Social Science Research on Video Games

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Videogaming has become a popular and influential recreation in recent years so it is important that we begin to study the subject. About 10% of U.S. and Canadian households now have a video game machine and about 4% have a home computer. The annual trade in hardware, software and arcade play of video games is about ten billion dollars. This is an exploratory study into some of the kinds of research that journalists and social scientists have begun looking at, particularly on the issues of innovation and social change. I have divided this research into 1) magazine sources, 2) the history of video games, 3) speculations about the psychological and social aspects of videogaming, and 4) the use of video games in education and advanced simulations.

Magazine Sources

There have been only two major academic conferences on video games so far, both in 1983. One was held at Harvard on Video Games and Human Development and the other was at University of California, Los Angeles on Video Games and the Graphics Designer. However, there is a broad range of magazines that contain articles that are useful in an initial exploration of social research issues. Of least use to research are magazines that just emphasize how to play and win, such as *Joystick. Videograming and Computergaming Illustrated, Electronic Fun With Computers and Games, Electronic Games* and *Video Games* are the main-line consumer magazines with reviews, ratings, high scores, descriptions of the game play, and an occasional article on the technical, financial, or social aspects of video games.

Three magazines that tend to be written for a more adult readership are *Computer Games, Computer Gaming World* and *Creative Computing Video and Arcade Games.* There are also various types of user group magazines. Atari produces *The Atari Connection* about computer uses in education and business and *APX, Atari Program Exchange* as a vehicle to sell user-designed software. Then there are the private, commercial user group magazines, such as *Antic, the Atari Resource* and *Hi-Res Magazine.* These are used to discuss programming problems and to distribute public software, either for sale on discs at cost or typed by readers into their own computers.

Today there are an estimated 2,000 user groups in the U.S and Canada with a combined membership of 250,000. Through their meetings, magazines and newsletters they can be powerful enough to persist even in the face of the financial failure of the commercial hardware system that they have in common. This is the case of the so-called Astrocade underground. Astrocade is a programmable home game system started by Bally in 1977. It has a plug-in cartridge that allows the users to design their own games. So many users went on to produce and sell the games they had made on casette tapes that some 400 games are availables for the system. The company that bought Astrocade from Bally went bankrupt in 1983, but the user network is still thriving, with a monthly newsletter (*Arcadian*) and a semi-annual catalog (*Sourcebook*).

The magazines all seem to have similar editorial policies when it comes to social issues. They are careful when discussing or carrying advertisements for games that might be offensive to readers on the grounds of racism, sexism, sexual explicitness or the promotion of undesirable behavior. For example, none of them defended the Custer's Revenge game, which was banned for import into Canada and for sale in several U.S. communities, because the game ends with a cartoon characterization of sexual intercourse between a cowboy and an Indian. *Videograming Illustrated* received a lot of negative letters when they ran an advertisement for X-Man, another adult's only cartridge. Firebug was criticized in magazine letter columns by fire departments as an invitation to arson so the company changed the title to Firefly and made the game description one of moving a firefly through an electric trap before its own trailing light catches up with it. *Electronic Games* (1982, March) stated that in their editorial policy they accept no advertisements for products or services that are not apropriate for young readers; that no employee may accept fees from or hold stock in an electronic games enterprise; and they insist on high standards in reviews.

History

The first video games came with visual signals on the early cathode ray tube screen. In 1958 William Higinbotham wanted to design something that would please visitors to the annual open house at the Brookhaven National Laboratory in Long Island, New York. It was already known how to produce the effect of bouncing balls on the cathode ray tube screen wired to an analog computer. Using that information he programmed a working model of a tennis game. He did not take out a copyright on the game because, "It seemed so obvious to me that I didn't think it was worth it." (*Videograming Illustrated* 1983: Nov., p. 47).

In 1961 the Hingham Institute in Cambridge, Massachusetts had

a Study Group on Space Warfare which published a paper on Theory of Computer Toys, stating that the programs should 1) demonstrate the computer's abilities, 2) be interesting and different from other games and 3) involve the player in a pleasant and active game (Bloom 1982). By January 1962 the Institute had developed a game called Spacewar, first with just a dot on the screen that was later shaped into a spacecraft in a field of stars. By February they had two spacecrafts, each controlled by separate boxes with two levers for left-right and up-down and one "torpedo button," which sent a line of light across the screen from the craft's nose that would destroy the other craft if it hit it. The background stars were then rearranged into actual constellations. A heavy star with a gravity field that affected the flight of the spacecraft was then incorporated into the program. Finally a "hyperspace" feature with its own button was added.

