in which a player excelled in this regard; he would certainly treat this case as a discrepancy to be corrected - outside the wargame environment.

We agree with his comment and then conclude that the game designer, director, and controllers must encourage players’ emotions and instincts in wargames. However, players must not allow their emotions and instincts to interfere with their decisions. Players must be trained to suppress them.

Another participant suggested contextualizing the chosen mechanics in the OODA (Observe, Orient, Decide, Act) loop [51]. This reference model for the decision-making process reflects the elements of moving war. Table V shows a framework where those wargame mechanics are embedded in the OODA loop.

TABLE V
WARGAMES MECHANICS IN OODA LOOP

Observe	Orient	Decide	Act
Search	Deploy	Move	
Sustain		Combat	
Communicate			

Few participants think that there may be enjoyment in wargames. Most military may see wargames primarily as training activities. Learning is the purpose of serious games, but nothing prevents serious games from delivering an enjoyable learning experience to motivate students. The positive impact of fun in learning is recognized by many authors, such as [52] [53].

As recognized by the MDA framework [4], and other authors such as Callois [54], fun can have many perspectives. For example, Callois divides fun in games in 4 categories that can be detected in wargames: *Agon* - the hard competition against difficult opposition; *Alea* - fun that comes from randomness; *Mimicry* - related to role-playing, and *Ilinx* - related to disorientation [54].

V. CONCLUSION

This work aims to define meaningful actions that players can take in wargames to support wargame designs. In this case, wargames are used as didactic and analytical tools to stimulate learning in the context of military planning. We modeled wargames in the MDA framework to analyze their mechanics and dynamics. We chose these mechanics and dynamics from wargames artifacts and emotions and instincts from the 6-11 framework.

We indirectly evaluated the model through a survey among wargame experts. The scope of the participants were limited to the Brazilian context, which may restrict the preliminary results in terms of the universality of the proposal.

The survey's results allowed us to improve the model mainly in mechanics and dynamics. Answers on instincts agreed with our understanding from the literature. But answers on emotions contradicted some views on wargames. Although the participants indicated that they can feel anger during the wargames, this result contradicts the authors who claim that wargames are limited tools to evoke anger in players. This discussion could be proposed to the controllers.

A Brazilian Navy Captain warned that players' actions will inevitably be linked to the decision level (tactical, operational, or strategic) addressed in the game. A tactical wargame would require more detail, presenting a greater variety of possible actions. This research did not focus on a specific decision level for a wargame. Perhaps it may be considered a limitation. Dynamics would also be linked to the war domain: land, naval, air, and even cyber.

Another limitation is that we only focused on the players' actions in wargames. Other actors, such as controllers in special, are relevant during the wargame because they umpire players' actions and reports adjudications results. Further studies should be done to map how their actions affect a wargame. Our next steps include using the model to aid the design of wargames. Thus, we intend to provide these actions for the military to build their strategies in order to fulfill the game's educational goals.

Finally, we would like to point out that although a wargame player in an educational situation is expected to act rationally and avoid the influences of emotions and instincts, both must

be seen as an important part of the design of educational wargames. Real life is stressful, and decisions in military operations are usually taken under different types of pressure, including emotional pressure. Therefore, we concluded that using the MDA framework, i.e., recognizing the emotions and instincts that are triggered by the dynamics and mechanics of wargames, is an important contribution to the field.

