

## **Modeling & Simulation: Linking Entertainment & Defense**

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## **Modeling & Simulation: Linking Entertainment & Defense**

***The Director of Defense Research & Engineering (DDR&E), Dr. Anita Jones, funded a study through the National Research Council Computer Science & Telecommunications Board (NRC CSTB).***

- A committee was formed representing the virtual environment, computer graphics, networked videogame, film and entertainment communities.

## Goal of the Committee



*To explore how the Entertainment Industry (EI) and the Department of Defense (DoD) and its associated industries can develop a stronger technology base for modeling & simulation and profit from a closer working relationship.*

## The two communities are connected ...



*EI and DoD are connected but we often don't think about it.*

Large amounts of government-funded research and infrastructure form the foundation of the EI industry from computing to computer graphics to the Internet...

## The path from technology to engineering ...



*We don't often think about this relationship because the connectedness spans a long period of time, the time required to research and create a technology that can then, later, maybe 20 years later, be easily used...*

## Span of Time ...

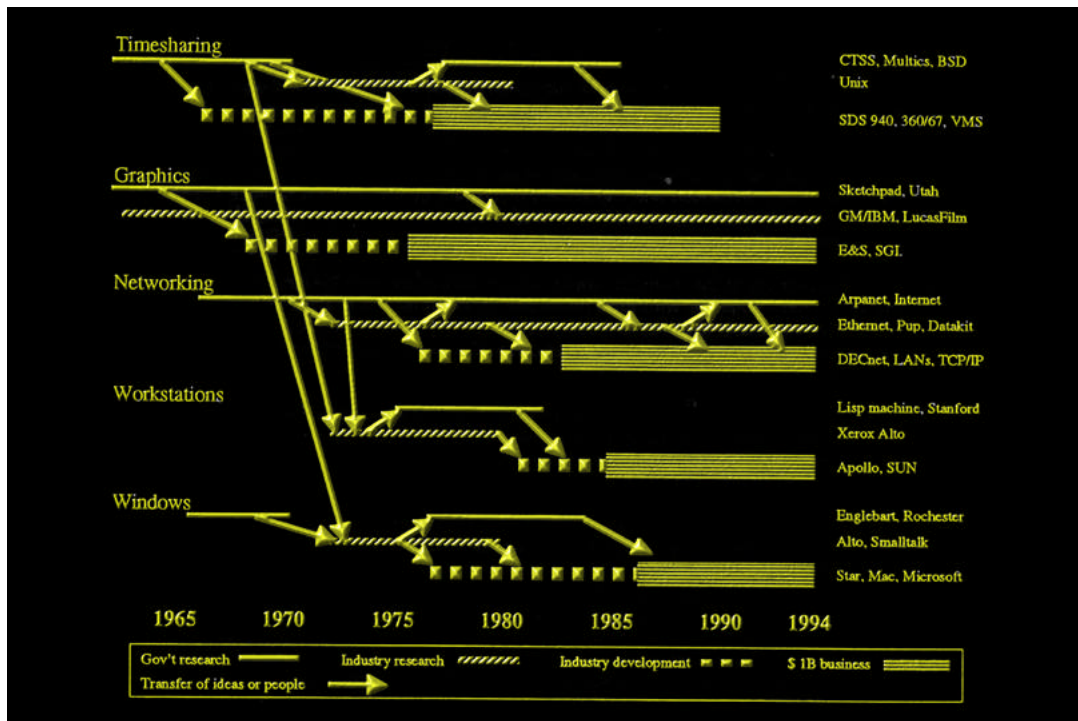


### ***DoD Funding***

- Computer graphics - Geometry Engine ~1979.
- Internet - ARPANET in late 1960's.
- SIMNET ~1984

### ***EI Use***

- Computer graphics - Nintendo-64 1996.
- Internet - Mosaic 1993, Netscape 1994.
- Networked Doom 1995.



