THE USE OF WAR GAME SIMULATIONS FOR BUSINESS STRATEGIES

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Abstract: War gaming, long used by military organizations to test strategies without actual combat, are now being used by nonmilitary private and public sector organizations to support the formulation of potentially high-impact decisions and plans. This chapter defines war gaming approaches, describes their application in two case studies, and identifies specific situations that they can effectively address.

1. Introduction

The concept of war gaming has its roots in military history and continues to be used extensively by armed services around the world. More recently, war gaming has been adopted and applied by businesses and non-government organizations as a tool to test and develop new strategies and procedures. The military routinely employs resources in training for operations, testing strategies, and operational plans without actual combat. These simulations are also referred to as "maneuvers" or "exercises," and underpin most collective training programs.

War gaming has also been employed to examine preparation and response measures to single or multiple chemical, biological or radiological (CBR) terrorist attacks and conventional strikes. For instance, the US TOPOFF (Top Officials) terrorism preparedness exercises mandated by the US Congress and run by the Department of Homeland Security [1].

I. Linkov et al. (eds.), Real-Time and Deliberative Decision Making.

This chapter will evaluate the use of war gaming as a decision-making tool and how this provides a valuable means to examine strategies in different scenarios as an effective futures tool for the public and private sectors. The simulations discussed here are based on human interactions and not computer modeling.

The chapter is divided into the following parts:

1. Background of simulations
2. Methodology of simulations
3. Outcomes of simulations based on analysis
4. Case studies

The chapter provides an overview of how the methodology has been adapted to the business environment by the pharmaceutical industry and public health sector, and how it could be applied to other areas.

Two case studies will provide insight into where the use of war gaming has been valuable as a decision aid. The first involves a large U.S. pharmaceutical company and examines the conditions under which precision medicines (drug diagnostics combination therapy) could be attractive to the organization. This included assessing these drugs' internal and external risks and benefits, from organizational structures and decision processes to how the external environment might respond. The external environment included regulatory agencies, patient groups, and key public health bodies. The pharma company benefited from running a number of simulations to assist in their decision making processes from product development through contingency planning.

The second example is an examination of United Kingdom (UK) preparation, response, and recovery capabilities relating to a pandemic flu. Sponsored by the Bioscience Futures Forum, established by the UK government Department of Trade and Industry, the event involved six biopharmaceutical companies, the National Health Service, pharmacy bodies, and regulatory agencies (EMEA and MHRA). The simulation focused on two key themes: operational response and reputation management issues (risk communication and public relations). The outcomes helped to shape public health, government, and industry thinking to better prepare for a pandemic flu.

This paper draws upon research undertaken by this author from a three-year pharma-funded research project in 2003 at King's College London, and since commercialized into a consultancy service by Simfore and HFC. The project adapted war gaming in the defense arena into an effective risk management tool to provide government, industry, and academia a means to develop and stress-test risk assessment approaches. The tool is designed to address uncertainty and inform decision-making processes. War gaming offers

a simplified and structured framework for identifying possible and probable outcomes from the interaction of qualitative variables and uncertainties and for stress-testing and identifying new strategies and approaches. The use of war gaming has become increasingly accepted in the corporate environment, with companies reporting greater demand to simulate the interactions of multiple actors in a market [2].

2. What Are Simulations and Why Are They Not Scenarios?

When discussing a simulation, we frequently are met with "Yes, we do this already. We do scenario planning." In fact, interactive simulations are the next step beyond scenarios. They can start with and are frequently adapted from scenario planning and/or financial modeling, enabling organizations and stakeholders to develop and validate novel strategies in a hypothetical but credible exercise. Simulations reveal likely outcomes, including unintended consequences, and enable the participants to challenge assumptions by allowing stakeholders' interactions to provide new insights.

To understand how simulations are adapted from the military sector, the following section provides an overview of military simulations.

