SimNavy – Phase 0
Building an Enterprise Model of the US Navy

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Introduction and Background

N7 has a desire for an enterprise model of the US Navy, a model that can be utilized to perform what-if studies in an interactive fashion similar to that found with simulation games like SimCity. Inspiration for this project comes from the NRC study "Modeling and Simulation: Linking Entertainment and Defense," wherein it is suggested that the Department of Defense can benefit from partnering with entertainment companies in order to accomplish its requirements for modeling and simulation [Zyda,1997].

The Naval Postgraduate School in Monterey has a long history in developing visual simulations and has recently established a Modeling, Virtual Environments and Simulation (MOVES) Academic Group and Curriculum. Thinking Tools of Monterey has a long history in developing simulations utilizing agent-based adaptive simulation and dramatic computer-game interfaces. NPS and Thinking tools are partnering to develop the SimNavy enterprise model and simulation system. Thinking Tools is responsible for developing the software to support SimNavy. NPS is utilizing students in the MOVES curriculum and expertise from the Center for Naval Analyses (CNA) and the Institute for Defense Analyses (IDA) to add the Navy-domain knowledge into the SimNavy system.

SimNavy

The notion of developing an enterprise model of the US Navy originates with discussions held by Al Zeman of N7, CAPT Dennis McBride, of the Office of Naval Research and Michael Zyda of the Naval Postgraduate School. CAPT McBride had attended the NRC workshop focusing on linking entertainment and defense and wondered how difficult it would be to harness some of the available entertainment industry technology for the Navy. A concept was quickly developed called SimNavy, with the goal being the production of a program to simulate the enterprise operation of the US Navy. This program is to operate in a manner similar to Maxis' SimCity, with a dramatic computer-game interface, but with much higher resolution and Navy-relevant scenarios.

The SimNavy concept is to simulate the OPNAV/N-code operation of the Navy, including: resource allocation, the psychology of decision making, the zero-sum economy, multilateral decisions and constraints, the conflict between political process and military requirements, what-if scenarios and alternate outcomes, the motives and goals of the decision-making process, the negotiation, compromises, tradeoffs, frustrations and anxieties of top-level policies, and the Navy's interactions with the other services and political organizations. It is planned that all assumptions in SimNavy are observable and changeable. We hope to provide a high-spark, controversial platform for understanding problem solving in the Navy hierarchy. SimNavy's value will be to provide an interactive experience through which Naval officers and senior leadership can learn how to make decisions at the various levels of the Navy. It should be understood by all that this is not a simulation for Navy war-fighting or tactics.

Agent-Based Adaptive Simulation[1]

The advanced simulation in Thinking Tools' products takes advantage of Agent Based Adaptive Simulation technology. Agents are independent software objects that adapt to changes in the environment by altering their behaviors. Many agents interacting with each other produce what is called "emergent" behavior. Emergent behavior has many of the characteristics of natural complex systems - including its unpredictability. Thinking Tools leverages this phenomenon to develop simulations of complex business situations.

Computer simulation is an imitation of selected properties of reality, usually for the purpose of getting answers or practicing and rehearsing problem-solving skills. Prior to the advent of digital computers, scale models and analog computers were used in design to simulate ship hulls and other structures. Whether eighteenth century wooden scale models or the latest adaptive simulations, these tools help their users understand the dynamic behavior of complex systems.

Simulations were among the earliest digital computer applications. Since the first days of digital computers, simulations using equations have been applied to scientific and engineering problems. The quintessential example of a computer simulation is the flight simulator. The flight simulator teaches the pilot to be a problem solver rather than a rule follower. It does not predict that the right engine will fall off of the aircraft on the next flight, but rather helps the pilot learn how to react to such an emergency. If only a very limited number of problems could occur on a flight, the pilot could merely be a rule follower. But the reality is that the number of problems that can arise is unimaginably large, so the good pilot must be able to solve problems in a cool, calm, collected manner. Many jobs in business present a level of complexity and magnitude similar to that of problems that a pilot faces. These occupations require top problem-solving skills. Rule following is insufficient. Thus, simulation can be as valuable to business people as to pilots.

Business simulations first began to appear shortly after the introduction of the digital computer. Companies have attempted to simulate complex adaptive systems with models that were either fixed (deterministic) or stochastic (probability-based). Alternatively, companies have developed their own custom systems based on executive information system (EIS) software packages. In all cases, the models lacked the adapting and evolving characteristics of real world systems, particularly because the most interesting business systems are made up of elements (e.g., customers, competitors and markets) that adapt their behaviors to each other. The elements in these systems modify their external behavior and internal structure in order to make more efficient use of their environments. Models based on formulae alone cannot effectively recreate these complex, adaptive systems.

