The Use of Basic Object Models (BOM) in the Virtual Backlot (VB)

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ABSTRACT: *This paper examines the use of Base Object Models (BOM) as implemented in the University of Central Florida's (UCF) Virtual Backlot (VB) project. A BOM is a SISO approved form of Reference FOM designed to enable reuse of HLA components. SISO's BOM Study Group has proposed general BOM design guidelines and federate development methodologies by which reuse capabilities may be designed into an HLA compliant simulation.*

The VB project is a natural testbed for the BOM paradigm. The VB project applies reuse methods that have roots in the traditional entertainment industry in which physical entities are repeatedly reused. For example, the same physical backlot street may appear in many movies with a minimum of modification, giving the illusion of different locations (New York, Paris, Rome, etc). It is a goal for the VB that virtual entities be repeatedly reused. These models are specifically designed for a Mixed Reality environment in which a user encounters a physical environment enhanced by the addition of virtual entities.

The current VB project is directed towards rapid population of a physical MOUT facility with virtual entities. Ideally, the VB will provide a menu of readily reconfigurable virtual entities for MOUT scenario designers to work with. This paper will discuss aspects of the BOM philosophy that were able to be implemented in the VB as well as areas where the VB diverges from the BOM philosophy. Lessons learned and suggestions for future use are reported.

1. Introduction

"All media as extensions of ourselves serve to provide new transforming vision and awareness."
--Marshall McLuhan

Simulation is the newest of all media forms. The future of innovation of the simulation industry is not much different than any other media market in history. There is a need for both the creation AND adoption of standards that are able to extend the distribution and application of assets across many applications. The creation of standards must consider not only technological capabilities, but also existing standards and practices of the industries they serve. The military is a vast resource for the state-of-the-art of technological standards and through organizations such as SISO has provided a solid base for the *creation* of standards. [5] However, the success of those standards depends as much on their *adoption* as on their creation. The entertainment field has historically been a critical leader in the mainstream adoption of new media standards, which, due to the size of consumer markets, drives the future of emerging technology. This can be seen with the increased penetration and capabilities of consumer grade PCs for military simulation applications.

Based on this future of simulation as media, UCF and STRICOM have embarked on several research initiatives to bring these important elements together to look at how we can help provide insight to cross-industry adoption of new technology and standards. One example of these research initiatives is a project sponsored by STRICOM's Cross Domain Technologies (CDT) enterprise, The Enhancement of MOUT Training with Mixed Reality and Theme Park Technology. As part of this project we are experimenting with the latest Augmented Reality head mounted display (HMD) technology from Canon Inc. (the COASTAR), and the most advanced techniques and practices in experienced-based entertainment (theme parks and computer games). We are conducting proof-of concept experiments that support embedded training and simulation in a live urban environment using augmented reality technology. With experts from each sector, we have created an environment where we are building multi-modal simulated assets to be integrated into the reality of live training exercises.

The remainder of this paper is organized as follows. A brief overview and discussion of BOM's is presented in section 2. Section 3 describes three diverse areas that share a common need for BOM prototypes and a Virtual Backlot capability. Section 4 describes UCF's VB project in detail. Section 5 discusses some aspects of incorporating physical effects in a mixed reality environment using MacroStimulators. The paper is summarized in section 6.

## 2. Base Object Model (BOM) Background

The BOM concept extends SISO's interest in exploring methods that support and promote the reuse of simulation components, while encouraging agile, rapid and efficient development and maintenance of FOMs. The present disadvantage of HLA is that FOM development remains complex and time consuming. In addition, the exclusive use of one or two FOMs severely limits flexibility, capacity, and capability. This hampers the HLA goal of model reuse and ease of maintenance. The BOM concept allowed for a more flexible component-based development of assets. The basic premise was that the design and development of interoperable environments should begin with the exploration of reusing available simulation object model components. Essentially, an individual aspect of a larger model is factored out into a BOM new models are developed by reusing and composing these aspects.

The VB project is a natural testbed for the BOM paradigm. The VB project applies reuse methods that have roots in the traditional entertainment industry in which physical entities are repeatedly reused. In this sense, a VB project has goals that parallel the BOM philosophy.

