> "Serious games are more than entertainment. Using the medium of a game, they change the way that people interact with each other for a short period of time, but long enough to achieve results that playing by the normal rules of conduct has not produced."

> — Tom Grant,
> Guest Editor

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Serious Games as Tools for Innovation

Experiences Using Online War Games to Improve the Business of Naval Systems Acquisition

by Nickolas H. Guertin, Paul Bruhns, Douglas C. Schmidt, and Adam Porter

Each year the US Navy spends billions of dollars to maintain and upgrade the readiness of war-fighting systems on its sea-, air-, and land-based platforms. The Navy must find ways to meet its growing maintenance needs at ever lower cost as defense budgets continue to shrink. This requires changes in business relationships between acquisition organizations and their contractors to identify new acquisition strategies, policies, processes, and technical architectures. In short, there is a compelling need for new business and technical models to support defense acquisition reform. To better understand these challenges — and to identify incentives that will help it meet its future demands — the Navy recently ran two Massive Multiplayer Online War Games Leveraging the Internet (MMOWGLIs).[1] This article describes how the Navy used these games to crowdsource novel ideas from contractors, government staff, and academics on how to encourage industry and the acquisition workforce to find innovative ways to develop, sustain, and apply robust competition to the acquisition of naval systems.

PROBLEM: LARGE VENDOR-LOCKED SYSTEMS ARE NO LONGER AFFORDABLE

The US Navy is seeking to evolve its war-fighting system acquisition practices, moving them away from vendor-locked business arrangements. It is also reforming its business practices, again shifting away from using proprietary approaches that only a single incumbent integrator can readily understand.[2] The problem with vendor-locked systems is they yield redundant "point solutions" that, over time, are prohibitively expensive to develop, certify, and sustain. For example, many of these single-point solutions involve unique networks, computers, displays, software, and operators. This practice impedes interoperability and integrated management with other systems and increases the costs and defect rates of system modifications. Furthermore, the tightly coupled design of these vendor-locked systems inhibits Department of Defense (DoD) program

offices and system integrators from leveraging more affordable, recent advances in commodity hardware and software platforms, such as multicore and distributed-core computing environments, that stem from commercial sector investments in off-the-shelf information technologies.

To address these problems, the Assistant Secretary of the Navy for Research, Development, and Acquisition recently approved a new Open Systems Architecture (OSA) strategy. The business goals of the Navy OSA strategy focus on challenging acquisition programs to:

- Maximize their buying power to open up competition

- Incentivize better contractor performance and increase access to innovative products and services from a wider array of sources

- Decrease the time needed to field new capabilities

- Achieve lower acquisition and lifecycle costs while sustaining fair industry profitability

The technical goals of the Navy OSA strategy focus on:

- Using modular, loosely coupled, and explicitly articulated architectures that provide many shared and reusable capabilities to war-fighter applications

- Disclosing requirements, architecture, and design specifications and development work products to DoD acquisition programs

- Adopting common components based on published open interfaces and standards

- Achieving interoperability between hardware and/or software applications and services by applying common protocols and data models

- Sharing the efforts across many programs in order to create conformance and regression test suites that help automate the continuous verification, validation, and optimization of functional and nonfunctional requirements

WHY REFORMING ACQUISITION PRACTICES IS A WICKED PROBLEM

The Navy believes that changing its existing acquisition practices to use open business models will help it meet the challenges posed by the new OSA strategy. It also realizes that these changes will have a vast impact throughout the naval acquisition enterprise. Using an open business model would be a dramatic evolution in the way systems and services are procured. In fact, the changes posed in the Navy OSA strategy will affect the Naval Systems Commands (SYSCOMs) and Program Executive Offices (PEOs), each of which has its own organizational structure. The SYSCOMs and PEOs jointly manage over 200 major procurement programs.

