# Video Games: Evolving from a Simple Pastime to One of the Most Influential Industries in the World

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#### Abstract

Video games have gone from a childish pastime to a major force on the global stage. Many people today see video games as a pointless pastime, played only by young people, with little to no real use. In reality, other industries have profited off the technological advancements of the video game industry. By consolidating articles providing information on technology and industries affected by the game industry found in engineering journals, and an interview with Dr. Steven Berdock, Director of Clinical Services Department of Anesthesia at the Hospital of Sick Children of Toronto in Toronto, Canada, I will show the game industry's widespread effects on technology. Graphical rendering, hacking and reverse engineering, and low-cost, state-of-the-art hardware are allowing other industries to ride the game industry's wave into new advancements of their own. The gamer of today may become the computer scientist of tomorrow. Who can say how far video games can really take us unless we continue to encourage young gamers to study game design and development and push the industry to its very limits?

#### **Games and Technology**

Games have been popular for decades. From the early days of arcade games to in-home and handheld consoles and computer games, the game industry grew into the most profitable of the entertainment industries. In 2007, game industry sales reached a staggering \$41.90 billion (Caron, 2008, para. 2). Video games have gone from a childish pastime to a major force on the global stage.

#### Gamers Drive Personal Computer Upgrades

Game designers push themselves year after year to provide a better gaming experience for their customers. Games evolved from 2D worlds with the most basic of character control to immersive 3D worlds and characters with multitudes of abilities. With these advancements in graphical, sound and control elements, games require increasingly powerful machinery to run them.

We see the effects of this every time we walk into an electronics store. Desktop computers today come with a minimum of three gigabytes of RAM standard. Graphics cards can handle far more detailed images than ever before. Figure 1 illustrates how far computer graphics have come. In the late 80s (left) games had a cartoony, 2D look. Highlights and shadows were minimal, and typically a static coloration change

on the image. By the mid-2000s (right) game graphics evolved to allow for 3D images with highlights, shadow and detail that moved with the character, creating a more realistic experience.

Many people today still see video games as little more than a pointless pastime, played only by young people, and of little to no real use. But in reality, other industries profit greatly off the technological advancements of the video game industry.

3D rendering is becoming more important in a variety of fields. Today, average computers can render at tremendously high speeds with a great amount of detail and 3D modeling is fast approaching photographic quality. Rendering is the process of the computer drawing an image onto the screen of the monitor.



Figure 1: On left: Prince of Persia 1989 for PC (Broderbund, 1989). On right: Prince of Persia 2004 for PC. The difference in graphical quality shows how far computers have come in the field of graphical rendering (Ubisoft, 2004). Images cropped and resized by Catherine Lyons.

Jim Rapoza with eWEEK magazine argues computer games are keeping the computer hardware industry moving. After the tech bubble burst, the speed at which computers were advancing declined. A decade ago, computers would become obsolete after only a year or two of use, and consumers had to buy a new computer to handle the most basic everyday computing needs. Today, computers are lasting much longer, allowing consumers to use computers several years old for everyday use (Rapoza, 2008, p. 41).

Unless you are a gamer.

Gamers' demand for top of the line computers led Dell to purchase the popular game hardware company Alien Ware. Now, they are pushing the specifications of their gaming computers higher and higher. This means the models a step or two down in specifications from these gaming models are dropping in price, making it easier for average users and businesses that do not need the same computing power to still upgrade their computers regularly for a fraction of the cost it once was. The cycle concludes with software developers creating more powerful software and games to take advantage of the new highpowered computers (Rapoza, 2008, p. 41).

# Games Branch Out to More than Computer Hardware

With this technology, other industries reap the benefits. The military is able to create more realistic simulations, as well as creating more intuitive HUDs. An HUD (Heads up Display) is a common video game entity. It is a display of information not part of the 3D game world. It typically includes information such as player health, a mini-map of the region, player lives, score, and other things a player may need to know. Advancements in this area have lead to making HUDs less jarring to the eye and less distracting for the user. In a military application, such as the HUD on a fighter plane, a well-rendered HUD can mean the difference of life and death if the pilot's eye gets distracted at the wrong moment. Schneider and Mateev's instructions on how to create an effective HUD shows how game designers have studied the effect of HUDs on users, and how these studies have led to better HUDs.

Rhyne discusses 3D rendering used in scientific fields as a tool to visualize data by many agencies including the US Department of Energy. She details the pros and cons of using technology created for video games in a scientific environment. Games do not require the same level of detail and stability a

scientific experiment does. This provides some challenges in incorporating the technology (Rhyne, 2002, p. 42).

