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Strategic Competition and Crisis Wargame: Integrating a Dynamic Reputation Model to Enhance the Strategic Competition and Crisis Wargame for the Center for Army Analysis

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Abstract: The Center for Army Analysis (CAA) developed the Strategic Competition and Crisis (SC2) Wargame to address shortcomings in the U.S. Army's strategic planning during competition and crisis. This capstone enhanced the SC2 Wargame over the course of two years. Last year, the capstone developed a dynamic, perspective-based reputation model designed for integration into SC2. This year, the capstone integrated the model to produce a more efficient, objective-focused wargame that optimizes strategic learning for senior military leaders. Building off the work from the previous year, this capstone combined tools from the Systems Decision Process with the theoretical framework within the Defense and Strategic Studies Department to create and implement an improved product. Analysis of the original framework of the game uncovered three improvement areas that address each component of gameplay: strategy-focused player guidebooks, a realistic negotiations-pairing process, and real-time feedback through a Player Dashboard.

Keywords: Wargame, Competition, Interdisciplinary

1. Introduction

This capstone project aimed to enhance the Center for Army Analysis's (CAA) Strategic Competition and Crisis (SC2) wargame to improve the strategic planning skills of Global Combatant Command (GCCs) staffs. The client, CAA, developed the SC2 wargame two years ago "to capture the discussion associated with 'Competition,' and how it supports the Army's Global Strategic Framework" (Engelmann & Kearney, 2021). The objective of the game is to improve one's global reputation score through actions impacting Diplomatic, Military, and Economic influence. Last year, this capstone created a model to output perspective-based, dynamic reputation scores based on credibility, capabilities, and stability metrics (McConville, 2021). This year, this project focused on integrating the dynamic reputation model metrics to enhance the SC2 wargame by contextualizing game actions with aggregated data on strategic objectives, increasing realistic factors within the negotiation process, and improving the player's narrative experience through architecture that automates game mechanics and incorporates a robust game user interface.

2. Background

In March 2021, the Chief of Staff of the Army released the Chief of Staff (CSA) Paper #2, "The Army in Military Competition." CSA Paper #2 outlines what a global state of competition is and how the Army plays a crucial role in the United States Government's (USG) ability to achieve broad national objectives during times of international competition (McConville, 2021). This paper describes a theme of difficulties the US Army appears to have in setting and achieving strategic-level objectives during periods between conflict. While competition and crisis are the typical steady state of the international system, as shown in Figure 1, the majority of US military actions center around conflict and few strategic leaders develop an adequate framework to execute strategic-level plans created for states of competition or crisis. To address this shortcoming in leader development, the CAA developed the SC2 wargame to provide a simulation space for executing strategic level, globally scoped actions—and examining their impacts—during times of competition and crisis.

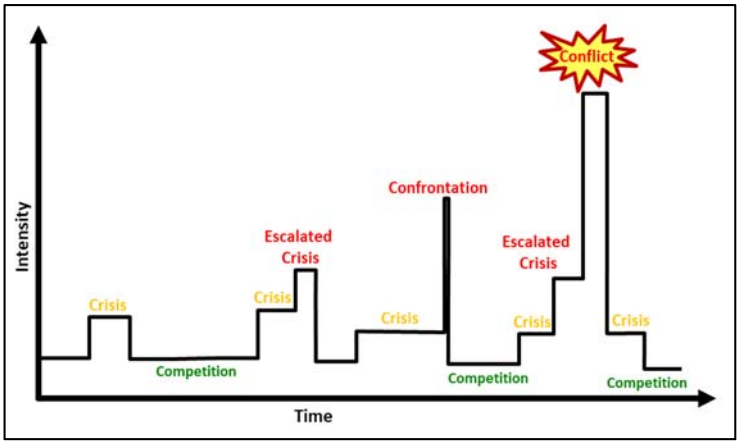

Figure 1. Phases of Cooperation in the International System (Engelmann & Kearney, 2021)

Last year, the capstone improved the SC2 wargame by developing a dynamic reputation model based on real-world data (Braun et al., 2022). This reputation model outputs perspective-based reputation and influence scores sensitive to subject-matter expert opinion and tied into the mechanisms of the game. The data-driven nature of the reputation model and its contextualization within the wargame provide valuable insight for strategic-level leaders developing decision making skills in phases of competition. Continuing the work from last year, this team sought to further improve the game's efficiency and applicability. Specifically, the team aimed to alleviate the heavy administrative burden on proctors that made the SC2 wargame difficult to adjudicate and detracted from the player's experience and outcomes. To inform our solution design, we created an Integrated Definition Level 1 (IDEF1) Diagram, as shown in Figure 2, to holistically assess each part of the wargame from the players' perspective and identified several areas of improvement to optimize the SC2 wargame objectives.