These proposed changes are clearly disruptive to the status quo. The Navy will not only have to adopt new procedures, but must also evolve its workforce's behavior and culture. Such large-scale changes cannot be imposed effectively by fiat. They are more likely to succeed if they can evolve through a consensus-building dialogue with those most affected by them.[3] A necessary challenge is to devise the appropriate incentives and organizational processes from which some consensus can emerge among 20,000-plus practitioners, each doing a critical job that cannot be stopped while the Navy works out the details of changing it.

In short, the Navy needs rapid and economical methods for engaging a broad, diverse audience in developing consensus-backed proposals for radically changing long-held and deeply entrenched ways of doing business. This situation is a classic example of a "wicked problem,"[4] which is hard to solve because it's complicated to understand and express, it's difficult to manipulate and evaluate, and it involves many interconnected parts that mutually influence each other and are hard to untangle. So faced with a wicked problem and needing a solution right away, what did the Navy do? It turned to *serious games*.

PLAYING SERIOUS GAMES TO REFORM ACQUISITION PRACTICES

To help address the wicked problem of acquisition reform, the Navy's OSA Business Innovation Initiative (BII)[5] recently applied the MMOWGLI platform, which is a serious games platform designed by the Institute for the Future (IFTF), developed at the Naval Postgraduate School (NPS), and sponsored by the Office of Naval Research (ONR). This Web-based platform can support thousands of geographically distributed players who work together asynchronously in a crowdsourcing

manner to understand, discuss, debate, and (ideally) resolve wicked problems. The MMOWGLI BII games address both innovation and adoption, where the goal of the games is to create concrete pathways from ideas to actions and where game playing includes crowdsourcing as a way of getting buy-in from the practitioner community for adoption of new acquisition practices.

Players are introduced to the MMOWGLI through a "call to action" that explains the game's central problem, provides additional context, explains the rules of the game, and motivates the player to solve the problem. Players use their organizational email addresses to register to play a game. Their organization must be approved by the game master in order for an individual to play. Once players are approved, they each establish an avatar that decouples their identity from game play and protects their personal information.

MMOWGLIs are designed by the client with the help of a group of subject matter experts (SMEs). In the case of the BII games, the client was the office of the Deputy Assistant Secretary of the Navy for Research, Development, Test, and Evaluation (DASN RDT&E). This group conducted workshops with the SMEs to develop high-level game themes. Themes set the context for all the topics that are presented in the games. Once these are established, the SMEs then develop topics and generate the "seed cards" to which players will respond during game play.

The MMOWGLI BII games are presented to players in a conversational form. The top "tier" presented is the theme, followed by a seed card. Whenever a player offers an idea, others can respond to it in one of four ways: Expand (agree), Adapt (modify the thought), Counter (disagree), and Inquire (ask a question). This relationship is illustrated in Figure 1 in the context of the MMOWGLI BII games we (that is, we authors and hundreds of our colleagues from government, industry, and academia) recently played.