The medical field takes advantage of 3D rendering as well. Dr. Steven Berdock, Director of Clinical Services Department of Anesthesia at the Hospital of Sick Children of Toronto, describes how the medical field's use of technology has changed in the last twenty years, and the advantages and disadvantages of using 3D graphics in the lab and in medical education.

Video games affect traditional education as well. Hakan Tüzün, Assistant Professor in the Department of Computer Education and Instructional Technology at Hacettepe University in Ankara, Turkey, performed a study on video games used as an effective learning tool in all levels of education. His study provides evidence the technology has not yet reached the level where full curriculums can be created around video games, although it may be possible in the near future (Tüzün, 2007, p. 465-475).

Combining technology in new ways unforeseen by the creators is also known as hacking, or reverse engineering. Grand provides examples of gamers using hacking and reverse engineering to show companies the security risks with their hardware and software. Although hacking and reverse engineering have led to interesting discoveries, it is questioned whether they do more harm than good due to the complicated legal and ethical aspects.

HUDs and improved 3D imagery are far from the only advancements video game technology is driving. Harrow reveals technology developing at the Massachusetts Institute of Technology will bring life to an idea straight from science fiction. Scientists use graphics cards intended for gaming to create 3D holographic technology likely to replace television as the primary medium of in-home entertainment.

This report will detail the pros and cons of the effects the game industry on other industries and global technologies. By contrasting these, I will show the game industry is one of the most influential industries in the world, and investment in games and pursuing a career in game development is to help bring the world cutting edge technology as we move into the future.

# **Research Methodology**

My research focused primarily on technical journals and magazines. Searching through academic databases, I found several articles providing information on technology and industries affected by the game industry. By consolidating this information, comparing the pros and cons, and including an interview with Dr. Steven Berdock of the Hospital of Sick Children in Toronto, I will provide a strong case in favor of the game industry and continuing to invest in the game industry is a key element in keeping our technological and scientific industries booming.

# Games and the Global Effect on Technology

#### Games Bring Advancements to the use of HUDs

Games are first and foremost visual entities. A game's success depends heavily on the realism of the virtual world it presents. Some games are better at this than others. Schneider and Mateev have provided a guide for programming graphical elements to the highest possible quality.

One of the main areas they touch on is how to create an effective Heads up Display (HUD). This is a key element in many of today's games. It provides the player with information about the health and number of lives of his or her character has, score, mini-maps and other information that needs to be readily visible but is not actually a part of the game world.

Schneider and Mateev detail how to create an effective HUD using orthogonal rendering. The Oxford English Dictionary defines orthogonal as "Of a linear transformation of a vector space: preserving lengths and angles; leaving unchanged the inner product of any two vectors" (OED.org). Hess uses the term "orthographic" and defines it as "remov[ing] the shortening due to distance that is found in perspective, making things appear "flat"" (Hess, 2007, p33).

Rendering of crosshairs and target nameplates done at the same visual depth as the target prevents confusion and eyestrain caused by rendering these elements at the HUD depth.



*Figure 2: Orthographic Visualization (Hess, 2007).* 

Although written for game producers, the same other industries import these same concepts. HUD technology made its way into the private sector for use in motor vehicles. GM and BMW have both made use of HUD displays, with the option available in the Pontiac Bonneville, "GMC Acadia and Cadillac STS. BMW also has an available HUD system on many of its vehicles" (Bruzek, 2008, para. 1).

The use of HUDs in cars allows drivers to see information such as the speedometer, tachometer, oil levels, etc at eye level so the driver has no need to take his or her eyes off the road. The military industry uses seamless, non-distracting HUD graphics in fighter planes. A pilot with an ineffective, distracting HUD could face severe injury or even death if they are distracted at the wrong moment. With an effective HUD, the pilot has access to necessary information without visual hindrance.

#### Game Technology and the Scientific Fields

The United States government has seen the potential and value in encouraging game developers to expand their technologies in other fields besides just military applications. In 1999, the US Department of Defense joined with the University of California in Berkley to create the Institute of Creative Technologies. ICT scientists "are developing combat video games to enhance the strategic, combat and decision-making skills of next-generation military field commanders" (Rhyne, 2002, p. 41).

But game industry application does not stop with the military. The US Department of Energy funds studies on scientific visual modeling done by using graphics cards optimized for video games in "clusters" (Rhyne, 2002, p. 41). Such visualization would allow scientists to study images in a lab of a specific geographic location, or model bone structures, and be able to visualize them digitally in ways never possible before.

