Split-Screen: Videogame History Through Local Multiplayer Design

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Introduction

This article provides a historical look at the evolution of mainstream videogame production by examining how the roles of two game design patterns, "collaboration" and "competition," have been altered in *shared screen play* (SSP) during the past five decades.[1] In the present context, SSP refers explicitly to the design of multiple local "player positions," which offers the designed opportunity for multiple players to directly influence the mechanics of the videogame using 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]

The economic and technological vectors of videogame production represent two forces that influence the design process and the final choice of design patterns. The economic 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: SSP was previously a particularly desirable factor in early commercial videogame design, but it has gradually become problematic because of economic and technological evolutions in the industry.

In the past decades, use of the word "evolution" in design theory and research has seen a notable increase. With reference to this tendency, John Langrish aptly points out the confusions and misunderstandings that come with the word—namely, the confusion of progress in the Spencerian sense (evolution toward complexity via the "survival of the fittest") with 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. (Rather, it involves alterations of successful patterns that fluctuate along with environmental changes.)

1 José Zagal et al., "A Model to Support the Design of Multiplayer Games," *Presence: Teleoperators & Virtual Environments* 9, no. 5 (October 2000): 448–62. See also Staffan Björk and Jussi Holopainen, *Patterns in Game Design* (Hingham, MA: Charles River, 2005).

2 Veli-Matti Karhulahti, *Adventures of Ludom: A Videogame Geneontology* (Turku, Finland: University of Turku, 2015).

3 For a summary of pattern theory's position 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* 16, no. 5 (October 1999): 71–82. In particular, consider Alexander's principle on "the moral capacity to produce a living structure" and its influence in game design.

4 John Langrish, "Darwinian Design: The Memetic Evolution of Design Ideas," *Design Issues* 20, no. 4 (Autumn 2004): 4–19.

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

> [B]y 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 article, we rely on this practical, instrumentalist use of biological vocabulary and present the case study of SSP as a particular instance of *design vestigiality*: a momentary loss of contextual function for a design pattern as a result of techno-economic evolution. Or, in less jargoned words, we show how certain (technological and economic) 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 across 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). Note that these three eras overlap, and the so-called "PC gaming" genre extends across them all. Regardless of these caveats, we do consider them to be fairly descriptive labels for the periods, representing the historical transformations in the economic and technological vectors reasonably well. Of further note, we stress that our analysis specifically concerns the industry "mainstream"; we are aware that various small and marginal(ized) design lineages (especially in non-Western contexts) might diverge from the trends that we discuss here. One specific example of such a domain is the independent game scene, which often reinvents and returns to older design paradigms.[7] That said, these techno-economic counter-histories must be studied with an explicit focus of their own, thus falling outside the scope of this work.

Before the analysis, we offer 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 trends being discussed here. The premises of the two-vector model are that including or excluding SSP is a

5 Ibid., 10.

6 Jennifer Whyte, "Evolutionary Theories and Design Practices," *Design Issues* 23, no. 2 (Spring 2007), 53.

7 See Maria Garda and Paweł Grabarczyk, "Is Every Indie Game Independent? Towards the Concept of Independent Game," *Game Studies* 16, no. 1 (October 2016). See, for comparison, Mary Flanagan, *Critical Play: Radical Game Design* (Cambridge, MA: MIT Press, 2009).

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 "technological," we rely on these viewpoints:

1. "Economic incentives" refers to the videogame developers' (and producers') desire to increase both financial profits and the perceived value of the videogame, the latter of which can be assumed to lead indirectly to further financial profits.
2. "Technological incentives" refers to development and production challenges related to both software and hardware that accompany features like SSP; such incentives also might support these development and production processes in some ways.

Through this frame, we now analyze SSP as a distinct design pattern that has been part of the videogame industry since its origin 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* was the first two-player pinball machine.) Not surprisingly, 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.

However, attracting and satisfying multiple simultaneous players is not always a trivial task. In her retrospective study on the golden era of the arcade, Carly Kocurek observes:

> [I]f 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]

The engagement of multiple players has the potential to generate more revenue than engaging solitary players, but keeping each of the players concurrently both engaged and motivated 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. The developers of many player-versus-player arcade games (those of fighting games in particular) found an interesting solution to this particular design problem by introducing a timer that forced an end to the duel, even in situations where standard victory did not indicate the end of the match.

