Split-Screen:

Videogame History through Local Multiplayer Design

Abstract

By looking at videogame production through a two-vector model of design – a practice determined by the interplay between economic and technological evolution – we argue that shared screen play, as both collaboration and competition, originally functioned as a desirable pattern in videogame design, but has since become problematic due to industry transformations. This is introduced as an example of what we call design vestigiality*: momentary loss of a design pattern's contextual function due to techno-economical evolution.*

Introduction

This article provides an historical look at the evolution of mainstream videogame production by examining how the roles of two game design patterns, "collaboration" and "competition", have altered in *shared screen play* over the past five decades.[1] In the present context, shared screen play refers explicitly to the design of multiple local "player positions," which refers to the designed possibility for multiple players to directly influence the mechanics of the videogame via a single screen.[2] Following Christopher Alexander and his colleagues' established view of design patterns as solutions to (design) issues, our contribution builds on a two-vector model of videogame design that looks at the practice through screen-related solutions contra economic and technological change.[3]

1 José Zagal, Miguel Nussbaum & Ricardo Rosas, "A Model to Support the Design of Multiplayer Games," *Presence: Teleoperators & Virtual Environments* (October 2000): 448–462. See also Staffan Björk & Jussi Holopainen, *Patterns in Game Design* (Hingham: Charles River, 2005).
2 Veli-Matti Karhulahti, *Adventures of Ludom: A Videogame Geneontology* (Turku: University of Turku, 2015).
3 For a summary that positions pattern theory in the present context, see Christopher Alexander, "The origins of pattern theory: the future of the theory, and the generation of a living world," *IEEE Software* (October 1999): 71–82. In particular, think about Alexander's "moral capacity to produce a living structure" in game design.

The economic and technological vectors of videogame production represent two forces that influence the design process and the final choice of design patterns. The economical force represents the need for a videogame to be profitable. The technological force represents the constraints a given machine (or hardware) puts on the designer. Accordingly, we show how the balance between the two vectors fluctuates across three historical eras of videogame design, and our ultimate argument is this: shared screen play was previously a particularly desirable factor in early commercial videogame design, but has gradually become problematic due to economic and technological evolutions in the industry.

Over the past decades, use of the word "evolution" has seen a notable increase in design theory and research. With reference to this tendency, John Langrish aptly points out the confusions and misunderstandings that come with the word; namely, progress in the Spencerian sense (evolution toward complexity via the "survival of the fittest") and progress in the Darwinian sense (adaptive change via "natural selection").[4] In this article, our understanding of evolution relies on the latter definition, with the view that adaptation lacks a final goal and does not necessarily involve increased complexity (but rather alterations of successful patterns that fluctuate along with environmental changes).

Langrish stresses that "Darwinian change does have trends, pressures, and so on, but mainly within a limited time span".[5] While this "limited time span" is evidently a relative concept that ranges from years to millennia, it also applies to the trending patterns of design evolution. Jennifer Whyte's more practical interpretation explicates:

[4] John Langrish, "Darwinian Design: The Memetic Evolution of Design Ideas," *Design Issues*, (Autumn 2004): 4–19.
[5] Ibid., 10.

> by drawing attention to the way that the designer operates within a selection environment, an evolutionary [Darwinian] perspective draws attention to the way the intentionality of the designer is, to some extent, contingent on this environment.[6]

In this paper we employ this practical, instrumentalist use of biological vocabulary and wish to present the case study of shared screen play as a particular instance of *design vestigiality*: momentary loss of contextual function for a design pattern due to techno-economical evolution. Or, in less jargoned words: we show how certain (technological and economical) changes in the environment affect the trending patterns of design so that (the majority of) designers end up avoiding or abandoning features that used to be popular.

Evolution of Shared Screen Play

In this section we describe the history of mainstream videogame design gradually by three chronological eras: that of the arcades (1970–1980s), that of home computers and consoles (1980–1990s), and that of internet-connected machines (1990–2000s). These three eras evidently overlap, and the so-called "PC gaming" genre extends across them all. Regardless of these caveats, we do think of them as fairly descriptive periodic labels that represent the historical transformations in the economic and technological vectors reasonably well. Of further note, we stress that our analysis concerns specifically the industry "mainstream"; namely, we are aware that various small and marginal(ized) design lineages (especially in non-Western contexts) may diverge from the trends that we discuss here. One specific example of

6 Jennifer Whyte, "Evolutionary Theories and Design Practices," *Design Issues* (Spring 2007), 53.

such a domain can be found within the independent game scene, which often reinvents and returns to older design paradigms.[7] That said, those techno-economical counter-histories must be studied with an explicit focus of their own, thus falling out of our present limited scope.