In order to imitate complex adaptive systems, models must have two properties. First, the model has to have richness to duplicate at least selected aspects of the real world system's complexity. To accomplish this, most Thinking Tools simulations now involve more than 10,000 objects - or working parts - roughly the same number of parts contained in an automobile. Second, the model must have adaptive behavior - in other words some parts of the model must be able to adapt their behavior to the actions of the human user and to the other parts. In our simulations, these adaptive parts are agents. As a result, we refer to these systems as "Agent Based Adaptive Simulations." Some further definitions will help to explain how this is accomplished:

Object - A way to organize the code and data of a software program. An object is a self-contained capsule of data and logic that is an independent piece of the program.

Agent - An object designed to take action on its own. An agent selects its action using information it chooses from a range of available actions.

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[1] This section of the paper is taken directly from the http://www.thinkingtools.com/html/technology_fs.html web page, with modifications.

Autonomous Agent - An agent that selects its behavior with the goal of achieving a better fit to the requirements of its environment.

Adaptive Agent - An agent that creates new behaviors in a non-random way with the goal of achieving a progressively better fit to the requirements of its environment.

Both adaptive and autonomous agents can be used to produce adaptive simulations. Adaptive simulations customize the learning experience by allowing the simulation to discern each user's vulnerabilities and then confront that user with simulated events that focus on his or her weaknesses. This hostile environment introduces the challenges that a particular user needs most to understand. Training based on adaptive simulations emphasizes diagnosis, planning, and problem-solving skills rather than rote learning or routine/automatic responses. A technology bibliography for agent-based adaptive simulation is included below.

Potential Spinoffs

A number of potential spinoff, follow-on projects are possible utilizing the proposed technologies including:

Design a Navy Career - A simulation to help Naval officers plan a Navy career using the actual rewards/punishments for the decisions in an officer's career. This could lead to alternative guidance for the Naval officer career path.

Simulation Story-Guide Engine - The technology planned for SimNavy can additionally be utilized to develop a Story-Guide Engine for melding story line and character for use in interactive simulations. The planned technology can provide computer-generated characters for simulations in which human behaviors, personalities and cultures can be modeled and interacted with. Interactive improvisational stories can also be supported.

Group Decision-Making and Collaboration - The human dimension of C4ISR systems can also be simulated with the planned technology. Different players cooperating on a particular mission can be modeled and simulated.

SimNavy - the Game - With reduced complexity and changes to the underlying models, the SimNavy work can be converted to a marketable game.

Large-Scale 3D Virtual Environment - Simulation scenarios such as fleet composition and joint carrier ACTD could be supported utilizing a merger of virtual environment and agent-based adaptive simulation technologies. Long-term benefits might include integration of story line development, national policy making, wargaming and physically-based 3D virtual worlds.

Partners

There are four partners in the SimNavy development – the Naval Postgraduate School's MOVES Research Center, Thinking Tools, Inc., the Center for Naval Analyses and the Institute for Defense Analyses.

The MOVES Research Center is comprised of faculty of the NPS MOVES Academic Group, a multidisciplinary faculty collection focused around providing support for the Navy on its mid-term and long-term issues in modeling, virtual environments and simulation. The MOVES Research Center has evolved from the NPSNET Research Group, a research group of faculty and officer students with more than twelve years experience in research and development on the large-scale, networked virtual environment.

http://www.moves.nps.navy.mil

http://www.npsnet.nps.navy.mil

NPS faculty involved include Michael Zyda, Professor of Computer Science, Don Brutzman, Assistant Professor of Applied Science, Dan Dolk, Professor of Systems Management, Ted

Lewis, Professor of Computer Science, Robert B. McGhee, Professor of Computer Science, Rudy Darken, Assistant Professor of Computer Science and VADM Phil Quast, USN (ret). NPS MOVES students involved include LCDR Kim Roddy, USN, LT Todd Gagnon, USN, and MAJ Mark Boyd, USA

Thinking Tools develops and markets interactive simulation software that helps people think and work more effectively in complex business environments. Thinking Tools' products combine interactive multimedia interfaces with Agent Based Adaptive Simulation technology. The company evolved from the Business Simulation Division of Maxis Corporation, makers of the popular software game, SimCity. In 1993, Thinking Tools spun off as an independent company. Thinking Tools has applied its expertise in Agent Based Adaptive Simulation technology and the lessons learned from customers' experience with interactive computer games such as SimCity to developing simulations for business. Thinking Tools participants include John Hiles and Richard Rosenbaum.

http://www.thinkingtools.com

The Center for Naval Analyses (CNA) and the Institute for Defense Analyses (IDA) are providing the anayltical equations and models for the SimNavy project. NPS MOVES students and faculty are providing the domain knowledge and interpretations of the CNA/IDA data for Thinking Tools.