Spacewar was shown at M.I.T.'s annual open house in May 1962. Many people involved in computer science in the 1960s learned how to program and play Spacewar with the large computers available in universities and research institutes across North America. At the same time people began to put existing ideas about programmed learning into computer programs. Programmed learning involves such things as 1) logical sequences of ideas, 2) built-in questions to determine a specific individual's mastery of a subject; and 3) reviews or progress to a new subject depending on the individual's answers to the questions. In order to make learning more enjoyable these programs began to include a lot of ideas from games and stories, resulting in a new form of video game that emphasized the memory of the computer rather than the video screen display. That is the text adventure form of video game, which flourished when home microcomputers such as the Apple became popular after 1979.

Sanders Electronics is a defense-oriented electronics firm in Nashua, New Hampshire, where a team working under Ralph Baer developed a video hockey game in 1967 in which the velocity of the ball depended on how hard you hit the puck. This was further developed until in 1972 they licensed their electronics developments to Magnavox, a producer of television receivers, who then built the Odyssey home game machine to play simple hockey, tennis and maze games in black and white on home television receivers. It had some forty transistors and a number of diodes because integrated circuits at the time were too expensive. It had plug-in circuit cards that reprogrammed the internal circuits of the game. The game machine was not very widely distributed because it was sold only through distributors of the Magnavox television receivers and the advertisements left the false impression that the game would play only on the Magnavox set. It was a fairly simple system that required the placing of plastic overlays right on the television screen to provide the background setting

for the video games and it did not have automatic scoring.

Also in 1967 Nolan Bushnell adapted Spacewar for commercial use by using the integrated silicon circuits that were becoming available in the area where he worked around San Jose, California, called Silicon Valley for all the high technology firms that located there. He sold the game to Nutting Associates, a small arcade games manufacturer, who released the world's first commercial video game under the title of Computer Space in 1970. Only 1,500 of the machines were sold, in part because the game was too complex and too difficult to play.

Determined to come out with a game that was not too complex, in 1972 Nolan Bushnell started the Atari Company. Their first game was a Ping-Pong game called Pong for the arcades. Pong was highly successful and it was widely imitated. The programming ideas in it, like those of William Higinbotham, the Hingham Institute and Sanders Electronics, were quickly used to produce new games by other companies now that integrated circuits had become inexpensive. About thirty paddle and ball games derived from Pong were on the market by the end of 1975, all for arcade play. One great advantgage of video games over pinball games soon became apparent. They require very little maintenance because they work by solid state electronics.

Bushnell hired a staff of engineers to produce advanced variations of Pong: Pong Doubles in 1973; Super Pong, Quadrapong and Tank in 1974; Breakout in 1976; and Super Breakout in 1978. In those early years Atari engineers also produced three games that, although they soon lost their popularity, set basic patterns for the industry for years to come: track 10, a racing game; Got'cha, a maze game; and Space Race. Space Race in 1973 introduced asteroids, which led to the later Atari game of Asteroids, and crossing a playfield by maneuvering around obstacles, as in such games as Freeway, Frogger and Preppie. Got'cha in 1973 was copied by Heads On, Targ and Pac-Man. Track 10 in 1974 set patterns that were followed in Le Mans, Bug Car, Spring, Night Driver, F-1, Monaco GP, Turbo and Pole Position. Touch Me (Simon) and Video Pinball were also important as arcade games in 1974.

In 1975 Pong was first made for the home market by Atari and distributed through Sears Department Stores. By the end of 1978 some 13,000,000 units were sold. Also in 1975 a large pinball machine company, Midway, began producing video game machines for the arcades, starting with Gunfight, that had been developed in Japan by the Taito Corporation. At first people were just impressed with how good the Japanese were at imitating the American electronics developments. By 1981 the Japanese games were doing so well in America, as well as around the world, that the Americans feared that creative superiority had passed to the Japanese.

Death Race in 1976 was criticized by the media for promoting

violence because it combined driving with knocking down these little characters that crossed the road, identified as "gremlins." Microcomputers that were just being developed greatly reduced the cost and expanded the functions that could be possible in home video game machines, as well as arcade games.

