Video Game Play and Design: Procedural Directions

Moderator
George Suhayda
Sony Pictures Imageworks
9050 West Washington
Boulevard, Suite 358
Culver City, California 90232
USA
+1.310.840.8411
+1.310.840.8261 fax
geo@imageworks.com

Panelists
Tom Hershey
Sony Pictures Imageworks

Dominic Mallinson
Sony Computer Entertainment
America

Janet Murray
Georgia Institute of Technology

Bill Swartout
USC Institute for
Creative Technologies

Procedural simulation is an opportunity to revolutionize the way games are played and produced. Game-play design has relied on traditional models and has been constrained by old hardware design. New consoles will allow for procedural simulation and a "drama-on-the-fly" that no other form of entertainment is capable of. It will allow game consoles to reach their true artistic potential. For the developer, procedural simulation will offer a lighter, more versatile library of assets. The payoff will be twofold: a new, unique art form and a more cost-effective method of recreating intelligence, behavior, physics, and modeled environments.

This panel presents a snapshot of the current state of procedural simulation and the potential that it offers for game play and game design in light of advances in hardware design.

Video and computer games have come a long way from their simple beginnings in the arcades. PacMan, Space Invaders, and Donkey Kong made a fortune on simple colorful game play. As consoles have evolved, game development has become incredibly complex, exceeded only by the consumer's expectations for a higher level of game art and game play. Developers, keenly aware of consumers' expectations and stiff market competition, are spending record amounts of time and money on game development. There is no relief in sight, as manufacturers plan for more highly sophisticated consoles and shorter development times between successive versions.

Despite the pressure, game developers continue to rely on labor-intensive traditional methods (polygonal models, texture maps, and forward kinematics). It's no wonder that the cost of developing new games has risen from $1 million per title to more than $6 million. Production schedules have gone from one year to 2.5 years. Profitability is more uncertain.

The greatest relief for game developers will come in the form of procedural simulation. Creation of rule-based worlds to recreate intelligence, behavior, physics, and modeling could take the place of painstakingly modeled, animated worlds composed of thousands of human-engineered and painted polygons. The greatest advances may come in the type of game play that procedural simulation may allow. So far, game developers have used other art forms, particularly film, as a template for game play. This easy route does not necessarily allow for the computer or console to mature into its own unique art form. Groundbreaking game play development takes time and ingenuity, but it's potentially the greatest windfall for video game and hardware developers. It's already clear that games have piqued consumer interest much more than films. One look at box-office revenues versus game revenues is proof enough. Developers will need to satisfy that interest if they wish to unlock an even larger revenue flow.

Traditional Notions of Procedural Simulation

Specific areas of traditional procedural simulations include:

Intelligence
Recreating the inner workings of the human brain has long been a goal of science. Perhaps it's the $8-billion game industry that will lead to the greatest innovations, much like feature film was the catalyst for realistic modeling and simulations.

Behavior
So far, there is only as much behavior as can be animated using inverse and forward kinematics. The downside to this is that motion and animation are limited to the movement an animator gives a character. What needs to be explored is a universe where the entire range of body motion is written into the character, and intelligent agents within the game choose the proper motions for any given time and situation. The range of possibilities for game play then becomes infinite.

Speech
Interactive speech is probably the most underdeveloped aspect of gameplay. Pre-canned color commentary gives sports their sense of realism. Introduction of fresh, spontaneous commentary will give gamers a unique experience. Sadly enough, even simple speech communication between players has not been developed, although modems are standard on PCs and the new consoles include ports for broadband access.

Physics
Some of the greatest advances in procedural simulation are represented by depictions of real physics. Although they do not represent game play, they allow the audience to settle into a real world in which the game play can unfold. Depictions of moving water, collateral damage, and plumes of smoke add to the game's ambience. The consumer has seen what computer graphics are capable of producing with procedural effects in feature film. Their question is simple: "Why can't my console do that?"

Modeling
A healthy chunk of game production schedules, and the CD on which the game is distributed, is devoted to modeling and models. Modeling of environments, props, and characters is due for a procedural-simulation overhaul. Creation of entire cities and environments using procedural algorithms is potentially the greatest enhancement. The weight of polygons and texture maps is shifted to a lighter combination of lines of code and an infinite number of possibilities.