Before the analysis, a few more words on the two-vector model. First, to be clear, we do not suggest the two vectors (economic and technological) as the sole determinants of videogame development. Instead, we perceive them as a fruitful angle from which to look at videogame development and, as such, useful for scrutinizing the presently discussed trends. The premise of the two-vector model is that including or excluding shared screen play is a decision that videogame developers make and that this decision is encouraged or discouraged first and foremost by economic and technological factors. As to the nature of the terms "economic" and the "technological," it suffices to say that:

1) economic incentives refer to the videogame developers' (and producers') desire to increase both financial profits and perceived value of the videogame, the latter of which can be assumed to lead to further financial profits indirectly.

2) technological incentives refer to development and production challenges, both software and hardware, that follow features like shared screen play, while keeping in mind that such incentives may likewise support these processes in some ways.

[7] See Maria Garda & Paweł Grabarczyk, "Is every indie game independent? Towards the concept of independent game." *Game Studies* (October 2016). Cf. Mary Flanagan, *Critical play: Radical game design* (Cambridge: MIT Press, 2009).

Through this frame, we now move on to analyze shared screen play, henceforth *SSP*, as a distinct design pattern that has been part of the videogame industry since its birth in the 1970s.

Arcade (Era)

In the coin-operated economics of the arcade, an additional player brings an extra penny—a premise that was successfully pioneered by the pinball table (Gottlieb's 1955 *Duett* being the first two-player pinball machine). Unsurprisingly, then, many arcade games in the 1970s and 1980s were designed with one or more multiplayer features in mind and the economic incentive for SSP was (and still is) strongly present in the design philosophy of the arcade.

Attracting and satisfying multiple simultaneous players is not always a task trivial, however. As Carly Kocurek observers in her retrospective study on the golden era of the arcade:

> if someone in a two-player game of *PONG* simply refused to move his paddle, the game would end almost immediately—an outcome unlikely to be mutually desirable for the players at 25 cents a game.[8]

While the engagement of multiple players has the potential to generate more revenue than solitarily engaging players, keeping the players both engaged and motivated concurrently is a design challenge as well. Kocurek's observation accentuates the fact that even when players compete against each other, a level of cooperation is necessary for the game to function: the players want to win, but they also wish to prolong the pleasure of play. One interesting solution

[8] Carly Kocurek, "Coin-drop Capitalism: Economic Lessons from the Video Game Arcade," in *Before the Crash: Early Video Game History* (Detroit: Wayne State University Press, 2012): 202.

to this particular design problem was for the developers of many player-versus-player arcade games (those of fighting games in particular) to introduce a timer that forced an end to the duel even in situations where standard victory did not indicate the end of the match.

Statistically, the popularity of SSP in the arcades should be measured by comparing the overall machine earnings (global gross revenue), yet this metric remains largely unobtainable due to the significantly lacking historical records (most of the arcade operators never recorded these data). With the caveat that a successful title builds on various quality factors that need not directly relate to our present design concerns, some indications can be drawn from the more reliable numbers of arcade machine sales. The list of all-time best-selling arcade games collected by Wikipedia (Figure 1), for instance, includes 21 multiplayer titles out of the overall number of 26.

Pac-Man	(400,000)
Space Invaders	(360,000)
Donkey Kong	(132,000)
Ms. Pac-Man	(115,000)
Asteroids	(100,000)
Defender	(60,000)
Centipede	(55,988)
Galaxian	(40,000 in the US)
Donkey Kong Jr.	(30,000 in the US)
Mr. Do!	(30,000 in the US)
Tempest	(29,000)
*Q*bert*	(25,000)
Robotron: 2084	(23,000)
Dig Dug	(22,228 in the US)
Pole Position	(21,000 in the US)
Popeye	(20,000 in the US)
Missile Command	(20,000)
Jungle Hunt	(18,000 in the US)
Dragon's Lair	(16,000)
Berzerk	(15,780)
Scramble	(15,136 in the US)
Battlezone	(15,122)
Stargate	(15,000)
Star Wars	(12,695)
Super Cobra	(12,337 in the US)
Space Duel	(12,038)

Figure 1. The list of all-time best-selling arcade machines according to Wikipedia (November 2018).