In 1976 Fairchild Camera and Instruments produced the first video game system that would accept programmable ROM (reads only memory) cartridges, Channel F. Channel F had button controls for on-off, reset game, time limits, speed control and pause of game in progress. The hand controllers were in the style of joystick-in-a-tube with a fire button. The company made 25 game cartridges for their console. The late 1970s also saw the introduction of a large number of hand-held electronic games.

Channel F was soon followed by such consoles as 1) Bally's Professional Arcade, 2) R.C.A.'s Studio II, 3) Atari's Video Computer System (2600), 4) Magnavox's Odyssey 2 and 5) Coleco's Telstar Arcade. Of these six early or first generation systems only the Atari 2600 survived very well and even Atari (5200 and the computer line) joined Magnavox (Odyssey 3) and Coleco (Colecovision and the Adam computer) in producing more advanced or third generation consoles. The middle range or second generation of consoles are still used, such as Astrocade, an improved version of Bally's Arcade; Mattel's Intellivision; and Vectrex, the system with vector graphics and its own screen.

The Atari 2600 was brought out in 1977 and became the world standard for home video game machines, with some fourteen million units sold by the end of 1983. The heart of the 2600 is a microprocessor called Antic or 6502 and 4K RAM (random access memory). The impressive thing is not the machine itself but the increasing sophistication of designing games for it, design ideas that were later applied to other systems. If we look at just one type of video game, say racing games, we see year-by-year improvements in design over several years: Indy 500, with its own controllers and crude graphics and sounds; then Night Driver, the first to use the driver's own perspective; Grand Prix, with greatly improved colorful graphics, racing sounds and obstacles; and now Turbo, Enduro and Pole Position, with scrolling landscapes, three-dimensional effects and advanced speed controls.

A programming technique was developed for the 2600 called bank switching that allowed the memory to be effectively doubled to 8K. Today about forty companies produce game cartridges for the 2600 and many have engineered innovative hardware peripherals to plug into it, such as RAM enhanced keyboards to operate it as a computer. The supercharger has its own memory and allows loading games into the 2600 from an ordinary audio tape player. The Personal Game Programming System allows the user to temporarily reprogram any 2600 cartridge game, to change its shapes, speeds, sounds, colors and

strategies. Reads 2600 and EPROM are systems sold to those who want to design their own cartridge games for the 2600. Coleco and Intellivision sell peripherals for their own consoles for the playing of 2600- compatible cartridges. Then Coleco went farther and duplicated the 2600 itself with the Gemini system on which they pay a royalty to Atari for every unit sold. Designers added game play sound effects and psychological music. They had to create new sounds so that we could hear Q-bert swearing, the Qix swirling, Pac-man eating and Frogger jumping. They created the impossible sound of two spaceships passing each other in the arcade version of Star Wars by recording real elephant screams. For mass sales to the homemarket they had to learn how to add sounds cheaply, using little memory, by such techniques as electronically slipping the sound introductions in during that one-sixteenth of a second when, on American television, there is a pause in vertical picture scanning.

In 1978 Midway licensed Space Invaders from Taito in Japan, a game which used a microprocessor to produce better sound effects and new features, such as shields and a mothership and a high level of timing skills, learning and strategy in successful play. Atari licensed Space Invaders for their 2600 and came up with Asteroids with two microprocessors to compete with Space Invaders in the Arcades.

Using microcomputers, Space Wars by Cinematronics in 1978 offered a wide range of new features to arcade games: buttons for left, right, forward, fire and hyperspace; six levels of difficulty; black holes and gravity option; and vector graphics. Vector graphics are created by lines, while raster graphics draws in pixels or blocks of dots and is more limited in terms of the number of objects that can be moving at any one time. Atari first used vector graphics with Lunar Lander (1979), improved on them in Tempest (1981) and still further in Star Wars (1983). Star Wars uses isometric drawings based on mathematical formulas handled by the computer to achieve the effect of movement in any direction through a three-dimensional field.

Atari became a training ground for a lot of the industry's designers. In 1979 Steve Jobs left Atari to design a cheap microcomputer called Apple. In 1981 designers left to form Activision and Imagic, companies that would specialize initially producing game cartridges for the 2600; to Mattel to work on the Intellivision console and its games; to do arcade games for Video and Williams Electronics; and to form Arcadia in 1982, the company that produced the Supercharger.

