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# Graphical technologies, innovation and aesthetics in the video game industry

## A case study of the shift from 2d to 3d graphics in the 1990s

For a decade now, game studies have steadily progressed and covered ever more ground in the fields of humanities, arts and culture. An important dimension of video games, however, is still left unaccounted for: the dynamics of innovation in the games industry. Searching for *innovation* in the Title and Keyword fields of the Digital Games Research Association (DiGRA) digital library returns only 8 papers out of the 618 entries. This is all the more surprising given that the 2009 DiGRA conference was titled *Breaking New Ground: Innovation in Games, Play, Practice and Theory*. There seems to be a clear lack of research on innovation, which this project aims to remedy to a degree. A few Game Innovation Labs exist in universities in the U.S.A. (at the University of Southern California and at New York University, for instance), but they are spaces of practice where games are designed and developed. Theoretical research on innovation is limited, but existing. A research seminar on game innovation, initiated by the GAIN (GAMES and INnovation) project led by Annakaisa Kultima at the University of Tampere, stated in its call for papers that “we know relatively little about the innovation processes that take place within the industry, [and] the bulk of the influential work on games and innovation is found in practically oriented guidebooks authored by experienced games industry experts” (Game Research Lab, 2011). The GAIN project has provided the most extensive writings on theorizing innovation in the games industry and game design process, along with the annual international Games Innovation Conference, which has been running since 2009.

The present project aims to unravel the links between graphical technologies and innovation in the games industry and in gamer culture by focusing on a specific historical corpus: the transition from 2D to 3D graphics in the 1990s. This transition is of the utmost importance in video game history because it conflates two different issues, which analysis and research will distillate: inno-

vation in graphical technologies, in the capacity to represent and implement tridimensional game spaces, and in types of gameplay. From a research and disciplinary standpoint, rooting this study in the graphical dimension of gameplay allows for interesting and fruitful interdisciplinary explorations of art history and film studies approaches; moreover, it makes a strong case for the shortcomings of any single disciplinary framework, and for the importance of game studies to establish itself as an academic discipline of its own.

### **BEYOND THE SUPERFICIAL: FRAMING GRAPHICS AND MATERIAL CULTURE**

From game reviews in specialized magazines to general newspaper articles on the games industry, marketing claims, advertisements, and interviews with game developers, it seems that everything that revolves around video games ties into larger issues of technology. id Software, makers of the infamous *Doom* (1993), were pioneers in developing graphical technology to the point where most of their business came from selling their proprietary technology to other video game developers (Kushner, 2003). Popular game magazines from the 1990s featured elaborate comparisons of megahertz, RAM and ROM or number of on-screen colors, sprites or background layers between Nintendo's Super NES and Sega's Genesis consoles, and dedicated whole articles to the benefits of CD-ROM technology, Full-Motion Video (FMV), pre-rendered 3D graphics, or some special software technique or hardware configuration that allowed spectacular visual effects.

The Sega Genesis console had the terms “16-BIT” and “HIGH DEFINITION GRAPHICS” centrally embossed on its very hardware. When the TurboGrafx-16 console attempted to topple Nintendo's NES, it launched the “bit wars,” claiming that the NES was an 8-bit console, while the TG-16 was 16-bit, and hence more technologically advanced. This argument backfired when it was discovered that in fact, the TG-16 had a 16-bit graphics processor, coupled to a Central Processing Unit (CPU) that was only 8-bit. This goes to show the level of technical expertise and literacy that was put forth by the games industry and its culture, and also the need for conducting a rigorous historical study. None of the various websites and articles that treat this topic (including Herman, 2008, for a single example among others) detail how and when the 8-bit nature of the TG-16 was discovered, or who called it out. More importantly, as the failures of the TurboGrafx-16, NeoGeo, CD-i and other consoles proved, technology alone cannot make a platform successful. Why then do we find such a strong focus on this subject in various video game publications?

The hypothesis upon which this part of the research rests, and that this project will allow to test and refine, is that technology does influence the success of a game platform, but in an indirect and limited way. More precisely, it has to affect graphical capabilities to have an impact on the public, but only in a certain, precise way: its graphical innovations must be geared towards new

modes of gameplay, rather than simply upgrading the fidelity, resolution, or “polish effects” that graphics can provide. We wholeheartedly agree with Michael Nitsche (2008) that “it is time to move away from graphics that function as ‘eye-candy’ that remains largely unused in actual gameplay” (p. 6), and are similarly irritated by those graphics engines which “offer little to no development of their original interactive features. They concentrate predominantly on improved performance of 3D graphics. Visual detail has become the fetish of some game developers who entered into a kind of space race to the most advanced presentation form” (pp. 71-72). Our irritation does not come from any prescriptive position on what and how games “should” be, but is epistemological: these technical innovations run the risk (and, in our view, have already done so to some degree) of reducing graphics to a qualitative surface layer, thereby clouding the vital role that they play in shaping the gameplay.