Once we look at the multiplayer titles closer, a subtler pattern emerges. Out of the 21 arcade games incorporating multiplayer gameplay, no less than 20 used one specific multiplayer type that is today largely forgotten: an impoverished version of "turn-taking" between the players. Practically speaking, in turn-taking the machine identifies multiple players respectively (Player 1, Player 2 …) and allows them to engage one by one without enabling play in a shared environment.[9] The players thus alternate between parallel separate sessions, which can be called neither cooperative nor competitive; instead, the players' outcomes are only comparable. For instance, in the best-selling *Pac-Man* (Namco, 1980), whenever one player "dies" and passes the turn to another player, there is no continuation or interaction between the two, but rather both sessions operate individually. This solution differs visibly from the turn-taking used in board games like chess or videogames like *Heroes of Might and Magic* (New World Computing, 1995), in which players not only share the screen (or a board) but also operate in the same environment with the decisions of one affecting those of the others. Due to their lack of such interactive elements, we call the impoverished form of turn-taking in videogames like *Pac-Man: pseudo-SSP*.

While pseudo-SSP activity could easily be engaged without the machine identifying multiple players, the mode does still encourage inserting more coins at once and succeeds in keeping the player group physically close to the machine. It does not, however, allow the players to *spend* the inserted coins simultaneously (play at the same time), which is an evident economical defect and one of the reasons that this multiplayer mode has become rare in later design (see Figure 2). So why did the arcade game designers of the 1980s so often implement pseudo-SSP

[9] This form of multiplayer is the birthplace for the classic expression "Ready Player One," which has been popularized in popular culture by Ernest Cline's correspondingly titled book and Steven Spielberg's film adaptation of it.

instead of its full-fledged counterpart? An explanation derives from the technological challenges that were present specifically during the first half of the 1980s. One of the pioneer arcade designers, Mark Cerny, points out:

> [Arcades] started contracting because to get the players to put enough money into the machines they had to be two-player, they had to be four-player. But a lot of games don't work two-player or four-player. I want to go this way, you want to go that way. It just doesn't work.[10]

One main issue related to the design of SSP for the arcades was space. Early arcade games that allowed up to four concurrent players such as Atari's *Warlords* (1980) solved this problem by using the so-called "cocktail mode" in which the position of the machine's screen resembles that of a regular table or a desk. This enables approaching the arcade game from both sides instead of cramming the entire player group together in front of a small screen. This solution naturally influenced the rest of the game design significantly: the software had to be crafted so that players could observe and play from both positions (in *Warlords* the playfield consists of four identical inverted sections).

In this technological respect, *Gauntlet* (Atari, 1985)—one of the first arcade games to support local collaboration for up to four people—offered an alternative. *Gauntlet*'s designer, Ed Logg, explicitly stated that his main incentive for the inclusion of local collaboration was "the multiplication of income without the multiplication of the number of machines."[11] To achieve

[10] Brian Crecente, "How One Coin Saved Arcades in Japan and Another Killed Them in the U.S.", *Kotaku* (February 2011).
[11] Ed Logg in *YouTube* video "Gauntlet Revisited by Creator Ed Logg" (March 2012). *GameSpot*.

this, typical *Gauntlet* cabinets used the standard upright machine position, which freed the developers from the constraint of multi-perspective design yet resulted in a new challenge: the screen had to be bigger so that all four players could see it.

What makes *Gauntlet* of extra interest to us is that, while being originally released for the arcade, it was heavily inspired by *Dandy*: a title created by a single independent developer (Palevich, 1983) and released for the Atari 8-bit line of computers. *Dandy*'s mechanics are very similar to *Gauntlet*, and it likewise features a mode for up to four players. Thus, in contrast to the common trend of converting popular arcade games to home computer versions, here we see the process going the other way around: a popular videogame within the home computer market gets converted to the arcade. For comprehending the present economic and technological vectors, the conversion of *Dandy* to *Gauntlet* makes an illustrative case.

In the usual arcade-to-home conversions, the products usually retained most of their original mechanics even if these mechanics made little or no sense in the new environment. For example, many of the fighting games converted to home computers and consoles retained a session-limiting timer, even though it no longer had an economic function. Apart from the converting teams' evident need to save resources, another logical reason for retaining such mechanics derives from the fact that a successful conversion can be expected to comply with the original: players want to have the arcade experience at home. The case of *Dandy* is different, however. Being a fairly unknown independent home computer game, there was no pressure to retain its mechanics, but the key mechanics that changed in transition were directly connected to economics: cooperation between players significantly helped to prolong play without further inserted coins. Hence, *Gauntlet* introduced a special "energy depletion" mechanic that effectively functioned like a session-limiting timer that could be extended with money. This is

absent from the independent home predecessor: *Dandy* does measure player health by means of replenishable energy, yet energy does not decrease automatically.