The use of game technology in the fields of science is not without downsides. Computers can render only triangles and quadrangles. All curves and details that appear on the screen are drawn using small polygons. The more polygons a computer draws for an image, the smoother and more realistic the quality. This is taxing on the computer's computational resources. As a result, game designers will reduce the amount of polygons drawn, trading accuracy and realism for better game performance.

This loss of accuracy could be disastrous in a scientific application. "Imagine eliminating a few polygons in the digital terrain model representing the Grand Canyon, then giving the model to geologists looking for a particular formation" (Rhyne, 2002, p. 42). The tendency of game designers to cut corners with their rendering created mistrust among the scientific community when it comes to using

game technology for scientific purposes. Is the game industry accountable for creating scientifically accurate graphical technology? It falls to the scientific community to reach out to the game industry to join forces, not simply snub the advancements the game industry has made for no reason other than the game industry's graphical needs differ from the their own (Rhyne, 2002, p. 42).

We already see 3D rendering emerging in scientific fields. Dr. Steven Berdock , said in the twenty years he has worked in the medical field, he has seen the use of computers going up astronomically. 3D graphics currently model things such as a person's face before reconstructive surgery. Currently, this technology is costly, but as the price comes down, it is possible it will be used more frequently (Berdock, Interview, 2008).

He hopes 3D modeling does not take the place of using real cadavers in medical schools. It is very possible one day the technology will be available to create realistic 3D images of the human body and would allow medical students to see customizable body parts for studying. He feels nothing can replace the experience working with a cadaver provides. He believes the best learning environment would be one that incorporates both (Berdock, Interview, 2008).

Rhyne contends most people that work in a scientific field may find it odd to work with technology originally designed for gaming, but Dr. Berdock believes there is nothing odd about it. Using what works is more important than where the technology originated from (Berdock, Interview, 2008).

## Games and Education

Video games are already making their way into the educational realm. The idea of educational games does not surprise most people. Many people played games in school such as Oregon Trail, or Where in the World is Carmen San Diego, which provided educational material as a game. But what of the idea of an entire educational curriculum taught in game form?

In 2007, Hakan Tüzün, Assistant Professor in the Department of Computer Education and Instructional Technology at Hacettepe University in Ankara, Turkey set out to try exactly that. He and his team created games to teach the curriculum for elementary, secondary and college level classes. His study showed students were very open to learning through video games, and became more engaged in what they were learning (Tüzün, 2007, p. 472).

Tüzün found video games would be a very powerful teaching tool, but there are still kinks to work out. All students in the study, accustomed to higher-quality commercial games, had a hard time immersing themselves in the environment. The in-game chat system, though helpful for working together on problems, offered a major distraction.

The cost was unreasonable as well. It took over 60 hours of work to produce each game, and to create the quality of game the students expected would take even longer. This would be prohibitive for creating games for every subject at every level of learning. Monetary concerns about the school's computer technology also came up. Unless a school had a computer for every student, it would be difficult to use games for even one subject due to scheduling time in a computer lab to do the work (Tüzün, 2007, p. 471).

His findings showed while the technology may not be there yet, it is certainly moving in the right direction. As games are becoming easier to make, and schools get access to more computers, it is very possible education may move from the dusty world of textbooks to the virtual world of video games.

## Games and Reverse Engineering

Today, some educational projects are making big waves in the world of technology. Some universities use reverse-engineering as learning tools. Gamers are one of the largest groups in the community of hackers (Grand, 2006, p. 46). Gamers typically hack consoles to play pirated software, or to play homemade games (Grand, 2006, p. 46). In 2001, Andrew Huang, a graduate student at MIT, set out to hack the security software on Microsoft's Xbox console as part of a thesis project. When he was successful, he made presentations on his findings and methods. While at first nVidia (the company that made some of the elements Huang hacked) and Microsoft were unhappy with their security being breached in such a manner, they were able to use those findings to make their next console, the Xbox 360°, harder to hack.

Sometimes, hackers find information about a piece of technology the manufacturers never intended consumers to know. In 1999, DigitalConvergence gave away millions of handheld devices called CueCats. CueCats scanned special barcodes on a variety of products, and connected the user to web pages that provided more information about the product scanned.

Hackers worked to break the security elements on these devices in an effort to reprogram their units to work with all barcodes, not only the special barcodes specifically designed for the CueCat. These hackers discovered the CueCat was not only directing consumers to information about the product scanned, but also transmitted data on the consumer's shopping habits to a database for marketing analysis without consent or knowledge of the user (Grand, 2006, p. 48).