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REFERENCES

- [1] P. Perla, *The Art of Wargaming: A Guide for Professionals and Hobbyists*. Naval Institute Press, 1990.
- [2] J. Elg, "Wargaming in military education for army officers and officer cadets," Ph.D. dissertation, King's College London, 2017.
- [3] P. P. Perla and M. C. Markowitz, "Wargaming strategic linkage," Center for Naval Analyses (CNA) Alexandria VA, Tech. Rep., January 2009.
- [4] R. Hunicke, M. LeBlanc, and R. Zubek, "Mda: A formal approach to game design and game research," in *Proceedings of the AAAI Workshop on Challenges in Game AI*, vol. 4. AAAI Press San Jose, CA, 2004, pp. 1–5.
- [5] G. Longley-Brown, "What is wargaming and why do it?" Professional Wargaming, 2012. [Online]. Available: <http://www.professionalwargaming.co.uk/WhatsWargamingAndWhyDoIt-Longley-Brown.pdf>
- [6] J. F. Dunnigan, *The Complete Wargames Handbook: How to play, design, and find them*. William Morrow & Co., Inc., 1997, 2005.
- [7] P. Sabin, *Simulating war: Studying conflict through simulation games*. Continuum, 2012.
- [8] —, "Wargaming in higher education: Contributions and challenges," *Arts and Humanities in Higher Education*, vol. 14, no. 4, pp. 329–348, 2015.
- [9] R. Blunt, "Does game-based learning work? results from three recent studies," in *Proceedings of the Interservice/Industry Training, Simulation, & Education Conference*. National Defense Industrial Association Orlando, 2007, pp. 945–955.
- [10] A. Haggman, "Cyber wargaming: Finding, designing, and playing wargames for cyber security education," Ph.D. dissertation, Royal Holloway, University of London, 2019.
- [11] R. Dillon, "Serious games and fun: an analysis," *International Journal of Innovative Research and Development*, vol. 2, no. 5, 2013.
- [12] D. R. Michael and S. L. Chen, *Serious games: Games that educate, train, and inform*. Muska & Lipman/Premier-Trade, 2005.
- [13] J. Breuer and G. Bente, "Why so serious? on the relation of serious games and learning," *Journal for Computer Game Culture*, vol. 4 (1), pp. 7–24, 2010.
- [14] Y. H. Wong, S. J. Bae, E. M. Bartels, and B. Smith, *Next-Generation Wargaming for the US Marine Corps: Recommended Courses of Action*. RAND Corporation, 2019.
- [15] A. Järvinen, *Games without frontiers: Theories and methods for game studies and design*. Tampere University Press, 2008.
- [16] J. Schell, *The Art of Game Design: A book of lenses*. CRC press, 2008.
- [17] R. Dillon, *On the Way to Fun: an emotion-based approach to successful game design*. CRC Press, 2010.
- [18] G. P. Kusuma, E. K. Wigati, Y. Utomo, and L. K. P. Suryapranata, "Analysis of gamification models in education using mda framework," *Procedia Computer Science*, vol. 135, pp. 385–392, 2018.
- [19] L. S. Pereira and S. Fragoso, "Fcecf: um método iterativo composto aplicado ao desenvolvimento de jogos analógicos," in *XV Brazilian Symposium on Computer Games and Digital Entertainment*. São Paulo, SP, Brazil: SBC, 2016, pp. 478–486.