- **BOMs can support a wide variety of interoperability environments** just as Movie backlots have supported the unlimited production of movies for a hundred years.
- **BOMs represent a "A single aspect of simulation interplay that can be used as a building block"** as do backlots

work with a network of prop houses, sound stages and locations.

- **BOM building blocks may very well have more impact on the simulation industry economically and creatively than they do technically** as does the movie industry in how it is still the major driver of entertainment and storytelling even though the technology is over a hundred years old.
- **BOMs can be the key to transferring the use of interoperability standards to other industry applications** because they provide the seed of true innovation in the way that inventions are adopted by diverse applications and applied in unintended ways.
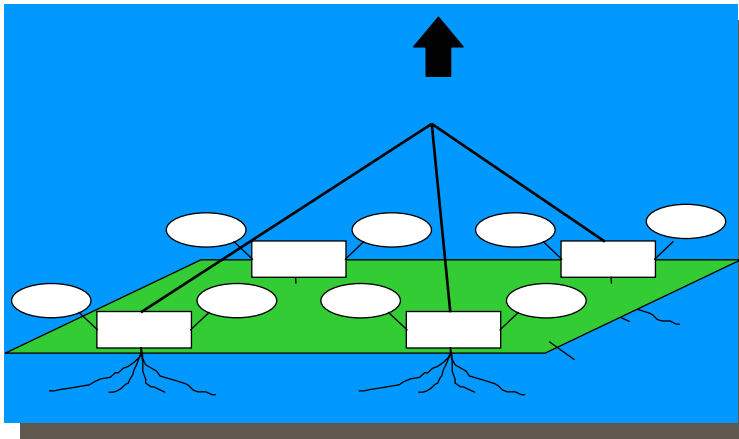
Innovation is defined not by advancement in technology, but in how successful the technology is in getting into the hands of diverse users and applications. Innovation is gauged by how it changes our lives, not by the novelty of new technological capabilities. A true sign of Innovation is when technology is incorporated into diverse applications for unintended uses.

3. Related Applications and Motivation for the Virtual Backlot

This section presents examples of three diverse areas of virtual and mixed reality simulations, showing how each of them requires the same underlying characteristics, and thus provides motivation for the development of BOMs and of the VB.

3.1 Virtual Forest

Virtual worlds tend to have sparse or unrealistic vegetation. The primary reason for this is the demand that dense realistic vegetation places on

the computational and rendering resources of workstations. For the past two years, STRICOM has funded a UCF project to develop novel techniques for constructing and displaying virtual trees and other vegetation in virtual worlds. [3] These techniques, now available in software prototypes, produce an arbitrary number of individually unique trees and plants from a small number of leaf-and-branch texture maps. The software system constructs and manages levels-of-detail (LOD) in an efficient manner based on the mutual visibility of objects, rather than the traditional range-to-target concept. This effort also produced tools for evolving a forest based on a realistic biological model. Finally, preliminary studies were carried out on the effects of reduced details on the ability of subjects to perform tasks within the resulting virtual environment. [4] The prototype for this project resulted in models that produced a virtual rain forest. It is notable that these same models, driving the rain forest imagery, were reused to create virtual pine and oak forests and will be reused this fall to create a virtual kelp forest in an underwater environment.

UCF has proposed extending the research to produce an integrated software system that allows the creation of complex, visually correct graphical models of vegetation (trees, shrubs and grasses); the production of evolving, biologically correct forests populated by this vegetation; the traversal of these forests in virtual and mixed reality environments; and the evaluation of the resulting system for effectiveness in task-oriented training. The challenging problems include the automatic production of varying level-of-detail models especially in light of a forest's growth and succession; the management of these LOD models so that a user does not perceive loss of detail; the development of controlled experiments to assess the efficacy of the system; and the integration of all these components into a seamless, single development and deployment environment.

This approach to creating virtual vegetation is in accordance with the BOM philosophy. The models behind the imagery represent a single aspect of the environment (biological vegetative growth patterns) and then carry that aspect into a

wide variety of virtual environments (tropical, deciduous, and under water). A fully developed application of this technique would effectively comprise a vegetation VB.

3.2 Mixed Reality Training
Consider the problem of deploying virtual enhancements in an environment where MR based training is to be done. The scenario planners would need to map the real world terrain and overlay the virtual elements in some fashion.

