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On virtual environments and agents in next-generation computer games

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Abstract

This paper holds the material presented at our keynote at the Intelligent Virtual Environments and Virtual Agents Conference, where we analyzed future trends in virtual agent and environment technologies, as applied to the fields of videogames and interactive multimedia. We begin by observing current tendencies in game development projects, both in the market and in the academia, outlining their respective strengths and weaknesses. We follow by describing the aspects of game development that will come to shape the next generation of games, and discuss the requirements for academic projects to achieve the level of quality required to be competitive in this field. In the rest of the paper we analyze the roles, importance, challenges, and research opportunities that a new generation of virtual characters and environments will bring to the world of interactive entertainment.

1 Introduction

Videogames present an interesting and unique convergence point between art and science. In this discipline, art finds an extremely fruitful playground, while science holds numerous research and development opportunities in fields as diverse as artificial intelligence, computer vision and multimedia, computer graphics, man-machine interfaces, software engineering, database systems, networking, machine learning, among others. Challenges are not only those natural to research, but also come from the ability to keep art and science together, making them support each other toward the goal of entertainment.

Needless to say, the industry of videogames and the academic world benefit from collaborating with each other. Game development studios have tight schedules and very small time and resources for research. After all, their mandate is also to be economically successful, and as such they must get products to the market frequently. Universities, on the other hand, have departments devoted to research and development, with numerous students interested in solving challenges related to videogames. While universities have the research component that few game development studios can afford, the game industry provides a realistic environment in which experimental projects can be practically tested, validated, and applied to a final product.

Game developers know the importance of art and design in the composition of a videogame. Professional, specialized art, on the other hand, is something that few research laboratories consider—or have resources for—when developing new technology. As a result, academic research often looks unappealing, repetitive, and empty, unable to transmit their real potential to the audience (observe, for example, the number of papers in computer graphics that illustrate their techniques with bunnies, primitives, or generic and publicly available meshes), while game developers must resort to old methods (or commercially available solutions) to provide artists with tools to express their creativity.

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The objective of this paper is twofold. First, to show the trends that will differentiate the next generation of virtual environments and agents in the games of upcoming years, noting the challenges that both the academia and the industry must face to reach an acceptable level of quality. Second, we propose that both work together to reach common goals and fight their weaknesses. Our election for environments and agents as a subject, with the future of games as the background, is not only adequate to illustrate the benefits of this industry–university interaction; it is, in fact, the most important innovation area that next-generation games will bring to our homes in the following years.

We divide the rest of this paper as follows: Sections 2 and 3 shall serve as a background to understand the current situation of game research and development, both in the industry and in the academia. In Section 2, we briefly describe general trends of commercial game development, while Section 3 talks about qualities and characteristics of game-oriented research in academic laboratories. Section 4 describes the areas and concepts that will differentiate future games from the current selection of products we have in the market today. Sections 5 and 6 describe the role, importance, and future of virtual environments and agents, respectively. Section 7 extends our discussion on how the industry and academia can work together, presenting instances and organizations that have made that possible. Finally, Section 8 closes by briefly reviewing the presented material.

2 Current and future tendencies in the videogame industry

The times where games were purely based on sprites bouncing or scouting around our screen are long gone. Currently, a single videogame project will need terabytes of space just to store its artistic resources. A typical game engine will enclose tens of thousands of lines of code, and if your computer does not contain the latest technology, chances are you will not be able to run the game at more than 15 frames per second unless most of its graphics features are disabled. Naturally, the videogame market has grown as well. According to a report by DFC Intelligence (2005), in 2004 the top 17 game companies generated an annual revenue of $25 billion dollars (the top four being Sony, Nintendo, Electronic Arts, and Microsoft). Most publishers transcend international barriers, and with so much investments on the line, entire companies can go bankrupt when one of their titles fails to produce as much revenue as expected.

It is only natural that the primary concern of most companies has become producing enough money to remain in business. Similar to the mainstream movie phenomena, new games are mainly designed as a selling product. Creativity and innovation can become risk factors, given that there are no sales figures for games without precedence in the market. Games are being tailored according to rules and elements that market research advise necessary to generate revenue. Originality is often sacrificed in order to create an article of predictable payoff.

