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Visual Design in Video Games

Carl Therrien

> So why did polygons become the ubiquitous virtual bricks of videogames? Because, whatever the interesting or eccentric devices that had been thrown up along the way, videogames, as with the strain of Western art from the Renaissance up until the shock of photography, were hell-bent on refining their powers of illusionistic deception.
>
> —Stephen Poole (2000, page 125).

Illusion refining, indeed, appears to be a major driving force of video game evolution. The appeal of ever-more realistic depictions of virtual universes in itself justifies the purchase of expensive new machinery, be it the latest console or dedicated computer parts. Yet, one must not conceive of this evolution as a linear progression towards perfect verisimilitude. The relative quality of static and dynamic renders, associated with a wide range of imaging techniques more or less suited to the capabilities of any given video game system, demonstrate the unsteady evolution of visual representation in the short history of the medium. Moreover, older techniques are sometimes integrated in the latest 3-D games, and 2-D gaming still enjoys a very strong following with portable game systems. Despite its short history, a detailed account of the apparatus behind the illusion would already require many volumes in itself. In this chapter, we will examine only the fundamentals of the different imaging techniques along with key examples. However, we hope to go further than a simple historical account of illusion refining, and expose the different ideals that governed and still governs the evolution of visual design in games.

In video games, visual representation started from scratch again; a few shapes, a few colors. The first arcade games, *Computer Space* (1971) and *PONG* (1972) proposed strikingly abstract universes that could nonetheless be associated with real-world referents (science fiction and table tennis). The popularity of space settings in early games is not surprising; notwithstanding the programmers' interest in science-fiction, a black backdrop could depict the emptiness of space with minimal costs in terms of system resources, thus favoring certain genres like the shoot'em-up. During the first decade of its history, the appeal of video game entertainment is to be found elsewhere than in its figurative potential. The bitmap display mode, based on the subdivision of the screen in discrete units (pixels) to which individual values are associated, is bound mainly by two sets of restrictions: display capabilities (most notably screen resolution and simultaneous on-screen colors), and processing capabilities (working memory and central processing unit frequency). The two are closely tied: the "blockiness" of early games can be explained by low screen resolution (the maximum theoretical resolution of the Atari 2600, for example, is 192x160), but also by the inability to manipulate detailed bitmaps (hence the dominance of large, uniformly colored "blocks"). These restrictions favored frontal or lateral depictions and different points of view were often merged in a single scene. A few simple bitmaps, like building bricks, were assembled and piled to create the playfield (fig. 1).

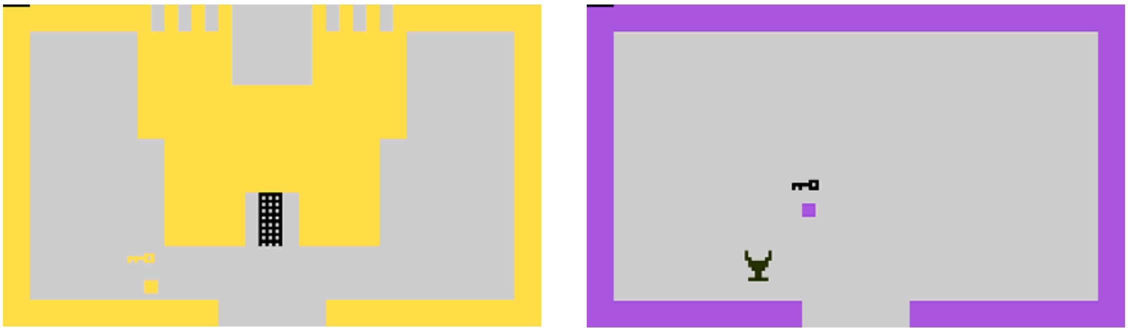

Fig. 1: *Adventure* (1980) for the Atari 2600.

To prolong the art history analogies set forth by Steven Poole, one could observe that the stacking of space planes and point of view discrepancies found in many pre-Renaissance paintings are also typical of early game corpuses.

Through a steady flow of home consoles, arcade games and personal computers, display and processing technologies evolved rapidly. Higher resolution bitmaps could represent objects from odd angles more easily, thus adding some depth to the game world with a simple pictorial illusion. *Zaxxon* (1982, Arcade version) systematizes these efforts by introducing isometric perspective, a subtype of axonometric perspective which represents a tridimensional space with no vanishing points, giving all three dimensions equal importance (fig. 2).

