# Video Games

## SERIOUS BUSINESS FOR AMERICA'S ECONOMY

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[†] Senior Fellow, the Brookings Institution

[††] Visiting Professor of Law, Georgetown University Law Center. This report was commissioned by the Entertainment Software Association. The views expressed here are those of the authors and not those of their academic institutions. The authors would like to thank John Kelley and Scott Brooks of IBM, Joel Radford at Mercury Computers, and Richard Doherty of Envisioneering for their interviews.

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# Executive Summary and Major Findings

"Every dollar spent on entertainment software in the United States contributes directly to the gross domestic product (GDP). … the direct, immediately identifiable contribution of entertainment software to the nation's output exceeded $10.3 billion in 2004 and growing quickly."

This paper analyzes the contribution of the computer and video gaming industry ("entertainment software") to the U.S. economy. In 2005, revenues for entertainment software products and directly related accessories were $10.5 billion. By definition, every dollar spent on entertainment software in the United States contributes directly to the gross domestic product (GDP). In 2004, U.S. sales of entertainment software reached $8.2 billion; total world sales reached $25.4 billion. The cumulative average rate of entertainment software sales in the United States is expected to remain at 15 percent per year through 2010. GDP also increases with exports of U.S. video games to foreign countries. According to the annual reports of some U.S.-based video game software firms, these exports totaled $2.1 billion in 2004. Hence, the direct, immediately identifiable contribution of entertainment software to the nation's output exceeded $10.3 billion in 2004 and growing quickly. We analyze these contributions of the entertainment software industry in a section entitled "The Market for Entertainment Software as a Good."

The direct contribution to the nation's output does not reflect the total contribution of the entertainment software industry. The purchase of video game triggers the purchase of a host of complementary products, and thus the sale of software contributes indirectly to the nation's output. We analyze these specific contributions of the entertainment software industry in a section entitled "The Stimulative Effect of Entertainment Software on Technological Innovation and Consumer Demand in Complementary Markets." These complementary products can be placed in four categories: processors, content, devices, and broadband Internet access. By tracing the sales of these complementary products, we estimate that the direct sales of entertainment software stimulate additional purchases of roughly $6.1 billion each year in the United States. Some complementary sales, such as those of specialized gaming personal computers, can be claimed in their entirety. A portion of other sales, such as the sale of high definition televisions and broadband Internet access service, should also be allocated to the entertainment software industry. Not only does entertainment software trigger complementary sales, it triggers those complementary sales faster than they would otherwise occur. For example, but for the demand for video games, computer processing would not have developed as quickly. When one accounts for these complementary sales, the direct and indirect contribution of entertainment software to the nation's output exceeded $16.4 billion in 2004.

As impressive as this $16.4 billion is, the simple calculation of the direct contribution to GDP still understates the total economic contribution of the entertainment software industry because it does not consider two other important sources of economic value. First, the entertainment software industry invests significantly in specialized human capital and other specialized inputs, such as hardware and software, used to make a video game. The industry invests a large percentage of its sales into research and development (R&D) in an effort to generate even more innovative games for the next generation of players. Those investments in human capital and R&D create external

"U.S. sales of entertainment software reached $8.2 billion in 2004. Sales in 2009 are expected to be $15 billion."

benefits that are enjoyed by other sectors of the economy. We analyze these particular contributions of the entertainment software industry in a section entitled "The Demand for Inputs Used in the Production of Entertainment Software." Second, video games find other applications, sometimes intentionally and other times by accident, in other industries throughout the economy. Although these "technological spillovers" are not captured in the GDP numbers, they represent a significant contribution to the overall economy because increases in productivity caused by advances in entertainment software translate into a higher standard of living in the future. We analyze these particular contributions of the entertainment software industry in a section entitled "Technological Transfers from the Entertainment Software Industry."

In what follows, we provide some of our key findings from each section of the report.

## PART I: The Market for Entertainment Software as a Good

- U.S. sales of entertainment software reached $8.2 billion in 2004. Sales in 2009 are expected to be $15 billion.
- The entertainment software industry is driven by its own product cycles, thereby insulating it from economic downturns, which implies that the industry is even more important for the overall economy.
- U.S.-based entertainment software producers sold $2.1 billion worth of video games abroad in 2004.
- In 2003, video game rental revenue in the United States was $804 million, and it is expected to grow by seven percent annually through 2008, reaching $1.1 billion in annual revenues.
- The value of video games to consumers exceeds the dollar value of their purchases of these products. Total U.S. consumer welfare, including the "consumer surplus" generated by the consumption of entertainment software, is currently between $9.8 and $11.4 billion per year.

## PART II: The Demand for Inputs Used in the Production of Entertainment Software

- The average cost of developing a video game in the early 1990s was $40,000. The average cost in 2004 was $10 million. The increase is due to the recent demand for three dimensional graphics, artificial intelligence, and enhanced voice and sound effects. It is widely estimated that in the next five years these development costs will range from $15 to 25 million per game as new hardware systems with faster and more complex processors drive up the cost of creating more immersive and graphically rich games.
- Entertainment software companies have invested a large share of revenues into research and development in a race to provide ever more innovative games. Electronic Arts spent between 16 and 22 percent of revenues per year on research and development, and we estimate that the industry spent $1.6 billion in 2004.
- Entry-level workers in the entertainment software industry typically earn almost twice as much as the average recent college graduate. Entry-level game developers earn about $67,000 per year.
- There were roughly 50,000 direct employees working in video game development in 1998 in the United States. Consumer expenditures on entertainment software in 2005 supported 144,000 full-time workers in the United States.
- Given the projected increase in sales, the entertainment software industry is expected to support a quarter of a million jobs by 2009.

## PART III: The Stimulative Effect of Entertainment Software on Technological Innovation and Consumer Demand in Complementary Markets

- Entertainment software has added significantly to consumer welfare by allowing for the introduction of new products and technologies before they would otherwise be available.
- Entertainment software has stimulated the introduction of newer and faster central processing units (CPUs) in computers. The new IBM/Toshiba/Sony CELL chip is an example of the boundaries in computer technology that are being pushed by the demand for video games.
- Sales of dedicated game consoles reached $1.4 billion in 2004.
- The first movie disk designed for a portable game console reached 100,000 units sold nearly nine times faster than the first DVD to reach 100,000 units sold.
- There is a strong and growing market for high performance PCs specialized for gaming applications. As of 2006, companies such as Alienware, VoodooPC, and Falcon Northwest sold specialized gaming PCs ranging in price from $700 to $10,000.
- Approximately $73 million dollars in high definition television (HDTV) sales can be directly attributed to the Xbox 360 game console.
- Sales of specialty interactive devices for entertainment software, such as dance pads and recliners with built-in joysticks and speakers, reached $1.2 billion in 2004.
- Over 13 percent of online broadband users subscribe to an online gaming service, which suggests that a significant share of the demand for broadband Internet access can be attributed to the demand for video games.
- Mobile gaming surpassed ring tones in 2005 as the largest wireless data application worldwide, with $11.2 billion in sales.

## PART IV: Technological Transfers from the Entertainment Software Industry

- Technologies developed for video games have been adapted in the fields of education and advertising to provide innovative solutions that would have otherwise been unaffordable.
- Real estate, rental housing, and hotel reservations provide examples of advertising technologies that have benefited from using software developed for video games that would not have been economically viable to develop on their own.
- The U.S. military is using software developed by video game companies to train soldiers in peace keeping techniques in more realistic and cost effective ways.
- Video game software is allowing nurses and doctors to experience better simulations of medical scenarios for training purposes.
- Supervised video games are allowing for better corporate training, leading to a better prepared and more productive workforce.

Because it is difficult to quantify the benefits associated with technological transfers from the entertainment software industry to other industries in the economy, we do not attempt to do so. But it is likely that beyond the $11.2 billion in impacts described, the migration of video game industry technology to other sectors is having, and will continue to have, a material and positive impact that will ripple through the economy in countless ways. In sum, by focusing on direct sales of entertainment software (including exports) and complementary sales triggered by the demand for entertainment software, and not including any impact associated with this profoundly important effect on technology transfer, our estimate of the industry's total contribution to the U.S. economy is highly conservative.

“The contributions of the entertainment software industry to the U.S. economy are large and growing. According to our best estimates, video games generate $10.3 billion in direct sales per year, and $7.8 billion in sales of complementary products. Future contributions of video games are sure to be equally significant, but they will occur in unpredictable ways.”

# Introduction

To evaluate the contribution of any industry to the overall economy, economists can rely on various measures of economic performance—such as output, consumer welfare, investment, innovation, and employment. Computer and video games (which we will collectively call "entertainment software") make a measurable contribution to the nation's economy. There are a variety of data sources that provide estimates of entertainment software spending. The most comprehensive is available for 2004. While 2005 data are available for some segments of the industry, these data lack the granularity that our analysis requires. For example, in 2005, the NPD Group estimated that $11.5 billion was spent in the United States on entertainment software and directly related accessories.[1] Although this information is more current, it does not allow us to paint as complete and detailed a picture of the entertainment software industry. Because of the greater granularity and to retain consistency throughout the report, we rely on the Price Waterhouse Coopers 2004 data, except where noted otherwise.

As of 1998, 38 percent of U.S. households owned at least one dedicated entertainment software console.[2] And by 2004 this household penetration rate had risen to roughly 50 percent.[3] In 2004, U.S. sales of entertainment software totaled $8.2 billion, which accounted for 32.3 percent of the $25.4 billion in worldwide sales of entertainment software.[4] U.S.-based entertainment software firms recorded another $2.1 billion in exports to foreign countries, which are not captured in the $8.2 billion U.S. sales estimate.[5] These sales are especially impressive when one considers that in 2005 two of the three major home console makers were waiting until 2006 to release their new consoles.

These statistics on industry sales, however, tell only part of the story, because annual revenues provide a lower bound on the total value that consumers attach to entertainment software. This concept can be understood by a recent eBay listing for an Xbox 360, which fetched hundreds of dollars more than the retail price.[6] There are many consumers who value video games at levels that greatly exceed their retail price. This difference between a consumer's value for a product and the retail price, known as consumer surplus, is a key component of the economic value associated with video games.

Economists generally measure the size of the relevant "goods market" by its revenues—in this case, the total revenues for entertainment software. In Part I, we examine the market for entertainment software as a good. These revenues are used to defray the costs associated with producing the software, such as labor, computer equipment, and the game discs. Therefore, one can also evaluate the importance of entertainment software through the "input markets" that are tapped to develop, produce, and distribute it, such as the labor market and the market for advanced computer equipment used by programmers to make such software. In Part II, we examine the market for the goods and services that are used to produce entertainment software, or the "inputs market." The entertainment software industry employs large numbers of highly educated engineers and computer scientists, and these workers are well compensated for the human capital they possess. Indeed, entertainment software programmers in the beginning of their careers can earn significantly more, roughly 71 percent, than the national average salary of all recent college graduates. But again, the story does not stop here. If someone set out to evaluate the economic significance of the entertainment software industry by only examining the goods that the industry produces and the good and services, or inputs, that it consumes, he or she would miss the larger story.