8 Carly Kocurek, "Coin-Drop Capitalism: Economic Lessons from the Video Game Arcade," in *Before the Crash: Early Video Game History,* ed. Mark J. P. Wolf (Detroit, MI: Wayne State University Press, 2012), 202.

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
All-time best-selling arcade game machines.
Source: Wikipedia (November 2018).

Statistically, the popularity of SSP in the arcades should be measured by comparing the overall machine earnings (global gross revenue). However, this metric remains largely unobtainable because the historical records are lacking. (Most of the arcade operators never recorded these data.) With the caveat that a successful videogame 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. For instance, the list of all-time best-selling arcade games collected by Wikipedia (see Figure 1) includes 21 multiplayer titles among the overall number of 26.

When we look at the multiplayer titles more closely, a subtle pattern emerges. 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. The players thus alternate between parallel separate sessions, which can be called neither cooperative nor competitive; instead, the players' outcomes are simply 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; rather, both sessions operate individually. This solution differs visibly from the turn-taking used in board games (e.g., chess) or in videogames (e.g., *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 where the decisions of one affect those of the others. Because of the lack of such interactive elements, we call the impoverished form of turn-taking in videogames pseudo-SSP.

Although users can easily engage in pseudo-SSP activity 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. However, it does not allow the players to spend the inserted coins simultaneously (i.e., to play at the same time), which is an evident economic defect and one of the reasons that this multiplayer mode has become rare in later designs (see Figure 2[9]). So why did the arcade game designers of the 1980s so often implement pseudo-SSP instead of its full-fledged counterpart? An explanation derives from the technological challenges that existed specifically during the first half of the 1980s. Pioneering arcade designer Mark Cerny points out:

9 Figure 2 is constructed from multiple cited databases in Alex Ioana, "The Incomplete History of Videogame Sales," *Medium* (December 2016), https://medium.com/the-peruser/a-brief-history-of-video-game-sales-49edbf831dc. Note that in Figure 2, two titles, Asteroids (1980) and Mahjong (1983), provided both pseudo-SSP and SSP; both versions were included in the count of their respective years.

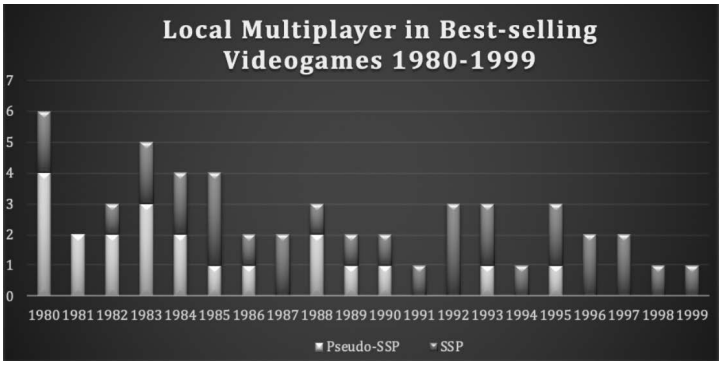


Figure 2
Local multi-player options in top five videogames, 1980–1999 (based on the five best-selling titles across all platforms). Source: Multiple cited databases in Alex Ioana (2016).

> …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 configuration enables players to approach 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. (For example, 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 this goal, typical *Gauntlet* cabinets used the standard upright machine position, which freed the developers from the constraint of a 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, although 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,

10 Brian Crecente, "How One Coin Saved Arcades in Japan and Another Killed Them in the U.S.," *Kotaku* (February 2011).

11 Ed Logg, "Gauntlet Revisited by Creator Ed Logg" (Game Developers Conference, March 2012), GameSpot, https://www.youtube.com/watch?v=ltH-mV32KQY.

the process went the other way around: A popular videogame in the home computer market got converted to the arcade. The conversion of *Dandy* to *Gauntlet* provides an illustrative case for understanding the economic and technological vectors.

