Five Forces Driving Game Technology Adoption

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ABSTRACT

The computer gaming industry has begun to export powerful products and technologies from its initial entertainment roots to a number of "serious" industries. Games are being adopted for defense, medicine, architecture, education, city planning, and government applications. Each of these industries is already served by an established family of companies that typically do not use games or the technologies that support them. The rapid growth in the power of game technologies and the growing social acceptance of these technologies has created an environment in which these are displacing other industry-specific computer hardware and software suites.

This paper introduces five specific forces that compel industries to adopt game technologies for their core products and services. These five forces are computer hardware costs, game software power, social acceptance, other industry successes, and native industry experimentation. Together these influence the degree and rapidity at which game technologies are adopted in a number of industries. The military simulation industry is just one of the many industries that are being impacted by these technologies and the five forces are affecting it just as they are many other industries.

The paper extends the concepts of simulation industry disruption that were introduced by the author in the *Journal of Defense Modeling and Simulation.* Earlier papers have applied the innovation and disruption model of Clayton Christenson to the simulation industry and demonstrated that the industry was in the "process innovation" phase of Utterback's innovation lifecycle model. This paper defines the forces that are driving these changes and indicates why these forces are undeniable and will permanently change the landscape of virtual and constructive military simulation products.

ABOUT THE AUTHOR

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GAMES AS A DISRUPTIVE TECHNOLOGY

The very nature of games in Western society makes them a disruptive force. As Parker Brothers discovered in the late 19th and early 20th century, games have the power to influence society, but they must fit within societal norms (Orbanes, 2004). Today we see computer games extending their influence into the serious business of military operations, medical education, and emergency management training. In doing this, game technology is jumping the gap between entertainment and work. Throughout the evolution of electronic and computer games, this gap has kept this technology out of business, largely because games were not seen as "serious" tools. Games have been viewed as toys, not as tools for productivity. But the incredible power of the personal computer, graphics cards, broadband Internet connections, intelligent software agents, accurate physics models, and accessible user interface are making it impossible to ignore the potential of these "toys" to be applied to some very difficult problems in the "real business world".

Once the barrier between entertainment and work was bridged, game technologies flooded into industries like the military, government, education, health care, emergency management, architecture, city and civil planning, corporate training, politics, religion, scientific visualization, sports broadcasting, exploration, and law (Bergeron, 2006; Casti, 1997; Maier and Grobler, 2000; Michael and Chen, 2005).

As a relatively mature technology, games entered with a huge disruptive potential to the established players in those fields. Christensen's analysis of the disruptive effects of hydraulics on the steam shovel industry, mini-mills on large steel foundries, and small disk drives on their larger predecessors is a direct corollary to what is happening with game technologies (Christensen 1992 and 1997). These technologies offer significant computer and software power at a much lower price point than the solutions that are used in many industries (Figure 1). Games and serious industries were kept separated by the social stigma that has defined games as toys. This allowed the technology to mature significantly while that stigma dissipated. When it was finally gone, game technologies offered significant power for industry application and have been impacting these industries relatively rapidly. Each industry that is assailed by these technologies faces its own set of arguments over whether games can perform serious work. But, those who insist that it is a passing fad are being bypassed by others who experiment with the technology and find a valuable use for it. Game technologies appear to be a natural next step from the graphics hardware and software that have most recently been adopted by military, medical, architectural, and other "serious" industries.

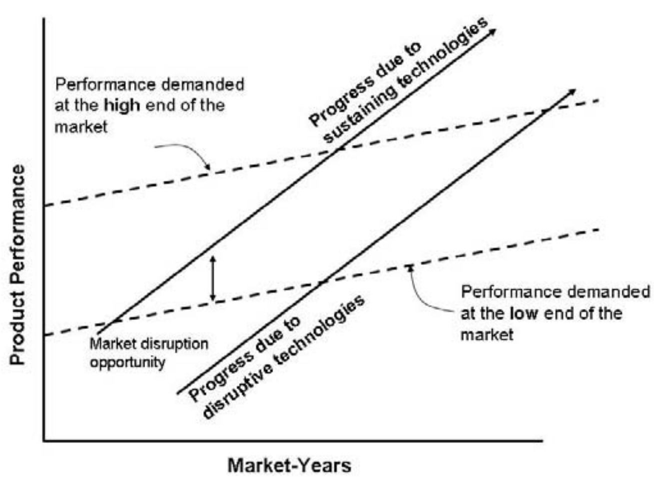

Figure 1: Christensen's theory of disruptive innovations explains how new technologies overthrow established businesses by offering better performance at lower prices (Christensen, 1997).