2.1. WAR GAMING IN THE MILITARY

War gaming in the western military can be traced back to Prussians, whose victory over the second French Empire in the second Franco-Prussian War (1870–71) is partly credited to the senior officers receiving training from playing a war game (*kriegspiel* in German). In 1898, naval analyst and writer Fred T. Jane, who founded *Jane's Fighting Ships*, developed a series of rules depicting naval actions through the use of model ships and miniatures. Military war games evolved rapidly into more complex systems during the first half of the 20th century, which included the U.S. 'gaming' its military campaign in Asia and the Pacific Rim during the Second World War [3].

Modern armed forces run two main types of simulations: *soft gaming*, with individuals playing and interacting as teams; and *hard gaming*, or computer modeling. The present business simulation approach is adapted from soft gaming, which focuses on decision making through qualitative interactions between individuals and teams.

Hard gaming principally relies on inputting the profiles of military assets (e.g., aircraft, tanks, ships) on both the allied and enemy sides into a computer model. The computer simulation, through knowledge of military capabilities (e.g., fire power, speed, range, agility) and vulnerabilities (e.g., available countermeasures and shield strengths) calculates

the attrition and casualty rates of personnel and equipment deployed in combat operations.

The objective of both approaches is to assess what force structure would best suit the desired operations. For instance, prior to the 2003 Gulf War, British forces ran simulations to assess how best to fight Iraqi forces in their approach to Basra in the event of engaging the enemy in the desert, or within the city. The advantage of hard gaming (involving computer modeling alone) is the ability to run scenarios multiple times with minimal resources. But hard gaming does not provide training or evaluate effective decision making and interactions between various groups.

While the military conducts large-scale outdoor operational maneuvers (field training exercises) involving land, air, and sea assets across thousands of square miles, to evaluate response strategies and contingencies involving a large number of personnel at once, they also conduct indoor simulations that require significantly less manpower and resources (soft gaming). One of the most common forms is the Command Post Exercise (CPX), which focuses on simulating the environments experienced by command (leadership) teams and planners without the need to physically deploy troops [4]. The CPX retains human input and is thus highly effective at simulating human imponderables and behaviors, but is easily accessible at a lower cost.

The scenario could be, for instance, a humanitarian crisis in the Balkans that requires military forces to be deployed while opposition elements are conducting offensive military activities against civilians. In the simulation there would be political interests and challenges at both the regional and international levels (e.g., the United Nations). In these types of exercises, military personnel would role-play the external political and opposition elements, while also performing their day-to-day real-world duties.

Running the exercise would be a control group responsible for umpiring the simulation, providing scenario injects (e.g., major political or military developments), and deciding what additional information the teams are allowed to receive. The control group also makes sure that the team's tasks are accomplished within the time frame allowed.

There are two clocks running. The simulation scenario environment can cover a period of days, weeks, or months. The participants are taken through the day's activities in real time. CPX simulations can last from one day to several days, or even a couple of weeks.

2.2. BUSINESS WAR GAMES

Unlike the armed forces, the business environment has a wide variety of war game options offering various degrees of complexity and value. Some options do not necessarily involve interactive simulations. For instance, Shell

scenario planning provides alternative views of the future. This first came to prominence in the 1970s.

Business war game simulations, which are the focus here, are typically played over one or two days to simulate a period of weeks, months, or years in a series of sessions. The simulations can either be used to explore new strategies or as a training tool. Typical uses include:

- Ethical preparation to understand social stakeholder opinions.
- Evaluate the understanding of a strategic plan to accelerate strategy implementation.
- Assess reactions and possible responses.
- Explore intended and unintended consequences.
- Practice/rehearse communication.
- Evaluate behavior of competitors—blue and red teaming.
- Use time compression so teams can see the longer term implications of decisions.

The output value derives from three distinct phases: simulation development, execution, and analysis. Simulations address uncertainty and inform decision making, and can test assumption robustness under various conditions. These simulations are played by human subjects rather than involving computer modeling; however, they may include databases and computer models as part of the event. For instance, teams may model their financial strategies or clinical trial options using existing tools from their day-to-day activities. In such cases, the computer model is then customized with a user-friendly interface that is flexible in the simulation, for instance, populated with profiles of products that are being examined in the exercise.