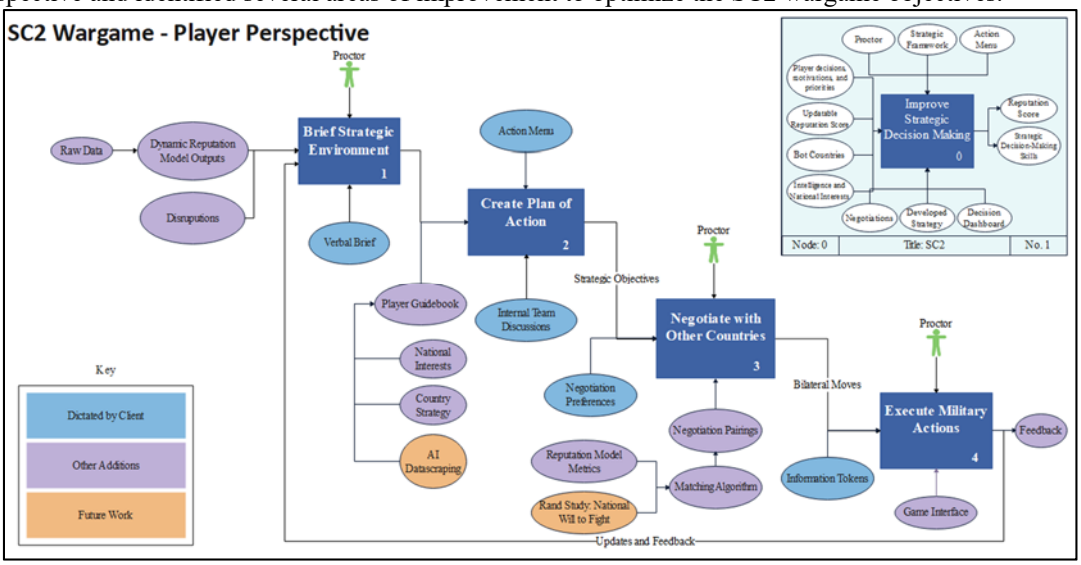

Figure 2. Integrated Definition Level 1 (IDEF1) Diagram

3. Methodology

3.1 Player Guidebooks

The player guidebook encompasses qualitative and quantitative information on each country represented in the wargame. The team used the Diplomatic, Information, Military, and Economy (DIME) framework to represent the qualitative information for each country. Within this framework, Open-Source Intelligence (OSINT) sources—such as Janes Intelligence, The CIA World Factbook, Global Firepower Index, and The Military Balance—provided the data to build educational handbooks for players that shape their game actions within real-world context. The Diplomatic section is comprised of a brief overview of the political structure, leadership, and espoused national objectives for each country. The Information section consists of offensive and defensive cyber capabilities, a cyber-security commitment score, media freedom, external relations, and multilateral co-operations in the data security of each country. The Military section consists of a short description of each country's military capabilities, including a description of the most recent defense modernization and reshuffling effects and any possible out-of-area operations, and a capability assessment graph, which assesses current defense capabilities measured against assessed threats. The Economic section contains information on gross domestic product, inflation, unemployment, country debt, and other economic assessment data points.