These conversations form idea chains around which players can create action plans that define how the idea can be put into practice. Players use screen names to remain anonymous throughout the game. This anonymity allows them to focus on the issues rather than on an individual's pedigree, organization, or perceived position. The online community then uses the MMOWGLI Web portal to vote on the plan as presented. There are no formal meetings, no travel, and no game-playing expenses for the players, and each player's normal workflow is only minimally disrupted. The overall process is illustrated in Figure 2.
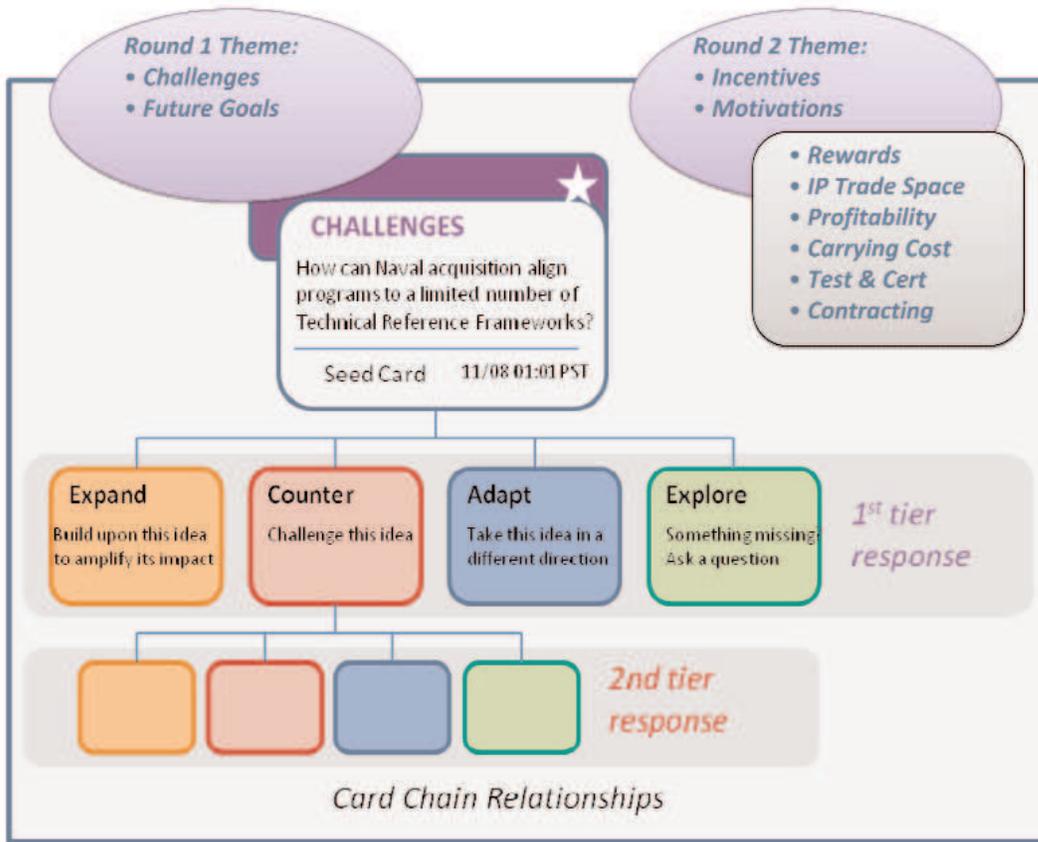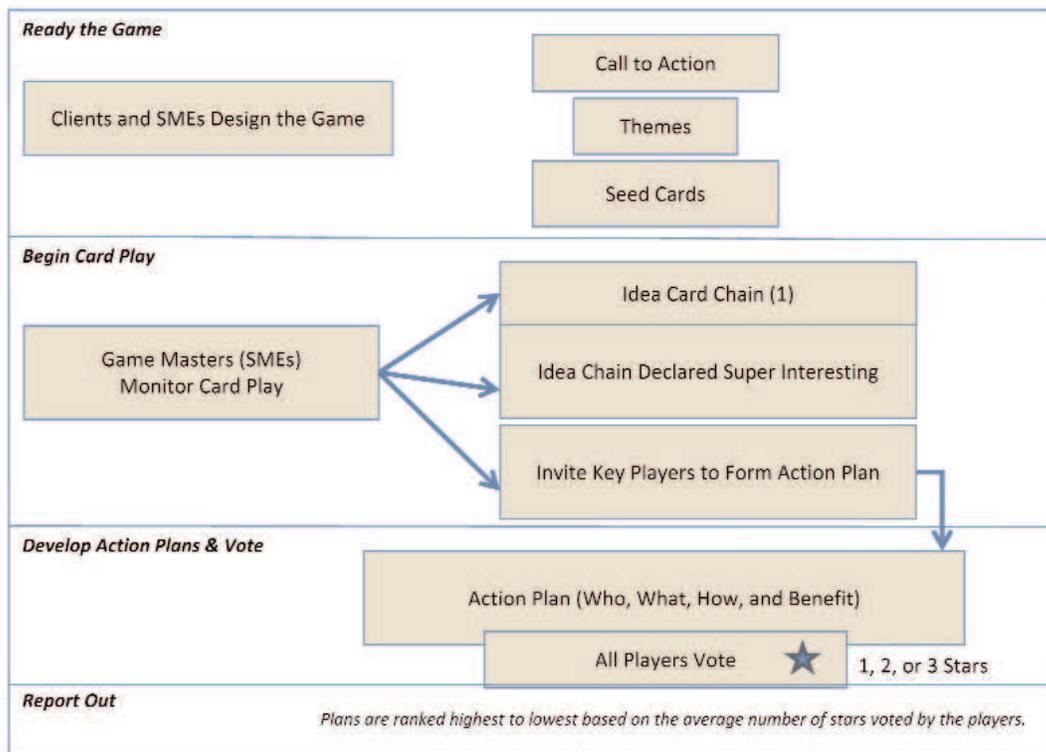
Figure 1 — MMOWGLI card chains.