In 1980 Midway introduced Galaxian, developed in Japan by Namco, a colorful offshoot of Space Invaders in which the invaders break ranks and take looping dives in the attacks. Three other new games were important that year in the arcades: 1) Battle Zone, 2) Defender by Williams and 3) Pac-Man designed in Japan by Namco and produced for the North American arcades by Midway. Defender

had the free flight that was in the Asteroids game, a continuous cityscape at the base, a task of saving humanoids, hyperspace and smart bombs. Climbing games, another Japanese innovation, were started by Space Panic in 1980 by Universal and in 1981 with Donkey Kong by Nintendo.

"Puck" is the sound you make in Japanese when you smack your lips over something good to eat, so when Namco made an eating game they called it Puck-Man. Some of the machines were distributed with that title, but the American manufacturer, Midway, thought that "puck" sounded too close to "fuck" so they changed the name to Pac-Man. It was highly successful so it was widely imitated: Gobbler, K.C. Munchkin and Crazy Pucker. Also many new maze games were tried: Mouse Trap, Make Trax, Turtles and Lock 'n' Chase. Then there are what might be called direct relatives: Ms. Pac-Man, Baby Pac-Man and Professor Pac-Man.

In the early 1980s the four important trends had been 1) the design of microcomputers to include the playing of games at a high level, 2) the great expansion in the number of games available for all formats, 3) the transmission of video games into homes, and 4) laserdiscs. There is a continuation of the trend toward deeper memory and more complex games with the Atari 5200, Colecovision and a new line of microcomputers by Atari, Coleco, Commodore and Mattel. These are machines with much better capacities for game playing sounds and graphics than the computers of just a few years earlier by such companies as Apple, Radio Shack and Texas Instruments.

From 1979 through 1983 the number of new game cartridge titles issued each year was roughly double that of the previous year so that the number increased from a few dozen to some five hundred in four years. There are also several hundred more game titles available for computers on tape or floppy discs. Although at least three major game software companies went broke (Apollo, Data Age and U.S. Games) in that extremely competitive situation, there are still about fifty companies now producing video games in North America. Innovations still come principally from the costly development of high quality arcade games and then the adaptation of arcade successes for the home market. However, each year there are a few very original games by individuals or small design teams working on their home computers, such as Minor 2049 or Pinball Construction Set. The industry is fortunate if it can produce a dozen or so genuinely original games per year.

Game Line and Control Video Corporation offer telephone modems with additional memory which can be plugged into a 2600 to receive and store current games for a fee. QUBE, Play Cable and The Games Network are three video games delivery systems that use cable television lines. Games are also available through the telephone lines to computer data base services, such as PLATO, The Source and Com-

puServe. A Gallup Poll found that 51% of all home computer owners include game playing in the use of their computers.

The first viodeodisc game for the arcades was Astron Belt in 1982, but it involved long pause periods and was just too similar to scrolling style space games. Then the big arcade hit of 1983 was Dragon's Lair on interactive laserdisc. Other laserdisc games for the arcades are Cliff Hanger, about an action detective; Bega's Battle, about a Japanese cartoon superhero and his pals of various races; Laser Grand Prix, driving the Fuji Speedway in Japan; and MACH 3. Unlike the high speed arcade games which require a short game to make money, the home versions can be slow, cerebral and involve group play. For home or school use there is the Mystery Disc series; Vincent Van Gogh, with a play and two hundred of his paintings; The Art Disc, 1,600 works of art from the U.S. National Gallery; The Joy of Relaxation, with a questionnaire to individualize the program; and History Disquiz, a quiz on historical events of the 20th century using newsreel films. General Motors now uses videodiscs to sell their cars and the U.S. Army uses them to train soldiers in tank warfare.

The laserdisc has a plastic core, an aluminum oxide covering etched with the data, and a protective clear plastic coating. It is 30 centimeters across with 54,000 data tracks per side laid out in a spiral, just like audio records except that the play begins in the center and moves outwards to the outer edge. A laser beam reads the digital information etched in the surface and converts it to electronic signals for the television receiver, the audio receiver or a computer. Since this is done without touching the disc, but just by bouncing a light beam off it, the disc will not wear out the way an ordinary audio record will. Also it is possible to have scanning at fast or slow speeds and undistorted freeze frames held indefinitely. For successful interactive gameplay it is necessary to use a microprocessor or computer in conjunction with the laser disc. It is predicted that laserdisc games will be even less costly than earlier computer games because the hardware can be permanently immune to changes in game popularity and the player will be allowed to select his game disc, like the old jukebox record players.