This has not always been the case. In times when making a game involved less risk, companies were able to invent and innovate more freely. Two examples that are mentioned in today's game designer textbooks include *Grim Fandango*, by *LucasArts* (1998), and *Ico*, published by *Sony Computer Entertainment* (Team Ico, 2001). In contrast, producing a game nowadays involves so much money and resources that few companies risk working on completely original concepts. For this reason, *safe* inspiration and ideas for new videogames in our current market come, usually, from the following three sources.

2.1 Currently active intellectual properties

Most games today are released as part of a bigger intellectual property (IP)[1] marketing operation. For example, the movie of a superhero is screened as the game and other promotional products like clothing or action figures are made available. The media hype guarantees that the game material is well known and a minimum expected amount of people would buy it. Usually, these

[1] *Intellectual property*: Trademarked material like superheroes, well-known cartoon or movie characters, etc.

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operations have very well-identified market niches. Examples include the latest *Spiderman* games, published by Activision (Marvel Comics, 2005–2007), and the *Harry Potter* series, published by Electronic Arts (Rowling, 2004–2007).

2.2 Continuous exploiting of existing intellectual properties

A common practice is to design IPs with the intention of long-term promotion and investment. Instead of risking a new storyline or design every time, a previous one is iterated with improved resources, creating the *next* version of an existing game. This has the advantage of launching a product that is already known by the public, and is hopefully supported by a group of consumers who are likely to buy new installments. As examples, consider the *Quake* series by id Software (1994–2007) or the *Tomb Raider* series by Eidos Interactive (1996–2007).

2.3 Amalgam of features from other successful games

Frequently, game designers extract popular traits from games that have proved to be commercially successful, and merge them to create a new game that offers a combination of those features. As an example, consider the number of games that resort to plots, environments, and characters similar to those found in *Rockstar*'s *Grand Theft Auto* for the PlayStation platform (2004) before and after its publication. Based on a very risky premise, this acclaimed game opened the door for many others who realized that there was a public who would buy this kind of product.

2.4 Into the future

As the capabilities of platform hardware increase, the tendency in North America is to improve the graphic quality of games, leaving proven design practices unaltered. An excellent counter-example of this philosophy is given by Mr. Satoru Iwata, president of *Nintendo*, who asserted in a press conference during the *Tokyo Game Show* in 2003 that companies who trust technology as their only strategy for success would surely fail. Nintendo's strategy is centered on creating simple yet fun and interesting games. Their intention is to expand the market to people who are not used to playing games, and people who used to play them in the past but desisted because of the complexity of current games. With the launch of the *Wii* platform, Nintendo has made clear that innovation is an important part of their philosophy. And rightly so, given that Asia is a market that looks for originality and diversity. According to *Reuters*[2], by the end of November 2006 Nintendo had sold 476 000 units in the United States alone (more than twice the number of PlayStation 3s at that date), and more than 600 000 worldwide on its first 8 days following its release. According to *NPD*, during May 2007, the number of Wii units sold reached 338 000, while the PlayStation 3 and the XBox 360 only sold 82 000 and 155 000, respectively[3].

We can expect to see games with better graphic and cinematic detail, as development studios gain experience and a better understanding of the current consoles in the market. Although certain studios are risking the production of radically different content immediately (as explained later in this article), most publishers will take a longer time to adapt and converge to these technologies given the risk involved. In the immediate future, many publishers will still follow conservative approaches until pioneer developers start publishing games with features like the ones described in Sections 5 and 6, and it is proved that the public is prepared to pay for such a content.

The videogame market is also evolving. A reduced number of publishers satisfy the demand of original content in North America by releasing Asian games that previously proved to be successful. Two examples are *Katamari Damacy* by Namco (2004) and *Okami* by Clover Studio (2006). This phenomenon will come to speed up the alignment of other publishers and prompt domestic developers to produce original content.

[2] Reuters Limited, December 8, 2006.

[3] NPD Group. Sales report for May 2007. `http://www.npd.com`

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3 Current tendencies in the academia

Videogame development has always been an attractive research subject among graduate and undergraduate students. Its ramifications are so vast that it has no difficulty providing open research challenges to almost every area of Computing Science departments. There are a great number of papers and ongoing projects proposing solutions and applications to the problems that our videogame industry faces on a daily basis.