Fig. 2: Isometric perspective in *Zaxxon* (1982, Arcade version)

Zaxxon also integrates advanced bitmap-handling techniques. Game worlds expanded beyond the initial one-screen limit, either by displaying multiple adjacent spaces ((*Adventure* (1980) and *Pitfall!* (1982)) or through a technique known as scrolling, first introduced in Atari's arcade game *Football* (1978). Space appears gradually, in a continuous motion either controlled by the computer (Xevious, 1982) or in response to user navigation (*Defender*

1980, Arcade version). *Zaxxon* actually uses two distinct scrolling levels: the enemy's asteroid base moves faster than the outer space backdrop. This technique, known as parallax scrolling, creates a basic illusion of depth made more convincing with every added plane. Through the horizontal and vertical parallax scrolling of many action games, a simulated vanishing point emerges, and on its virtual horizon, one can already see a first occurrence of the virtual camera.

"It is perhaps due to the desire to measure up to the standards of visual realism set by film and television that the video game has evolved as it has" (Wolf, 1997, 12), supposes Mark J. P. Wolf. Incidentally, technological evolution quickly stirred up the game developers' cinematographic ambitions. The development of the graphic adventure genre, associated early on with ever-more vivid depictions of settings and characters through the integration of elaborate bitmaps, is the first major manifestation of these ambitions. Close-ups of characters gradually become mandatory during conversation sequences (fig. 3), with some games trying to simulate basic shot-linking structures: medium shot/close-up in *King of Chicago* (1987, fig. 4); shot/counter-shot in *Croisière pour un cadavre* (Delphine Software, 1992, Amiga). Early on, developers even use digitized photographic material to produce these detailed bitmaps (*Mean Streets*, Access Software, 1989, DOS).

"May I help you, sir?"

But the wisdom of the Elders may not be questioned.

That is the final Rule of Membership.

Fig. 3: Close-up in *King's Quest V* (Sierra On-Line, 1990, DOS) and *Loom* (LucasFilm, 1990, DOS)

You gotta see it, Pinky.

Pinky had something...

Fig. 4: *King of Chicago* (Cinemaware, 1987, Amiga)

However, all this added detail often accounted for particularly static scenes, most of the processing resources being dedicated to the data-intensive images. This flaw was even more striking with digitized photography; photo-novels being a rather scarce cultural reference amongst gamers, photographic material inevitably points towards the greater ideal of cinema.

The obvious, most sought-after aspect of cinematographic representation is indeed the illusion of motion.

Throughout the first generations of hardware, the dynamic objects of game worlds are called "sprites", a term actually referring to the underlying display mechanics (more-or-less hardwired depending on the system). Sprites moving on the screen are animated by displaying a series of different bitmaps, or animation "frames". In 1984, Brøderbund Software releases *Karateka* (J. Mechner, Apple II), whose animated characters impressed the gaming community. *Prince of Persia* (J. Mechner, 1989, Apple II), Mechner's latter and most renowned effort, is associated with the advent of motion capture in video games but actually borrow a well-known animation technique: rotoscoping. Each step of the needed movements is drawn painstakingly from the performance of a model captured on film. The prince's impressive action range (walking, running, jumping, climbing, sword-fighting) is brought to life with unknown fluidity for the time (fig. 5).

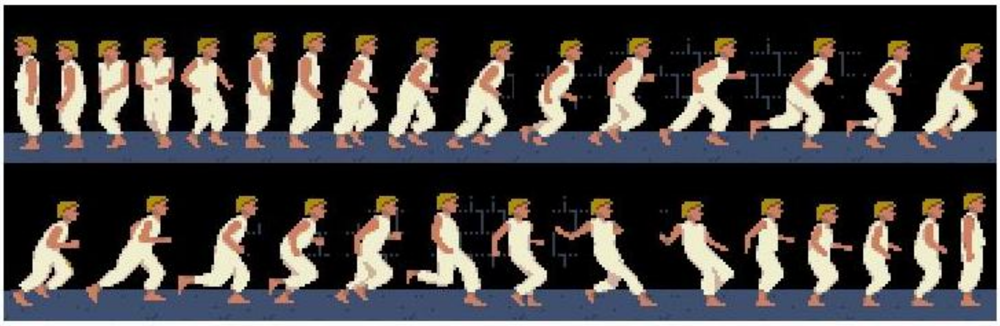

Fig. 5: Decomposed running animation from *Prince of Persia* (J. Merchner, 1989, screenshots from the Amiga version)