In addition to providing qualitative information, players receive quantitative data, which allows them to compare the credibility, capability, and strength measures of other countries through interactive graphs in the Player Dashboard. This project gathered quantitative data using web scraping, a method of automatically pulling indicated information using code (Joshi, 2022). The team used RStudio code to access indicated web pages, identify the location of relevant data, and extract the data into a spreadsheet. The RStudio packages used include Rvest, tidyverse, rvest, dplyr, readr, tidyr, stringr, and datatable. After completing the scraping, the team converted the compiled data into a csv file and exported it into an Excel spreadsheet. The CIA World Factbook and Global Firepower Index provided the quantitative data scraped, but the methodology described is applicable to any other sources as well. The military metrics used to compare capabilities are ranking, power index, manpower, airpower, army strength, and navy strength (CIA World Factbook, 2023; Global Firepower Index, 2022). Economic metrics used are population, land area, real GDP (purchasing and per capita), exports, imports, and exchange rates (CIA World Factbook, 2023; Global Firepower Index, 2022).

Each of the metrics displayed connects to the actions available to players in the game. This connection allows players to better contextualize their decisions within real-world data and facilitates the development of applicable decision-making skills. The inclusion of all aspects of DIME supports the SC2 objective of preparing GCC decision makers to pursue globally scoped objectives using all the resources available, not only military capabilities. This product helps players build skills in identifying important data points and tying them to effective, data-driven decisions that optimally leverage a country's full range of abilities.

3.2 Negotiations-Pairing Process

A primary aspect of building strategic thinking frameworks is conducting negotiations as it simulates competing country interests and the impact of relationships in achieving global influence. The identification of the potential for improvement in the original negotiation framework within the SC2 wargame resulted in an objective to develop an automated negotiation pairing process that decreased proctor input and optimized input of real-world factors. To achieve the first part of this objective, this project developed mechanisms for player negotiation preferences to be pulled in and sorted automatically through the Player Dashboard and the backside architecture, as discussed in the next section.

To achieve the second part of the negotiation objective—incorporating realistic conditions—this project created a matching algorithm in Excel based on Irving's work on the Stable Roommates Problem to output perspective and preference-based pairings (Fleiner et al. 2011). This algorithm incorporates metrics from the dynamic reputation model developed by Braun et al. to weight areas of importance based on proctor and player input (2022). The proctor facilitates the selection of metrics that mimic relevant conditions for the players and a swing weight matrix then weights the selected metrics. The weighted metrics and their associated value functions multiply together to output the reputation scores for each player country. These scores and the perspective-based reputation scores of each country combine to output a negotiation reputation score that accounts for the standing relationship between two countries and any outside, variable considerations that may impact the outcome of negotiations. The multiplication of the rankings of each country based on their negotiation reputation score and the pairing preferences identified by each player result in a pairing score for each potential negotiation pairing. The developed

matching algorithm inputs the pairing scores and outputs optimized pairings for each round. The algorithm uses a series of conditional statements to inform outputs that ensures each country only has one pairing per round and pairings are not repeated within the negotiation rounds of a single turn.

The team created a matching algorithm following a discussion with the Office of Economic and Manpower Analysis (OEMA) on matching algorithm methods that account for different variables within negotiations (K. Greenburg, personal communication, January 31, 2023). The developed algorithm sums each player's preference for every possible match up and then weights their preference score by multiplying it by their normalized negotiation reputation score. There are no repeated pairings within each turn and the proctor may change the metrics used to shape the negotiation reputation score at the start of each turn.

To further integrate elements of realism and keep players from settling into negotiation and action routines, we introduced "disruptions" at the beginning of each turn (Siyu et al. 2020). We developed these disruptions from real-world situations, such as earthquakes and failed insurgencies, contextualized within game mechanisms. These disruptions shape the interaction space for the players and add additional considerations for players by changing the advantages of negotiating with different countries, altering the negotiation discussion, and shaping which moves are optimal in any given turn.

3.3 Backside Architecture and the Player Dashboard

This capstone developed a computer-based backside architecture network to automate proctor mechanics in response to the problem CAA faced with the heavy proctor burden that resulted from the original SC2 wargame design. Improving the efficiency of the game mechanics allows players to learn strategic decision-making skills with minimal required input from proctors. The developed architecture network includes a Proctor Control Board and individual Player Dashboards that provide players with real-time feedback on strategic actions. Subsequent sections will explain the components of the Player Dashboard, which is shown in Figure 3 below.