Entertainment software developers compete on the basis of product innovation. Here, product innovation means producing a more compelling

experience for the consumer, which depends on the game's video and audio quality, the degree of interactivity with other players, the ease of interfaces, portability, and so forth. Product innovation in entertainment software loosens the constraints of location, time, and memory capacity. Some of these innovations can be offered directly by the firm producing the entertainment software, but many of them require complementary advances in other product markets. Thus, the entertainment software industry has a powerful stimulative effect on technological innovation and consumer demand in complementary markets.

Broadly speaking, the complements of entertainment software are processors, consumer electronics devices, bandwidth in the form of fixed and mobile telecommunications, and content. This report explains how the growth of entertainment software stimulates innovation and consumer demand in each category of complementary products. In Part III, we provide anecdotal evidence of this complementary effect with respect to the following:

- **Processors:** Entertainment software, as it becomes more and more realistic, requires more and more processor speed. Companies such as IBM and Intel are developing faster processors to meet the large demands that entertainment software is placing on central processors. The computer industry and its customers benefit from using this processing power for other applications.
- **Content:** Content drives entertainment software, and entertainment software drives content. Whether that content is visual or auditory, movies and music are an integral part in realistic and successful entertainment software. Content such as *Star Wars*, NFL Football, and popular music boost the sales of entertainment software. These forms of entertainment benefit from the exposure they gain from their integration into software.
- **Devices:** Entertainment software is a compelling reason to buy various devices. Thus, demand for gaming stimulates the demand for high definition televisions (HDTVs), flat panel displays, home theater equipment, and cellular handsets. Entertainment software also stimulates the demand for advanced gaming devices such as Microsoft's Xbox 360, Sony's Play Station III, and personal computers with higher processing speeds.
- **Bandwidth:** Online gaming consumes bandwidth, and it is a growing reason for further investment in the deployment of broadband networks. First-adopter consumers of entertainment software stimulate the demand for broadband Internet access, just as similar early adopters stimulate the demand for new processor-intensive consumer electronics devices generally. Entertainment software will also stimulate demand for third-generation and fourth-generation cellular telephony, which will have broadband speeds. Gaming will facilitate the evolution of the cellular handset into an advanced wireless device that will challenge cable television and the personal computer as a screen with broadband capability.

Entertainment software is responsible for generating a portion of all sales and innovation in each of these related industries. We undertake to quantify those benefits.

In Part IV, we analyze how entertainment software contributes to technological innovation that transcends the immediate market for computer and video games. We explore several applications of technologies that were originally developed for the entertainment software industry but were later applied to seemingly unrelated industries. Real estate sales over the Internet, military training, health care education, pollution control, intelligence testing, and corporate training have all benefited from technologies initially developed for entertainment software.

# I. The Market for Entertainment Software as a Good

**Entertainment software encompasses personal computer (PC) games, console games, online games, and wireless games.** The consumer demographics for each of these categories are extremely diverse and transcend the stereotypical teenage male. Individuals exposed to entertainment software at a young age (entertainment software was introduced commercially in the 1960s[7]) have continued to enjoy gaming throughout their lives. Increasing numbers of women are also entering the entertainment software market. In 1987, women accounted for 14 percent of entertainment software players.[8] By 2005, women accounted for 31 percent of the general entertainment software market,[9] and women were the primary consumers (64 percent) of casual online games.[10] Many games, such as the popular Nancy Drew Detective series by Her Interactive, a partner of Atari, target a female audience.[11] A small group of "core gamers," who account for only 21 percent of all gamers, purchase roughly 60 percent of all console and PC games.[12]

## A. The Economics of the Entertainment Software Industry

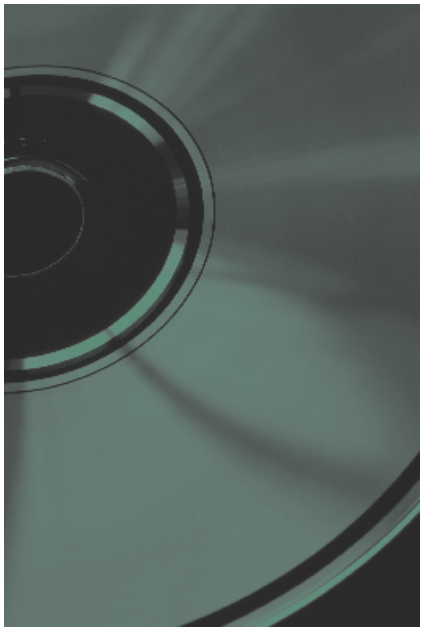
Over the past three decades, entertainment software has evolved from a concentrated industry in which hardware manufacturers produced games for their own products to its current configuration in which royalties are paid to numerous independent game producers. One of the first entertainment software games, Pong, made its debut in a tavern in Sunnyvale, California in 1972.[13] During its initial phase, each entertainment software console played a single, hardwired game.[14] In 1976, companies began selling consoles that could use interchangeable game cartridges for playing numerous games.[15] Initially, all software was developed in house. In 1980, several Atari programmers left to start Activision, which represented the beginning of the independent software producing business.[16] Nintendo, maker of the Nintendo Entertainment System (NES), created the game-license-fee business model in the 1980s, which was later adopted by Sega, Sony, and Microsoft. Nintendo received licensing fees for every game sold for the NES.[17] Worldwide sales of Nintendo games were roughly $5 billion in 2005.[18] By 2006, there were dozens of game developers serving all forms of entertainment software.

Prominent characteristics of the entertainment software industry that have been noted by economists include (1) its cyclical nature, (2) first-mover advantages, and (3) network effects. Historically, the entertainment software cycle has lasted between five and seven years.[19] Demand for software generally peaks one to two years after the peak demand for the related hardware.[20] This peak in demand for entertainment software is followed by a slow decline in demand as consumers curtail purchases in anticipation of the next generation of game consoles.[21] Individual titles

have a short lifespan, with more than half of a software title's units sold in the first three months from its release during the 1990s.[22]

A second prominent feature of the entertainment software industry is the first-mover advantage. The first mover in a console cycle can establish market share before other companies can release competing consoles and gains an advantage. For example, many credit the arrival of the Sony's PlayStation II before the Microsoft Xbox or Nintendo GameCube as the reason for Sony's dominance of the 128-bit generation console cycle.

This first-mover effect is also related to the third prominent economic feature of the entertainment software industry, network effects. Additional users of a console increase the potential sales of entertainment software producers, which increases the number of entertainment software titles produced for that console. Consumers are less likely to switch brands after they have invested in a console, because it represents a sunk cost, and the increased number of software titles increases the value of a console, further increasing the number of consumers who purchase it. This phenomenon is an example of "the complementary bandwagon effect."[23] Complementary bandwagon effects occur when consumers of a hardware product benefit from greater availability of complementary software as the set of users of the hardware product expands.[24] An example of network effects and first-mover advantage in the entertainment software industry is the looming war to establish the dominant platform for watching DVDs in high definition: As of April 2006, Sony planned to integrate its Blu-ray DVD player into the PlayStation 3, and Microsoft planned to offer an HD-DVD add-on to its X Box 360.[25]



Console purchases depend primarily on three factors: the current variety and quality of games, the expected future variety and quality of games, and the initial console price.[26] Like the motion picture industry, the entertainment software industry relies on a small number of titles to earn a majority of its revenue. In 1998, only ten percent of games released earned a profit, and nearly half of all games sold fewer than 10,000 copies.[27] Three percent of PlayStation 2, Xbox, and GameCube games accounted for 30 percent of the firms' combined 2004 revenues.[28]

## B. The Entertainment Software Industry's Contribution to Consumer Value

Consumer spending provides only a lower limit on an industry's contribution to consumer value. Because many consumers are willing to pay more than the retail price for the product, the product's contribution to consumer value (equal to consumer spending plus consumer welfare) always exceeds total sales.

### 1. Consumer Spending

In 2004, spending on entertainment software in the United States reached $8.2 billion. Console games accounted for 75.7 percent of this total. PC games accounted for $1.05 billion (12.8 percent), online games accounted

for $647 million (7.9 percent), and wireless games accounted for $281 million (3.4 percent).[29] Sales of PC games have not shown the same growth as sales of console games.[30] Demand for PC games does not appear to displace demand for console games. Console and PC games tend to be very different. For example, "god games," which allow players to control almost all aspects of an artificial world, are popular on PCs but are not popular for consoles.[31] As of 2001, 91 percent of video game system users who also own a PC used their PC as well as their dedicated console to play entertainment software.[32]

Consumers are less likely to switch brands after they have invested in a console, because it represents a sunk cost, and the increased number of software titles increases the value of a console, further increasing the number of consumers who purchase it.

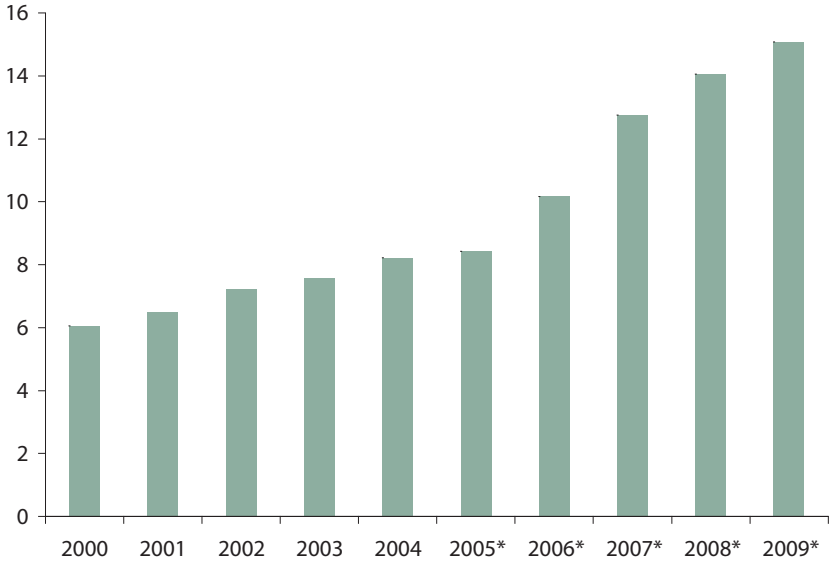
Figure 1 shows inflation-adjusted actual sales of entertainment software in the United States from 2000 to 2004 and projected expenditures from 2005 through 2009 (in 2004 dollars).