### TECHNOLOGY IN PLATFORM WARS

While the significance of graphical technologies and innovation cannot be understated for the games industry as a whole, it is of paramount importance when considering platforms — notably, the release of new game consoles. Ultimately, a platform is only as strong as its library of games on offer. While console manufacturers make games themselves, a broad and sustained selection of genres and titles can only be achieved by resorting to third-party developers. By developing games themselves, they contribute to making the platform ever more appealing to consumers, which creates a positive feedback loop that results in ever more adopters. But the problem lies in the very first moments of a new platform’s life, when little to no third-party support exists and must be built from the ground up.

In this crucial stage, technology acts as a pole of attraction for game developers by delimiting a technological trajectory (Nelson & Winter, 1982), a natural orientation for technological changes to follow according to the demands and realities of a given environment. To claim that graphics are important in promoting video games is self-evident, as Mark J. P. Wolf observed: “The number of games available for a given system was one consideration for system buyers, along with graphical complexity. Game graphics were, and to a large extent still are, the main criteria by which advancing video game technology is benchmarked” (Wolf, 2003, p. 53). Hence graphics, when envisioned in the context of technological innovation, are more than eye candy: they act as a conceptual interface that allows consumers (and, to a lesser extent, developers) to see the underlying, invisible technologies. But this technological trajectory must be coupled with a trajectory of innovation, which the platform stakeholders themselves will set by developing games that revolve around the idea of demonstrating the possibilities which their technology affords.

In this context, Nintendo’s abundance of mosaic effects, scaling and rotation, and scrolling background layers in *Super Mario World* can be read as

a means to demonstrate the strengths of the Super NES platform for other developers interested in traditional games, while titles such as *F-Zero* and *Pilotwings* showcased the console’s unique Mode 7 graphical perspective in order to stir experimentation in other directions. The production of these games (as well as other flagship titles, such as Sega’s *Sonic the Hedgehog* or id Software’s *Doom* and *Quake*) cannot be thought of as simply providing entertainment to its consumers. Instead, these games become rhetorical devices in themselves, parts of a wider discourse from technology stakeholders that attempt to seduce and convince third-party game developers and consumers to choose their own technology over that of competitors.



The composite image presented in Mode 7 in *F-Zero*. From top-left to bottom-right: 1) the natural view of the aerial 2D plane; 2) the deployment of Mode7 perspective effect by foreshortening the pixels at the top of the screen; 3) the 2D plane projected up to a horizon line, without the skyline background image; 4) the skyline image without the 2D plane projection; 5) the final, composite image with all layers.

While all game platforms have historically employed graphics as a rhetorical device supporting claims of technological superiority, the 1990s period is particularly relevant for this study because it featured a common goal that each platform aspired to: the “conquest of the third dimension”. In this regard, the Super NES console (1991-1997) holds a determining spot, and deserves the lion’s share of the research efforts because it offers several hardware and software innovations. The Super NES had a built-in capacity to display four background layers, each of them being able to scroll at variable speeds. This set an innovation trajectory for video game creators to take a cue from traditional film animation and implement parallax scrolling (the movement of different background layers at different speeds to simulate a depth of field that increases the perceptual illusion of perspective). The Super NES’ most interest-

ing contribution to the conquest of the third dimension, however, is its special (and much-touted in discourse) mode 7 graphics, a form of planar projection that can render a 2D bird's eye view image in pseudo-3D by foreshortening the pixels up to a horizon line, with the rest of the frame being occupied by another background layer (such as a skyline). Over the mode 7 playfield, the 2D sprites (individual movable objects) are superimposed and scaled according to distance.

### TECHNOLOGICAL INNOVATION AND TECHNIQUES

The nature of video games as technological constructs (and subjected to Moore's law that processors double in power every two years) makes any investigation of innovation seem inherently technology-driven. Even in fixed, standardized platforms like the Super NES, some manufacturers resorted to external processing chips added in particular game cartridges. For example, Nintendo used a Super FX chip in *Star Fox* to compute real-time 3D polygons (again with much fanfare, the game's box itself reading "Revolutionary Super FX Micro Chip Creates Special Effects Like Never Before!"), while Capcom included in *Mega Man X2* a C4 chip to integrate 3D wireframe meshes in their 2D platform game. Quite significantly, the back of the box's very first bullet-point feature reads, "Enhanced realism and 3-D effects with the new CAPCOM C4 graphics chip!" These are the most high-profile examples of technologies that aim to bridge the 2D-3D gap; others are doubtless waiting to be found, as we discovered, shuffling through an issue of *Electronic Gaming Monthly*, the existence of a Sega Virtua Processor chip meant as a riposte to Nintendo's Super FX chip (which fared much worse, having been used only once in *Virtua Racer*).