The power of the 3D graphics, accessible user interfaces, collaborative network connections, and intelligent agents is a persuasive argument. But, lower cost computer hardware and software to apply these technologies is making this technology irresistible and undeniable. In many cases, game applications run on machines that are an order of magnitude less expensive than their predecessors.

Rather than paying $20,000 to $50,000 for specialized computer workstations, they can run on a $2,000 to $5,000 personal computer. Morris & Ferguson have pointed out that low-cost systems always swallow high-cost systems when this type of confrontation occurs (Morris and Ferguson, 1993).

The military has been one of the first and most avid adopters of game technologies. These games originated from military roots in the 1990's and contain many similarities with the training devices that are used to train soldiers. Therefore, the transition back into serious military applications has been much more direct than in other industries. Figure 2 extends Christensen's traditional graph of disruptive technologies to illustrate the multiple waves of game technologies that are transforming military simulation and training (Smith, 2006).

The first disruptive wave in Figure 2, labeled "Virtual Trainer", represents the creation of immersive simulators with three-dimensional graphics in the 1990s. Simulator Networking (SIMNET) and the Close Combat Tactical Trainer (CCTT) replaced a previous generation of devices by providing 3D computer generated worlds and networks to connect multiple training devices into the same world. They capitalized on the early Gould, Harris, and Silicon Graphics computers that brought 3D graphics to the engineering world (Miller and Thorpe, 1995).

The second disruptive wave labeled "PC Games" describes the emergence of SIMNET-like environments on desktop computers. The first set of applications like the game Spearhead demonstrated that PCs were capable of doing this type of work and encouraged other companies and government organizations to investigate new applications (Lenoir, 2003; Mayo, Singer, and Kusumoto, 2005, Zyda et al, 2003).

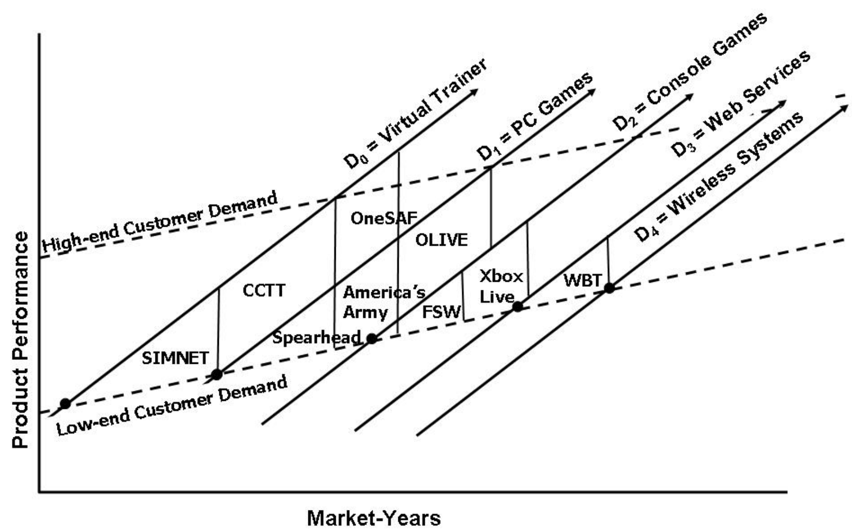

Figure 2: Multiple waves of game technologies that have already or are poised to disrupt the military simulation industry (Smith, 2006).

The third disruptive wave labeled "Console Games" describes the entrance of game consoles into the military market. These consoles offer yet another order of magnitude of reduction in computer hardware costs, dropping from a range of $2,000-$5,000 to $200-$500. This wave is just beginning in the military and it is not clear whether it will be able to overcome the licensing issues associated with developing a console game for a non-consumer audience.

The forth and fifth waves are speculative in that they suggest that technological advances will make it possible to run military training using game technologies through web-based services and wireless connections and that desktop hardware specifications will become a less important part of deploying these systems. Smith suggests that the pattern shown by the military adoption of game technologies will be repeated in other industries and that those industries should begin studying this issue themselves (Smith, 2006).

FIVE FORCES DRIVING ADOPTION

We suggest that game technologies will continue to move from one industry to the next based on five core forces of the technology and the environment in which it is emerging. The five forces that govern the impact of game technologies on serious industries describe the attractive forces of these technologies into new areas (Figure 3). Where Porter's Five Forces model lists the competitive forces faced by an industry, the Game Impact model represents the five compelling forces behind game technology adoption (Porter, 2001).