One of the most powerful aspects of simulations is the lessons learned by participants as a result of their experience. Unlike other styles of workshops, these simulations are not about instructing participants. But through their experience in the simulation, participants encounter learning opportunities by living through the scenario and witnessing how their decisions and the consequences of their actions and the actions of those around them could impact their future.

There are two broad categories where simulations can be used: research and training.

2.2.1. Research Simulations

These typically allow a client to develop and stress-test the robustness of current or alternative business assumptions. Their value derives from evaluating concepts

in a safe environment before implementing them in the real world. Participants are encouraged to be less risk-averse than they might be in the real world when exploring and developing new strategies. The simulation tool that has been developed also creates a collaborative space that brings together leading industry peers or other stakeholders to develop strategies and create opportunities. A key feature is that it accelerates the decision making and negotiating time.

2.2.2. Training Simulations

Training simulation offers a powerful experiential tool to immerse groups and individuals into testing their decision-making processes or learning new procedures and routines. This can include new day-to-day decision-making processes that might be implemented by an organization or new standard operating procedures. Where individuals and groups have been used to one set of routines, a simulation would enable individuals to fully explore their potential value and challenges to implementation, and test their adoption in a safe environment. A second main use of training simulation is crisis management or contingency planning. Organizations can test their emergency response public relations and risk communication procedures following an adverse event (e.g., a major product recall following contamination, or pressure on a company to withdraw or revise the labeling of a high-profile drug following reports of severe side effects). In both cases one would be training and testing the organizational structure in what information and tacit knowledge from individuals is available within and outside a company to make informed decisions in the context of uncertainty. A simulation could test an organization's public presentation of issues with invited external consultants role-playing stakeholders like the media, consumers, and the regulatory authority.

3. Methodology

Developing and running a simulation is a three-stage process:

1. Building the customized model
2. Running the simulation
3. Reporting the key findings and recommendations

3.1. BUILDING THE CUSTOMISED MODEL

A key aspect to this approach is customizing the model to the client's needs. There is no one-size-fits-all model. Key questions that need to be

addressed include capturing the key objectives, identifying the timeline to be examined, and determining the key variables that need to be populated in the simulation. As it is not possible to have all the internal and external variables running at once, the simulation designers have to prioritize which ones should be factored in the model. Finally, the client's teams and line functions are identified.

During this process, the simulation design team identifies the individuals within and outside the client's organization who should be invited. Parallel to this is the development of the simulation scenario. To ensure that the simulation moves smoothly through the time period being examined, the simulation design team needs to build in advance the scenario to be examined. This includes a case study (for instance a mock product profile), scenario injects in the form of mock newspaper stories and company announcements, and one or two major external shocks. The latter could be developed in conjunction with the client to meet the needs of and stress-test the decisions being made in the simulation. Throughout simulation development, those who will take part in the player teams should not be aware of what the unfolding scenario will entail.

Although the scenario material and injects are developed in advance, there is a fine balancing technique involved to make sure that the simulation model is not overburdened with too much information and interaction nor does it have so little that the output is superficial. Getting the right balance also extends to compiling the briefing for all the participants. For instance, participants may not have that much time to read through all the material. Therefore, when building the scenario and related material, the designers have to be aware of the capabilities and time participants have available to prepare and be engaged in the simulation.

There is no one set way of getting the right balance. Developing a successful simulation requires the experience to know how much information should be included. This will partly depend on the topic at hand; for instance, the degree of familiarity the player teams will have with the issue being examined and the case study at hand.

3.2. RUNNING THE SIMULATION

The one- or two-day simulations establish all links and partnerships via player interactions. For the pharmaceutical area, these include physicians, pharmacists, payers, wholesalers, economists, and commercial interests. These can be role-played in the exercise by consultants and client employees with expertise in these areas.