In 1992, *Mortal Kombat* (Midway, Arcade) attracted a lot of attention in the arcades. Each fighter of this tournament was created from video sequences shot with real actors, key frames being integrated into the sprite animation system. The resulting illusion is still short of cinematographic quality. Laserdisc-based arcade cabinets already integrated filmic material in the early 1980s (*Firefox*, Atari, 1983, Arcade), but the gameplay was limited and relatively few games were produced. The ultimate attempt to integrate cinema in video games occurs concurrently with the Motion Picture Coding Experts Group's (MPEG) efforts to develop a motion-picture compression standard for CD-ROM technology. However, the quality of digitized video sequences (Full-Motion Video, FMV) varies greatly from game to game and often pales in comparison to the MPEG-1 standard of 1989. *Martian Memorandum* (Access Software, 1991, DOS) introduced FMV to depict some of the characters interrogated throughout the adventure. These sequences are short, restricted to a small window, pixelated, and suffer from erratic frame rates. The advent of CD-ROM technology as a storage medium allowed for better quality FMV along with a more consistent integration throughout the games. The long-running Tex Murphy series perfectly illustrates the evolution of FMV integration (fig. 6).

myself. "She's a client, and falling for a client is dangerous in my business." Still, if only I knew how she felt for me ...

RHONDA
HELLO TEX. LIKE MY OUTFIT?

Pleased to meet you, Mr. Franco. Tell me, you do most of your business in dark theaters?

Fig. 6: Evolution of FMV integration in the Tex Murphy series (Access Software): digitized photographs in *Mean Streets* (1989, DOS; upper-left), windowed live-action sequences in *Martian Memorandum* (1991, DOS; upper-right), live-action characters integrated into the scenes in *Under a Killing Moon* (1994, DOS; lower-left) and full-screen sequences in *Tex Murphy: Overseer* (1998, PC, lower-right).

Video games, it is now clear, remediate cinema in a variety of ways: through the integration of conventions and language, animation techniques, up to complete digitization. The concept of remediation, central to Bolter and Grusin's genealogy of new media, is often interpreted in a progressive manner: newer media "remediates" the "defects" of their predecessors. The case of video games is clearly more complex; for all the interactivity offered by the medium, games can't claim superiority in terms of strict visual realism. One could conceive of remediation in this context not as reform of older media, but assertion of a representational ideal. But what exactly constitutes this ideal? Beyond the lack of detail and/or fluidity, the most obvious shortcoming of visual representation in video games is repetition: tiled bitmaps, re-used animations create an undesirable impression of homogeneity. In addition to visual realism, cinema also embodies the ideal of representational variability. The cinematographic quality of *Croisière pour un cadavre* relies first and foremost on ability of its game engine (aptly named "Cinématique") to present a variety of points of view. Furthermore, the appeal of FMV lies in the possibility to make any given part of the image evolve into something completely different. How is it, then, that when gaming systems finally acquired the technical means to convincingly remediate cinema, interest towards FMV dissipated so abruptly?

For all its representational qualities, live-action video cannot easily adapt to user input. The so-called interactive movie fell short of living up to its ambitions, production and storage issues hindering the integration of significant variations on the local scale of the event and the global scale of the narrative. But this explanation is insufficient; the then-popular graphic adventure game genre, which served as a mould for interactive movies to a great extent, also proposed highly-scripted interactivity. Ironically, part of the explanation is to be found in exactly the same games that relied heavily on live action sequences. Virtual, computer-generated locations were more suited to the relatively low-budget productions than, say, built sets or expensive on-site shooting. The very principle of the computer-generated imagery seen in those games announced a future where the medium could merge the cinematographic ideal with its own interactive ambitions, affording a representational variability that could constantly be affected by the user.