However, the main disadvantage of academic research is the fact that it is conducted in a *closed* and *controlled* environment. Very often, students will prepare testbeds that favor their own techniques, or impose heavy restrictions to the validity of their solution domains. Frequently, tests are based on wrong assumptions or utilize misguided stress simulations. Consider, for example, the claim of a computer graphics paper stating its solution runs at *interactive frame rate*. This formally means that the application will provide real-time graphic feedback within *seconds*, after its internal states have been updated. Being optimistic, the fastest solutions will run at around 50–70 frames per second, having all the resources committed to the simulation. In a real videogame, the same solution will have a tenth of the resources, given that it must share memory space and processing power with the rest of the real-time systems; still, it must ensure the best performance. When applied to the industry, most academic papers must undergo heavy optimization procedures before they can be helpful for a commercial product.

Another problem comes from academic game-oriented research that ignores the challenges faced by real games, opting to solve popular or traditional problems common to the academia only, hoping their solutions will be later applicable to videogames. The result is a greater number of redundant papers related to the same problem, most offering solutions that are appropriate neither to games nor to any real-world application. In most cases, the problem in question has been already solved by game programmers and scientists in ways that might not be as elegant as those in the academia, but are practical enough to be applicable, guaranteeing a minimum level of performance.

Given that most students are highly competent, why does academic research produce unpractical solutions? In most cases, it relates to the following two reasons:

1. Few researchers have real-world experience in the videogame industry.
2. There is a general misunderstanding between the objectives of academic research and those of interactive entertainment research.

3.1 The importance of experience

To understand the technological needs of a real-world game, a person must be closely involved in its development process. It is necessary to experiment the deficiencies of day-to-day activities like content pipelines and processing, development tools, game system architectures, and in general, the way in which all the modules and resources of a complex game interact with each other to create a final product.

This experience provides the developer with two valuable pieces of knowledge. First, it illustrates what goes wrong in a typical application, outlining not only the problem but also the human and technological factors involved, along with the context, available resources, and characteristics of an acceptable solution. Second, it will usually force the researcher to know all the existing options (in the form of products or current research), their advantages, and, more importantly, the reason why they fail to solve the issue at hand.

Armed with this knowledge, the researcher can focus his work into a solution that effectively solves the problem, within the constraints and quality requirements of the game.

3.2 The objective of game development research

Within the walls of the university, and more specifically, our science departments, it is common to forget the primary objective of computer games: *Entertainment*. Scientific publications are full of intelligent agents that solve tasks efficiently and quickly, but few are *fun*, *believable*, or *interesting*.

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Facing an enemy that cannot be tricked is boring; playing against an agent that seems to either make the best decision or adjust its difficulty level on purpose is neither realistic nor amusing. Teachers preach that AI solutions must provide for perfect systems, capable of quick, flawless logic. Games, on the other hand, require systems that are capable of translating an *artistic* concept and design into a thriving interactive experience. In the world of entertainment, the best path is not always the shortest one.

3.3 Advantages of academic research

In spite of the previously discussed challenges, universities and academic laboratories have an essential role in the future of videogames. It is important to mention that a great portion of the research done in the academia *is* extremely useful to the videogame industry, and is in fact creating a change in the way we make games. The new trends that we are going to review would not be possible without the help and support of students and their interaction with pioneer game development studios.

Students provide a fresh source of ideas that contrast with the conservative approach of the videogame industry. Because academic research is less biased by market trends, university students have the flexibility and resources to create original projects that could change the rules about how we make interactive entertainment. Since laboratories are less tied to old ideas or methodologies, it is their students who are in the best position to cause paradigm shifts in the industry, and constitute agile development groups to showcase new arrays of tools, techniques, and technologies, to embody the artistic concepts of the games of tomorrow.

In the following sections we will discuss the nature of some of these changes, along with the general trends of games that are currently on the design board of the most innovative studios. With this background in mind, it will be easier to understand the role that virtual agents and environments hold for the next generation of games.

4 A brief look into the future

In general terms, current evolutionary trends in videogames are deeply touching the following disciplines. Each one constitutes open areas of research, and numerous papers and articles are available both from academia and from game development studios.

4.1 Content and storytelling

Games are leaning toward deeper plots and more interesting stories and themes. As we will analyze later, cutting-edge studios are looking for technologies to support better, stronger characters, with more realistic and believable personalities. We also look for new ways of interaction between the audience and the game. This includes changes in narrative, inclusion of action/consequence and moral systems, and a stronger focus on emotions, with the objective of building a fruitful link with the audience.