Additionally, both *Dandy* and *Gauntlet* struggled with a technical limitation posed by the introduction of SSP. As implied by Cerny above, designers were often forced to make painful compromises. The particular problem that the developers of *Dandy* and *Gauntlet* faced was continuous screen movement, as players are allowed to move in different directions.[12] While many later developers overcame this issue by means of split-screen—displaying two active windows on a single physical screen using a clear separation line (vertical or horizontal)—rendering two parts of the environment simultaneously was too heavy a task for the computers of the time. Consequently, *Gauntlet* ended up moving the screen only when the players moved in the same direction, whereas *Dandy* allowed the players to go off-screen, centering the visible area only on one of them. Both solutions were greatly mitigated by the videogame's labyrinthine topological structures, which rarely permitted players to move completely freely anyway.

In sum, the interplay of economic and technological vectors in the arcade, regardless of their limitations, strongly favored SSP design. Including the possibility for players to experience arcade games simultaneously benefitted the designers both economically (multiple players led to multiple coin-input) and technologically (arcades could only accommodate a limited number and size of machines). In practice, SSP in the arcade took form mainly as pseudo-SSP and favored linear gameplay design, which solved screen issues in the case of conflicting player

[12] See Clara Fernández-Vara, José Zagal & Michael Mateas, "Evolution of Spatial Configurations in Videogames", in *DiGRA Proceedings '05* (September 2005). See also Alison Gazzard, *Mazes in Videogames: Meaning, Metaphor and Design* (London: McFarland 2013).

movements. The interrelation between the technological limitations and SSP is even more prominent for home consoles, which we analyze next.

Home Computer (Era)

In the mainstream home computer market of the 80s and the 90s—both consoles and PCs—the economic incentive for SSP turned out to be much weaker than in that of the arcade. Since multiplying the number of concurrent players on a home videogame does not directly multiply its profits, such direct economic incentives no longer functioned as key motivations in local multiplayer design. Therefore, the role of SSP moved more toward exploiting the "social glue"[13] and adding perceived value for the product: as people across cultures enjoy social play,[14] providing the former in one way or another becomes profitable even if it does not immediately accumulate financial profits.

The home computer era can be perceived through three sub-eras. In the first sub-era, most of the best-selling titles were simply conversions from the arcades. When pseudo-SSP was employed in the original arcade game, its computer conversion usually retained it, even though its economical function was lost in the home setting (cf. timers in fighting games earlier). The popularity of this solution waned across the years, and it is nowadays practically non-existent

[13] See Scott Rigby & Richard Ryan, *Glued to Games: How Video Games Draw Us in and Hold Us Spellbound* (California: Praeger, 2011).
[14] See e.g. Florence Chee, *Online Games as a Medium of Cultural Communication: An Ethnographic Study of Socio-technical Transformation* (Simon Fraser University, 2012). See also Graeme Kirkpatrick, *Computer Games and the Social Imaginary* (Polity, 2013). Cf. Jukka Vahlo et al. "Core Gamers: A Cross-cultural Comparison of Gaming in Canada, Finland, and Japan", *Finnish Yearbook of Game Studies* (December 2018): 35–59. [In Finnish.]

(Figure 2). Even retro-inspired throwbacks to the 8-bit and 16-bit designs do not reproduce the feature.[15]

Figure 2. Based on the five best-selling titles across all platforms. Two titles, Asteroids (1980) and Mahjong (1983), provided both pseudo-SSP and SSP, which were doubly included in the count of their respective years. Sales data from Deltanomics and Alex Ioana Ioana, "The Incomplete History of Videogame Sales," Medium *(December 2016).*

From a technological viewpoint, the design of SSP for the home machines of the 80s and the 90s was heavily dependent on the genre. Apart from early systems such as the Atari 2600 or ZX Spectrum, 8-bit and 16-bit machines were very capable of fast and fluid screen movement and used this effect extensively. As long as the videogames followed the conventions of platformers, or shooters with linear level structures, implementing genuine SSP was rarely a major challenge. Likewise, fighting and sports games—with the prevalent design paradigm

[15] The reappearance of pseudo-SSP in 1993 and 1995 in Figure 2 is explained by the re-release of older titles from the early 80s in compilations: *Super Mario All-stars* and *Namco Museum Vol.1* respectively.

forcing players to focus on the same part of the screen—followed (and still follow) the same logic.