Cost advantage of hardware platforms

Computer games are designed to take advantage of all of the power available on a consumer-grade computer. Their focus is on reaching the most customers based on the hardware that these customers have available. Therefore, unlike serious industries, game companies do not want to create a product that requires a new hardware purchase. As a result, these technologies are designed to be as efficient as possible, maximizing the amount of work that can be done on a consumer-grade computer. These machines are often an order of magnitude less expensive than a professional workstation, dropping hardware costs from the $20,000 to $50,000 range, down into the $2,000 to $5,000 range.

For games that run on the console platform, the hardware costs can drop another order of magnitude into the $200 to $500 range. These hardware savings can be significant for a company that must deploy its "serious applications" to hundreds of employees or customers.

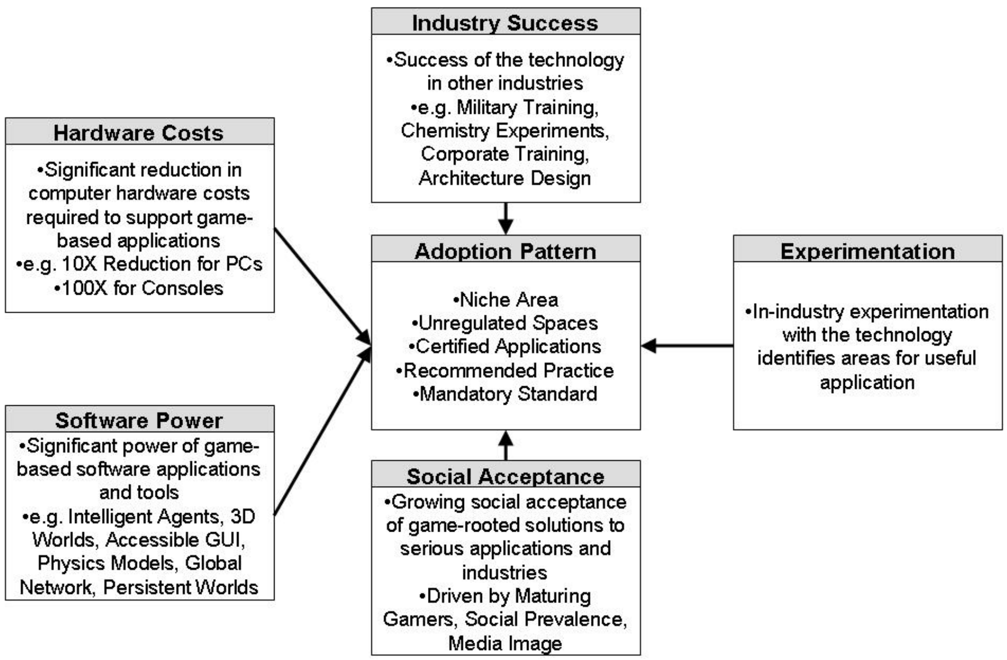

Figure 3: Game Impact Theory: Five forces behind the adoption of game technologies by diverse industries.

Software Power

Game technologies are conquering some core problems that are shared across a number of industries. The ability to create a user interface that an average employee or customer can understand and operate is critical to a product's success. For a computer game, the goal is usually for the customer to understand how to use the product without ever reading a manual. Any instruction that is required is built into the game itself, allowing the customer to learn while they are using it.

Games also require clever and adaptive artificial intelligence to create game controlled characters that interact with humans in a realistic and engaging manner. Sophisticated AI has always required significant hardware resources and significant expertise to configure and run the system. Games fit this power into a consumer PC and provide scripting languages that allow a customer to change the behavior of the system.

Similarly, the 3D engine, physical models, global networking, and persistent worlds provide power that is impossible to achieve through any competing software products.

Social Acceptance

Games have largely overcome the stigma that they are just toys focused on play. The technology has persuaded most critics that these systems can be applied to serious industries. As the children who were raised with these games have become the leaders inside of companies and government organizations, the level of acceptance has increased significantly.

All of society has become accustomed to seeing 3D representations in courtrooms, medical facilities, museums, building designs, and military systems. After experiencing the advantages of this type of interface, people are much more willing to accept these technologies in serious products and services.

Other Industry Success

The television industry and the military have been two of the first adopters of game technologies. Television shows like Modern Marvels, Nova, National Geographic, and those on the Discovery and History channels have applied 3D visualization and physical modeling to illustrate the behaviors of animals, machinery, and the universe. The clear communications that these game technologies enable motivates other industries to experiment with them as well.