4.2 Environment design

At the industry, we strive for a more cinematic experience, not only in terms of graphics, but also by paying closer attention to the influence that sound and correct camera scripting have over the audience, and contribute to the overall immersive experience. Designers are looking to take advantage of environmental elements to convey a mood, sustain their story, and interact with the character, as opposed to just providing a background for events to happen.

4.3 Character design

As mentioned before, the future of virtual agents lies in the creation and support of more interesting and believable characters, with strong focus on emotion and personality. Such characters must appear to be alive, creating a natural connection (both emotionally and circumstantial) with the audience.

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4.4 Collective experiences

Massive multiplayer scenarios are one of the biggest trends in the videogame industry of our days. Thousands of players connected to the same virtual environment, providing all the necessary blocks to build virtual communities, complete with their own economic and organizational systems, allowing human-to-human interaction and collaboration for the resolution of the plots presented by the game.

5 Virtual environments

The role of the virtual environment in a videogame is to create a perfect, believable context for a story to be told. An adequate environment will help to justify the events that take place inside it, giving them a logical time and place. It constitutes a high-quality canvas in which we paint the events of our game. A well-designed environment causes the story to flow naturally and *make sense*, while an unfortunate environment will cause the user to stop suspending her disbelief and break the illusion of the game. Can you imagine a science fiction movie that takes place in your backyard? A carefully designed spaceship, on the other hand, makes the audience accept that the story happens in space, and allows their attention to focus on the characters and the events as they develop. If you do not believe where characters are, you will have a hard time believing what they are doing.

In the gaming industry, virtual environments are very appealing, as game companies have teams of professional artists behind their design and construction. However, the potential of such environments is frequently wasted because they are nothing but a rigid backdrop in which the story is told. In the academia, few are the students who actually pay attention to the quality of the environment. Most academic projects center their efforts and resources on the solutions they showcase, but forget about creating a believable presentation for them. If it was not completely disconcerting, many students would show their virtual characters floating in space. In fact, some do.

If we, as the audience, fail to believe the authenticity of the environment in which an event takes place, we will not give much importance to the events themselves either.

5.1 Into the future

The environment is changing its role from a passive observer to become an active player in the game. We already have games in the market that experiment with a more complex environment, one that interacts with the user and supports the mood and intention of events and plots. The environment as one more character is one of the missing ingredients to create a closer and personal connection with the audience. Future environments will have a personality by themselves, reflect an emotional state, and reinforce the overall message that designers want to convey for each given moment of the game.

Future environments will boost the emotional charge of the scene, blending seamlessly with their characters, both graphically and technically speaking. They will create and maintain the mood of the scene and its players, inspire fear, loneliness, joy, and interact with the audience, submerging them in the story and making it easier for them to suspend their disbelief. Next-generation environments will present a perfect synchronicity of meaning, action, intention, and emotion with characters and events.

6 Virtual agents

Virtual agents, as considered in this paper, constitute the automated characters that bring the story or situation pictured in a videogame to life. As the environment creates and maintains an illusion of immersion, virtual characters conform the crew that our audience gets to meet on its interactive

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experience. When such characters appear natural, realistic, and interesting, the attention of the player will naturally follow the plot of the game. If the characters, on the other hand, seem unrealistic, cold, or fake in any way, the player will find it hard to suspend his disbelief, and the overall impression of the game will be negative. A good character conveys its role, intention, and emotional state to the user; it grabs the audience by the hand and pulls them into the virtual world.

Not a long time ago there was an interesting trend, both at the game industry and at the academia, about making photorealistically looking characters. The result (from both sides) was a series of stiff, zombie-looking agents that were more scary than realistic. Game studios have understood that it is wrong to attempt photorealism when our agents are unable to show traits such as effective facial gestures, adequate lip synchronization, and a body language that would rival that of a real actor. In most cases, successful characters are not those who look like pictures of real people, but those who follow a consistent artistic design. As explained by *Johnston* and *Thomas* in their masterpiece (Thomas & Johnston, 1995) *The Illusion of Life*, the key to Disney's success in the field of animated films is due to the degree in which they are able to convey the emotion and realism of their characters (which are seldom photorealist). In spite of all we have learned, the majority of games in the market still design their characters with a *Hollywood*-like criteria: beautiful, strong, and with no short supply of swords and firepower.