The second sub-era of home computers can be associated with the rise of non-linear level design. Genres such as adventure games, role-playing games, and simulation games were not strongly present in the arcade market due to multiple practical problems—being longer, larger, and more laborious to learn—yet eventually boomed for the home computer due to a technological fit with personalized machines. For these genres, implementing SSP was initially a problem that few even dared to try solving. Ultimately, it can be said that the reduced economic incentive for SSP contributed to the evolution of single-player genres in the home computing market, which started to appear in the top spots of the lists in the 1990s. We elaborate on these initial challenges to SSP by taking a closer look at one historically notable instance on the Commodore Amiga, *Bloodwych* (Taglione et al.).

Bloodwych is a role-playing videogame created in 1989, stylistically similar to better known titles like *Dungeon Master* (FTL Games, 1987) and *Eye of the Beholder* (Westwood, 1991). In contrast to both, *Bloodwych* allows two players to roam a dungeon simultaneously via split-screen. What makes this example enlightening is that the split-screen effect is present even in the single player mode, in which the view to the videogame's graphical world is still only through half of the screen (Figure 3). As indicated earlier, one reason for this design choice was the lack of contemporary computer power and running performance; moreover, while the designers could have also scaled up the graphical presentation in the single player mode by stretching the interface to cover the entire screen, this would have resulted in a rather unattractive outcome due to inherent problems with scaling raster graphics.

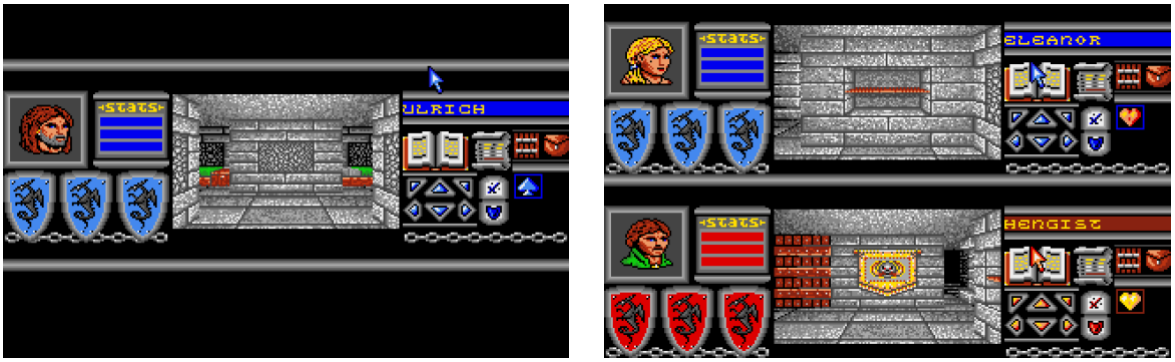

Figure 3. Bloodwych *single-player (left) and multiplayer (right). Personal screenshots under fair use.*

In some cases, these same split-screen limitations applied also to videogames from genres that should have been more fitting for the feature. For instance, *Lotus Esprit Turbo Challenge* (Magnetic Fields, 1990)—a fairly typical racing videogame with a visual presentation similar to Sega's *Out Run* (1986)—also allowed two players to simultaneously play on a horizontal split-screen, but did not allow players to use the full screen when playing alone (Figure 4). In this particular case, however, the developers hid the limitation by utilizing the second half of the screen for another purpose: showing the preparations made to the second (inactive) car.

Figure 4. Lotus Esprit Turbo Challenge *single-player (left) and multiplayer (right). Personal screenshots under fair use.*

To summarize: making use of the split-screen was truly taxing for computer systems of the time, and with the common use of raster graphics in 8-bit and 16-bit videogames, interfaces could rarely be rescaled efficiently and had to be redrawn from the scratch when developers wanted to adjust the visual presentation based on the number of players. Generally speaking, the inclusion of SSP meant that the designers had to create the videogame around it in particular, which typically led to serious compromises to the single-player mode.

The paradigm shifted in the late 90s and early 2000s, which can be described as a third sub-era of the home computers. Many non-linear videogames such as *Goldeneye* (Rare, 1997) and *Halo* (Bungie, 2001) started introducing shared split-screen play without notable compromises to the single player mode. This can be explained by three major technological changes converging at the time:

a) Polygonal based graphics established itself as the *de facto* visual standard for almost all existing videogame genres. As a result, it was much easier to scale the screen back and forth depending on the number of players.
b) The computing power of home computers had increased in general, thus making smooth split-screen play possible even with four players (albeit titles like Nintendo's *Mario Kart 64* from 1997 had decreased animation framerate in the split-screen mode).
c) The size of an average TV screen increased significantly, which made split-screen play viable even when displayed on one quarter of the screen.