Constructing useful databases for the virtual elements of a mixed reality training exercise is a large effort. In a purely virtual environment the database modeler's job can be made easier by considering that, for skill-building forms of training (as opposed to mission rehearsal), precise correspondences to a real-world site (so-called "geospecific data") is not really required. Thus, database builders often use convenient simplifications such as generic trees and buildings, or plausible approximations to terrain elevation and plant cover.

However, when building databases for Mixed Reality systems, this kind of shortcut cannot be taken. The enormous effort required to accurately measure the user's position and orientation in the augmented reality environment is wasted unless the virtual features are precisely constructed and registered in the environment with equal fidelity. What is needed is a technique whereby virtual objects can be added to a real-world training environment in a convenient fashion, with the required accuracy. The scenario designers need to draw upon a collection of existing virtual elements, and modify them to meet the needs of the specific exercise at hand. In other words, the scenario designers need access to a VB and need the tools to modify the existing elements to allow reuse.

3.3 Mixed Reality and the MOUT Environment
The United States Army is embarking on a revolutionary individual soldier and small team system of systems called the Objective Force Warrior (OFW). The goal of the OFW program is to field a combat force that is capable of dominance across the spectrum of operations and environments from complex urban terrain to open and rolling terrain. The OFW will demand higher soldier performance at all levels, placing new demands on training systems. Exploitation of Embedded Training (ET) and on-demand simulation capabilities anywhere, anytime, are needed to support the OFW. Of particular interest is the ability of the dismounted soldier to interact with virtual entities and overlaid training information in live urban environments within which they can train and rehearse real world missions. The need exists for a capability to rapidly interface to a mixed reality simulation system so that virtual objects of interest can be added to a real world training environment.

The reuse of component based objects is an ideal concept for a Mixed Reality MOUT (MR MOUT) application. The existing highly instrumented physical facility serves as a FOM. Effective use of MR MOUT requires a mechanism to collect, manage and integrate existing assets into a dynamic live simulation training environment. Once more, the entertainment industry model of a backlot provides the core practices that can be adopted to provide a rapid development and deployment of training and mission rehearsal scenarios. The BOM concepts combined with the historical backlot would encourage adoption of techniques to be developed within the VB research.

4. Virtual Backlot
In the system being developed by UCF within its Institute for Simulation and Training (IST), scenario planners would be able to walk through a location, carrying hand-held devices such as a wireless-enhanced personal digital assistants (PDA). By simply selecting items from a menu while standing at a particular doorway, ambush site or the location of a desired piece of "virtual rubble," a planner would automatically build up a database of virtual objects that appear as soon as the Mixed Reality system is activated. This database would also be observable and dynamically modifiable on map-based interfaces, running on PCs back at command centers.

In fact there are two distinct phases to the problem. First there is a kind of planning process, in which the training designers need to "block out" the overall scenario. Objects need to be associated with their locations, and a map of the overall scene developed. In a second "fine tuning" pass, the objects' final positions and orientations need to be set up for optimal performance in the actual training scenario.

The GeoPresence project at UCF has produced technology that addresses the first problem - the creation of a "planning map" that is populated with the objects to be used in the scenario. [2] In this project we have developed an interface to allow content creators to associate information with a physical location, either through a map interface or by using a wireless device to "drop"media while at the actual site. Users can then access this information through the same means (map interface or wireless device.) Our protocols allow simultaneous use by multiple creators and accessors, each using the most appropriate interface for their needs. Thus, mission planners may be observing placements in a MOUT at the same time that these placements are occurring on site.

The GeoPresence interface is intended to be so simple that any user can, without prior instruction, create, place and retrieve rich media associated with specific geographical locations. In fact, it has already been used by English professors to build a walk through experience at Leu Gardens in Orlando, Florida, recording and playing media that depict the history and beauty of the gardens. It has been used by citizens of Eatonville, Florida to chronicle the history and culture of their community, the oldest incorporated African American governed town in America. It is now being used by digital media students to build databases intended to display geospecific announcements on the Lynx Lymmo buses in downtown Orlando. (See [1] for a discussion of user interface issues in geospatial systems.)