DigitalConvergence tried to argue the hackers had no right to hack their systems, as it says in the CueCat's End User License Agreement (EULA) CueCat users did not actually own the CueCat, and were only "borrowing" from DigitalConvergence. Giving CueCats away as unsolicited gifts nullified that portion of the EULA and the hackers were not held in error for hacking the device.

Although DigitalConvergence was ethically in the wrong with their practices, other companies are trying to do similar behavior by stating a consumer cannot actually own the company's products, and therefore hacking or reverse engineering them would be criminal vandalism of the company's property. But do they have the right to say someone does not actually own the device they bought? This has led to a long legal debate as the government tries to adapt its copyright laws to deal with the dilemmas of a technical world.

For better or worse, hackers, many of which are gamers, are still hacking and reverse engineering technology. While the issue is currently legally and ethically ambiguous, finding the places a system can be broken into led to advancements in computer security. Despite these ambiguities, hardware hacking and reverse engineering are a vital part of technological discovery. The laws the government enacts to

limit these concepts need to focus on the piracy issue, and not hacking and reverse engineering across the board. Hacking and reverse engineering are vital parts of the discovery process, and to completely quash it would hamper engineering and technological advancements.

#### Games and Cutting Edge Technology

Reconfiguring current technology to create new technology is the backbone of technological discovery. With all the technology we have now, it can be hard to imagine advancements that would make commonplace technology like television completely obsolete. A team



*Figure 3: 3D Hologram of Princess Leia for the 1977 film "Star Wars: New Hope" (Lucas, 1977).* 

at MIT is trying to do exactly that. In *Star Wars: A New Hope*, the droid R2-D2 tilts forward, an image of Princess Leia appears, and she says the famous words "Help me Obi-wan Kenobi. You're my only hope." In 1977, the idea of 3D holographic imagery was considered nothing more than an element of science fiction, and few thought it would ever be possible. If it did come around, it would be centuries in the future. The team at MIT is already very close to producing that kind of technology.

"It will be small enough to add to an entertainment, provide resolution as good as a standard analog television, and cost only a couple hundred dollars" (Harrow, 2007, p. 2). To get 3D holographic imagery for less than what a high-definition digital television costs today sounds impossible, but video games drove down the cost of the technology. By using off-the-shelf commercial graphics cards in the cluster the team is using for the graphical processing, they are able to keep the cost of the project low.

# **Conclusions and Recommendations**

## Present and Future: The Game Industry Will Lead the Way

Video games have long been held to be little more than a time-wasting activity. But advancements in technology are proving this activity is actually behind some of the greatest advancements of our day. Graphical rendering, hacking and reverse engineering, and low-cost state-of-the-art hardware are allowing other industries to ride the game industry's wave into new advancements of their own.

No one can say what technological marvels tomorrow holds, but it is a safe bet video games will remain on the cutting edge of that wave, paving the way for technological advancements around the world.

It is undeniable how the game industry has fueled technological advancements. Improved graphics, computer hardware, visualization tools and more have their roots with video game technology. Without game technology, it would be difficult to find a field that would not feel the loss of these advancements.

As we move into the future, the game industry will continue to spur on technological advancements across the world. From military applications to scientific visualizations, to whole new technologies, video games will continue to be the main driving force.

New ways of rendering graphics will provide more detailed visualization for use by scientists. Combat simulations and advances in HUD design will provide the military with better trained soldiers while giving them the tools to get information in combat situations safely. Those same advancements will change the way everyday people drive their cars. Education will move from static textbooks to interactive games allow students to move through a virtual world as well as work with other students from around the world. Hackers will provide companies with insight as to how to provide better security for their systems. Science fiction dreams of holographic technology will become a reality. The technology in each of these areas is imperfect.

Scientists may find some of the visualization tools adapted from video games to be too unstable or inaccurate to be of use in experiments. Schools will face challenges in providing educational games at the quality students today expect, as well as providing enough computers to serve every classroom's needs. Hackers and companies will continue to face off in legal battles trying to determine where exactly to draw the line between exploring and studying technology legitimately, and infringing on a company's intellectual property.

Despite these drawbacks, video games continue to push technology to its fullest. But they can only do this if consumers continue to provide them the capital. The industry also requires new generations of computer scientists to drive the industry.

The only way to do this is to encourage young people to play video games and develop an interest in them. Rather than cutting off video games or dismissing them as a pointless time-wasting activity, children and teens should be encouraged to explore them as a hobby, and more than just playing them, but exploring the technology behind them. The gamer of today may become the computer scientist of tomorrow. Who can say how far video games can really take us unless we continue to encourage young gamers to study game design and development and push the industry to its very limits?

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