A brief note on the differences between home consoles and PCs must be made here. Contrary to consoles, PCs of the time did not use TV display and the average size of the PC monitor was (and still is) significantly smaller than that of the TV. Additionally, since the PC is primarily

controlled via a keyboard-mouse interface, videogames exclusively designed for the PC typically lacked SSP entirely, while multiplatform titles providing split-screen for consoles—e.g. *Call of Duty Modern Warfare* (Infinity Ward, 2007), *Borderlands* (Gearbox Software, 2009), and *Don't Starve* (Klei Entertainment, 2013)—still often shipped without that feature for the PC.

Following the preceding observations, both the economic and technological vectors of the home computer appear clearly less favorable for the design of SSP in comparison to the arcade. Despite the fact that technological progress (with by-products like increased computing power and potential screen size) did contribute to videogame design by facilitating certain aspects of the production process, it also continued to redefine our aesthetic and mechanical standards so that features like SSP remained problematic.

Internet (Era)

To recap our chronology so far: in the arcade (including the still vivid arcade domain), designing SSP was moderately favorable in terms of both the economic and the technological vectors since it contributed somewhat positively to profits and the production process. In the home console era of the late 1980s and 1990s, the feature became less favorable to design due to its generally altered economic effects and increased technological difficulties in genres employing non-linear design—regardless of the availability of bigger screens and increased computing power somewhat improving the situation. As we now move to the era of internet-connected machines in the 2000s and the proliferation of online games, designing SSP became even less favorable. Let us start by looking at the unit sales of videogames with and without SSP from the late 1990s onwards (Figure 5).

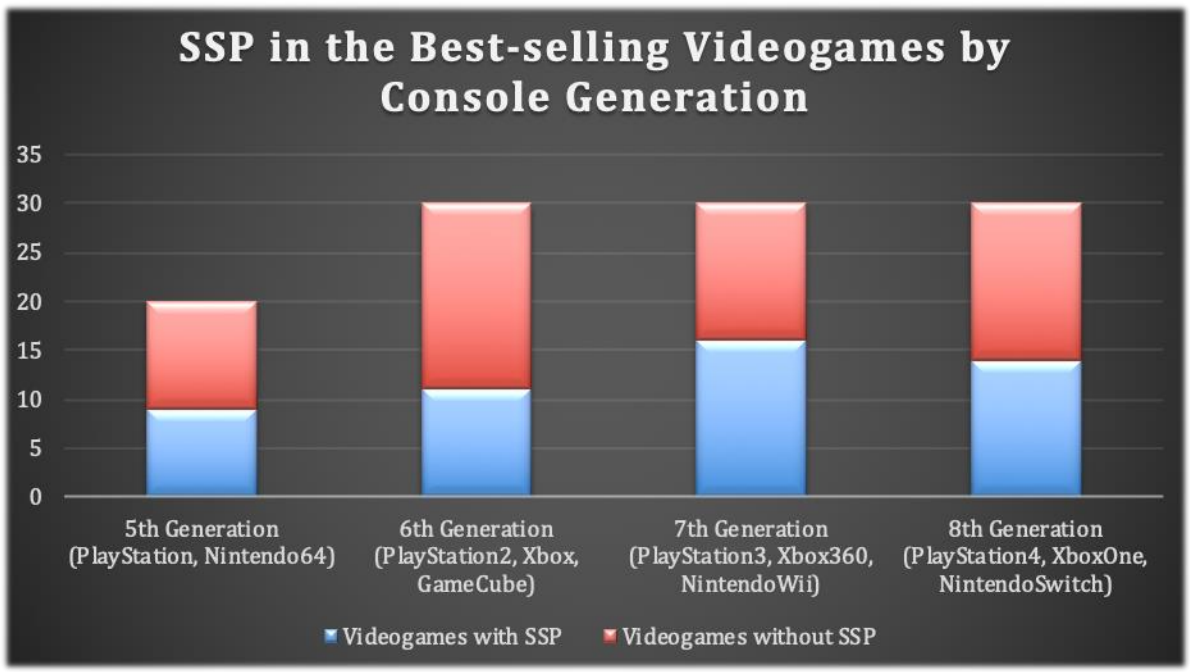

Figure 5. The ratio between videogames with and without SSP in the Top 10 best-selling title lists by console generation. Does not include PC sales. The sales data collected from various locations in Video Game Sales Wiki *(2018). Obviously, the figures are indicative at best.*