Psychological and Social Aspects of Videogaming

Psychological Aspects

Most video games emphasize a spatial, perceptual and hand-eye coordination dimension of intelligence that our society has tended to down play in recent decades. I initially got involved with video games because I discovered that my retarded adult son Wally, who can only mumble a few words in speech, could acquire good skills at video games that do not require much in the way of memory, strategy or simultaneous tasks. Thus he can often beat people of normal intelli-

gence at single action games such as Pong and Breakout. Similarly, in U.S. Veteran's Administration Hospitals brain-damaged patients have been helped by playing games that exercise their reaction time, perception and verbal and visual recall. People who are so physically handicapped that they do not participate in physical sports can excel at video games.

In playing video games I found that I was progressively improving quite a variety of these perceptual kinds of intellectual abilities. After two years of occasional play I had progressed to the level of the average teenager and I could learn to be proficient at new games quite rapidly. It seems that these perceptual abilities can be transferred to other areas of life, such as working with machinery and the visual arts.

Another psychological dimension to video games is the emotional. There are emotional cycles as you move merrily along in the easy play at the beginning of the game; through the tension, anxiety and sweating of the advanced levels; until you are swearing as you finally lose. Throughout the game there are small internal cycles of successful pattern completion and pauses, a resting time with a tuneful and visual reward, before moving on again to challenge the next round of struggles. Freudians might see the joystick as a phallic symbol in name, shape and use and the game as a semi-sexual experience; the Gestalt psychologists would point out the great satisfaction of pattern completion; and the learning theorists would assess rapid learning through high feedback, projections about characters in the game, and rewards that keep players coming back.

Whatever the reasons, video games are machines that are so well adapted to human nature that humans will pay to interact with these machines for long periods of time. The psychological study of video game play might help to improve the design of machines in general. For example, automobile engineers are trying to understand how humans react to the electronic signals and voices in new cars that nag you on such things as brake left on, fasten safety belts and do not exceed speed limits. I cannot stand these signals so I have just disconnected them in my car, but I think that they could be designed to provide that kind of information in an acceptable way. A video game slot machine called Gold Fever is being tested in Las Vegas. Then there is an interactive videodisc with game qualities on premarital counseling called Lovers and Strangers that shows compatibility between two people according to their likes and dislikes in seven subject areas.

Social Aspects

A major social issue is the fear of and resistance to video games, particularly in the arcades. Legislative and zoning controls have been treating arcades as if they were comparable to taverns, restricting their

number and keeping them away from schools. In some parts of the U.S. it is illegal for any arcade game to award free games or credits, because years ago some pinball games were used in gambling. Businesses complain that teenagers use up parking spaces, do not spend much money and just use the shopping mall near an arcade as a social gathering place. Parental groups express such complaints as the waste of money on games and that people acquire violent behavior through playing video games.

According to the U.S. National Coalition on Television Violence video games in 1983 were dominated by a violent fantasy in 89% of the arcade games and 65% of the home games. This seems to be somewhat higher than the level of violent fantasies in the movies and television that teenagers watch. In any case, the relationship between fantasies and changes in overt behavior seem to be low and still poorly understood. Do violent people who play peaceful games become more peaceful? Research on the use of video games in prisons so far has indicated only that video games help in recreation programs and on such obvious mental activities as hand-eye coordination.

David Brooks of the University of Southern California studied the school performances of 900 youths who play games in video arcades and found that few of them were truant or had failing grades. Children of lower-income familes tend to play in the arcades, while children of upper-income families tend to play at home on computers. There is also a class correlation with the difference between the kinds of games played in the arcades and those played on computers, with the children of lower-income families playing at being individual front-line soldiers in the arcade and the children of upper-income families playing long-lasting strategic games on their computers. A survey of readers of *Creative Computing Video and Arcade Games* (1983: Vol. 1, No. 2) found that the respondents reported an average of 16 hours a week playing games: 6.9 with home game machines, 3.7 with computers, 1.7 with other board and electronic games, and only 3.3 hours per week with arcade games. Young players tend to be more serious and intense in their play while older people want slower, more enjoyable and more humorous games.