As Figure 1 shows, sales of entertainment software increased steadily in real (inflation-adjusted) dollars between 2000 and 2004, and sales are expected to increase another 87.5 percent by 2009. To put these numbers in perspective, sales by the music industry were $11.4 billion in 2004.[33]

These sales figures are highly conservative because they exclude sales by U.S.-based entertainment software firms to foreign countries. According to our own calculations, U.S. game designers exported over $2.1 billion in entertainment software to foreign countries in 2004. The largest U.S. game producer, Electronic Arts, estimated that 45.6 percent of its revenue in 2004, equal to $1.347 billion, came from international sales.[34] Table 1 summarizes our results.

As Table 1 shows, U.S.-based entertainment software producers earned one-third of their revenues in 2004 from foreign markets.

## FIGURE 1: Observed and Projected U.S. Inflation-Adjusted Sales of Entertainment Software, 2005-2009 ($ Billions, 2004 Dollars)




Source: Price Waterhouse Coopers, Global Entertainment and Media Outlook: 2005-2009 (Apr. 2004).
Note: *Projected spending.

## TABLE 1: Exports By U.S.-based Entertainment Software Producers in 2004 ($millions)

| Software Producer | Total Sales | International Sales | Share of Total Sales |
|---|---|---|---|
| Electronic Arts | 2,957.0 | 1,347.0 | 45.6% |
| Take-Two Interactive | 1,127.7 | 310.4 | 27.5% |
| Activision | 947.6 | 218.9 | 23.0% |
| THQ | 640.8 | 187.4 | 29.2% |
| Midway | 161.6 | 29.5 | 18.3% |
| Atari | 447.5 | 28.7 | 6.4% |
| Total | 6,282.2 | 2,121.9 | 33.7% |

Source: Company Annual Reports.

In addition to the sales of new software, there is a strong secondary market (in the form of rental and re-use) for entertainment software, particularly for console games. Companies such as Blockbuster Video, Hollywood Video, Gamefly, and Interflix rent video games. In 2004, video game rental revenue in the United States was $700 million,[35] and it is expected to grow by seven percent annually through 2008.[36] Consumers do not necessarily perceive renting a game as a substitute for purchasing it; most see renting as a trial before purchasing.[37] Although it is difficult to quantify sales from all used video games, GameStop, the largest seller of used video games, reported $511.8 million of revenue in 2004 from used video games.[38]

### 2. Consumer Surplus

The total value to consumers associated with playing video games is equal to the sum of consumer spending and consumer surplus.[39] Consumer surplus represents the difference between the value a consumer derives from buying a product and the cost of the purchase. For example, if a gamer purchases an Xbox 360 for $400 from a store, but would have been willing to bid $1,000 for the same device on eBay, then that that person's surplus would be $600. By measuring this effect for all consumers, economists can estimate the total value that consumers derive from the existence of an industry.

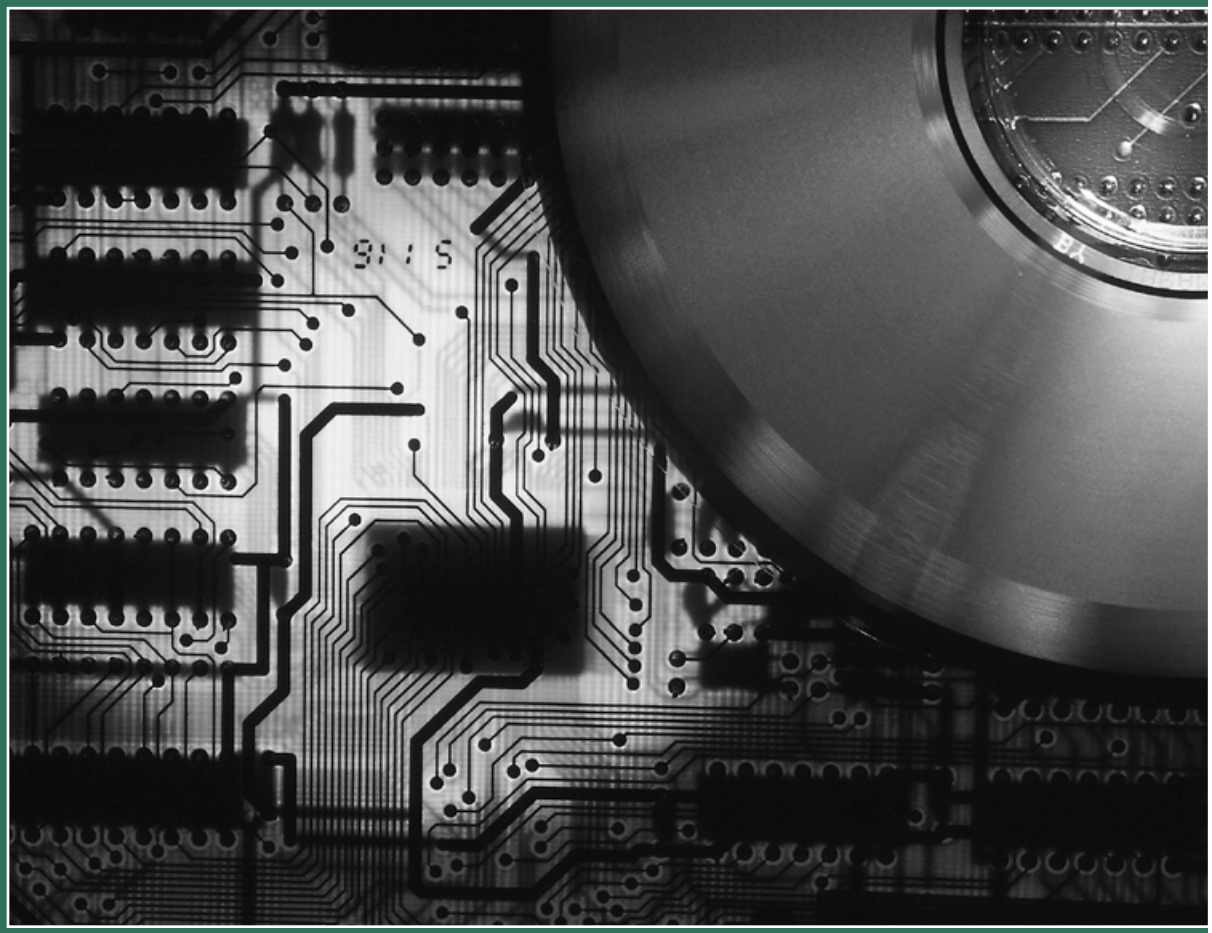
The price at which a product sells does not represent the actual value of a product for each consumer. The value of a product for a consumer is the maximum he or she is willing to pay for it. Only the "marginal" consumer—that is, the consumer for which the price just exceeds his or her value for the product—fails to earn surplus. A company that can perfectly price discriminate will charge each consumer his or her maximum willingness to pay. For example, airlines charge customers very different prices depending on when and how they purchased their tickets. Retailers

generally cannot price discriminate this way. A retailer of entertainment consoles or software, such as Best Buy or Circuit City, must price all items at a uniform price available to all consumers. Because these retailers cannot price discriminate, most consumers are willing to pay more than the retail price, and thus most consumers earn some surplus on each purchase. Stated differently, the retailer generally leaves some "money on the table" whenever it sells a video game.

We estimate consumer surplus in the entertainment software industry under two scenarios. The details of our methodology are explained in the appendix to this report. Under the first scenario consumers have the same willingness to pay for software as for consoles. The second scenario, which we feel is more likely, assumes that consumers are more willing to pay for games than they are for consoles. We believe that this assumption is more likely because a console represents an investment that consumers would not be easily willing to abandon. In the parlance of economics, games remain a variable cost to the consumer. The variable cost of playing a game on console 1, which the consumer already owns, is lower than the cost of playing a game on console 2, which the consumer does not own. After a consumer is committed to a certain console, he is more willing in theory to tolerate a price increase for the dedicated software that operates with that console. Switching to another console (the newest consoles are priced at $400 or more) to avoid a price increase for the dedicated game of one's current console is a very expensive alternative.

Under our first scenario, we estimate that total value of the entertainment software industry to the consumer is $9.8 billion for 2004. In our second scenario, which we believe is more accurate, we estimate that the total value of entertainment software to consumers is $11.4 billion for 2004. These estimates are derived in the appendix and are based on the $8.2 billion valuation of entertainment software spending in 2004, which is a conservative base considering that many areas of the entertainment industry are not taken into consideration in this number. We conclude that consumers received over $3 billion in benefits over and above their total spending in 2004.

The demand for entertainment software supports the wages of software programmers and finances the investment in advanced computer equipment used to create more innovative games.



# II. The Demand for Inputs Used in the Production of Entertainment Software

**Measuring the value of any industry requires valuing both the outputs and the inputs.** There is a wide array of inputs used in the production of entertainment software, only some of which are valued in this paper. Because of the difficulty involved in measuring some, including packaging and advertising, we do not attempt to measure the effect that they have on the U.S. economy. Two areas that are measurable are employment and equipment. The demand for entertainment software supports the wages of software programmers and finances the investment in advanced computer equipment used to create more innovative games. Software programmers and others involved in the production of entertainment software are typically highly educated and well compensated. These highly educated workers use specialized inputs to create software, such as high-performance workstations and software packages. Entertainment software production is more complicated than non-interactive entertainment, because game designers must conceive of every possible contingency in a game. The "script" of a game is not linear; rather, it more resembles a geodesic network of possible paths.

Entertainment software production is more complicated than non-interactive entertainment, because game designers must conceive of every possible contingency in a game.

The entertainment software industry devotes a large percentage of its revenue to research and development (R&D), which generates greater product innovation. According to Electronic Arts, between 16 and 22 percent of the firm's sales has been invested directly in R&D since 2002.[40] Applying the midpoint of that range to the total sales of entertainment software in the United States, roughly $1.6 billion was spent in 2004 on labor, advanced equipment, and other specialized inputs used to create the next generation of video games. This ratio of R&D to revenue compares favorably with other high-technology companies, such as Intel (14 percent) or Microsoft (18 percent).