While the presence of SSP remains strong all the way from the late 1990s fifth generation consoles to those of today's eighth generation, this picture is evidently but a small part of the modern gaming culture that changed somewhat radically in the 2000s with the growth of the internet. In particular, esports and free-to-play online phenomena have come to dominate the PC market and are clearly changing the design economy of consoles as well (Figure 6).[16] In other words, while console videogames with SSP are still doing well in terms of unit sales, their prominence in the overall gross market has dropped significantly. For reasons to be probed below, SSP is a much less viable design choice in the present videogame market than in the preceding ones.

[16] The typical monetization strategy of free-to-play allows the players to install and play without making purchases. Instead, purchases are supposed to enhance the experience. See Veli-Matti Karhulahti and Kai Kimppa. "Two Queens and a Pwn, Please: An Ethics for Purchase, Loot, and Advantage Design in Esports", *CEUR-WS* (Spring 2018).

	PC	CONSOLE	MOBILE
1	League of Legends	Fortnite: Battle Royale	Honour of Kings
2	Dungeon Fighter Online	God Of War	QQ Speed
3	Crossfire	Fifa 18	Fantasy Westward Journey
4	Fantasy Westward Journey Online II	Call of Duty: WWII	Clash Royale
5	Fortnite: Battle Royale	Far Cry 5	Monster Strike
6	World Of Warcraft	Grand Theft Auto V	Fate/Grand Order
7	Heartstone: Heroes Of Warcraft	Tom Clancy's Rainbow Six: Siege	Pokemon GO
8	World Of Tanks	Tom Clancy's Ghost Recon: Wildlands	Candy Crush Saga
9	PlayerUnknown's Battlegrounds	NBA 2K18	Onmyoji
10	Counter-Strike Global Offensive	Battlefield 1	Clash of Clans

Figure 6. The top grossing videogame titles in 2018 according to Superdata Research (2018). Two of the console game titles provide SSP. None of the titles in the PC list provide SSP.

The decline in SSP prominence coincides rather well with the increase of broadband internet connections over the third millennium, which eventually led both the console and the PC videogame markets to incorporate online co-play. Because local co-play via split-screen or other means usually runs on a single sold copy, disregarding those features enables further monetization: each player collaborating online can be made to purchase a separate copy of the product. Namely, the economic vector starts to provide strong incentive against SSP. While this obviously applies to the majority of subscription-based design frameworks too—such as those of massive multiplayer online games—the specific gains in the console market are worth emphasis: by forcing collaborating players to purchase individual copies, the dominant platform owners (Microsoft, Nintendo, Sony) also further their machine sales and membership subscriptions that are currently required for online play with few exceptions.

In addition to the above, online play also eliminates the technical difficulties related to shared screen design and split-screen design in particular. As pointed out previously, the split-screen

feature entails either increased computing power or a sacrifice of visual quality. In contrast, online co-play does not demand similar compromises from the developer: they do not have to scale the graphics, animation fluidity, or worry over input interfaces. In fact, being connected to an online server rather opens the possibility of offloading some of the computing requirements to the server itself, thus making online co-play even more advantageous to design. Lucidly, a look at the present market yields a drastic decrease of SSP, especially among bigger productions: best-selling shooters like *Destiny* (Bungie, 2014) and *Overwatch* (Blizzard Entertainment, 2016) have never provided the feature, and some that previously relied strongly on it (*Halo*) have decided to remove it from their future iterations.

In sum, both the economic and technological vectors of today seem to have turned against the inclusion of SSP. While the feature is still strongly present in various smaller productions and indie game development, the macro-level evolution of videogame culture appears to dovetail (and move further toward) trends where the design of social videogame play moves away from shared screens with an increasing preference for multi-screen solutions. The current trend toward battle arena and open-world design pushes the technological vector still farther from the SSP, as creating split-screen solutions in such contexts is extremely demanding technically and memory-wise.[17] Genres that previously contained SSP, such as racing, are also tending to replace this option by online play.

Conclusions

[17] See Samer Al Dafai, "Conventions within eSports: Exploring Similarities in Design", in *Proceedings of DiGRA/FDG* (August 2016). This about this also in the context of Carl Therrien, "From video games to virtual reality (and back): Introducing HACS (Historical-Analytical Comparative System) for the documentation of experiential configurations in gaming history", in *Proceedings of DiGRA'17* (August 2017).