## Modeling & Simulation: the Overlap of DoD & EI



**Many of the future challenges that face the movie industry, the games industry and the DoD are the same.**

**The task of the committee was to try and help the DoD and EI move forward in a more coordinated, and hence more efficient, manner, learning from each other's successes and taking advantage of apparent commonalities.**

## **Research Agenda**



***Technologies for Immersion***

***Networked Simulation***

***Standards for Interoperability***

***Computer Generated Characters***

***Tools for Creating Simulated Environments***

## **Research Agenda**



***Each of these areas has sufficient overlap in interest for the DoD and EI that some common work should be carried out.***

***The actual mechanisms for this collaboration are discussed separately from the research agenda.***

## Technologies for Immersion



- *Image generation - real-time, graphics workstations capable of generating complex visual images.*
- *Tracking - technologies for keeping track of human participants in virtual environments.*

## Technologies for Immersion



- *Full sensory interfaces - technologies for providing a wide range of sensory stimuli: visual, auditory, olfactory, and haptic.*
- *Locomotion - technologies that allow participants to walk through virtual environments while experiencing hills, bumps, obstructions, etc.*

## Technologies for Immersion



*Interfaces that allow players or participants to enter and interact with virtual environments are of great importance to the DoD and the EI.*

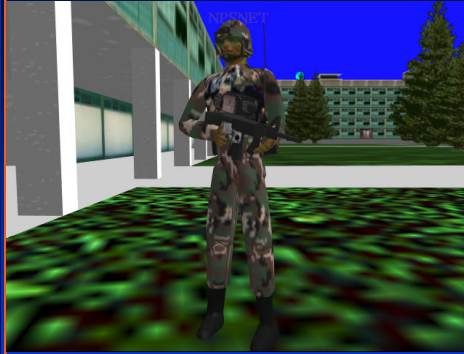
## Tracking the virtual soldier



*The DoD wishes to place a company of soldiers into unobtrusive bodysuits, on locomotion platforms, in order to track those soldiers' movements and interactions in a networked virtual environment.*



## El & DoD need a bodysuit!



*The El needs bodysuits to build keyframes for animated characters for film and videogame production.*

*Bodysuits are also needed for the development of full-body immersion, location-based entertainment systems.*

## Where is the funding for the bodysuit?



*The need for research into lightweight, body tracking technology was fully described in the NRC VR report.*

*Yet, since that report's publication, little funding has been available for some of the hard problems involved.*



## Networked Simulation

- ***Multicast and area of interest managers - to facilitate many-to-many communications while using limited bandwidth.***
- ***Higher bandwidth networks - to allow faster communication of greater amounts of information among participants.***

## Networked Simulation

- ***Latency-reduction - techniques for reducing the true or perceived latency in distributed simulations.***

## Standards for Interoperability



- *Virtual reality transfer protocol - to facilitate large scale networking of heterogeneous distributed virtual environments.*
- *Architectures for interoperability - network software architectures to allow scalability of distributed simulations without degrading performance.*

## Standards for Interoperability



*Networking capabilities that allow multiple users to interact in large-scale virtual environments is familiar territory for the DoD and new territory for the EI.*

## Large-Scale Virtual Environments (LSVEs)



*The DoD wishes to carry out theater size battle simulations across wide area networks.*

*The EI wishes to build large-scale virtual environments as games.*

## Common protocols for scalability



*Both DoD and EI need common protocols for networking their scalable virtual environments.*

- Currently DoD goes its own way on this and EI slaps something together on a game-by-game basis.
- It is clear that some common research into the technology required for this would be beneficial.

## **Interoperability - What needs to be done?**



*A careful, considered, joint research program needs to be put together that actually studies the issues involved (as opposed to slapping code together for rapid demo) in designing a common, scalable network software architecture capable of supporting large numbers of players across wide area networks.*

## **Computer-Generated Characters**



- *Adaptability - development of computer generated characters that can modify their behavior automatically.*
- *Learning - development of computer generated characters that can modify their behavior over time.*

## Computer-Generated Characters



- *Individual behaviors - computer-generated characters that accurately portray the actions and responses of individual participants in a simulation rather than those of aggregated entities such as tank crews or platoons, etc.*

## Computer-Generated Characters



- *Human representations - authentic avatars that look, move, and speak like humans.*
- *Spectator roles - ways of allowing observers into a simulation.*

## **Computer-Generated Characters**



- ***Aggregation/deaggregation - the capability to aggregate smaller units into larger ones and deaggregate them back into smaller ones without sacrificing the fidelity of a simulation or frustrating attempts at interoperability.***

## **Realistic Intelligent Human Behavior**



***Computer generated autonomous characters are a part of every major DoD simulation system and every videogame produced. The goal behind such characters is to reproduce human behavior such that humans interacting with the characters receive a compelling experience from that interaction.***