Figure 2 — The BII MMOWGLI game flow.

THE GAMES PEOPLE PLAYED

The Navy ran two MMOWGLIs for OSA in 2013. The first game (called BII Round 1) was organized as a pilot study to test the viability of using the MMOWGLI platform to help identify and solve OSA business problems. The game was titled "Challenges and Future Goals" and involved only a limited number of invited players, mostly acquisition practitioners from industry, government, and academia who had specific interest in and experience with open business models. The community identified major challenges implied by the new OSA strategy, enabling naval leadership to better understand the scope of the changes needed and how the broader naval organization would view and react to those changes. Moreover, the game players took it further: they wanted to solve the challenges they identified, and they formed action teams to build solution plan outlines. This game was extremely successful, generating 890 ideas and 11 action plans. In addition, the results validated the soundness of the overall Navy OSA strategy and illuminated many ideas for further exploration in subsequent events with broader audiences.

As a result of BII Round 1's success, the Navy held a second game entitled "BII Round 2," which built upon the findings of the first game, focusing on how to best incentivize industry and motivate government programs to adopt open business models. In this round, we made a concerted effort to reach a much broader audience. We advertised the game through multiple channels, including the SYSCOMs' public affairs officers, the Navy's and the DoD's Office of Small Business Programs, as well as through media interviews in such outlets as Federal News Radio. In the end, more than half of the participants in this game hailed from industry, and many of them were from the small business community, which is critical to spurring innovation in both the technical and business dimensions of acquisition reform.

Through these channels, we explained that our goal was to identify and codify promising ways to incentivize industry to help the government achieve OSA goals, particularly in cost savings. We also wanted to engage the government players simultaneously with, and in full view of, the industry players, to identify impediments and find motivation to adopt change. Together, the two supporting themes of the game — incentives and motivations — were explored through card play. Each player engaged another player across the table (figuratively speaking) to evolve problem conversations into solutions and action plans. BII Round 2 generated 1,750 ideas, which were then validated, discussed, and translated into 15 action

plans for implementing the Navy OSA strategy. In the next section, we discuss some of these action plans.

ANALYSIS OF RESULTS

Now that we've explained how a MMOWGLI works and outlined how we used it, we'll examine the results we drew out of BII Round 2. Recall from Figure 1 that the BII Round 2 game had the dual themes of incentives and motivations. These themes were played through seed cards intended to stimulate problem-solving ideas on rewards, intellectual property (IP) rights, profitability, carrying costs, testing and certification, and contracting. As noted above, Round 2 generated 15 action plans (see Figure 3).

Given the current fiscal climate in the DoD and the Navy, it's not surprising that many of these action plans dealt with cost-containment strategies. Below we list a few of the action plans that came out of BII Round 2, followed by the goal of each of these action plans:

- **Give bonuses to Navy team members who save money on acquisition programs.** The goal is to incentivize program office teams to take both a short- and long-term view toward efficient acquisitions by optimizing prompt/early delivery of artifacts with accrued savings over the lifecycle.

- **Publicly recognize and reward companies for saving money on acquisition contracts.** The goal is for industry partners of all sizes and types to receive tangible recognition of cost-saving innovations, thereby improving the public image of both government and the companies involved.