Our historical analysis of shared screen play (SSP) suggests that the feature was initially a desirable and profitable pattern in mainstream videogame design, but following cultural evolution, no longer is. We consider this loss of contextual function as an exemplary instance of *design vestigiality*— momentary loss of contextual function for a design pattern due to techno-economical evolution—and thus hope to open new ways of looking at design history through component-specific vectorial analysis.

The interplay of the two forces determining the choice of design patterns, represented by two vectors (economic and technological), can be presented via a 6-point history of design development (Figure 7). Point (1) represents the arcade era in which both economic and technological incentives favored SSP, mostly for the ease of implementing pseudo-SSP. Point (2) represents the beginning of the home era that decreased the economic factor, but kept the technological aspect intact due to the choice of linear genres and pseudo-SSP. Point (3) represents the rise of non-linear level design, which decreased the technological vector. Point (4) represents a short period during which technology developed to a point where implementation of SSP in non-linear design became possible. As presented by point (5), this quickly changed during the internet era: the economic vector turned along with SSP becoming less profitable contra its online counterparts (even while remaining technically viable). Point (6) represents the move towards new challenging design genres, which brings both vectors to a state where the whole incentive to keep SSP almost disappears.

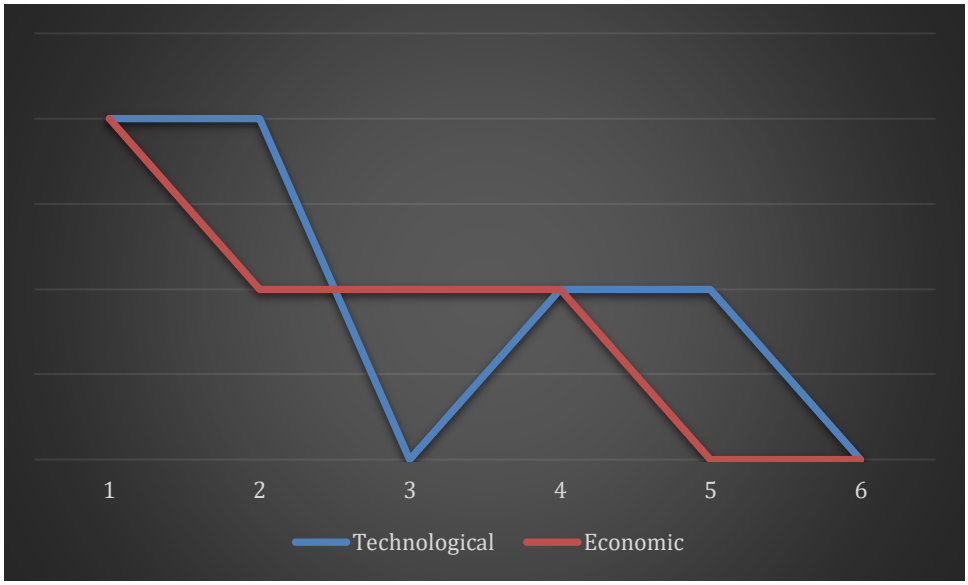

Figure 7. Economic and technological vectors across development eras.

Four reservations follow. We chose not to discuss the ongoing mobile gaming culture due to the present spatial limitations, yet the alternations within it appear to fit the argument: despite the proliferation of larger mobile screens, no major trends towards shared screen play have emerged so far. Second, we nod toward our other deliberate omission, the modern independent game phenomenon, within which SSP seems to be relatively popular. We hypothesize the reasons behind this to lie in socio-cultural factors (e.g. small indie developers often lack the infrastructure needed for securing online play), but the issue calls for a separate study. Third, it is worth noting the slowly progressing "interactive film" movement, as companies like Quantic Dream may have potential for reinventing SSP forms. Lastly, we mention Nintendo's recent design philosophy that has (especially with the Wii and Switch consoles) begun to rebuild co-play features by compensating for their economic and technological disadvantages with innovative efforts on hybrid analog equipment. We look forward to following how these ongoing developments turn out.

The evolution of organisms has no ultimate goal beyond adaptation, and this applies to the evolution of design as well. In the same way that vestigiality in biological organisms is relative

to its time, so it is with videogame design: perhaps we will see the reinvention of SSP in mainstream gaming one day; and if so, it can likely be explained by the same vectorial environment variables of economy and technology that this article has now established.