At the beginning of the simulation all participants are in one room for the scenario briefing, and then move to their separate team rooms to work

on their set tasks and interact with other groups During this time participants receive scenario injects of mock news stories and press releases. After a set time period, participants reconvene in one room for the report back session to present their recommendations and agreements they may have reached. This concludes one time frame move. Each move covers part of a period of weeks, months or years which forms part of the overall scenario being examined. There are several moves in one simulation. During the work stages where participants are given set tasks and objectives to fulfill, communication between teams and those representing the external environment is conducted by email and face-to-face contact. Decisions and deliberations are captured and later analyzed.

While the simulation has a prepared scenario with set aims and objectives for each of the moves (time frame segments), it is important that the simulation is not too structured to constrain freedom for the variables to interact. At the same time, there should not be so much freedom that the set tasks and objectives cannot be accomplished. As with balancing the variables in the model, there is no set way of doing this other than by experience in running simulations.

A simulation is effectively a time and space entity that you can expand and contract in segments as you see fit to meet the purpose. The only real restriction is the actual real time one has to run the simulation. Like a piece of plasticine, you can mold and move it into the shape and length you wish within the constraints of the amount of plasticine you have. The amount of plasticine in this case represents the real time and resources you have to run an event. But it is also important to keep in mind the main objectives.

3.3. REPORTING THE KEY FINDINGS AND RECOMMENDATIONS

Following a simulation, the key aims and objectives are extrapolated from an analysis of the material generated in the simulation. This includes team presentations to meet the key tasks set throughout the simulation, and report notes of meetings and interactions that have taken place between the different groups. Typically a simulation provides an extensive amount of material to assess, which is captured through specific tools and approaches.

With all the material and data at hand, the process begins to reverse-engineer the key decision points and events. Analyzing the results leads to two main outputs. The first is a timeline diagram capturing the key decision points and outcomes. The second is a series of key findings and recommendations. At this stage, the simulation output entails proprietary elements in analyzing and presenting the data. The timeline graph of the key interactions includes junctures where certain decisions were made, and their consequences. From this, a series of alternative scenarios and outcomes can be extrapolated from

which the end user can see the upside and downside of various options from both internal and external perspectives.

4. Case Studies

Below are outlines of two simulation case studies that highlight how the simulations were compiled and the resulting key findings and recommendations. Given the client confidentiality of the simulations, only selected lessons are included.

4.1. PANDEMIC FLU

4.1.1. Background

While the UK Government has run pandemic flu simulations (including a Whitehall exercise run in early February 2007 called "Winter Willow," and Health Protection Agency simulations), this was an opportunity for stakeholders to collectively challenge their thinking and behavior in response to a pandemic. The simulation was run in June 2006 for the UK government body, the Bioscience Futures Forum [5]. It tested the impact of different levels and types of stakeholder engagement across public and private sector organizations and how they can best come together to coordinate and communicate complex operational policies and procedures to engage with the public. Eight biopharmaceutical companies took part as one main pharmaceutical company. Public health representatives and stakeholders included a London Primary Care Trust, the Health Protection Agency, physicians, pharmacists, and wholesale distributors. Regulatory participation included the UK's MHRA and the European body EMEA. The Department of Health observed the simulation.

4.1.2. Scenario Structure

The scenario covered a ten-month time period from July 2006–May 2007 covering one wave of a pandemic. The time period was divided into the following four sections:

- Pre-pandemic: first UK human H5N1 bird flu case from a Norfolk poultry farm (July–December 2006)
- Wave 1: pandemic starts in Sumatra, Indonesia (December 2006–January 2007)
- Wave 1: pandemic reaches the UK (January–April 2007)
- Inter-pandemic: preparation for a second wave (April–May 2007)

4.1.3. Key Findings and Recommendations

The simulation identified a number of ways to better utilize resources and capabilities, including repurposing existing assets. Many of the recommendations could be implemented through better coordination and alignment among key public and private sector stakeholders.

The first recommendation was to create a list of "essential drugs" the delivery of which needs to be maintained to ensure critical healthcare delivery. The list included a number of existing drugs that could be used to treat secondary infections from pandemic flu.