Through its competing platforms and their varying technological promises, the 1990s offer a unique window into the various processes of innovation. This includes the fact that many innovations cannot be attributed to technology, but are instead dependent on *techniques*. An innovation comes through techniques (often in programming) when a novel usage of a given, established technology is made. This is the case for games which managed to include a form of parallax scrolling prior to the presence of multiple background layers (see *Star Wars: The Empire Strikes Back* on the Atari 2600, or *Joe & Mac* and *Metal Storm* on the NES), or the various ways which game developers used to represent a tridimensional game space using bidimensional graphics and different depth cues and perspective effects. Examples could be enumerated *ad libitum*, but we only need to think of games from the beat 'em up genre (such as *Double Dragon* and *Streets of Rage*) that offered a playfield with navigable depth, even though actions were still performed on the horizontal x-axis only: fighting moves could not hit targets positioned a single step nearer or farther on the z-axis.

Perhaps the most famous graphical techniques came from id Software's *Wolfenstein 3D* and *Doom*; John Carmack's ingenious computing skills allowed the developer (and those game developers who licensed their engine) to create fully navigable tridimensional game spaces before the technology of



3D accelerated graphics cards streamlined the process and made it viable to resort to polygons. The success of the raycasting technique at work in both of these games is important for four reasons: first, it explicitly shows the need to distinguish between techniques and technologies; second, it illustrates the two global models of innovation (reiteration, which follows progressive additions and revisions, and innovation itself, which is thought of as a more radical break from established forms and conventions); third, it stands as the point of departure of a trajectory of innovation, before the wave of new 3D-focused hardware opens a technological trajectory; finally, it calls attention to the need to trace a common filiation between games that concretize a given gameplay mechanic (such as the treatment of space), independently of the technical or technological means through which they do so. The concept of graphical regimes, which we are developing as part of this research project, stems from this necessity<sup>1</sup>.

#### **TRIGGER: TECHNOLOGY / REITERATION / INNOVATION / GRAPHICS / GENRES / EVOLUTION / REGIMES**

Arsenault has shown (2009, 2011) how video game genre is a driving factor in the development of innovation. In this light, Nintendo's Super NES can be said to favor reiteration across already-proven genres, such as platform games, turn-based role-playing games (RPGs), and 2D action/adventures, integrating its graphical technological innovations into these reiterations of familiar gameplay aesthetics. *Super Mario World* is representative this approach: whether by placing trees in the foreground to occlude the playing field, or by having Mario climbing on fences and using revolving doors to move from the second to the third background layer, seamlessly transiting from the front to the back of the fences and vice-versa to avoid or to hit the Koopas that he meets, the graphical capabilities of the Super NES console were not simply used to woo the target audience with images that were impressive in themselves, but were the starting point of new explorations in form — albeit very limited explorations that stick close to a well-known formula. Nuances must be made, though, since clearly some SNES games experimented with innovative control schemes, gameplay mechanics, or spatial treatment; but many of the new gameplay possibilities were integrated at first as specific parts or alternative modes in the context of a larger, more traditional game type. For example, while Mode 7 graphics were used as a key game mechanic in the original *S.O.S.* (1994), where a side-scrolling game environment literally revolves around the player-character to open or block possibilities for spatial navigation, that idea was first introduced in stage 4-2 of *Super Castlevania IV* (1991).

The importance of generic templates in game design, which Ernest Adams (2009) attributes to Nintendo's draconian policies with the NES platform that dominated the 1985- 1990 period, reached its apex during the 1990s on the Super NES. Meanwhile, bolstered by new technologies such as CD-ROM storage and real-time polygon-based rendering, the personal computer and Sega's Genesis/Sega-CD hardware engage in experimentation through a number

1. See the paper in this issue by Dominic Arsenault and Pierre-Marc Côté, *Reverse-Engineering Perspective Innovation: An Introduction to Graphical Regimes*.

of new genres: full motion video (FMV) games with digitized footage, 3D action/adventures, and the ubiquitous first-person shooter (FPS), which is a genre that perfectly espouses a technological trajectory (of 3D accelerated graphics cards and general computing power) with little radical innovation (aside from the *Doom* spark that launched it).