Beyond Cinema

The principle behind computer-generated imagery (CGI) is very simple: dedicated computer tools simulate a three-dimensional world where objects and eventually whole scenes are modeled from the combination/manipulation of geometric primitives (cubes, spheres, etc.). Textures (2-D images) are applied to the modeled surfaces, and specific algorithms handle phenomenon like lighting, shadowing, transparency, reflection, liquid and volatile matter, etc. The self-proclaimed ideal of CGI artists is photorealism. To this day, computer generated images often look too perfect. Getting rid of this hyperrealist impression proves to be difficult; the addition of filth and the simulation of oxidation cannot completely erase the virtual surfaces' homogeneity. A greater challenge than photorealism resides in the animation of virtual scenes, which requires intensive fin-tuning in order to achieve realistic movement or "kino-realism". Virtual skeletons are incorporated into objects, with each joint possessing its own set of attributes. For complex movements such as those of humanoids, animators often rely on the technique of motion capture: a performer executes the needed movements wearing a special suit equipped with a set of captors at key joints. Finally, a point of view on the scene must be selected. The virtual camera materializes at last, endogenously, at the very heart of computer imaging.

With the proper resources, CGI has reached near-cinematographic visual realism. It is integrated seamlessly on filmic material, minimally in many Hollywood movies, to a greater extent in some projects (the new *Star Wars* trilogy, G. Lucas, 1999-2005); already, a full-length feature aiming for perfect verisimilitude has been produced (*Final Fantasy: The Spirits Within*, Hironobu Sakaguchi and Moto Sakakibara, 2001). Videogames, too, integrated CGI in a variety of ways. In 1993, *The 7th Guest* (Trilobyte, DOS) and *Myst* (Cyan Worlds, Mac) propose virtual worlds that can be explored through computer-generated images, the former in glorious full motion. Most of *Donkey Kong Country*'s assets, from backgrounds to animated sprites, were pre-rendered on powerful Silicon Graphics workstations (Rare, 1994, SNES). Thanks to its novelty in the media landscape, CGI became even more of an attraction than the contemporary digitization of live-action sequences. Computer-rendered cinematics were integrated in any genre, but soon became associated with Japanese role-playing games through the success of *Final Fantasy VII* (Square, 1997, PlayStation). In these examples, CGI doesn't redefine the fundamentals of visual design in videogames; it simply replaces drawn or digitized material. Therefore, how can we associate this imaging technique with the pursuit of a greater ideal?

Philippe Quéau eloquently defines the core principle of CGI: "digital image synthesis techniques break off with photons. They are completely seized by language." Through these techniques, "we do not seek the 'reproduction' of reality, but the very conditions of its production" (1986: 31; my translation). 3-D models are mathematically formulated and thus easily manipulated by the computer; a digitally rendered image is but one of many possible actualizations that can be reformulated endlessly. But in order to claim any kind of superiority in the realm of video games, this manipulation has to occur in real time. Even though 3-D gaming became the norm during the 1990s, techniques allowing the reformulation of virtual objects in a 3-D space were developed relatively early in the medium's life. In the arcade parlors at the turn of the 1980s, raster displays (bitmap) cohabitated with another technology: vector display. Instead of drawing every pixel of the screen thirty-times or more every second, the electron beam in vector displays traces the needed lines directly, the rest of the screen remaining black. In comparison to raster displays, lines could be rendered in much higher resolution and manipulated much more fluidly. 2-D games with sharp images and fluid movement were produced (most notably *Asteroids*, Atari, 1979, Arcade), but most interestingly, vector graphics quickly became associated with the creation of wire-frame 3-D worlds.

In 1980, Atari's *Battlezone* arcade game proposed the first three-dimensional game universe in a video game. The world's objects were made of basic geometric solids (cubes and pyramids), their surfaces completely transparent due to the limitations of vector graphics. As they piloted their tanks, players could explore the universe in any direction; the planar surfaces of the objects (or polygons) were reformulated according to their virtual first-person point of view (fig. 7).