Death from pandemic flu is usually due to respiratory failure or other complications from secondary effects. Young adults can have an exaggerated immune response ("cytokine storm") that can lead to extensive damage in the lungs and cause multiorgan failure. There are a number of existing drugs that can treat this response, of which adequate supplies need to be maintained. As a vaccine based on the pandemic strain is unlikely to be available in the UK during the first wave based on what vaccines had received regulatory clearance in 2006 and there will be limited supplies of antivirals, reliance on existing therapies to treat secondary infections becomes of greater importance.

The second recommendation noted that alternative forms of pandemic flu vaccines with higher production yields could reduce the overall fatality rate. While the current egg-inactivated vaccine can provide around 300 million doses globally (insufficient to meet the needs of a global pandemic), alternative vaccines like the cold-adapted egg-based vaccine codeveloped in the UK and U.S. can increase the number of doses by several times and have a shorter development period. Another strategy is providing a lower dose of a pandemic flu vaccine to individuals to provide some protection to a larger number rather than more complete protection to a smaller number of people. While some individuals may still not survive, the overall fatality rate would be lower. This decision would require ethical considerations of whether what is better for society outweighs individual treatment needs.

The simulation also identified inconsistencies in national and local public health contingency plans that must be resolved and distribution channels for disseminating antivirals and vaccines that must be strengthened. Pharmaceutical wholesalers and pharmacists called for their supply and delivery channels to be fully integrated and consulted as part of the UK government's response plan.

To address these and other issues, the simulation recommended the establishment of a biopharmaceutical working group to ensure close collaboration and communication within the industry in order to share knowledge and expertise and communicate credibly to the wider public. Finally, effective pharmacovigilance measures to monitor the safety and efficacy of vaccines, within an acceptable safety framework, should be established to accelerate vaccine approval during a pandemic, particularly for novel drugs.

4.2. PRECISION MEDICINE SIMULATION FOR A MAJOR PHARMA COMPANY

4.2.1. Background

In 2004, the first simulation took place as part of a major pharma company's research project to pilot the methodology. The simulation examined under what conditions precision medicines (pharmacogenomics) could be attractive to that company. Precision medicines are compounds that—when combined with a diagnostic device—can identify and treat subsets of a population (e.g., responders, nonresponders, and those who may experience severe adverse effects). The concept behind this approach is that if one could identify these population subsets through a biomarker (for instance, a genetic test), then patients could be provided with the most suitable treatment from the outset. At the time of the simulation, the company wanted to investigate whether precision medicines would be of value to the organization. The traditional business model for this company and other pharmaceutical organizations has been the blockbuster model, which entails developing a product for the mass market without specifying population subsets.

The key aims and objectives of the simulation were to:

- Provide insight into the environmental challenges and opportunities of precision medicines for the pharma company.
- Illustrate the realities of drug development and external conditions.
- Determine whether simulations can capture and manipulate the main pharmaceutical variables.
- Explore to what degree the simulation can define new deliverables.
- Ascertain to what extent the results provide operational utility to further understand whether precision medicines can be attractive to the company.

The project team represented a hypothetical drug development team of a dozen company employees. Although the simulation was originally intended to look at pharmacogenomics, post-simulation analysis revealed some fundamental lessons for how the pharma company's drug development teams and governance bodies should function. This demonstrated that war game simulations have the advantage of identifying opportunities and challenges far beyond other methods like brainstorming.

4.2.2. Scenario Structure

Two key groups participated in the simulation: the facilitators, who ran the exercise and represented the external and internal stakeholders; and the drug development team, who actively played the simulation. The external variables

were represented by individuals with in-depth expertise about the roles they were playing. Each team had its own room. In addition, the pharma company had a governance body to which the drug development team reported their strategy to get a go/no-go decision.

Figure 1 shows the simulation timeline examined by the pilot simulation. This timeline extends from 2007 to 2017. It was split into four moves, from Phase III of development to the fifth year of the product's launch in 2017. The last move followed a time jump, from 2011 when the drug development team submitted their proposal, to the regulatory bodies FDA and EMEA for new drug approval.

4.2.3. Key Findings and Recommendations

The post simulation analysis revealed the following.