The military has incorporated many of these technologies into its training systems. Training devices for tank crews and company commanders all incorporate the 3D engine, GUI, physical models, AI, and global networking of games. The successes of these lead-users encourage other industries to explore them seriously as well.

Innovative Internal Experiments

As managers, programmers, and artists experiment with game technologies within an industry that is facing adoption, they discover useful methods for studying chemical reactions, understanding the stresses that occur between an aircraft and the atmosphere, evaluating the visual appeal of architectural designs, or delivering city services in a growing suburb.

When these internal experiments succeed in creating a new product or service, the established projects begin to experiment with the technology and look for ways to improve on their established practices.

Adoption Pattern

At the center of this model is the adoption pattern of the technologies. The adoption of game technologies in many industries may follow a pattern that is similar to that experienced by the military. It will begin in a niche area that is closely aligned with at least one powerful game technology. If successful there, it will be adopted for applications and activities that are not regulated. These are spaces where local groups define their own processes and measures of success. From this position, support will grow for the technology in a number of organizations and geographic areas. This will lead to some form of certified status of game technologies as an acceptable solution to specific problems. Success at this level will lead to it becoming a recommended practice in which the recognized regulating bodies will include it among the proven and preferred approaches to solving a problem. Finally, game technology may become a mandatory standard method of solving problems across the industry (Figure 4).

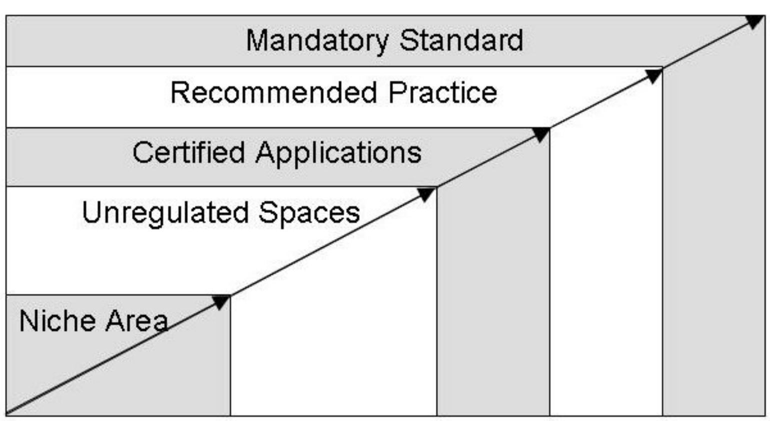

Figure 4: Potential stages of industry adoption of game technologies.

The visual, auditory, and mental stimulation that come with games are often strong motivators for adopting and promoting the technology. Along with the flexibility that is built into the tools by core developers, these come together to create a very energetic lead-user community that contributes advances to the technology. von Hippel (2001) described this enthusiasm in the open source software development community, and these forces appear to be even stronger in the game communities.

CONCLUSION

Game technologies have the power of technology, personal investment, financial profits, and social change behind them. In this paper we proposed a game impact theory that describes the forces that are driving the adoption of these technologies in a number of industries. The five forces described by this theory are:

1. Cost advantage of hardware platforms,
2. Sophistication of software applications,
3. Social acceptance of game tools,
4. Successes in other industries, and
5. Innovative experiments in the adopting industry.

In addition to being technologically powerful, these tools and techniques are becoming more socially acceptable, even socially desirable, as the people who experienced games as children become the next generation of leaders in business, government, and the military.

"Why use simulations and games? An overly cynical answer to this question might be: because they get people enthusiastic and because we all have computers now!" (Lane, 2005). This cynical statement also captures some of the social/cultural forces that are driving this adoption. These technologies are overcoming the same types of resistance that confronted computers as tools for analysis and the Internet as a primary form of communication within business.

"The forces that hone games, and gamers, have more to do with anthropology than code" (Herz and Macedonia, 2002). As with the games introduced by Parker Brothers over 100 years ago, these forms of entertainment test the edge of socially acceptable behavior and the use of one's time (Orbanes, 2004). They impact the social relationships and cultural norms of a generation. The same can be said of business practices. It is the nurture of the individual that creates the current set of practices. As a generation of gamers enters the corner office and the oval office, these technologies will continue to gain acceptance. The five forces of game impact theory attempt to describe why this is happening and provide a framework within which managers and academics can evaluate game technology impacts on their industry.

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