Fig. 7: *Battlezone* (Atari, 1980, Arcade)

Earlier games oriented their gameplay on the depth axis, most notably *Night Driver* (Atari, 1976, Arcade). But on the pitch-black road, as on the more colorful rides offered by later games such as *Gyruss* (Konami, 1983, Arcade) and *Space Harrier* (Sega, 1985, Arcade), objects coming towards the players are in fact 2-D sprites scaled by the game engine. Even if they offered a convincing illusion of depth, these game engines simply transferred the action on a different axis; in terms of point of view redundancy, they are not more capable than side-scrolling games. Wireframe 3-D gathered interest and was used for the adaptation of the first two *Star Wars* movies (Atari, 1983 and 1985 respectively, Arcade). But in order to represent solid 3-D worlds, polygons had to be “filled”, something vector displays couldn’t achieve. 1983’s *I, Robot* (Atari, Arcade) is the first foray into such a world (fig. 8). Interestingly, the cabinet’s controls allowed players to control the position of the camera with two dedicated buttons.

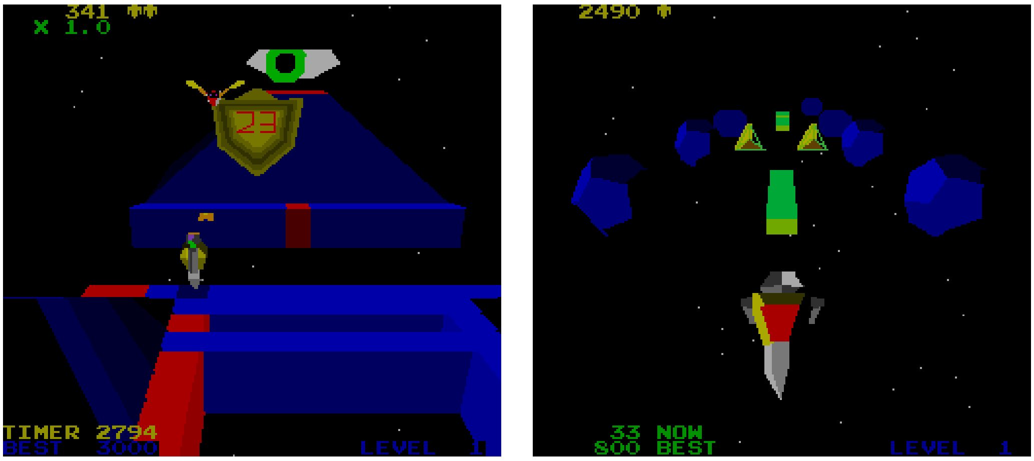

Fig. 8: *I, Robot* (Atari, 1983, Arcade)

After the commercial failure of *I, Robot*, polygon-based 3-D became associated with the vehicular simulation genre through long running series such as *Falcon* (Sphere, 1987), *Chuck Yeager* (*Advanced Flight Trainer*, Lerner Research, 1987, DOS) and *Microsoft Flight Simulator* (v. 3.0, 1988). Some action/adventure games were produced, most notably those built using Incentive Software’s Freescape engine (*Driller*, 1987; *Castle Master*, 1990). Ironically, 3-D gaming became widely popular through the release of *Doom* (Id Software, 1993), whose game engine is not fully three-dimensional. The engine integrated texture-maps (2-D images applied to a surface and interpolated according to a set point of view) with some tradeoffs: the walls, floors and ceilings of the game world were bound by strict rendering restrictions, thus limiting the first-person point of view, and objects (such as power-ups and enemies) were made of scaled sprites. In 1996, the game engine behind *Quake* (Id Software, DOS) renders most of the world in textured 3-D, including the various living creatures that populates it. Whereas *Doom*’s sectors had a uniform lighting value, *Quake*’s settings integrate lightmaps: lighting and shadowing produced by the light sources in a given scene are pre-rendered and applied on the textures. Along with a few other games, *Quake* became an incentive to buy one of the first generation 3-D accelerator cards that now replace the standard graphic adapter cards in personal computers. Arcade cabinets and homes consoles, too, had hardwired 3-D capabilities, and many genres began their transition to the third dimension (*Battle Arena Toshinden*, Tamsoft, 1994, Playstation; *Super Mario 64*, Nintendo, 1996, N64; *Sega Rally Championship*, Sega, 1995, Arcade).

In today’s game worlds, polygons are indeed the most commonly used bricks. CGI artist Alvy Ray Smith once estimated that it would require 80 million polygons per second in order to reproduce reality on the screen (Bolter & Grusin, 1999, 121). It would be naive, however, to think that the sole challenge of 3-D engines resides in geometrical complexity.