Characters in the academia often have a brain, but frequently lack a convincing body. Research in the field of emotional characters is plagued by *emotional robots*, that is, characters that express their emotional response as a number, a movement, an automated voice, or a selection in a hierarchical tree of dialogs. We know they are *technically* interesting because we have read the paper, but not because they take us to experience an authentic emotion when we see them in action. That is not to say that such characters are deficient; they are simply ineffective and incomplete. A believable character is an *integral* agent, which conveys a message not only by reasoning but also by *appearing* to possess an emotion, having a strong and well-defined personality, and supporting such personality and intention with effective body language.

6.1 Into the future

The first generations of *Digital actors* are starting to appear in games available on shelves now. Emotional behavior and believable characters are some of the most active research areas in computer science labs all over the world. The future of virtual agents truly lies on creatures that are capable of conveying their emotional state and intention to the player, involve her in the plot, have memorable moments with her, and overall appearing to be alive. They are important because a natural, authentic link between the audience and the computer is established when the interface is an agent that appears to be more than a computer, and their application goes far beyond videogames. Today, this first generation of agents is used on training and simulation software, virtual help desks, artistic installations, therapeutic tools, among others.

In order for videogame characters to fulfill this role, careful design must be applied from the very early stages of development. The objective is to create characters that are less *photorealistic* and more *believable*, less *intelligent*, and more *interesting*. Their AI must provide less linearity or simple rule-based behavior, and more *personality*. Every digital actor is *born* from a story or an objective, has a place, a role, and a personality. What kind of race, object, or animal is it? How does it move? How does it stand? What are its intentions and goals? What kind of emotions should it evoke? What is its relationship with the audience? A successful character, be it for an academic project or a videogame, must easily answer these questions.

7 The importance of working together

People often ask how is it possible for universities and game developers to work together. Each one seems to be walking on a very different schedule and, some think, with a very different set of goals in mind. Truth is, if the academia and the industry are to work together, the most important factor is *communication*. There are plenty of convergence points that benefit both parties, the most

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important of all being that the sooner this gets to happen, the fastest we will reap the benefits in our entertainment systems and interactive environments.

As a summary, some of the advantages the industry gets from working with the academia include the following: fresh, new points of view and approaches to break traditional paradigms; high-quality, tailored solutions for development problems; new ideas for new genres, storytelling methods, and interactive narrative techniques; new ways of optimizing and applying artistic resources, etc.

Universities, on the other hand, obtain realistic, practical testbeds for their research projects; professional advice from highly qualified people in the industry; adequate artistic resources (the perfect compliment for science); open, meaningful, research challenges; joint research opportunities; access to cutting-edge technology, such as development tools; the possibility of putting research to work on a real, published videogame; and even job opportunities for graduated students.

7.1 A wining collaboration

It is interesting to observe that the trends we have reviewed in this paper are being pursued in parallel by the industry and the academia. Joining forces means that both worlds get to achieve their goals faster. The future of virtual agents and environments is not so distant if this comes to happen. And it is indeed happening, as more and more organizations are created with these collaboration objectives in mind. Right now, the *IGDA*[4] is opening *study chapters* with universities, and working first-hand with students to promote game-oriented research and development. Individual members of the game development community are reaching out to universities to give seminars and talks on subjects as diverse as game design, digital character creation, rendering techniques and technologies, and even storytelling. Examples of such collaboration include Canadian universities like the University of Alberta and the University of British Columbia, exchanging knowledge and experience with companies like BioWare and Electronic Arts.

Game studios and universities naturally complement each other. All that is left to it is to keep the gears in motion.

8 Conclusions

We have reviewed current traits and challenges in the videogame industry, as well as game-related research and development at university laboratories. We outlined the challenges that both sides face in the present day, and discussed the way in which a close collaboration would come to complement the weaknesses of one side, with the abilities and strengths of the other. After providing this background, we have described the role that virtual agents and virtual environments play in current and future games, and elaborated on their future direction. We reviewed the mutual benefits that both sides obtain from working with each other, and stated that such collaboration is already taking place.

We hope the reader walks away with an understanding of pieces that are missing from both sides, and ways in which a positive collaboration with one another come to complement them. We sincerely hope this interaction will only grow, and the advantages soon be reflected in quality games that we can all enjoy, in a not so distant future.

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