Timeline

Phase 0 - Study to develop vocabulary and architecture for SimNavy. Work with Thinking Tools to develop a mock-up of the SimNavy enterprise model. Students from the NPS MOVES curriculum will be used to provide Navy-domain knowledge, utilizing ONR-provided CNA resources. Thinking Tools will develop the software for the mock-up.

Phase 1 - Develop single-role, single PC version of SimNavy. 24 months.

Phase 2 – Develop multi-role, multi-station version of SimNavy that runs on the Internet. 24 months.

Phase 3 – Maintenance and enhancement of SimNavy models. As long as desired.

References

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Biographies

MICHAEL ZYDA (Zyda@nps.navy.mil)

Michael Zyda is a Professor in the Department of Computer Science at the Naval Postgraduate School, Monterey, California. Professor Zyda is also the Academic Associate and Chair of the NPS Modeling, Virtual Environments and Simulation (MOVES) curriculum. He has been at NPS since February of 1984. Professor Zyda's main focus in research is in the area of computer graphics, specifically the development of large-scale, networked 3D virtual environments. Professor Zyda was a member of the National Research Council's Committee on Virtual Reality Research and Development. Professor Zyda was the chair of the National Research Council's Computer Science and Telecommunications Board Committee on Modeling and Simulation: Linking Entertainment & Defense. Professor Zyda is currently a member of the National Research Council's Committee on Advanced Engineering Environments. Professor Zyda is also the Senior Editor for Virtual Environments for the MIT Press quarterly PRESENCE, the journal of teleoperation and virtual environments. He is a member of the Editorial Advisory Board of the journal Computers & Graphics. Professor Zyda is also a member of the Technical Advisory Board of the Fraunhofer Center for Research in Computer Graphics, Providence, Rhode Island. Professor Zyda has been active with the Symposium on Interactive 3D Graphics and was the chair of the 1990 conference, held at Snowbird, Utah and the chair of the 1995 Symposium, held in Monterey, California.

Professor Zyda has consulted for the White House Office of Science and Technology Policy, the Ministry of Industrial Development Sabah Province, Malaysia, Japan Tech Services Corporation, Tokyo, Hitachi Plant Construction & Engineering, Ohtsuka, SimGraphics Engineering, Pasadena, Silicon Graphics International, Geneva, Nihon Silicon Graphics KK, Advanced Telecommunications Inc., TecMagik and Paramount Digital Entertainment, among others.

Professor Zyda began his career in Computer Graphics in 1973 as part of an undergraduate research group, the Senses Bureau, at the University of California, San Diego. Professor Zyda received a BA in Bioengineering from the University of California, San Diego in La Jolla in 1976, an MS in Computer Science/Neurocybernetics from the University of Massachusetts, Amherst in 1978 and a DSc in Computer Science from Washington University, St. Louis, Missouri in 1984.

JOHN E. HILES (JHiles@ThinkingTools.com)

Mr. Hiles is the founder of Thinking Tools, Inc., which was established when he organized the buy-out of Maxis Business Simulations, a former division of Maxis.

Mr. Hiles has produced the conceptual designs of Thinking Tools' products: SimEnvironment (environmental reclamation at a military base), SimRefinery (oil refinery), TeleSim (competition invades a regional telephone company's market), Transport (self-organizing distribution), PEG (understanding and anticipating the decision making of others), Project Challenge (project management), LogLab (Army and Air Force logistics), and Think 2000 (impact of Year 2000 problem on a business or agency). Work in progress deals with two new areas, the linkage between business structure and technology inside organizations, and business or infrastructure continuity. These innovative products combine dramatic human interfaces (based on interface developments in the computer game industry) and a new approach to generating adaptive simulator behavior (agent-based simulation architecture).

As General Manager of Maxis Business Simulations, Mr. Hiles transferred key properties of entertainment games to simulations of complex business, government, and public systems.

Prior to joining Maxis in 1992, Mr. Hiles was President and founder of Delta Logic, Inc., in 1986. Delta Logic explored object-oriented development technology and produced an object database that now serves as the foundation for Thinking Tools' products.

Before Delta Logic, Mr. Hiles was Senior Vice President of Product Development at Digital Research and led software development at Mead Data Central and Amdahl. Two of the many products his organizations have produced were GEM, one of the first graphical; user interfaces for the PC, and UTS, Amdahl's highly successful mainframe-compatible UNIX operating system which foreshadowed the Open Systems movement by several years.

Mr. Hiles has spoken at forums in South America, Europe, and throughout the United States. His topics include the human impact of information technology, graphical interfaces, agent-based programming, and the simulation of complex adaptive systems.

Mr. Hiles has been active in software product development for microcomputers and mainframes, first as a designer and programmer and then as a manager and executive, for over 26 years. He earned a Bachelor's degree from the University of California, Santa Barbara in 1969.