Our visual world is populated with phenomenon infinitely less tangible than bricks; water, smoke, fog, fire and explosions are difficult to mimic with simple textured polygons. Modern special effects in video games convene an impressive array of techniques. Programmable shaders, for instance, affect the display of pixels or vertices (points in space defined by 3-D coordinates), thus contributing to many subsystems of the graphics engine. The particle system reformulates simple primitives (usually small 2-D objects) and coordinates them in order to simulate the subtle behavior of flames, smoke, etc. Bump and normal mapping add the shading values of an uneven surface to a regular flat polygonal surface; the values adapt to the position of light sources in the scene, thus creating bumps with no additional geometry. Incidentally, the integration of light-related phenomenon in interactive environments constitutes a decisive aspect of visual realism. Light dispersion, reflections, transparency, various material refraction values, and shadowing need to be calculated in real time in order to dynamically adapt to the player's actions. To this day, few games have been able to fully simulate these aspects, considering the amount of moving light sources that arise in game settings such as weapon fire and explosions.

Beneath the surface

Even with the addition of evermore complex special effects, 3-D game worlds are still prone to repetition; tiled textures and re-used animations account for the same homogeneity impression that came to be associated with 2-D gaming. No doubt the medium will continue refining its illusions until it rivals cinematic visual realism. This ideal might be reached sooner than expected; recent examples such as *Half-life 2* (Valve Software, 2004, PC) suggest that virtual actors, in many ways the ultimate challenge of videogame visual design, may not sojourn in the uncanny valley for much longer (fig. 9).

Fig. 9: *Half-Life 2* (Valve Software, 2004, PC)

With its ability to reformulate a virtual world around the performance of a player, the medium is also perceived as a step towards the greater ideal of virtual reality. VR seeks to fully reproduce our corporal relation to the world and make computer-mediated interaction as natural and seamless as possible. 3-D game engines can indeed simulate a first-person point of view, and some developers are trying to integrate symbolic visual feedback (such as health and ammo meters) more seamlessly. Supposing that the interactive entertainment medium will strive towards this "greater" ideal seems like a natural assumption. Alison McMahan, for example, already sees most game genres adopting the first person point of view

(McMahan, 2003, 67). But such an assumption tells only half the story. Most interestingly, 3-D engines are now used to create striking cinema-style presentations. Virtual cameras are designed to momentarily frame the player's performance from spectacular angles (*Grand Theft Auto III*, Rockstar North, 2001, Playstation 2; *Prince of Persia: The Sands of Time*, Ubisoft, 2003, Xbox). Popular games reintroduce *Dragon's Lair* style gameplay (press the right key at the right moment) during computer-generated cinematic sequences (*Resident Evil 4*, Capcom, 2005, Gamecube; *Shenmue II*, Sega-AM2, 2001, Dreamcast; *Indigo Prophecy*, Quantic Dream, 2005, PC), whereas previous generations condemned it for being more "cinema" than "game". Camera-related effects like motion blur, focus, and lens flare are simulated and refined just like any other illusion. Some first-person shooters even introduce third-person segments (*Halo: Combat Evolved*, Bungie, 2001, Xbox; *The Chronicles of Riddick. Escape from Butcher Bay*, Starbreeze, 2004, Xbox).

Clearly, the game industry's fascination for the medium of cinema is still strong. The harmonious fusion of cinematic expressivity and interactivity (the ideal of interactive cinema), might very well be a major force driving the evolution of games for years to come. In this chapter, we introduced and contextualized the essential imaging techniques that defined the evolution of game visuals. The unsteady character of this evolution is now more apparent; a given technique sacrifices the gains of another one in order to develop a specific aspect of the illusion or to respond more completely to user input. Visual design in video games goes beyond the obvious graphical technicalities. Beneath the quality and diversity of animations, artificial intelligence determines how characters evolve in the environment and react to the virtual world's other actors. Beneath the appearance of this world, virtual physics simulate gravity and calculate the intensity of deflagrations in real-time. As they integrate these dynamic behavior models, virtual game worlds explore a whole new layer of visual realism. It would be naive to assume that the medium will evolve solely to integrate evermore complete and complex simulation models. But as new techniques emerge, as video games strive to refine their illusionistic deception, it is undeniable that these models, too, affect the way we look at games.

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