Another measure of product innovation is the increasing cost to make a video game. The average cost to make a video game in the in the early 1990s was $40,000.[41] By 2004, the average cost of making a large budget video game had increased to $10 million, due primarily to three elements that were not essential to gaming in the early 1990s: (1) three-dimensional graphics, (2) artificial intelligence, and (3) enhanced voiceovers and sound effects.[42] These three new features require "millions of polygons" and "teams of artists," thereby significantly increasing the cost of making a video game.[43]

## A. Labor

The most important input in the production of a video game is labor. The entertainment software industry creates many jobs for college graduates that pay significantly more than the average starting salary for college

## TABLE 2: Entertainment Software Average Salary Comparison (in 2004 Dollars)

| Profession | Salary |
|---|---|
| Game Designer | $42,901* |
| 3D Artist | $45,771* |
| Programmer | $60,152* |
| Average College Graduate | $35,214** |

*Source:* *2003 Game Developer Salary Survey, Game Developer Magazine, Feb. 11, 2004, available at http://www.gamasutra.com/features/20040211/olsen_pfv.htm. **Annual Demographic Survey of the Bureau of Labor Statistics and the Bureau of the Census, available at http://www.bls.census.gov/cps/ads/sdata.htm.

*Note:* All amounts adjusted to 2004 dollars.

graduates in other U.S. industries. These numbers are especially significant when one considers that entertainment software workers are recruited directly from college.[44] Table 2 shows several examples that are illustrative of the comparison.

As Table 2 shows, entertainment software workers can make significantly more than the salary of other college graduates.

The entertainment software industry also employs highly trained professionals in a variety of fields that do not involve directly the design or program the software, but are none the less crucial for its development. These professionals include producers, intellectual property lawyers, market analysts, customer service representatives, and foreign language translators.[45] The industry also employs testers to repeatedly play their games.[46]

The BEA job multiplier for the software publishing industry is 17.595 jobs per million dollars of software sales.

There has been strong growth in entertainment software industry employment, both from entry by new firms and from internal growth at existing firms. Most studios are small. Of the hundreds of studios that existed worldwide, 66 percent had fewer than 20 employees.[47] By the end of the 1990s, a new game took the work of between ten and 25 people working for 18 to 24 months.[48]

According to a Coopers and Lybrand study for the Interactive Software Developers Association, there were roughly 50,000 people working in video game development in 1998.[49] It is difficult to estimate the total number of U.S. jobs supported by spending on entertainment software, but a reasonable estimate can be derived from the Bureau of Economic Analysis (BEA) data. In particular, the BEA estimates "job multipliers" that can be used to determine on an industry-by-industry basis how many permanent jobs (in all industries) are supported as a result of consumer spending in a particular industry. The BEA job multiplier for the software publishing industry is 17.595 jobs per million dollars of software sales.[50] Table 3 shows the effect of entertainment software sales on job creation by segment within the industry.

Based on annual expenditures of $8.2 billion in 2004, the BEA employment multiplier implies that the entertainment software industry supports more than 144,000 jobs nationally. It bears emphasis that not all of these jobs are in the entertainment software industry. Based on the Coopers and Lybrand study, roughly one-third of these jobs are in the entertainment software industry. Using the same multiplier, projected video game sales over the next four years will support an additional 120,860 jobs, bringing the total number of permanent jobs supported by spending on entertainment software to over one quarter of a million jobs by the end of 2009.[51]

## B. Advanced Computer Equipment

Three examples illustrate the economic impact of the entertainment software industry that is not represented in sales data. The highly skilled software engineers described above require a variety of specialized tools, including both hardware and software to make entertainment software. Our three examples are high performance workstations, customized development software, and specialized data input devices.

Entertainment software development is no longer done on typical consumer PCs. 3D characters and environments require computers with high-speed processors and very large hard drives. Although many software designers choose to build their own workstations, ready-made workstations sold by computer manufacturers, such as Dell and Boxx Technologies, are reasonable substitutes.[52] A single workstation optimized for video game design can cost over $10,000.[53]

In addition to hardware, entertainment software companies require specialized software to develop their games.[54] This software can be

### TABLE 3: Multiplier Effect of Entertainment Software Sales on Job Creation, 2004

| Industry Segment | Expenditure (in $ millions) | Job Creation* |
|---|---|---|
| PC Software | 1,058 | 18,615 |
| Console Games | 6,212 | 109,300 |
| Online Games | 647 | 11,383 |
| Wireless Games | 281 | 4,944 |
| Total | 8,198 | 144,242 |

*Source:* Price Waterhouse Coopers, Global Entertainment and Media Outlook: 2005-2009 (Apr. 2004).
*Note:* * BEA Jobs Multiplier.

developed from scratch or it can be licensed. Because of the licensing possibility, software developed internally is an asset as well. For example, Id Software has created numerous "game engines" for its own games, and then licensed its engines for subsequent games. Id Software's "game engines" typically cost $250,000 per title and are released for open use (free of charge) by the computer programming community after five years.[55]

Interacting with a 3D world on a computer presents new challenges to game designers. 3D input controllers, which function like a three dimensional mouse, allow game designers to push, pull, twist, and rotate within a three-dimensional environment. For a programmer, 3D space is difficult to maneuver using only a mouse and keyboard. Although specialty interactive devices are not always required, they allow software developers to manipulate camera angles in 3D space with much greater precision than using traditional inputs, such as keyboards and mice. 3D input devices, such as IBM's 3D Space Input Device, are more expensive than these traditional inputs.[56] Finally, additional software is often used for creating 3D rendering and animation.[57]

As these three examples illustrate, other companies rely on the entertainment software industry's demand for computers, development software, and specialty devices. Further, the demand of entertainment software developers for such equipment distributes the fixed development costs of these items over a wider customer base. This benefits other sectors of the economy. A variety of firms demand inputs similar or identical to those demanded by the entertainment software industry, including aerospace and engineering. These fields benefit from the existence of entertainment software through decreased prices for necessary inputs.

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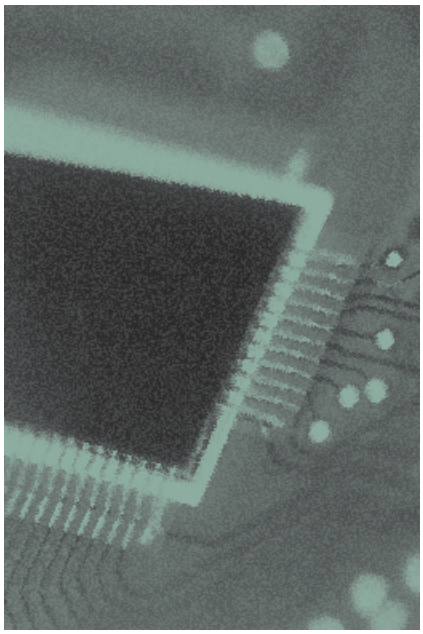
# III. The Stimulative Effect of Entertainment Software on Technological Innovation and Consumer Demand in Complementary Markets



**All goods have substitutes and complements. Growth in demand for one product will generate growth in demand for its complements.** Similarly, a reduction in the (performance-adjusted) price of a product will increase not only the demand for that product, but also the demand for complements of that product. Entertainment software has an array of complementary products, some of which are required to interact with the entertainment software, while others enhance the entertainment software experience. To the extent that the performance standards of each successful generation of PCs were designed primarily to accommodate the extreme processing demands of video games (with other functions, such as email and word processing, serving as a byproduct), all advances in personal computing can be attributed to entertainment software.[58] Broadly speaking, the complements of entertainment software fall into four categories: processors, content, devices, and bandwidth. In addition to stimulating demand in complementary markets, sales of entertainment software induce microprocessor manufacturers to innovate—for example, by introducing new chips with multiple processors to accommodate the demands of a complex video game. According to Dr. John Kelley, senior vice president and group executive for the IBM Technology Group, "IBM places value on chips made for entertainment software that goes beyond revenue and profits. These chips help drive technology in other areas."[59] These other areas include supercomputers and consumer electronics.

The demand for entertainment software also accelerates the introduction of complementary products. The earlier introduction of a product generates substantial value to consumers. For example, Professor Jerry Hausman of MIT has shown empirically that consumer welfare was reduced by billions of dollars per year due to regulation that impeded or delayed the introduction of new services, such as cellular telephony and voice messaging.[60] Entertainment software has the opposite effect. Instead of delaying the introduction of products, complementary product makers expedite the release of new products to satisfy the seemingly insatiable appetite of gamers. In particular, entertainment software has lead to a faster introduction of processors, high definition video disks (both HD-DVD and Blu-Ray), and many other technologies. In this respect, entertainment software probably has added billions of dollars in consumer welfare due to the earlier adoption of these technologies.

## A. Processors

Processors, which include central processing units (CPUs) and graphical processing units (GPUs), perform the in-game computations needed to make a game function. The demand for entertainment software has generated advances in processing capabilities, which in turn have created positive effects on other industries. CPUs are the "brains" of any computer, and they are required to play any entertainment software. The challenge for chip designers is to allow for high performance while producing little heat, because the gamer must be able to keep the device on a carpet or on his or her lap. Processors are customized to meet the needs of each console producer; some console producers value raw power, while others value multiple controllers or Internet connectivity.

The demand for more complex entertainment software stimulates the demand for more powerful CPUs. Console sales account for a significant share of CPU sales. Each sale of a gaming console results in the sale of at least one CPU. Indeed, because the Xbox 360 features three CPUs to handle the large amount of in-game computations, each sale of an Xbox 360 generates three CPU sales.[61] In the 128-bit console generation, a total of 140.5 million advanced CPUs have been needed to power the 100 million PlayStation 2s, 22 million Xboxes, and 18.5 million Nintendo GameCubes.[62]

The first gaming system to use a dedicated gaming processor was the PlayStation 1. The PlayStation 1 used a Reduced Instruction Set Computer (RISC) architecture, which outperformed the Intel Pentium with respect to graphics. Beginning with the 128-bit processor generation, gaming consoles started to incorporate GPUs to generate 3D graphics. Major manufacturers of GPUs include Nvidia, NEC and ATI. Nvidia produces the GPU for the Xbox[63] and the Playstation 3.[64] NEC supplied the GPU for the Xbox 360.[65] In April 2005, Nvidia expected to earn $50 to $100 million per year from Playstation 3 licensing fees between 2005 and 2009.[66]

As the above examples demonstrate, the demand for entertainment software generates demand for processors. By doing so, the demand for software also expands the boundaries of computing beyond the lesser functionality needed for the other common applications of home users. Gaming brings more powerful computing into the home than any other application. Consequently, non-game applications can piggyback on new processor technologies developed for games. Subsequent users of the new processor who have a lower willingness to pay (like the subsequent buyers of the paperback edition of the new book) benefit as the manufacturer reduces prices and thereby reaches a wider customer base. The entertainment software industry unambiguously increases consumer welfare for non-gamers who can own, access, and use other technology that might not have existed at all but for the game industry, or that might have been delayed or only made available at a higher cost.