- **Increase the incentive paid to contractors if the actual cost of the delivered solution was less than the targeted cost.** The goal is to give industry a clear mechanism for reporting cost savings, a clear way to calculate the reward for cost savings, and a transparent method for inspecting actual costs over time.

Although cutting costs is an important goal, the MMOWGLI players also recognized that cost containment would be a hollow victory if it yielded less costly but lower-quality solutions that don't meet their operational requirements and can't be sustained effectively and affordably over their lifecycles. Some of the highest-ranked action plans from BII Round 2 addressed the need for automated testing and retesting as an evaluator and enforcer of system quality. Testing stimulates an executable component with known inputs and under known preconditions and then compares the actual and expected outputs and postconditions to determine
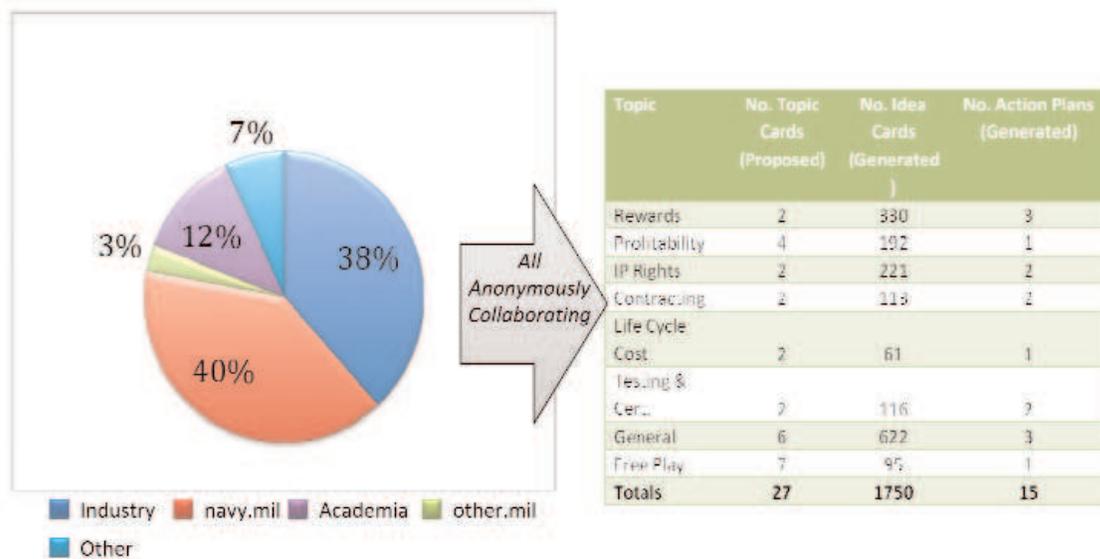
Figure 3 — The collective output of 322 registered players.

Topic	No. Topic Cards (Proposed)	No. Idea Cards (Generated)	No. Action Plans (Generated)
Rewards	2	330	3
Profitability	4	192	1
IP Rights	2	221	2
Contracting	2	113	2
Life Cycle Cost	2	61	1
Testing & Cert...	2	116	2
General	6	622	3
Free Play	7	95	1
Totals	27	1750	15

whether the component's actual behavior is consistent with its required behavior. Automated testing is essential to achieving positive cost-saving results in OSA initiatives by ensuring that the components and products delivered at lower costs have the requisite quality; it also reduces the time and effort required to conduct the testing processes.

The top-rated action plan from BII Round 2 proposed using automated tools and industry best practices to reduce manual testing and evaluation effort and increase the coverage of automated regression testing in mission-critical naval systems. When there are many frequent development steps — as is the case with iterative and incremental development methods — it is necessary to perform regression testing on the previously developed software. This testing verifies that the software continues to operate properly after being integrated with the new software and as defects are fixed and improvements are made. Iterative and incremental development cycles greatly increase the need for regression testing, and this additional testing becomes infeasible when it is performed manually.