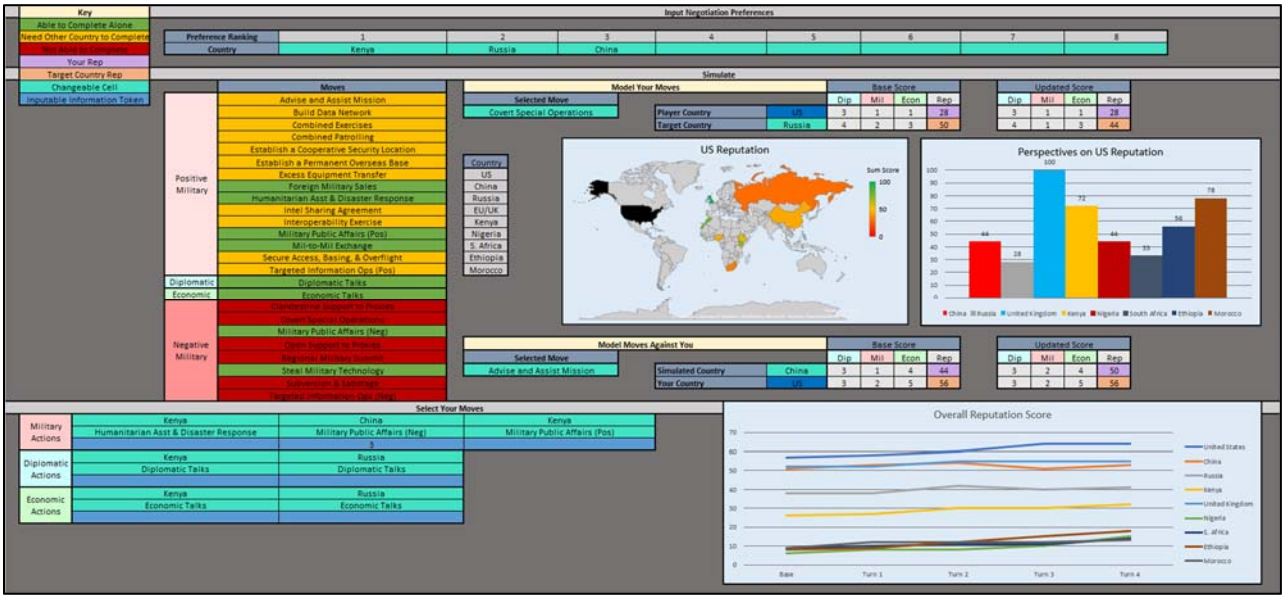

Figure 3. United States Player Dashboard

3.3.1 Proctor Adjudication Components

The Player Dashboard and associated backside architecture automates much of the game mechanics through a series of Excel functions that pull data from CAA-provided products and adjudicate moves based on a series of predetermined conditions provided by game mechanics. The implementation of this backside architecture decreased the burden on the proctor to administer the mechanics of the game and improved the player's immersion in the game. The teal player input cells on the top and bottom sections of the Player Dashboard, shown in Figure 3 above, connect to the proctor's adjudication tool to allow for efficient information collection. The top section. "Input Negotiation Preferences," is for players to input negotiation preferences, which the proctor then puts through the previously discussed negotiations matching algorithm. The bottom section, "Select Your Moves," is for players to input moves, target country of move, and any information tokens used to increase the

odds of move success. These inputs automatically populate on the proctor's main interface, centralizing the information the proctor must process and allowing the proctor to conduct die rolls to determine move success and initiate reputation score updates. This automation changes lower the cost of running the SC2 wargame and allow players to remain engaged in simulation and learning.

3.3.2 Player Interaction Components

The Player Dashboard provides players access to simulation options to help improve their understanding of the impact of specific actions. The dashboard uses color indicators to highlight the availability of moves based on a player's perspective-based reputation scores and provides turn-by-turn feedback on the overall reputation changes from the adjudication of moves made in the previous turn. To further aid in understanding the impact of strategic actions, the middle section of the Player Dashboard, "Simulate," allows players to simulate moves against other countries—or moves other countries may make against them—to understand how their influence and reputation may change as a result of specific actions without impacting their actual game score. Paired with contextualization from the Player Guidebook, the Player Dashboard Simulation provides players with an understanding of how DIME influence impacts state reputation on a global scale. To guide simulation, the dashboard provides a color-coded action menu, shown to the left in Figure 3, that indicates move availability based on influence scores relative to the indicated country of interest. The colors provide the player with a quick understanding of the actions available to their country based on their relationship with a target country and the resources invested into that country.