Procedural Simulation and Game play

The biggest challenge to researchers in AI is creating fresh, spontaneous gameplay. Hard assets provide limited possibilities in gaming. With procedural simulation, developers could create more malleable assets programmed with a multitude of possibilities, which will allow for more spontaneous game play. Why not create spontaneous drama-on-the-fly? What keeps us from creating a five-act structure on the fly so that games become a roller coaster ride with dips and climaxes like feature films? More importantly, procedural simulation may play its greatest role in creating unique gaming experiences rather than just mimicking other forms of media and storytelling.

George Suhayda
A graduate of Clemson University and Yale School of Drama, George Suhayda joined Sony Pictures Imageworks in 1998 and has worked on "Contact," "Snow Falling On Cedars," "Sphere," "City Of Angels," and "What Planet Are You From?" Currently he is visual effects art director on "Stuart Little 2" and working on game development for Sony's PlayStation 2.

Tom Hershey

The advent of procedural techniques in videogame design has, and will certainly continue to have, monumental impact on the gaming experience that players enjoy. This impact is multifaceted: ranging from "nuts and bolts" advantages in hardware resource management to influencing the way that game designers approach narrative structure and character/environment interaction.

On a resource management level, procedural approaches optimize storage space and computational capacity, and basically allow more content to be packed into a game. Animations appear more organic than those created by transitioning between pre-calculated, pre-rendered poses, and the computing cycles and storage resources required for procedural-based animation are dramatically lower than those required by traditional methods.

On a higher level, procedure-driven interactions between characters and environments can and will continue to move us toward the realization of our classic vision of AI. To date, players are conditioned to expect a high level of predictability and repeatability in game play. Monsters are triggered to attack when the player enters a room. Guards follow a set search pattern. Shoot a bazooka at a static wall and generally nothing happens. But with a modest amount of procedural "hooks" embedded in the design of the characters and their environments, the game play takes on a radically realistic feel. Adversaries can interact with one another and behave in a more unpredictable, organic way. Environment becomes a major factor: an iron door is harder than a wood one, a stone wall is impervious to a tank, but a brick wall can be broken down. It's clear that in procedural simulation of this type, a little goes a very long way towards fulfilling our perceptions of realism, and we are in the very early stages of what can be achieved.

A graduate of MIT, Tom Hershey worked as a programmer specializing in graphics applications for PCs. In 1988, he joined Columbia Pictures and worked for four years as director of production administration, helping to oversee production of feature films. He now leads Imageworks' movement into content development for Sony's PlayStation 2.

Dominic Mallinson

Procedural techniques offer many advantages for interactive computer entertainment. The ability to parametrically describe objects offers a richer variety of graphics and conserves system resources such as memory and memory bandwidth. From a production standpoint, procedural techniques can reduce the amount of manual content creation and consequently offer the possibility of lower development costs. For truly interactive 3D worlds, pre-calculated animations cannot be used. They are too constraining and costly. In these situations, physical simulation must be used to create the best experience. To populate these simulated environments, we need autonomous characters with their own behaviors and decision-making processes.

The state of the art is only just touching the surface of this procedural potential. The latest generation of game consoles such as PS2 enable these technologies, and I am certain that we will see them used with increasing skill to produce more compelling entertainment over the next few years. A glimpse into the future reveals whole worlds described not in terms of polygons, but in terms of their features. Artists may create a terrain by identifying peaks, ridges, rivers, and oceans, and the algorithms will fill in the rich detail of mountains, valleys, and coastlines. When two football players collide, the resulting falls and acrobatics will be different every time and not an inappropriate motion capture. Finally, the most challenging future will be when the player is not sure if the character he is playing against is a human or a computer simulation.

After graduating in computer science from the University of Durham, Dominic Mallinson worked at Microsoft on their first C++ compiler. He returned to the UK to work for Pilkington Glass on CAD and factory automation, then joined Psygnosis and remained there for seven years, during which time Sony acquired the company and launched Sony PlayStation.

Janet Murray

Characters provide a good focus for thinking about what can be accomplished in game design using more powerful programming techniques. There is a rich history already of experimentation with characters who have some autonomous or spontaneous behaviors, including most notably, the work of AI researchers such as Joe Bates and Bruce Blumberg; Will Wright's recent game, The Sims; and the success of virtual pets like pf magic's Dogz and Catz series. As broadband technologies bring interactive entertainment into the home, the popularity of such creatures may increase, and they may be used as entry points into complex fictional worlds. One of the clear recent results of this work is the understanding that it is "believability" that is important rather than the elusive goal of actually modeling human (or even doggy) thought. Although researchers, led by Blumberg, have gotten very far with ethology (the science of animal behavior) as a structure for character

creation, the range of behaviors that can be produced this way can be less engaging to the interactor than simpler creations if the character cannot dramatize the full richness of its inner life. Similarly, it is possible to create the illusion of a rich inner life with very little modeling underneath. So the problem for designers is one of deciding what is worth modeling.