Microsoft's Xbox 360 is an excellent example of the processing power that is brought into the home because of entertainment software. Microsoft contracted IBM to design a custom processor matching the specifications that it anticipated would be required by the next generation of games.[67]

(IBM also supplied the microprocessor for the Nintendo Gamecube.) Microsoft engineers were involved in all stages of the chip development to ensure that the processor would be capable of the precise specifications of the Xbox 360.[68] The Xbox 360's CPU featured 3 64-bit Power PC cores, each running at 3.2 GHz.[69] IBM's chief engineer described this as the "highest core speed" ever achieved using IBM's 90-nanometer Silicon on Insulator (SoI) technology at the time.[70] These results were achieved in a very small time frame. The process of moving from "first silicon" to the working prototype took only eight months.[71] Entertainment software is driving the advancement of chip technology and forcing companies to make advancements in shorter and shorter time frames.

Entertainment software is driving the advancement of chip technology and forcing companies to make advancements in shorter and shorter time frames.

Beginning in 2000, Sony, IBM, and Toshiba collaborated on the development of the CELL chip, which radically departed from the architecture of traditional CPUs.[72] Together, the three companies spent $400 million to develop a CPU optimized for gaming and broadband.[73] The CELL chip uses a core processor with ancillary processors, such that it can draw additional processing power from dormant processors over a network.[74] Although the chip was originally designed for video game applications, the CELL chip has been used in non-gaming applications. For example, the CELL chip will be used in the IBM Blade Center servers, which is often used by companies to manage large databases. IBM is selling servers featuring the CELL processor to defense, entertainment, and medical companies.[75] The CELL processor will benefit any application requiring "sterling graphics and intensive computing," and, according to an IBM director, "it will make orders of magnitude difference" for these specialized applications.[76] Sony and Toshiba will use the CELL chip in their HDTVs.[77] The CELL chip is also featured in specialty computers manufactured by Mercury Computing Systems. Mercury Computing Systems CELL-based compute to perform a variety of functions, and it allows for faster real time imaging.[78] Thus, although these chips were developed for entertainment software, they are already being used in other applications.[79]

## B. Devices

Entertainment software was one of the first "killer apps" for PCs. Indeed, Steve Jobs and Steve Wozniak, the founders of Apple, began as game designers at Atari.[80] Entertainment software creates a demand for several classes of consumer electronics devices. Some are needed to run entertainment software, such as gaming consoles and personal computers. Other devices, like HDTVs and stereo systems, display the game content to the gamer. Still other devices enable gamers to interact with entertainment software. These devices range from controllers that are sold with the game system to specialty chairs that allow the gamer to become fully engulfed in the game experience.

### 1. Gaming Consoles

Gaming consoles operate in many of the same ways as personal computers, but consoles feature operating systems designed to take full

Table 4: Game Console Generations and Installed Units per Generation

| Generation | Release Period | Console | Installed Consoles (millions of units) |
|---|---|---|---|
| 8-bit | Oct. 85 | Nintendo Entertainment System | 36.3 |
| 16-bit | Jan. 89 -Aug 91 | Super Nintendo, Sega Genesis | 38.4 |
| 32/64-bit | May 95 - Oct 96 | Sega Saturn, Sony PlayStation, Nintendo 64 | 49.9 |
| 128-bit | Sept. 99 - Nov. 01 | Sega Dreamcast, PlayStation 2, Nintendo GameCube, Xbox | 81.3 |
| 5th generation | Nov. 05 - ?? | Xbox 360, PlayStation 3*, Nintendo Wii* | ??** |

*Source*: Wedbush Morgan Securities, Field of Dreams: Dream or Reality: An In-Depth Look at Adoption of The New Interactive Entertainment Technology (July 2005).
*Announced but not yet released as of February 2006. **As of February 2006, sales data were still being collected.

advantage of technological advances that the hardware may possess.[81] Console makers compete on innovation, as well as price. For example, Sega's introduction of its first-generation console spurred Nintendo to release the more advanced Super Nintendo, which in turn spurred Sega to launch an even more advanced console.[82] As consoles developed, manufacturers began to increase functionality, such as CD/DVD players. Additional functionality will exist in future consoles, such as the Blu-Ray DVD player used in Sony's PlayStation 3.[83]

By 2006, in-home consoles had evolved through five generations of console technology, each increasing in complexity.

### *a. In-Home Consoles*

For the first four console generations, over 80 percent of the market was supplied by only two manufacturers.[84] A majority of console sales come at the beginning of a cycle. Half of all console sales typically come within the first three months of introduction, and 80 percent come within the first nine months.[85] Because entertainment software cycles are independent of larger business cycles in the economy, the peak demand for a video game system may occur during a downturn in the general economy. For example, demand for the 16-bit console generation peaked during the 1991-93 recession, when the rest of the economy was stagnant.[86] In 2004, the three major in-home consoles (GameCube, PlayStation2, and Xbox) sold 10.5 million units.[87] GameCube retailed for $99 in 2004, and both the PlayStation 2 and the Xbox retailed for $149. PlayStation2 sold four million units, Xbox sold 3.5 million units, and GameCube sold three million units in 2004.[88] Multiplying units sold by the average price per unit for each console indicates that total U.S. sales for 2004 for the three consoles were roughly $1.4 billion.

Although the majority of entertainment software developed and sold in 2005 was for in-home use, some in-home console games were also available on personal computers. Many in-home consoles are used as DVD players. By 2006, in-home consoles had evolved through five generations of console technology, each increasing in complexity. As Table 4 shows, each successive generation of home console generated a larger number of units sold than its predecessor.

### *b. Portable Consoles*

Portable consoles have become one of the strongest areas of growth in the entertainment software industry. In 2005, increasing sales of portable consoles offset slow in-home console sales, as consumers anticipated the release of a new generation of in-home consoles in 2006.[89] Nintendo released the first portable console with the original GameBoy in 1998.[90] There are currently three significant participants in the portable console segment: the GameBoy Advance, the GameBoy DS, and the PlayStation Portable. The GameBoy DS is backward-compatible with the GameBoy Advance. The GameBoy Advance is primarily targeted to 10-12 year olds, whereas the PlayStation Portable is targeted to older age groups.[91] In 2004, only the GameBoy Advance and the GameBoy DS were available. The GameBoy Advance had 13 million in sales, and the GameBoy DS had one million in sales.[92] The GameBoy Advance retailed for between $99 and $79 and the GameBoy DS retailed for $149.[93] Multiplying units sold by the average price per unit for each portable console indicates that total U.S. sales for 2004 for the two consoles were roughly $1.3 billion.

## 2. Specialized Gaming Computers

There is a large and growing market for high performance PCs that have been optimized for gaming applications. As of 2006, companies such as Alienware, VoodooPC, and Falcon Northwest sold specialized gaming PCs ranging in price from $700 to $10,000.[94] Specialized gaming PCs are often used for online gaming. In addition to playing in one's home, these computers are brought to competitive game tournaments, such as GDFest in Belleview, Washington, where gamers compete on teams for prizes.[95] Alienware's sales totaled $175 million in 2005.[96] Falcon Northwest had sales of $45 million in 2005, and VoodooPC had annual sales well in excess of $10 million in 1999.[97]

## 3. Audio/Visual Devices

The enjoyment that a consumer derives from entertainment software depends critically on the peripheral audio/visual devices used to interact with it. These devices include HDTVs, flat panel displays, audio equipment, and cellular handsets. The current generation of video game consoles, including the Xbox 360 and Play Station 3, are designed to exploit fully the high resolution provided by HDTVs. Hence, someone who purchases one of these consoles is more likely to consider purchasing an HDTV.

Actual consumer behavior indicates that the Xbox 360 increases HDTV sales. As of January 2006, 10 percent of consumers who purchased an Xbox 360 purchased an HDTV *at the same time*.[98] Although the combined purchase of HDTVs and Xbox 360s could be consistent with a variety of theories, including the possibility that HDTV sales generate Xbox 360 sales, the fact that many video games are best viewed in high-definition (while a high definition television can be used without a video console) suggests that the Xbox 360 was the catalyst for the combined purchase. Assuming that the average price of an HDTV in 2005 was $1,216,[99] the sale of 607,000 Xbox 360s may have induced sales of at least 60,700 HDTV units and of at

least $73 million.[100] Moreover, 60 percent of consumers with an Xbox 360 already own an HDTV, and 90 percent of consumers purchasing an Xbox 360 either already own an HDTV or plan to purchase one within six months.[101] The Xbox 360 will likely generate even more HDTV sales when Microsoft introduces a HD-DVD drive as an add-on in January 2007.[102] A similar effect can be expected when Sony releases the Playstation 3, as it will similarly support HDTV and will feature a competing high definition DVD drive.

### 4. Specialty Interactive Devices

Sales of specialty interactive devices, which include customized controllers and online accessories, totaled $1.2 billion in 2003.[103] Specialty interactive devices are a growing sector within the entertainment software industry.[104] As the game industry grows and the diversity of games increases, consumers demand more specialized ways to interact with entertainment software. For example, gamers demand chairs with built-in controls and speakers, head-tracking devices for enhanced 3D game play, and specialty controllers specific for game types (such as a steering wheel and foot pedals for car-based games). For example, the DX1 Input system, made by Erogdex, is a keypad featuring moveable buttons that can be assigned and reconfigured to match different hand sizes and different gaming control requirements.[105] The DX1 sells for $149.95, and it is marketed through high performance PC makers.[106]

The demand for specialty interactive devices has been strongest for custom controllers for music and dance games.[107] As of 2005, *Dance Dance Revolution*, a game using a footpad to match onscreen dance moves, had sold over 6.5 million units worldwide.[108] The popularity of the game, combined with the short warranty of the mat, has generated follow-on purchases of higher quality dance mats, with some mats retailing for over $100. It bears emphasis that some of these purchases are included in the software sales numbers because they are bundled with software for using the specialty device.

Economists have recognized that ubiquitous adoption of broadband will produce large societal benefits, in part because network effects arise whenever more persons join a network and use it more intensively. Gaming induces more users to connect via the Internet and thus spurs greater use of fixed and mobile broadband.