In the more common 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 that were converted to home computers and consoles retained a session-limiting timer, even though it no longer had an economic function. A logical reason for retaining such mechanics derives from the fact that, in addition to the conversion teams' need to save resources, a successful conversion would be expected to comply with the original: Players want to have the arcade experience at home. The case of *Dandy* is different, however. As a fairly unknown, independent home computer game, the arcade game developers faced no pressure to retain its mechanics; instead, the key mechanics that changed in the transition were directly connected to economics: Cooperation between players significantly helped to prolong play without requiring that additional coins be inserted. Hence, *Gauntlet* introduced a special "energy depletion" mechanic that effectively functioned like a session-limiting timer that could be extended with money. This capability is absent from the independent home predecessor: *Dandy* does measure player health by means of replenishable energy, but energy does not decrease automatically.

In addition, both *Dandy* and *Gauntlet* struggled with a technical limitation posed by the introduction of SSP. As Cerny implied, designers were often forced to make painful compromises. The particular problem that the developers of *Dandy* and *Gauntlet* faced was continuous screen movement because the games allowed players to move in different directions.[12] 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); however, 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. Enabling players to experience arcade games simultaneously benefitted the designers both economically (multiple players led to multiple coin-input) and technologically (arcades could only

12 See Clara Fernández-Vara et al., "Evolution of Spatial Configurations in Videogames," in *DiGRA Proceedings '05* (Tampere: DiGRA, 2005). See also Alison Gazzard, *Mazes in Videogames: Meaning, Metaphor and Design* (London: McFarland, 2013).

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 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 1980s and 1990s—both consoles and PCs—the economic incentive for SSP turned out to be much weaker than it had been in the era of the arcade. Multiplying the number of concurrent players on a home videogame does not directly multiply its profits; as a result, 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" and adding perceived value for the product.[13] Because people across cultures enjoy social play, providing it in one way or another becomes profitable, even if it does not immediately accumulate financial profits.[14]

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 used in the original arcade game, its computer conversion usually retained it, even though its economic function was lost in the home setting (e.g., timers in fighting games). The popularity of pseudo-SSP solutions waned across the years, and they are now practically non-existent (again, see Figure 2). Even current retro-inspired throwbacks to the 8-bit and 16-bit designs do not reproduce the feature.[15]

From a technological viewpoint, the design of SSP for the home machines of the 1980s and the 1990s depended greatly 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 forcing players to focus on the same part of the screen—followed (and still follow) the same logic.

The second sub-era of the home computer era is 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 because of multiple practical problems: They took longer to play, were larger, and were more laborious to learn. Yet they eventually experienced a boom for the home computer market because of a technological fit with personalized machines. For these genres, implementing SSP was initially

13 See Scott Rigby and Richard Ryan, *Glued to Games: How Video Games Draw Us in and Hold Us Spellbound* (Oxford: Praeger, 2011).

14 See, e.g., Florence Chee, "Online Games as a Medium of Cultural Communication: An Ethnographic Study of Socio-Technical Transformation" (PhD diss., Simon Fraser University, 2012). See also Graeme Kirkpatrick, *Computer Games and the Social Imaginary* (Cambridge: Polity, 2013). For comparison, see Jukka Vahlo et al., "Tasavallan core-gamer: Videopelaamisen piirteet Suomessa, Kanadassa ja Japanissa" [Core Gamers: A Cross-Cultural Comparison of Gaming in Canada, Finland, and Japan], in *Finnish Yearbook of Game Studies* 10, no. 1 (December 2018): 35–59.

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 1980s in compilations: *Super Mario All-Stars* and *Namco Museum Vol.1*, respectively.

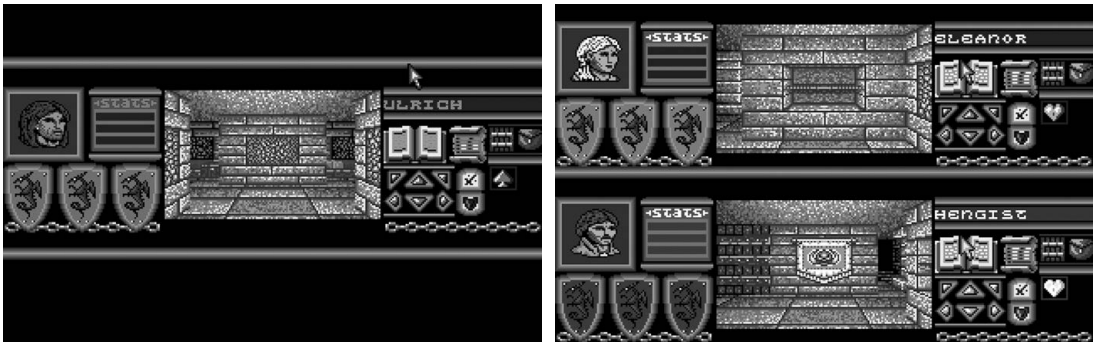


Figure 3
Bloodwych single-player (left) and multiplayer (right). Source: Author screenshots.