## **The desire for autonomous characters**



*The DoD wants computer generated forces that accurately mimic the behavior of humans and other battlefield entities.*

*El wants autonomous characters that are driven by campaign engines and storyline engines.*

## **Adaptable Behaviors**



*Both DoD and El want these autonomous characters to have adaptable behaviors, behaviors that cannot be “gamed”.*

## **Autonomous characters and storyline development**



***Both DoD and EI need mechanisms for rapidly developing autonomous characters and integrating them into a coherent story.***

## **Non-reusable autonomy**



***Current SAF programs are not easy to add new behaviors to.***

***Nor are they readily adaptable to new domains.***

***In addition, current SAF systems have no capability to model personalities or human character behaviors.***



## Human behavioral modeling



*Broadening this effort to include capturing and reproducing the entire spectrum of human behavior with such systems may prove invaluable across many domains.*

## Tools for Creating Simulated Environments



- *Database generation and manipulation - tools for managing and storing information in large databases, to allow rapid retrieval of information, feature extraction, creation, and simplification.*

## Tools for Creating Simulated Environments



- ***Compositing*** - hardware and software packages that allow designers to form composite images with images taken from different sources (whether live-action footage or 3D models) and facilitate the addition or modification of lighting and environmental effects.

## Tools for Creating Simulated Environments



- ***Interactive tools*** - tools that use a variety of input devices (more than a mouse and keyboard) to construct models and simulations.
- When you are building 3D VEs, you need to place things with hands, not nudge things with a mouse and keyboard.

## Tools for Creating Synthetic Environments



*Low-cost, easy-to-use tools for creating interesting synthetic environments, terrain, buildings, 3D objects, dynamic features were described as key requirements by both the DoD and the EI.*

## Higher-Level SE Creation Tools



*Tools that allow the rapid specification of polygonally-defined and textured worlds at a relatively high-level were mentioned repeatedly at the workshop.*

- The lack of such tools for virtual environments is also mentioned in a previous NRC study [the NRC VR report].

## Automatic synthetic environment creation



***There is a desire in DoD and EI for tools that work at a higher level than polygons.***

- There is a desire for tools that automate synthetic environment generation.
- The NRC report on VR lists these same desires.

## Carrying Out the Collaboration



***The main human resource issue is that there is an apparent shortage of talented, high-quality, experienced people to develop virtual environments, modeling and simulation software, digital animation, design, and scripting of virtual worlds.***

## **The shortage of content developers ...**



***This is a shortage that is seen by both the DOD and EI.***

***Programmers with content development experience, programmers familiar with the technical problems of multiplayer/multiprocessor games and simulations are just not to be found.***

## **Cross-disciplinary skill-sets**



***And the people sought are not just engineers and computer scientists.***

***They are programmers and content developers with cross-disciplinary skills.***

- Such skills enhance the quality of virtual world development and the implementation of such cutting-edge technologies.

## Interdisciplinary Infrastructures



***Interdisciplinary university infrastructures, with degrees we have never seen before, need to be constructed to solve this human shortfall.***

- We need people graduating with BS, MS and PhD degrees in subjects like modeling, virtual environments and simulation, electronic storytelling, ...

## Information Sharing: Create an M&S center ...



***The purpose of this center would be as a clearinghouse and continuing education source for the EI and DoD modeling, virtual environment and simulation community.***

- If this center can be co-located with a relevant educational program, we have an enormous win.

## **Carrying out the research agenda ...**



*The research base of the United States has at its bottom government funding.*

*In order to carry out the research charter between the EI and DoD, that funding may need to be delivered differently than such funding is now.*

## **Setting research directions**



*In the workshop, it was pointed out that research funding today is quite different than 20 years ago.*

*Government funded projects are now more product-oriented than they used to be.*

## **A return to the days of yesteryear ...**



***If we can return to the days of when we regarded university-trained people as the product of our funded programs, then our country will benefit tremendously.***

***Funding which is less product-oriented and more open-ended will also allow a greater amount of creative and innovative research.***

## **Revolution in the university ...**



***Our technology revolution is producing whole new careers and vocations which cannot be ignored.***

***Some of these technologies are taking us into unknown territory where crossing disciplines and university revolutions become necessary.***





## **Web site**

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