## C. Bandwidth: Fixed and Mobile Telecommunications

A major part of the national digital agenda is to build out still higher speed broadband and wireless networks. The demand for online content stimulates the demand for these networks. For example, online gaming and gaming downloads are one of the fastest growing uses for bandwidth connections. This growth in broadband connectivity will have overarching positive benefits on all of society. In 1997, survey data indicated that 42 percent of all Internet users play games online.[109] Economists have recognized that ubiquitous adoption of broadband will produce large societal benefits, in part because network effects arise whenever more persons join a network and use it more intensively.[110] Gaming induces more users to connect via the Internet and thus spurs greater use of fixed and mobile broadband. The immediate beneficiaries of this complementary demand for broadband are suppliers of cable modem service or DSL service, certain fixed wireless carriers, and the telecommunications

equipment manufacturers that supply these carriers. In 2004, there were 4.4 million online video game subscribers in the United States, which represented 13.5 percent of U.S. broadband subscribers.[111] An estimated 28.5 million U.S. residents will subscribe to online gaming services by 2009, which will further stimulate broadband penetration.[112]

### 1. Residential Broadband Usage

Consumers are more likely to invest in broadband Internet access for the home if they use entertainment software, and they are also more likely to use routers and wireless Ethernet ports to connect multiple home media devices.[113] According to a 2004 survey, 21 percent of households with a video game console were highly interested in purchasing a home network, whereas only 14 percent of households without a console were highly interested.[114] Households with game consoles are therefore more likely to acquire a home network. On the original Xbox, gamers went online an average of six times per week, and they spent an average of ten hours online total. With the Xbox 360, gamers are going online 25 times per week, and they are spending an average of 60 hours online.[115] This intensity of use (substantially more hours than the typical work week) can most likely be attributed to the fact that Microsoft gives away a free Silver Xbox Live subscription with the Xbox 360, which allows users to go online during all console usage, although it does not enable users to engage in multiplayer gameplay. In addition, 60 percent of users have downloaded content onto their Xbox, and 40 percent have downloaded and played games from the Xbox Live Arcade.[116] Because the next generation of game consoles will have greater network connectivity, gamers' demand for broadband access will further increase.

Massive Multiplayer Online Role Playing Games (MMORPG) have a particularly strong influence on consumer broadband demand. MMORPG, which began as text-based extensions of role playing games, were originally known as Multi-User Dungeons (MUDs).[117] As Internet connections advanced, these games began to include pictures as well as text. As Internet connections have increased, so has the complexity of MMORPGs. Games such as *Guild Wars*, *EverQuest*, *World of Warcraft*, *Asheron's Call*, and *City of Heroes* all feature persistent-state gameplay where users can log in at any time to play with thousands of other players around the world. For example, *World of Warcraft* has a membership of 5.5 million gamers.[118] MMORPGs are very profitable due to their large subscriptions fees. *World of Warcraft* subscribers pay close to $15 per month for the privilege of interacting with gamers who have similar interests.[119] In 2002, Sony reported 65 to 75 percent margins on its online gaming unit, largely due to the popularity of its *EverQuest* game.[120]

Not all games require the user to pay for the service. *Guild Wars* has a unique business model that forgoes a subscription fee and instead relies on sales of new in-store material to generate revenue. MMORPGs also generate electronic commerce revenue through eBay. Numerous listings exist for selling in-game currency and for transferring characters that have gained significant amounts of in-game "experience." Characters with

accumulated experience can sell for thousands of dollars. In-game currency often fluctuates in value, which suggests that the market for entertainment characters has significant depth and liquidity. For example, on the afternoon of March 8, 2006, eBay listed more than 2,000 *Guild Wars* items.

### 2. Mobile Usage

The expansion of mobile gaming has generated demand for mobile broadband connections. Entertainment software, along with music, video, and other content has stimulated growth in the mobile telephone industry. In 2004, 6.5 million U.S. mobile users (equal to four percent of all mobile subscribers) downloaded wireless games to a mobile telephone.[121] Price Waterhouse Coopers projects that 67 million mobile users will download a wireless game by 2009.[122] Amp'd Mobile and Electronic Arts (EA), the largest producer of entertainment software, announced a publishing partnership in January of 2006 to make fifteen of EA's most popular games available over mobile broadband to Amp'd Mobile customers.[123]

Mobile game usage will likely stimulate the adoption of "mini-transactions" for wireless providers by which gamers pay for game add-ons or items.[124] The introduction of these small transactions will facilitate mobile commerce, and it will therefore induce higher levels of consumer spending.

Unlike more in-depth and immersive games found on consoles and PCs, most mobile games are expected to be short. Mobile games have been characterized as an "entertainment snack" as opposed to a "whole meal."

Mobile gaming surpassed $1.5 billion in worldwide sale in 2004.[125] Growth in this sector will be driven by a movement away from "single player device-only" games to "virtual community-oriented subscription" games.[126] As of 2005, worldwide sales of downloaded games exceeded worldwide sales of mobile games.[127] By 2010, the U.S. sales of online games will exceed sales in all other countries except Japan, and U.S. subscribers to online games will exceed subscribers in all other countries except China.[128] Online gaming is also expected to stimulate the adoption of third generation (3G) cellular networks.[129] 3G networks allow large amounts of data to flow quickly, and wireless games are expected to be the likeliest sources of this increased data usage.

Mobile gaming is not expected to cannibalize other areas of gaming. Unlike more in-depth and immersive games found on consoles and PCs, most mobile games are expected to be short. Mobile games have been characterized as an "entertainment snack" as opposed to a "whole meal."[130] In other words, as currently envisioned mobile-based gaming is intended to entertain consumers for minutes, not hours.[131]

## D. Content

Video games and entertainment software stimulate complementary demand for a wide variety of content, including non-interactive entertainment content, future game releases, and advertisements. Some games even surpass the movies upon which they are based. For example, the motion picture *James Bond: Goldeneye*, which was released in November 1995, grossed $106 million,[132] while the video game based on the movie, which was released in August 1997, grossed $250 million worldwide.[133] Although the revenue from the game is counted in total

revenues, the non-interactive content reaps large rewards from its association with video games.

### 1. Non-Interactive Entertainment

Non-interactive content is gaining a growing presence in entertainment software. By the mid-1990s, 38 percent of all entertainment software units sold contained licensed content from some other form of entertainment.[134] Music, film, television, and sports all complement the demand for entertainment software, and each of these sectors benefits from associations with video games. Licensed content such as movie characters is especially important at the end of a console cycle, because game developers are less likely to invest in product innovation when mostly "casual gamers," who are most interested in familiar material, are purchasing a particular game.[135] By the end of the 1990s, content providers commanded royalties of approximately 10 percent of the retail price of entertainment software.[136] *Star Wars* is illustrative. Demand for the *Star Wars* game is complementary to the corresponding motion pictures (theatrical exhibition, cable channels, DBS, DVD), books, soundtracks, toys, and other merchandise. The video game has a positive incremental effect on the demand for each of these complements. The makers of the *Star Wars* franchise, Lucas Films and Lucas Arts, coordinated the release of the DVD *Star Wars: Revenge of the Sith* and video game release of *Star Wars: Battlefront II* on the same day with in-store promotions linking the two products.[137] The products were further linked by including DVD trailers in the game, and a free game demo with the DVD.[138]

It is clear that entertainment software is capable of stimulating increased consumer spending on music. New artists are increasingly using video games at the beginning of their careers for free publicity, and they are increasingly scheduling album debuts to coincide with entertainment software releases.[139] Some portion of the recording industry's $11 billion in revenue can be attributed to sales resulting from song exposure through entertainment software.[140] One recording artist, Fall Out Boy, sold 70,000 copies of an album after being featured in a video game and before any of the album's songs had received airplay on commercial radio.[141] The best-selling football videogame, *Madden 2005*, showcased 21 soundtracks throughout the game as part of a program to bring gamers popular music through EA's videogames.[142] The music in *Madden NFL 2005* featured "American Idiot," the first single off of the new *Green Day* album and a new single from Will.I.Am of the *Black Eyed Peas*.[143]

### 2. Complementarity Among Games over Time

Games are often released in succession, with the most popular games leading to long series of games. These games are complementary over time, with past games helping to promote greater sales of future games. Even though a football fan can play *Madden NFL 2004* as an alternative to *Madden NFL 2005*, the two are clearly viewed on balance as complements, just as movie sequels are net complements rather than net substitutes. Sequels are extremely important to the entertainment software industry.

## Table 5: Complementary U.S. Sales Generated by Entertainment Software in 2004 (in $millions)

| Complementary Industry | Sector | Complementary Sales |
|---|---|---|
| Devices | Gaming Consoles | 2,720 [a] |
| | Audio/Visual Devices | 73 [b] |
| | Special Interactive Devices | 1,200[c]* |
| | Specialized Gaming Computers | 230[d] |
| Bandwidth | Residential Broadband | 616[e]** |
| | Mobile Usage | 1,800[f]*** |
| Content | Non-Interactive Entertainment | 1,000[g] |
| | Complementary Over Time | NA |
| | Advertising | 120[h]**** |
| Total | | 7,759 |

NOTES: (a) Criterion estimate of total home and portable console sales from 2004; (b) Total sales of HDTVs made at the same time with Xbox 360 purchase; (c) Specialty interactive devices are tracked by the NPD Group; (d) Based on estimated sales of Alienware, Falcon Northwest, and VoodooPC in 2004; (e) Based on percentage of broadband users subscribing to online gaming services times total spending on U.S. broadband as reported by In-Stat. We further assume that only one third of broadband spending by these consumers is induced by entertainment software; (f) Based on percentage of U.S. wireless broadband use attributable to downloads and total sales as reported by In-Stat; (g) Based on estimated cross-promotional value for movies and average yearly box office receipts of recent video-game-based movies, including those deemed successful (such as *Pokemon Heroes*) and those deemed failures (*Doom*). Total sales of video game software are from Price Waterhouse Coopers. We estimate that $4 in video game sales contributes $1 to non-interactive entertainment; (h) Taken from Yankee Group estimate of $120 million spent in 2004 on in-game advertising, which is expected to grow to $800 million by 2009. NA means that an estimate is not available.

SOURCES: * The NPD Group Reports Sales for Console and Portable Video Games Accessories, May 11, 2004 available at http://www.npd.com/press/releases/press_040511.htm; ** *Broadband A Bright Spot In Lagging Telecom Market,* In-Stat Press Release, Jun. 22, 2005 available at http://www.in-stat.com /press.asp?ID=1370&sku =IN0501966IA; *** *Gaming to be Key Contributor to Wireless Data Usage and Revenue*, In-Stat Press Release, Sept. 7, 2004, available at http://www.instat.com/press.asp?ID=1077; **** Advertising in Video Games Facts and Forecasts Released, Press Release, Apr. 14, 2005 available at http://www.digitalgamedeveloper.com/articles/viewarticle.jsp?id=31947&afterinter=true.

Being part of an established brand is strong predictor of success in the entertainment software. Sequels were the best selling games of 2004.[144]

### 3. Advertising

Another form of content that is generated for entertainment software is advertising. Microsoft lists "the ability to provide new revenue sources, such as advertising" as one of the main contributors to the profitability of its Xbox 360 game console.[145] Most of the high-traffic online gaming sites use advertising as their primary form of revenue.[146] According to one industry analyst, advertising will be a common fixture in video games due to "the tremendous reach of video games, extended exposure to ads when playing video games, and integration with on-line commerce."[147] This increasing advertising presence will help defray the cost of developing new software, while enhancing the experience of the gamer.