1. The simulation design produced a workable futures simulation that could record decision paths, capture data, and identify problems and opportunities. The exercise demonstrated that it is possible to simulate and manipulate the key internal and external drivers of the pharma company's business environment over two days and develop a credible output.
2. The simulation identified the stage points at which additional knowledge of the diagnostics industry and stakeholders was essential to make informed development decisions concerning the co-development of a diagnostic device with a compound. Through analyzing the information, it became clear at what junctures during a product's drug development teams would need to have Dx information. This would enable improved decision making and informed thinking about the options available to the teams.
3. Compressing the development timeline to two days allowed the simulation to discover unexpected issues and identified solutions to implement. While the simulation's main aim was to identify the conditions under which precision medicines would be of value to a major pharma

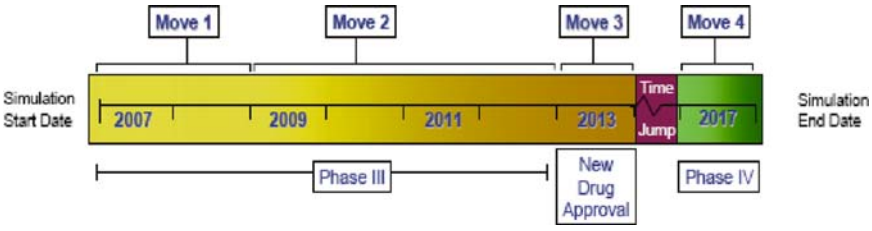

Figure 1. Timeline for the precision medicine simulation.

company, a byproduct of the exercise was to identify new issues regarding decision-making processes. This is a key advantage of simulations over more traditional management consultancy approaches, which would focus on a particular set of issues, but would not enable variables to interact freely to identify other key issues.

4. Internal governance bodies could be revised to deal with the uncertainties and identify opportunities of the changing pharma environment.
5. Potential efficiencies were identified by empowering drug development teams to influence the positioning of similar products to optimize the portfolio.
6. Product development could be more efficient and opportunities identified through reconfiguring drug development and worldwide teams.
7. Adopting the format the drug development teams experienced in the simulation could make for a more streamlined decision-making process.

5. Conclusion

Simulations can be used as a research tool to investigate alternative business strategies, and identify lessons that could streamline and improve product development and decision-making processes. In the pharmaceutical area, it is possible to use simulations to illustrate the realities of drug development and external conditions, and to provide insight into alternative drug development beyond the self-evident. The key output is a process map of the decisions made to identify the junctures where an organization can proactively influence and engage with its external environment and seize the initiative over the timeline examined. Subsequent simulations can always be conducted under alternative environmental conditions to test the robustness of strategies. The series of simulations that have been run provided operational utility to further understand the challenges and opportunities facing the pharmaceutical industry in developing innovative research and development strategies.

While the simulation model has been developed initially for the pharmaceutical and public health areas, the general concepts and approaches can be applied to other sectors, such as telecommunications, petroleum, the defense industry, and finance.

The following list summarizes key areas that war game simulations can address within each sector:

- Business optimization
- Evaluating the robustness of existing and proposed business models

- Exploring new stakeholder engagement solutions
- Increasing value from products and services from R&D to launch
- Identifying and assessing new organizational structures
- Technology optimization pathways
- Evaluating regulatory filing strategies
- Organizational optimization for team decision making

Key to running simulations is knowing the right time to apply the technique. While simulations can be applied to a broad variety of issues for training and research purposes, there may be occasions where a facilitated meeting or more traditional management consultancy approach is needed. It is up to those with experience of running business simulations to know when it is appropriate to recommend this tool, and how the simulation should be constructed.

It has been shown that simulations provide a highly innovative futures tool that provides the public and private sectors with a valuable means to test and develop new strategies in a safe environment prior to implementation. While futures and scenario tools tend to rely more on workshops and brainstorming activities, simulations have the benefit of identifying known and unknown elements, together with identifying critical but unrecognized aspects of a problem that could prove critical to the successful implementation of a new strategy. The freedom of the variables to interact in a safe environment, replicating the operating environment as much as possible, has a powerful effect.

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