- [20] G. Zaffari and A. L. Battaiola, “Integração do processo industrial de design de jogos com o modelo mda,” in *XIII Brazilian Symposium on Computer Games and Digital Entertainment*. Porto Alegre, RS, Brazil: SBC, 2014, pp. 1042–1050.
- [21] J. Kritz, E. Mangeli, and G. Xexéo, “Building an ontology of boardgame mechanics based on the boardgamegeek database and the mda framework,” in *XVI Brazilian Symposium on Computer Games and Digital Entertainment*. Curitiba, PR, Brazil: SBC, 2017, pp. 182–191.
- [22] S. Lundgren, K. Bergström, and S. Björk, “Exploring aesthetic ideals of gameplay,” in *DiGRA Conference*, 2009.
- [23] B. de Souza, A. Doreste, G. Xexéo, and C. Reis, “Utilizando o framework mda para avaliar a estética de um jogo: Um estudo preliminar sobre a percepção de estudantes de graduação,” in *XVII Brazilian Symposium on Computer Games and Digital Entertainment*. Foz do Iguaçu, PR, Brazil: SBC, 2018, pp. 348–351.
- [24] L. C. S. Duarte and T. S. Uhlmann, “The role of wargames in the development of game design,” in *XVI Brazilian Symposium on Computer Games and Digital Entertainment*. Curitiba, PR, Brazil: SBC, 2017, pp. 135–140.
- [25] J. J. Arias and C. O. Klay, “Insurgent uprising: An unconventional warfare wargame,” Master’s thesis, Naval Postgraduate School Monterey CA United States, December 2017.
- [26] D. Bowley and S. Lovasz, “Use of combat simulations and wargames in analytical studies,” in *Proceedings of SimTecT*, vol. 99, 1999.
- [27] S. E. Goehring, “Wargaming and operational art - how do we increase our practical experience level?,” Naval War College, Tech. Rep., May 2003, unclassified.
- [28] J. T. Hanley Jr, “Planning for the kamikazes: toward a theory and practice of repeated operational games,” *Naval War College Review*, vol. 70, no. 2, pp. 29–48, 2017.
- [29] C. R. Kanipe and D. W. Yeo, “A wargame for introducing cybersecurity considerations to first-year engineering students,” in *AIAA Scitech 2019 Forum*, 2019, p. 0066.
- [30] H. Lantto, “Wargaming cyberwar in network-centric critical infrastructure defence,” *Critical Infrastructure Protection Against Cyber Threats*, vol. 1, no. 36, pp. 19–36, 2014.
- [31] H. Lantto, B. Åkesson, M. Suojanen, T. Tuukkanen, S. Huopio, J.-P. Nikkarila, and M. Ristolainen, “Wargaming the cyber resilience of structurally and technologically different networks,” *Security and Defence Quarterly*, vol. 24, no. 2, pp. 51–64, 2019.
- [32] R. McCreight, “Scenario development: using geopolitical wargames and strategic simulations,” *Environment Systems & Decisions*, vol. 33, no. 1, pp. 21–32, dec 2012.
- [33] K. Mueller, “Paper wargames and policy making: Filling the baltic gap or how i learned to stop worrying and love the d6,” *Battle Magazine*, no. 11, pp. 53–57, october 2016.
- [34] P. Perla and M. Markowitz, “Conversations with wargamers,” Center for Naval Analyses (CNA) Alexandria VA, Tech. Rep., January 2009.
- [35] D. Shlapak and M. Johnson, *Reinforcing Deterrence on NATO’s Eastern Flank: Wargaming the Defense of the Baltics*. RAND Corporation, 2016.
- [36] S. Yildirim, “Serious game design for military training,” in *Games: Design and Research Conference, Volda University College*, 2010, pp. 3–4.
- [37] P. Ekman, “What scientists who study emotion agree about,” *Perspectives on Psychological Science*, vol. 11, no. 1, pp. 31–34, 2016.
- [38] B. Weiner and S. Graham, “An attributional approach to emotional development,” *Emotions, cognition, and behavior*, pp. 167–191, 1984.
- [39] T. Dalglish and M. Power, *Handbook of Cognition and Emotion*. John Wiley & Sons, 2000.
- [40] P. Ekman, “Univesal emotions,” Paul Ekman Group, September 2019, <https://www.paulekman.com/universal-emotions/> [Accessed: 10-Mar-2020].
- [41] —, “Atlas of emotions,” Paul Ekman Group, 2016, <http://atlasofemotions.org> [Accessed: 10-Mar-2020].
- [42] R. Dillon, “The 6-11 framework: A new methodology for game analysis and design,” in *Proceedings Game-On Asia Conference, Singapore*, 2011, pp. 25–29.
- [43] P. Perla, “Design development and play of navy wargames,” Center for Naval Analyses, Tech. Rep., March 1987, unclassified.
- [44] B. J. Wilkes, “Silver flag: A concept for operational warfare,” *Air & Space Power Journal*, vol. 15, no. 4, pp. 47–56, 2001.
- [45] P. K. Davis, “Illustrating a model-game-model paradigm for using human wargames in analysis,” RAND Corporation, Tech. Rep., 2017.
- [46] S. Kainikara, “Effective wargaming: Impact of the changing nature of warfare,” Royal Australian Air Force - Air Power Development Centre, Tech. Rep., october 2003.
- [47] P. P. Perla and E. McGrady, “Why wargaming works,” *Naval War College Review*, vol. 64, no. 3, pp. 111–130, 2011.
- [48] M. L. Herman and M. D. Frost, *Wargaming for leaders: Strategic decision making from the battlefield to the boardroom*. McGraw Hill Professional, 2008.
- [49] S. Naidamast, “The war game and understanding complex application development,” JAXenter, Jun. 2016. [Online]. Available: <https://jaxenter.com/new-column-war-game-understanding-complex-application-development-127447.html>
- [50] H. Freitas, M. Oliveira, A. Z. Saccol, and J. Moscarola, “O método de pesquisa survey,” *Revista de Administração da Universidade de São Paulo*, vol. 35, no. 3, 2000.
- [51] J. R. Boyd, “The essence of winning and losing,” *Unpublished lecture notes*, vol. 12, no. 23, pp. 123–125, 1996.
- [52] R. Koster, *Theory of fun for game design*. O’Reilly Media, Inc., 2013.
- [53] B. Upton, *The Aesthetic of Play*, 1st ed. MIT Press, 4 2015.
- [54] R. Caillois, *Man, Play, and Games*. Thames & Hudson, 1961.