<https://youtu.be/DpoE4FsxdPs>

The research will allow us to determine under what conditions a new technology can lead to new visual aesthetics, but also of new gameplay propositions (graphical regimes), and how these factors interact with other forces such as marketing imperatives or generic formulae. These findings will allow us to better contextualize, revise and enhance diverse statements on innovation, such as Matthieu Letourneux's explanation that games can be created according to a specific genre to lessen the financial risks of production (in Genvo, pp. 39–40), Chris Bateman's opinion that “[r]efinement of design is as valuable a process as raw originality. Sequels serve an important role in the development of games, and one quite separate from the occasional ground-breaking games” (Bateman, 2003), and Thomas Apperley's belief that “[t]he expectation is that the stability of genre will be tempered by innovation; this innovation may be technical, not necessarily stylistic” (Apperley, 2006, p. 9).

### AN ACADEMIC PARALLAX: THE CASE FOR CROSS-PERSPECTIVE ANALYSIS

The academic framework of this project is strongly related to art history and theories of visual perception. When looking at the various video game technologies and their associated discourses throughout the transition from 2D to 3D, one is struck by the resurgence of techniques, debates and philosophies that have marked art history. This leads us to a thesis, largely developed by Edmond Couchot (1988, 1991): for all its ontological novelty, computer-generated imagery (particularly in the case of the video game) presents itself as an extension of already-existing visual media history. For instance, Henry Jenkins (2004) situated the side-scrolling perspective of the platform game among the older tradition of Japanese map scrolls. Isometric and axonometric perspectives in games like *Final Fantasy Tactics* have eschewed perceptual realism (and notably accurate depth perception) in favor of providing a Cartesian view of space in its exact measurements and angles.

This leads us to one of our biggest challenges in tackling the question of graphical representation of game spaces: bridging our understanding of video game graphical technologies and the myriad ways in which they depict visual signs, which are articulated in a hybrid, dynamic visual flux during the gameplay experience, with the descriptive and analytical vocabularies developed in other disciplines, for other more linear objects<sup>2</sup>. Games present themselves to us as a motley configuration of tridimensional spatial depictions with depth cues and a vanishing point, static bidimensional backdrops or skylines (sometimes projected on a hemispheric dome to make up “virtual skies”), objects

2. Audrey Larochelle's contribution to this issue, *A new angle on parallel languages: the contribution of visual arts to a vocabulary of graphical projection in video games*, focuses extensively of this subject.

highlighted with glowing edges, parallax effects in bidimensional background layers, superimposed textual layers of menu items or dialogues, etc. If we ever hope to make sense of video games as complex visual objects, we need to adopt a broader view and import and adapt tools, vocabulary and methods from a variety of disciplines with both exacting rigor and creative flexibility, including graphical projection, architectural and technical drawing, art history and perspective, philosophy, animated film, photography, and so on.

This becomes readily apparent when we consider graphical techniques such as raycasting, used by id Software in *Wolfenstein 3D*: from the player's position on a 2D map, rays are traced in the direction in which he is looking, and when these rays hit a wall or an object, the computer draws the object at an appropriate scale (based on distance) in perspective projection. This technological resurgence of Plato and Euclid's belief that rays of light (or fire) emanated from our eyes and lit the objects upon which we gazed can appear surprising, but further highlights the need to situate these techniques and technologies in a much broader history. The same applies to the distinction between game spaces represented in perspective, and those game worlds which are rendered in parallel projection. In the first case, we are reproducing the world as we perceive it (or as we would, anyway); in the second case, we are depicting the object as it is in actuality, parallel lines never intersecting in the object's material structure. Plato's view that we should represent objects as they are in truth, and not in the way we perceive them, could have been formulated — all philosophical considerations set aside — as a game design principle for strategy and management games, where the exact representation of space as a dimensional grid of possible movement is to be valued over any sort of subjective view that would immerse the gamer in the fictional world "as if he was there". *Sid Meier's Civilization*, *Sim City* and *Warcraft: Orcs & Humans* may tell the player, through the fictional *mise-en-scène* that they are an emperor, a mayor or an army leader, respectively, but they clearly consider that role as an abstraction in their *mise-en-image*: no actual human being could have the free-roaming, disembodied view of space that the player is afforded in those games. This is radically opposed to such innovations as the multiple background layers that allow parallax effects in 16-bit game consoles, a digital remediation of the Disney multiplane camera used in animated film to simulate the human impression of depth.