A few things can be said about the arcade subculture. Individuals acquire reputations in playing abilities and other attributes, with local high scores being of some importance. A lot of social interaction involves watching one another play and discussing strategies. One of the points of conflict is how to share and take turns with a popular new game. A solution in some arcades is that each person will place one quarter on the machine so the quarters are lined up representing people, rather than having a literal lineup or excessive crowding around the current player. This is a somewhat non-verbal subculture in which you are not supposed to criticize how a person plays the

game, just demonstrate how to play it better. And you should not encourage addictions by loaning quarters to strangers.

One new problem is that electronic games and portable computers can create enough static in an airplane so as to interfere with the pilot's radio reception. Eastern Airlines bans the use of portable computers and Air Canada discourages the use of electronic games, as well as computers, radios and portable telephones. The U.S. Radio Technical Commission for Aeronautics is studying means to limit interference, such as the use of low-power liquid crystal displays.

There are several issues around illegal copying. Copyright law covers the games or software and patent law covers novel technologies and processes, essentially the hardware and its techniques of manufacture. In either case the law does not come into effect in just the idea stage. For several months of product development before something is copyrighted or patented there is some necessity for secrecy. In fact, the law tolerates rather close copying.

MCA, who made the film *Jaws*, pressured Apollo to retitle Loch Jaws, which became Shark Attack. The company with the rights to Tarzan forced Taito America to change the name and game features of Jungle King. It became Jungle Hunt, the character's clothes were changed from a loin cloth, and his Tarzen-like yell was dropped.

Tens of thousands of illegal copies of arcade video games are now being made and sold, particularly in Taiwan, Hong Kong and Italy. Nintendo found 700 illegal copies of Donkey Kong in U.S. arcades in just a short time. With an eprom duplicator one can simply "burn" games programs from the original integrated circuit into copies. If some legal problem is seen, then slight changes can be made in the game title, the attack mode, and cabinet painting. In this way Defender was renamed Mayday and Defense Command, Pac-Man became Speedy and Cruiser, and Centipede was called Bug Blaster and Bug Attack.

Pac-Man led to a lot of speculation about the difference between male and female preferences in games and the difference between American and Japanese games. It was noticed that Pac-Man was being extensively played by women, when arcade players are usually about 90% men. Why was this particular game being played by women right across North America? The answers seem to have been that 1) it is a simple game to learn and to play with only one controller and no firing buttons; 2) it has attractive graphics and sounds; 3) it has a lot of comic features and is more fun than the shoot-em-ups; and 4) it was the new popular game just at the time when arcade games became widely spread outside the arcades into more socially acceptable places for women, such as lounges and restaurants.

The discussion about women and video games has also turned to designing, where there are also few women. It was pointed out that

women designers have done some of the most colorful graphics, such as in the games of Centipede, Joust and Many Trails. However, there are tempering facts when trying to characterize the feminine game, such as the fact that Carol Shaw designed one of the most macho shoot-em-ups, River Raid, before she did Many Trails.

Both Germany and Japan, who were aggressive in World War II, now seem to resist military themes in their video games. Thus the Nutting Corporation found that German arcades resisted buying Sea Wolfe, Gorf and Wizard of Wor because they were shooting games. Japan is even more anti-war and became a major producer of cute, tuneful, colorful, cartoon-like video games that involve such things as running mazes, jumping and climbing rather than shooting. The first coin-operated video game from France is Bagman, about a burgler.

In 1946 American pinball was adapted in Japan into an upright and thus space-saving form of gambling game called Pachinko. This game spread throughout Japan so that even small towns usually have a Pachinko parlor. In Pachinko the player buys small steel balls from a cashier, drops them one at a time into the machine and attempts to shoot them at target holes in the vertical pin-covered board in order to win more balls. At the end the player cashes the balls in for prizes. This flat and vertical arrangement of Pachinko seems to have been part of the background design of many Japanese video games, such as Space Invaders, Pac-Man and Donkey Kong.

Japanese games tend to start slow and easy. They allow the novice player some playing time on an arcade machine. And they have more fixed patterns of play than the American games. American designers worked with assumptions about a need for greater depth or even three-dimensional effects, mobility and randomness in games, as in Asteroids, Defender and Zaxxon.