There are two main forms of advertising featured in video games. The first is "advergaming." Advergaming prominently features brand names throughout the game, and the brand is central to gameplay.[148] An example would be a Toyota-themed racing game featuring Toyota cars.[149] Advergaming has the highest level of exposure for any form of online advertising.[150] Advergames typically cost between $50,000 and $150,000 to develop.[151]

According to one industry analyst, advertising will be a common fixture in video games due to "the tremendous reach of video games, extended exposure to ads when playing video games, and integration with on-line commerce."

The second form of advertising is in-game advertising, which resembles product placement within movies and television. Although consumers currently may attempt to avoid advertisements, as games come to more closely mimic the real world, the presence of advertising in games can enhance the realism of a virtual world. Some large MMORPGs have attracted banner advertisements. *The Sims Online* has advertisements for McDonalds and Intel, and *There.com* features advertisements for Nike and Levi's.[152] Other games feature banner advertisements that allow for direct integration with commerce. For example, some advergaming companies have agreements with pizza chains whereby gamers can click on a banner within the game to have a pizza delivered to them without interrupting game play.[153] Companies are taking steps to maximize the effectiveness of in-game advertising, and they are closely monitoring the exposure of gamers to in-game advertisements. Massive Inc. is a software firm specializing in customizable advertisement in online gaming, and Nielsen Entertainment monitors the effectiveness of Massive's advertising.[154] Activision has also entered into an agreement with Nielsen Entertainment to have its in-game advertisements assessed.[155]

### 4. Summary

The demand for video games stimulates sales of several complementary products. Table 5 shows our estimate of the sales of complementary products that can be attributed to the purchase of video games.

As Table 5 shows, the $8.2 billion in video game sales stimulates another $7.8 billion in sales of complementary products. The largest component of these complementary sales is devices, which account for roughly 35 percent of all complementary sales. Complementary sales of broadband Internet access accounts for roughly eight percent of all complementary sales stimulated by video games, and mobile game usage accounted for roughly 23 percent.

Real estate agencies have embraced video game 3D technology to give prospective home buyers the opportunity to virtually tour a home over the Internet.

# IV. Technology Transfers from the Entertainment Software Industry

**Several notable technologies that were originally developed for the entertainment software industry are now being used by completely different industries.** In this section, we review several such technology transfers. Because these benefits are not captured in the goods or inputs or complementary markets for entertainment software, they add to our preceding estimation of the economic benefits generated by the entertainment software industry.

The transfer of entertainment software has allowed advances in realism and effectiveness of educational and diagnostic computer programs. Game designers are increasingly making there games in a ways that allow them to be easily modified. For example, *Dungeon Siege* has a modifying suite called Siege Editor that allows users to completely alter levels by adding trees and other landscape features.[156] We identify examples in the following industries: advertising, military, medicine, intelligence testing, and pollution control.

## A. Real Estate and Travel Websites

Technology transfers from entertainment software have allowed advertisers to present a closer representation of the advertised product. This advance has created greater consumer confidence in the products that are being sold and led to more numerous Internet-based transactions.

Real estate agencies have embraced video game 3D technology to give prospective home buyers the opportunity to virtually tour a home over the Internet.

Real estate agencies have embraced video game 3D technology to give prospective home buyers the opportunity to virtually tour a home over the Internet. Video game engines that were initially developed to model 3D landscapes for first-person views of combat video games can be altered to represent homes available in the real estate market. Current technology can give realistic lighting and even allow home shoppers to look out windows to see the actual views from a home.[157] According to Theodore Beale, cofounder of a 3D engine firm Trevada, real estate agents would not use these features if the technology had not been previously developed for video games.[158]

The same technology has revolutionized the marketing of hotels and vacation rental properties. It is now common for hotels to offer virtual tours of rooms and facilities. Websites such as RentaVilla.com and Wimco.com use virtual tours to advertise vacation homes on other continents.

## B. Military Training

Entertainment software is a proven training tool for the U.S. military. All military branches are either using or developing training software based on the technology of entertainment software. In 2004, the U.S. Army

established its own video game studio to develop software to use in training.[159] This training software is sometimes released later for consumers as widely distributed entertainment software. For example, *Full Spectrum Warrior*, a realistic game developed for the U.S. Army to simulate combat has a modified version available to the general public.[160] The Center for Advanced Research in Technology for Education (CARTE) at the University of Southern California trains military recruits on how to respond to a crisis in a virtual Bosnia.[161] The game relies on sophisticated artificial intelligence to mimic peace keeping operations, and the trainee uses normal speech to interact with the game.[162]

Virtual Training Technology is a military MMORPG, similar to *Everquest, World of Warcraft,* and *Guild Wars*, which soldiers from distant locations can use to train together on complicated missions that require group coordination.

A number of entertainment software technologies are used by the military to train soldiers. Virtual Training Technology is a military MMORPG, similar to *Everquest, World of Warcraft,* and *Guild Wars*, which soldiers from distant locations can use to train together on complicated missions that require group coordination.[163] The Talon Robot System, which has been deployed in Afghanistan and Iraq, relied on video-game software at all stages of development. The Talon Robot System is a tank-treaded titanium robot used to search for enemies and to photograph caves and terrain. It reduces casualties by allowing soldiers to perform these dangerous searches remotely. Software from the Army's video game studio was used to test the robot before it was built. The software was then used to train soldiers stationed abroad. Ironically, the training software was incorporated back into general entertainment software, its original source of inspiration.[164]

The CELL processor has also been adopted to meet the needs of many branches of the U.S. Armed Forces.[165] Craig Lund, chief technology officer of Mercury Computer Systems, stated that the CELL processor, although developed for home entertainment, has far reaching applications throughout the military: "The Cell BE processor was originally designed for the volume home entertainment market, but its architecture of nine heterogeneous on-chip cores is well-suited to the type of distributed, real-time processing that will power tomorrow's digital battlefield."[166] The CELL processor's increased ability to process real time data streams for imaging can handle workloads better and faster than traditional processors for sonar and radar.[167] Mercury Computer's blade servers featuring the CELL processor can be brought onto submarines to handle the sonar computation requirements and onto planes to handle the radar computing requirements.[168]

Additionally, Mercury Computers produces the Power Block 200, a processing appliance designed to deliver the power of 45 Intel Pentium R processors by using the CELL processor.[169] The Power Block 200 is contained in a chassis capable of withstanding battlefield abuse and is "roughly the size of a toaster."[170] The Power Block 200 will allow military vehicles to deliver new levels of performance by consolidating a wide range of sensor tasks into a single processing element, improving existing data links through new levels of intelligence compression, and accelerate response to threat detection from real time sensors.[171] Despite adding this functionality, the Power Block 200 greatly decreases weight and space requirements.[172]

## C. Health Care

Video games have immense possibility to advance healthcare, both through patient care and through professional training. One example of a game that is directly serving the needs of patients is *Re-Mission*. *Re-Mission* was developed by HopeLab, a non-profit organization dedicated to serving young people with chronic illnesses.[173] *Re-Mission* is a third-person shooter where players try to shoot cancer cells inside a patient.[174] *Re-Mission* combines entertainment with education. "*Re-Mission* wraps a true-to-life cancer simulation in a gaming interface, helping kids visualize the disease and vanquish it. The aim is to increase players' sense of control over their circumstance."[175] Players also learn about important side effects and complications of their treatment, including bacterial infection, nausea, fever, and constipation.[176] Players also learn about the benefits of proper diet, chemotherapy, and radiation.

In addition to developing the game, HopeLab tested the effect that playing *Re-Mission* had on cancer patients in four key areas: adherence to cancer medications, knowledge about cancer information embedded within the game, quality of life, and self efficacy.[177] HopeLab's test included 375 male and female cancer patients between the age of 13 and 29 who were enrolled in 34 different medical centers across the United States, Canada, and Australia.[178] Each patient was randomly assigned either *Re-Mission* or a control video game.[179] The study yielded positive results for those that played *Re-Mission*. All four categories were assessed at baseline levels, then again after one month, and again after three months.[180] The group playing *Re-Mission* scored higher in all four categories.[181] Additionally, those playing the game maintained higher blood levels of chemotherapy and showed higher rates of antibiotic utilization. HopeLab suggested that playing *Re-Mission* helped patients adhere more closely with cancer therapy.[182]

The possibility of modifying an existing game to better represent a "serious" topic is allowing advances in health care training. A particularly strong modifying effort is being undertaken at the request of the Office of Naval Research, which is creating a nursing simulation trainer based on the video game *Half Life 2*.[183] A teaching tool called "Pulse!" uses the existing game architecture, including 5,000 textures, 5,000 sounds, and 2,000 models of objects and characters, to create a learning tool at significantly lower costs than independent development.[184] The modified game involved turning civilian characters into doctors, and setting the scene with existing props, such as vital signs monitors and medical instruments. Modified games such as these do not require payment of a fee to the game's originator, but they do require that players of modified versions also own a copy of the original software.[185]

In September 2004, the first annual Games for Health conference was held in Madison, Wisconsin. The conference focused on meeting a variety of health care goals through "the more cost-effective methods of video games."[186] The discussion included programs using either "off-the-shelf or specially made video games" for a variety of medical programs.[187] For

Video games have immense possibility to advance healthcare, both through patient care and through professional training.

example, some games involved bio-feedback to decrease the biological signs of stress. Others used video games interactively linked to exercise equipment to increase fitness participation.[188] The conference proposed areas for future research, including video games to assist pregnant women.[189]

The CELL based Mercury Computer blade server is a direct transfer of technology from entertainment software to the field of medicine. Medical imaging requires the same high-speed processing that entertainment software uses to create 3D images in real time.[190] Advanced scanning techniques have lead to large increases in the amount of available data; a single scan can result in between 2000 and 3000 images, or slices.[191] With these scans, radiologists are forced to view the individual scan slices without being able to see the entire volume.[192] 3D construction of tissue is very processor intensive.[193] Using traditional processors, reconstructing an image takes two seconds per slice, or over five minutes for a full image.[194] The CELL processor can process the same image in seconds, not minutes.[195] The massive amounts of data resulting from these scans can result in delays, discomfort for patients, and a strain on hospital data processing.[196] Mercury Computers provides specialized computer systems to manage the processing requirements of advanced scanning and 3D imaging. Mercury Computers works with leading suppliers of medical imaging equipment, such as Siemens, GE, Philips, and Toshiba.[197]

## D. Intelligence Testing

Entertainment software enables users to interact with problems in ways that are not possible with a pen and paper. Using existing game architectures, test makers can create testing techniques that capture a better representation of certain skill sets, as well as being more stimulating and engaging for the test taker. One product that already takes advantage of video game functionality is *PQ: Practical Intelligence Quotient*.[198] *PQ* is based on the research of a Kyoto University professor who studies the different components of intelligence.[199] In the game, players are required to guide a character through different puzzles involving mazes, spatial relations, and memory. A player's score is based on the number of moves to complete a puzzle, and the amount of time required to complete a problem.[200] After finishing the game, players can post their score online and compare performance to other players.