### METHODOLOGY AND STATE OF RESEARCH

The project's theoretical framework is composed of texts from art history, psychology and philosophy on perspective and perception, and video game history and genre theory. A number of factual and basic information sources, such as reference works, will be consulted as well, in order to get a firm grasp on a number of concepts from related disciplines such as animated film, technical drawing, and technological innovation in industries.

As the first year of the project comes to a close, we can say that, so far, we have reviewed a high number of discursive materials in order to identify



common recurring tropes and types of discourses regarding graphics, technologies and innovation. These materials include the most popular gaming magazines from the time period: *Electronic Gaming Monthly*, *Nintendo Power*, *Game Informer*, *GamePro*, *Official U.S. PlayStation Magazine*, *PC Games*, *Video Games and Computer Entertainment*, and *Sega Visions*, as well as a number of particular guides and books, such as the *Super NES Players Guide*. We have also begun identifying games to form a corpus of study. These may be interesting because they pioneered a graphical technique or technology, or because they integrated new graphical effects in classic game genres and structures. A number of games will provide some examples: Super NES titles *F-Zero*, *Pilotwings*, the *Super Star Wars* trilogy, and *Super Mario Kart* for their extensive usage of Mode 7 graphics; *Mega Man X2* and *Mega Man X3* for integrating 3D wireframe graphics using a special chip; *Out of this World* and *Flashback: The Quest for Identity* for integrating polygons into 2D platforming games; *Star Fox*, *Stunt Race FX* and *Virtua Racing* (on the Sega Genesis platform) for their inclusion of 3D polygons computed with special chips on 2D consoles; *Castlevania: Symphony of the Night* as an example of a 2D game on Sony's predominantly-3D PlayStation console, that featured 3D effects for certain magic spells and background graphics; a few games for Nintendo's failed Virtual Boy portable console, that featured stereoscopic graphics in an evident bid for the conquest of the third dimension; *Alone in the Dark* as a prime example of early 3D games, where the settings and backgrounds are painted in static camera views and 3D polygons are superimposed over them; *Wolfenstein 3D*, *Doom* and *Quake* for their respective uses of raycasting, polygonal walls and floors, and full-3D characters and objects. We have identified 65 such games so far, but the list will undoubtedly grow to include peripheral titles on a monthly basis.

We have also looked at a high number of game boxes and manuals of the games from this period in search of mentions of techniques and technologies used in the games, as an important relay of material culture. In the coming year, these paratextual statements will be analyzed and filed in a public database on the Ludiciné website ([www.ludicine.ca](http://www.ludicine.ca)) according to the grounds on which the arguments are made (hardware technology, novel techniques or unique choices), the nature of the claims regarding the current state of similar games or genres (increased complexity, increased graphical fidelity, innovative approach to gameplay) and the larger interests they serve (stimulating interest in the game, selling the platform behind it, undermining competitors), etc. The descriptors will undoubtedly change and expand as the team encounters more and more of these discourses. The database will also grow as the team also reads and files various theoretical works on perspective, art history and technology, game studies and genre, and map the technological innovations identified in discourse onto the larger history of visual media and digital media ontology.

Ultimately, the bulk of the theoretical work will go towards a system of descriptors for the composite visual mediation at work in video games. We have

begun this work and while we cannot share our preliminary working hypotheses and system developed so far, we can say with confidence that the current 3-year project will not be enough to devise a system of descriptors that can account for the plurality of ways in which graphics can depict space and represent game events in any game type. We will have to settle for a partial system optimized toward our needs of articulating the transition from 2D to 3D graphics, and leave the vast peripheral questions and objects for future research.

The research project's main contribution will reside in a monograph on the Super NES console for the MIT Press' *Platform Studies* series, for which work has already begun. This publication will benefit the field of game studies as the Super NES is an important milestone in video game history, and the monograph, like the research project out of which it is born, addresses the larger question of the video game industry's seeming over-reliance on graphics and technology, as well as the medium's specificities and, perhaps more importantly, its ties to older traditions and debates in art history and visual media.

Furthermore, it is expected that a typology of graphical and generic innovation will be of interest not only to game studies researchers, but also to the games industry and academic game development communities, and could help to instigate new projects of experimentation.

Until then, we welcome any and all feedback and suggestions from like-minded researchers, whether on games, books or papers, conferences, magazines, advertisements, interviews with industry people, theoretical concepts or disciplinary approaches, etc. And we would like to thank the FQRSC (*Fonds de recherche Québec – Société et Culture* / Quebec Fund for Research – Society and Culture) for funding this project, and the editors of G|A|M|E for putting up an issue on such a timely question!

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