Another testing-related action plan was also well received, being ranked 8th out of a total of 15 action plans. This plan would seek to reduce certification costs by requiring integrated validation and verification processes to involve automated testing, including assurance cases; test plans, procedures, reports, and scripts; as well as test data, tools, environments, and labs. The goal is to replace time-consuming manual testing methods with formalized automated testing across the lifecycle. This automated testing process defines, delivers,

and maintains testing work products that enable effective, efficient, and repeatable testing during component development, system integration, sustainment, and recompetition for a contract after the initial product development is complete.

The action plans that focused on cost containment alone were ranked lower by the participants (10th, 12th, and 14th out of 15). Based on an analysis of comments, the low rankings did not stem from a lack of interest in controlling costs, but rather from the realization that without effective automation of testing and retesting, the benefits of cost savings and efficiencies from OSA initiatives may be compromised by inadequate quality.

After analyzing the results of the two MMOWGLIs carefully, the Navy recommended that a subsequent study area in the OSA and BII focus on affordable testing. The goal is to establish quality assurance processes that are efficient and comprehensive during the design phase and initial delivery, as well as throughout the sustainment and recompetition phases. It's also critical that these automated tests be delivered with the system and include sufficient documentation so that government and/or sustainment contractors can both execute *and* maintain these tests. The results of these plans are being used to inform policy and process change in naval working groups starting in calendar year 2014.

CONCLUDING REMARKS

To achieve greater efficiencies in the development, sustainment, and recompetition of major defense acquisition programs, the Navy has devised an open

systems architecture strategy designed to reduce cost, increase access to innovation, put improvements in the hands of the fleet faster, and improve competition. To meet these ambitious goals, the Navy needs to abandon long-standing ways of doing business, develop consensus-based changes, and commit to new open business models. These are wicked problems that cannot be solved easily. Therefore, to encourage innovative thinking, generate problem-solving ideas, and plan actions that realize those ideas, the Navy recently ran two serious games on the MMOWGLI platform and is planning a third.

The MMOWGLI business innovation games have been successful because the problems presented to the players focused on behaviors that the Navy wants to shape (through incentives and motivations), and the solution space was related to the way Navy programs create quality products affordably in the context of today's budget-conscious defense acquisition environment. Enabling innovation and facilitating the adoption of new business models are equally important outcomes in any problem-solving environment. The Navy was particularly interested in using an Internet-based platform to reach all its stakeholders in the most time- and space-efficient way possible. The MMMOWGLI platform certainly provided that forum.

The Navy's DASN RDT&E office also found these MMOWGLIs to be a powerful online collaboration tool. Many of the game procedures follow a typical problem management process, such as problem presentation, comment, action, review, and decision point. These games enable large numbers of players from across the enterprise to contribute to the potential solution space, as compared to the traditionally much smaller project teams with far fewer experts actively engaged.

A key finding from our experience with MMOWGLIs is that by combining effective testing with other action plans, Navy OSA initiatives can achieve cost savings and efficiencies without compromising the quality of the results. We don't just want competition; we don't just want lower cost. Instead, we need to use competition to get the same or better quality at a cost we can afford.

ENDNOTES

[1]MMOWGLI Players Portal (https://portal.mmowgli.nps.edu).

[2]Klemperer, Paul. "The Competitiveness of Markets with Switching Costs." *Rand Journal of Economics*, Vol. 18, No. 1, Spring 1987.

[3]Ford, Jeffrey D., and Laurie W. Ford. "The Role of Conversations in Producing Intentional Change in Organizations." *The Academy of Management Review*, Vol. 20, No. 3, July 1995.

[4]Rittel, Horst W.J., and Melvin M. Webber. "Dilemmas in a General Theory of Planning." *Policy Sciences*, Vol. 4, 1973.

[5]Guertin, Nickolas, Bryan Womble, and Paul Bruhns. "Innovating Naval Business Using a War Game." US Naval Postgraduate School, *10th Annual Acquisition Research Symposium*, 1 April 2013.

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