Nintendo offers a similar game on its Gameboy DS. *Brain Age: Train Your Brain in Minutes a Day* was released on April 17, 2006.[201] The game assigns the player's brain an "age," and then reduces the player's brain age over time through various digital training exercises, including rapid fire math problems, reading drills, and language challenges.[202] The game is based on the theories of Ryuta Kawashima, a Japanese brain researcher. *Brain Age* does not rely on traditional game controllers, but instead utilizes the GameBoy DS unique stylus and microphone inputs. Players either write answers onto the screen, or speak them into the microphone.[203] Math problems are entered in via the stylus. The "Stroop Test," where the player

must say what color is written, as opposed to the color of the font, uses the microphone.[204] These features allow answer speed to be accurately measured, as opposed to more traditional game controls. Other exercises include a "math-calculation race, counting and reading out loud; a number-and-letter maze, a game where you count the syllables in phrases; and another where you have to keep track of a rapidly changing group of people moving in and out of a house."[205]

## E. Pollution Control

Entertainment software can be used to help provide environmental education and to solve environmental problems. One example is NitroGenius, which was commissioned by the Dutch Ministry of the Environment to address its concern as one of the largest producers of nitrogen emissions.[206] NitroGenius debuted at the 2001 International Nitrogen Conference, where it was played by over 50 teams of experts.[207] The object of the game is to find the lowest-cost emission policy to help control the deterioration of the atmosphere. The game was developed by the private studio Play2Learn with assistance from the Energy Research Center and Alterra.[208] Now available in a one-player free version online, NitroGenius is an excellent example of how entertainment software can make a positive contribution to solving a social problem.

## F. Corporate Training

Corporations spend huge amounts of money on employee training. Effective training requires that the trainee absorb the information. Entertainment software is allowing corporations to improve their training of employees, both by engaging them more actively and by testing their comprehension of the information conveyed. One software company, Game2Train, has developed training games for American Express, Bank of America, IBM, JP Morgan Chase, Nokia, and Pfizer.[209] Game2Train's training games are based on other forms of entertainment software, ranging from casual online card games to modified versions of *Doom* and *PacMan*.[210] Games can be used as training tools for basic office situations, or they can be tailored for a particular industry. An example of the latter is a simulation game developed for Pfizer employees about the drug development process.[211]

Even mass market entertainment software may have positive effects on productivity. In the book *Got Game: How the Gamer Generation is Reshaping Business Forever*, John Beck and Mitchell Wade argue that video games have created more productive workers.[212] Beck and Wade based their research on surveys performed on over 2,500 business professionals of all demographics.[213] Gaming teaches employees to solve problems in a non-traditional way, using trial and error.[214] Gamers also develop marketable business skills. Beck and Wade show that, compared to non-gamers, employees who train with video games are good at "multi-tasking,

good at making decisions and evaluating risks, flexible in the face of change and inclined to treat setbacks as chances to try again."[215]

## G. Manufacturing Quality Control

High-tech semiconductor manufacturing requires high levels of quality control.[216] Silicon chips require etching millions of transistors onto a very small area. Defect detection on silicon chips requires high-resolution pixel accuracy.[217] Chip production is often constrained by the through put speed.[218] The CELL processor allows companies to look for defects at higher speeds and with higher degrees of granularity than other processors.[219] Mercury Computers incorporates the CELL processor into blade servers that process data at speeds and degrees of granularity higher than other processors.[220]

## Conclusion

The contributions of the entertainment software industry to the U.S. economy are large and growing. According to our best estimates, video games generate $10.3 billion in direct sales per year, and $7.8 billion in sales of complementary products. Future contributions of video games are sure to be equally significant, but they will occur in unpredictable ways. For example, the PlayStation 3 could model the human genome better than a $100,000 super-computer. Video games force chip makers to expand the frontiers of processing capabilities in areas such as real-time responses and 3D imagining. Future gaming-induced innovations will occur in graphics and in high-speed memory, which will allow information to travel back and forth between the graphics processor and the central processor at even faster speeds. Not far into the future, processors originally designed for gaming applications could be used to capture faces in a crowd with six million pixels, and even zoom in to distinguish between the fold of a parka or a concealed bomb. The current and expected benefits created by gaming are often overlooked by policymakers when evaluating the societal impact of the gaming industry. Because of the industry's leadership in propelling innovation, and because that innovation generates such significant benefits for the U.S. economy, policymakers should seek appropriate opportunities to ensure that the industry can continue to thrive and grow.

The current and expected benefits created by gaming are often overlooked by policymakers when evaluating the societal impact of the gaming industry. Because of the industry's leadership in propelling innovation, and because that innovation generates such significant benefits for the U.S. economy, policymakers should seek appropriate opportunities to ensure that the industry can continue to thrive and grow.

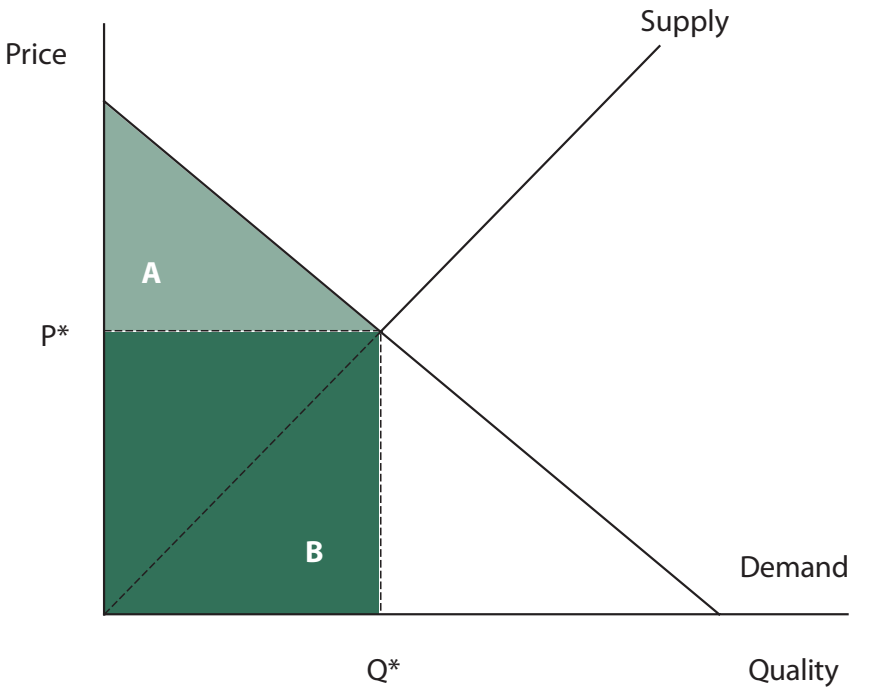
# Appendix: Consumer Surplus Calculation

**Consumer surplus equals the area between the demand curve and the product's price, and it therefore represents the value that consumers receive for a product beyond what they paid for it.**[221] Figure A1 graphically depicts the two components of consumer value: consumer spending and consumer surplus.[222]

Consumer surplus is the area between the demand curve and the market price, *P**, which is area *A*.[223] Because the demand curve represents consumers' willingness to pay for a product at any given quantity, consumers' value for the product exceeds *P** for all quantities less than *Q**. Consumer spending is depicted by area *B* in Figure A1.[224] The total consumer value from the existence of the entertainment software market equals the sum of area *A* and area *B*.

To estimate consumer value, one needs to estimate the slope or price-sensitivity of the demand curve for entertainment software. This price sensitivity is generally expressed as the price "elasticity" of demand, which is equal to the percentage change in quantity demand given a one-percent change in the price. Clements and Ohashi estimated the price elasticity of demand for entertainment software consoles between the years 1994 to 2002.[225] They found that the price elasticity of demand for each individual console starts high in absolute value but declines until the console is finally removed from production.[226] For example, when PlayStation I was

## Figure A1: The Two Components of Consumer Value



## Table A1: Consumer Spending, Consumer Surplus, and Value Estimates for 2004

| | Assume Same Elasticity for Console and Game | Assume Smaller Elasticity for Game Than Console |
|---|---|---|
| Elasticity | -2.58 | -1.29 |
| Intercept | $43.93 | $56.20 |
| Consumer Surplus (A) | $1,588 million | $3,177 million |
| Consumer Spending (B) | $8,196 million | $8,196 million |
| Total Consumer Value (A+B) | $9,785 million | $11,373 million |

introduced in 1995, its price elasticity of demand was -6.83,[227] but it steadily increased to -2.14 by 2002.[228] The average price elasticity across all consoles estimated by Clements and Ohashi was -2.58. Because consoles are usually not released at the same time, and because there is overlap between one generation of consoles and the next, the average elasticity over all console products never declines below 1.77 in absolute value.[229]

We estimate the consumer welfare associated with the purchase of $8.2 billion in entertainment software under two scenarios. In the first scenario, we assume that the price elasticity of demand for all entertainment software is equal to Clements' and Ohashi's average price elasticity of demand across all gaming consoles (equal to -2.58). In the second and more likely scenario, we assume that the demand for dedicated games, *conditional on purchasing a given console*, is less elastic than the demand for consoles by a factor of two (equal to -1.29). The logic is straightforward: After a consumer is committed to a certain console, he is more willing in theory to tolerate a price increase for the dedicated software that operates with that console.[230] Switching to another console (the newest consoles are priced at $400 or more) to avoid a price increase for the dedicated game of one's current console is a very expensive alternative. Moreover, as more consumers go online to play video games, the overall elasticity of demand for gaming declines. Online gaming has been shown to have a very low price-elasticity of demand; recent price increases for online games have not reduced subscription.[231] Table A1 shows the results of our consumer welfare calculations under both scenarios.

As Table A1 shows, assuming that the elasticity of demand for the console is the same as the elasticity of demand for the dedicated games, our estimate of the consumer surplus associated with consuming entertainment software in the United States is $1.588 billion for 2005—that is, consumers of video games are willing to spend roughly $1.588 billion more than the retail price of video games. When one assumes more realistically that the elasticity of demand for the dedicated games conditional on having purchased a console is less elastic, our consumer welfare estimate increases to $3.177 billion. Given the $8.196 billion in consumer expenditures on entertainment software in 2004, the total consumer value was between $9.785 billion and $11.373 billion.

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