As alluded to above, persons who interact with GeoPresence software may be in the optimum environment for the task component they are working on. It is inconvenient to take a laptop or CRT into the field to look at a dynamic map; it is also a work intensive activity to accurately survey an actual MOUT or other real world facility to make and maintain maps. The GeoPresence allows a "quick sketch" ability to go into the field and send back detailed information to update a basic floor-plan map.

After the models that are to be inserted are produced (their production is not the subject of this research), there are two problems to be solved in building useful MR databases. First general layout of the objects must be established as described above in the GeoPresence section, and then the virtual objects must be accurately positioned and oriented for interaction. This establishes the need for two tasks in this project.

The **Layout Task** will involve building a version of GeoPresence that is specialized for Mixed Reality database objects. This software will take as input, data from a fielded GeoPresence system (including PDA and base station), as well as a basic Mixed Reality database representing the intended MOUT facility. It will emit an updated MR database with appropriate objects (including concealment such as plants and rubble, as well as pop-up friend/foe targets) located in the appropriate sites within the MOUT model. Of particular interest to us is the use of data developed in the Virtual Forest Project. [3]

The **Fine Tuning Task** consists of developing special application-level software that runs on top of the Canon Mixed Reality software. Models in the MR system can be dynamically manipulated by users of the system (e.g., the dolphins in the Contact Water SIGGRAPH exhibit.) When the training developer puts on the MR equipment and runs the Fine Tuning software, he can adjust the positions and orientations of the objects which were initially located during the Layout Task using GeoPresence software.

During the layout phase, the planner is not encumbered with any head mounted equipment; he is simply using a GPS-equipped PDA. The resulting layout can be quickly examined and improved using a map-view display – or, in fact, the original planning can be done with the map view and checked with the PDA. GeoPresence's central concept is this duality between convenient map display and immediate in-the-field access to the placement data, mediated by a secure wireless link.

5. Mixed Reality and Macro Stimulators

In any mixed reality setting decisions need be made as to whether each effect is produced by virtual or physical means. A MacroStimulator (MS) is a device that physically produces effects. These effects include, but are not limited to, light, sound, and mechanical motion (referred to as "show-action" effects). Typically, immersion into a mixed-reality situation will be performed using a mixture of virtual and physical methods. The virtual methods currently focus on the visual and auditory senses. The movement of real

world objects is by default not virtual and so it is natural to assume a MS system performs these show-action sequences. But the MS may also be used to augment the virtual imagery (which is in turn augmenting real imagery). For example, an explosion may be composed of a virtual image of an object disintegrating while a MS equipped with speakers and a smoke machine provides the corresponding "boom" and residual smoke. Likewise a vehicle may be composed of a virtual image superimposed on a mobile robotic MS emitting engine noise.

The BOM philosophy supports the HLA goals of efficient model development via reuse and interoperability via well defined and documented interfaces. Specifically, the BOM philosophy advocates developing new models and scenarios by composing BOM's that each represent a specific facet or aspect of the overall model. The proposed MS design also follows this philosophy. The physical design of the MS builds upon light, sound, and show-action systems used in the theater and entertainment industry. This industry has demonstrated the need to build MS systems to support live entertainment. Each MS configuration is used for a short duration of time (the run of a show or event) and then disassembled, only to be reassembled in another configuration for the next show. To meet this need, Commercial Off The Shelf (COTS) theatrical hardware will be used that allows unique systems to be built readily by composing individual parts. These individual physical parts correspond to BOM's.

The physical events performed by the MS are driven by supporting software. There is no direct correlation between the software currently used in the entertainment industry and the BOM model. As part of the VB project, we are developing software models that can interact with the scripting software driving the events in the scenario. The software packages will correspond with physical packages and, when combined with supporting documentation, meet the BOM philosophy.

The end result is that the physical MS and the supporting software fall within the BOM guidelines and support the Virtual Back Lot goals of rapidly composing new scenarios and situations by reusing standardized hard and soft components.

6. Summary

SISO have provided a solid base for the *creation* of standards. However, the success of those standards depends on their *adoption*. This paper has presented a philosophy by which BOMs are used in the creation of model standards designed to support high levels of model reuse across a range of environments and applications. A survey of applications was presented by way of motivation for creation of both the models and a method by which they may be used. Finally, a description of UCF's efforts to create a Virtual Backlot was presented that outlines one approach towards adoption of the standards.

7. References

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