Video Games in Education and Advanced Simulations

Education

Video games have come into education through the back door in a sense. While video games were spreading in the commercial entertainment world of the late 1970s the computerization of programmed learning was being demonstrated as fairly productive. Education programmers quickly realized that their programs could be strengthened by the kinds of interesting graphics, sounds, and motivational techniques that were being used so successfully in video games. In 1983 hundreds of educational software programs for young people have the looks and sounds of video games, including some that teach how to do video game programming. For example, the Arcade Machine is a software program that guides a person step-by-step in the design of a computer game with animated graphics, sound effects, scoring, titles and options such as number of players. In the education software

market of K to 12 there are 217 software-producing companies in North America with more than 1,000 titles for sale.

Several guidelines have been developed for the design of educational software. The software should reflect the ways that children learn, including learning through play and parallel learning, where the child learns both the lesson and how to learn through computers. It should have specific and limited topics to teach. It should be relevant to the child's interests and use these in simulations. It should be clear in terms of what is expected of the child in routine actions, problem solving and goals. It should include an appropriate level of drills and testing before advancing the student to more difficult material. And it should be well designed in terms of the frequent and artistically designed use of maps, graphs, charts or other visuals. Similar kinds of information should be consistently presented in the same part of the screen. Motivation techniques can also be drawn from video games, such as scoring, timing and personalization through using a central character in a same format.

Educational programming should set up a dialogue between a person and the software, like an electronically individualized textbook that is flexible enough to present material at the learner's speed, that can quickly test learning, that can skip material already learned, and that can give small quick rewards for correct learning. Errors can be precisely and silently pointed out. It is important to make rewards for success more interesting than rewards for failure, to discourage guessing, and to repeat incorrectly answered questions.

Advanced Simulations

Except for gambling games, most games involve some kind of simulation of real or fictional activities. A board game like Chess is a simulation of feudal warfare, with the object of taking the opponent's kingdom. Monopoly is about a business competition between real estate corporations. Video games can give strong visual effects of actions that are rare or even impossible. Thus there are video games about the internal workings of a nuclear power plant: Reactor has just abstract play on a game machine and SCRAM has a more realistic level of problems on a computer game.

Simulation opens up issues about decisions that have to be made in real-life situations that are usually available only to specialists. The simulation in arcade and action games involves narrow tasks, such as moving and shooting, as if the player was taking on the role of an individual soldier. In many home computer simulation games more factors are brought in, there are more options of strategy, and a greater variety of possible outcomes.

The computer can speed up the time between decisions and outcomes and allow for far more more variables to be used than traditional

board game simulations. Thus a war game such as Eastern Front is more realistic than Chess because it goes beyond simple spatial strategies to include features such as terrain conditions, weather, mode of defense or attack, direction of attack, and combat strengths of plane, tank and infantry units, based on actual events in World War II. The gamer makes command decisions and the computer carries them out on a week-by-week schedule on a map of Eastern Europe, allowing the gamer access to the changing data on the strengths of the various military units.

In Lifespan the player can effect a human character's development and personality through a series of life-like situations. Oregon is an historical simulation of joining the westward migration and avoiding Indians and starvation. Lemonade simulates a small business with advertising, pricing and changing weather conditions. Cartels and Cutthroats is about large businesses in manufacturing. Energy Czar involves decisions for a large nation about fuel resources, energy production, pollution and political popularity. An architectural group at MIT created The Aspen Map, an interactive laserdisc that allows the viewer to simulate travel down any street in Aspen, Colorado. There is also a laserdisc that allows players to coach either the San Diego Chargers or the Los Angeles Rams through one game, based on films taken of games between these two teams over three years.

Dan Bunten (1982: 32), a designer for Strategic Simulations, claims that simulation games developed so far have not broken enough with the past of simple board games to use the full potential of computers. "We are using many game conventions that are no longer necessary. We don't need to take turns where each player gets a chance to make their input when we can allow simultaneous action. We don't need games built on game maps from the pre-computer era .... The great success of arcade games should make it obvious that the inclusion of changing graphics and continuous physical involvement in games are attractive features."

Finally, it seems that computer simulations would be a particularly productive way to introduce university students to more holistic views of academic issues. The tendency has been toward specialization and fragmentation of the disciplines and a rather linear presentation through textbooks and motion pictures. Simulations can show complexities and, like small seminars, give a lot of feedback, interactions and rewards for good decisions. Simulations could help to reintegrate specialized learning. Anthropologists, for example, might design simulations for classic situations, such as playing a role over time in a matrilineal kinship system, participating in the Trobriand Kula or the Kwakiutl Potlatch, and doing applied work in Vicos Valley, Peru.

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