One way of thinking about this is to start with how the behavior is going to be elicited. For example, the Petz series used "props" like feeding bowls and pet combs and catnip to suggest satisfying dramatic scenarios to the interactor. The more ambitious we make our characters, the more latitude we allow in the virtual worlds, the more complex the design questions of eliciting the characters' behaviors and making them legible and dramatically compelling. The Sims is the most ambitious such undertaking to date, using a dramatic structure much like the 19th century bildungsroman (novel of education) to shape the action. My remarks focus on the challenges of creating expressive characters in a procedural simulation framework and suggest some ways in which designers can think about the problem, drawing in part on the lessons of the earliest work in this genre (long before the days of multimedia): Joe Weizenbaum's classic program, ELIZA.

Janet Murray is the author of *Hamlet on the Holodeck: The Future of Narrative in Cyberspace* and the forthcoming *Inventing the Medium: A Principle-Based Approach to Interactive Design*, both from MIT Press. She is currently serving as a trustee of the American Film Institute and serves as a mentor in AFI's Exhanced TV Workshop. Before coming to the Georgia Institute of Technology in 1999, she led humanities computing projects at MIT, where she remains a distinguished contributing interactive designer in the Center for Educational Computing Initiatives. She holds a PhD in English from Harvard University. Her research has been sponsored by the Annenberg/CPB Project, the National Endowment for the Humanities, the Andrew W. Mellon Foundation, IBM, and Apple Computer. She lectures and consults widely on the future of television, interactive narrative, and curriculum development for interactive design.

Bill Swartout

Procedural simulation holds enormous promise for creating games and simulations that provide much richer and varied experiences than the games we create today. If behaviors are generated dynamically, instead of being pre-recorded, they can respond naturally to situations or circumstances that were not anticipated when a game was originally programmed. In principle, procedural simulation allows us to vary behavior in subtle ways that reflect small differences in circumstances, something that would be very expensive to do if all the behaviors had to be pre-recorded.

But there's a problem. In many cases, procedural approaches can not yet exhibit the required range of behavior in a natural and convincing way. For example, consider machine-generated speech. Most current text-to-speech systems sound very un-humanlike, and even the most natural-sounding are incapable of expressing the range of emotions such as stress, anger, or fear that can be expressed easily by a skilled actor. Thus we seem to be confronted with a dilemma: Either take the procedural approach and use a text-to-speech synthesizer, thereby gaining flexibility but giving up expressiveness; or pre-record a library of a lot of expressive speech fragments with the risk that the right line might not be available in the library when needed.

The way out of this quandary is to borrow from Hollywood, where filmmakers often take a hybrid approach to creating a movie. Recognizing that each technique has its own strengths and weaknesses, Hollywood artists select the most appropriate technique for a each element of an overall scene and then composite the results together to create a unified whole. For example, a single sequence in a film might include live action, models, and computer-generated images, all integrated seamlessly to create a unified view.

In a similar way, procedural simulation techniques can be integrated with conventional approaches if careful thought is given to how the techniques are integrated. Depending on the role they play in a simulation (and the requirements the storyline imposes on that role) some characters might use a procedural approach while the behaviors of others might be pre-specified. In this panel overview, I outline our experiences in using a hybrid approach to integrate procedural simulation into a highly immersive VR simulation we have been creating to train soldiers about decision-making in complex peacekeeping situations. Because no single approach is sufficient for the range of behaviors we wanted to simulate, we found it necessary to integrate multiple approaches.

Formerly director of the intelligent systems division at the University of Southern California's Information Sciences Institutes. Bill Swartout has served as an associate research professor for the past 10 years. He holds a PhD in computer science from MIT. His specific research interests in the area of artificial intelligence include: intelligent agents, knowledge-based systems, knowledge representation and acquisition, and natural language generation. He was elected in 1992 as a Fellow of the American Association of Artificial Intelligence (AAAI). He served as the Conference Committee Chair for the AAAI (1992-1994), as Program Co-Chair at the Third International Conference on Principles and Knowledge Representation and Reasoning (KR-92), and as Program Co-Chair at the National Conference of Artificial Intelligence (AAAI-90).