Throughout the game, players also receive real-time feedback as they simulate and take strategic actions. The heat map in the center of the dashboard depicts the player country's reputation from the perspective of each other player country and helps inform which countries players should focus their actions on. Beside the heat map is a bar graph displaying the reputation of the player's country from the perspective of all other countries in the game; this graphic further quantifies the heat map and supports informed player decision-making. Finally, the line graph at the bottom of the Player Dashboard shows the net changes to overall reputation score for each player after the completion of each turn. The overall reputation scores are based on an aggregate of all perspective-based reputation scores and net changes are determined after the adjudication of each turn. The inclusion of this graph allows users to map their progress relative to other players and increases the competitive drive to increase reputation, which further supports player development in strategic-thinking.

4. Results

This capstone iteratively tested the project solution with a variety of user groups before fully implementing it at the United States Naval War College (USNWC). To gain initial feedback in the early stages of product development, this capstone conducted a test play with DSS and DMI faculty who had never been exposed to the game before. These first rounds of test play exposed errors in the program and provided ideas for additional efforts. Immediately, the improved speed and efficiency of play was recognizable, and players were able to achieve the basic player objectives associated with the wargame.

Following these initial test runs, the group tested the Beta version of the solution at the Center for Army Analysis (CAA) with the developers of the SC2 wargame and other experienced wargamers to gain approval on our design and identify any further improvements. During the test play of this product, the game efficiency improvements reduced the lull between turns from hours to minutes. In previous SC2 wargame events at CAA, players from across the country slowly worked through six years of game time in a week of real time, with each turn taking multiple hours, with the solution developed, six years of game time can be completed in a day of real time, while retaining the achievement of player outcome objectives. This increased capacity for turn repetitions is an essential element of improving the game's educational value for GCC staff and other wargame players. With more opportunities to take multi-domain, globally scoped actions domains and reflect upon their outcomes, players have more opportunity to develop strategic planning skills tailored to periods of competition or crisis. Additionally, the game improvements greatly reduced the administrative labor required from game masters and referees, increasing the CAA's ability to conduct the game. According to the CAA's senior Strategist within their Strategic Wargaming Division, SC2 previously "took 14 facilitators to host 70 people" and can now likely be managed by 2 or 3 individuals (P. Kearney, personal communication, February 23, 2023).

Following the CAA's approval of the Beta version from CAA, the team took the final product to USNWC for the culmination of this project. Following an orientation brief on the SC2 wargame, this team conducted two rounds of gameplay with senior officers and civilian analysts from USNWC. The players, including the Senior Military Analyst for Wargaming at the USNWC, provided positive feedback on the player experience and affirmed the game mechanics supported the desired end state for player development in competition-focused strategic planning (P. Pellegrino, personal communication, March 22, 2023).

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5. Discussion

The product addressed the problem statement, accomplished the stated objectives, and met all client needs. In the near future, CAA will conduct a full-scale SC2 wargame involving countries in every GCC and will apply the methodology established in this project. While the established methodology has proven to be effective, there are several areas of exploration and development to further improve the wargame. First, the establishment of cloud integration or an internet server to store the game would improve the mobility and access of the wargame. This change would allow players to easily use the products without having to be on Microsoft Teams and connected to the same server. Second, the use of artificial intelligence to continuously scrape real-time, relevant data would allow the information within the Player Guidebook to remain up-to-date and ensure realistic identified considerations and reputation scores. inform the Player Guidebook before each execution of the wargame. Lastly, the negotiation process has potential for improvements to improve realism. One method identified is the inclusion of multilateral negotiations between more than two countries. These identified areas could further improve the problem solving and decision-making skills the SC2 wargame aims to instill in its players. This project's development of the SC2 wargame, however, has produced a wargame that meets the intended objectives for players through a coherent narrative experience and efficient instillation of realism.

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