a multilayered problem that few even dared to try to resolve. Ultimately, the reduced economic incentive for SSP in the home computing market spurred the evolution of single-player genres in the home computing era, which started to appear in the top spots of the best-selling 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 that stylistically is similar to better known titles, including 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 (see 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 also could have scaled up the graphical presentation in the single player mode by stretching the interface to cover the entire screen, this step would have resulted in a rather unattractive outcome because of inherent problems with scaling raster graphics.

In some cases, these same split-screen limitations also applied 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 play simultaneously on a horizontal split-screen, but it did not allow players to use the full screen when playing alone (see Figure 4). In this particular case, however, the developers hid the limitation by using the second half of the screen for another purpose: showing the second (inactive) car.

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 rarely could be rescaled efficiently; instead, they had to be redrawn from

Figure 4
Lotus Esprit Turbo Challenge single-player (left) and multiplayer (right). Source: Author screenshots.

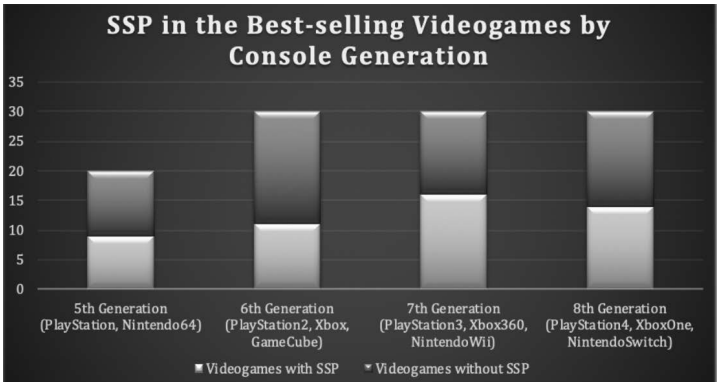
scratch when developers wanted to adjust the visual presentation based on the number of players. Generally speaking, the inclusion of SSP meant that the designers had to create the videogame around this feature in particular, which typically led to serious compromises to the single-player mode.

A paradigm shift in the late 1990s and early 2000s led to a third sub-era of the home computers era. 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. Three major technological changes converged at this time to allow for this feature:

1. Polygon-based graphics were established as the *de facto* visual standard for almost all existing videogame genres. As a result, scaling the screen back and forth, depending on the number of players, became much easier.
2. The computing power of home computers had increased, thus making smooth split-screen play possible even with four players (although titles like Nintendo's *Mario Kart 64*, from 1997, had a decreased animation frame-rate in the split-screen mode).
3. The size of an average TV screen increased significantly, which made split-screen play viable even when displayed on one quarter of the screen.

The differences between home consoles and personal home computers (PCs) is noteworthy here. Contrary to consoles, the PCs of the time did not use television display, and the average size of the PC monitor was (and still is) significantly smaller than that of the TV screen. In addition, because the PC primarily was (and is) controlled using a keyboard–mouse interface, videogames designed exclusively for the PC typically lacked SSP entirely; meanwhile, multi-platform titles providing split-screen for consoles—for example, *Call of Duty Modern Warfare* (Infinity Ward, 2007), *Borderlands* (Gearbox Software, 2009), and *Don't Starve* (Klei Entertainment, 2013)—still often were shipped for the PC without the SSP feature.

Figure 5
SSP to non-SSP ratio in the top 10 best-selling videogames, by console generation (not including PC sales). Source: Video Game Sales Wiki (2018), various locations.



In light of these observations, both the economic and technological vectors of the home computer appear clearly less favorable for the design of SSP compared to the arcade. Technological progress (including by-products such as increased computing power and potential screen size) did contribute to videogame design by facilitating certain aspects of the production process; however, it also continued to redefine 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 vector and the technological vector because it contributed somewhat positively to profits and to the production process. In the home console era of the late 1980s and 1990s, despite the improvement offered by bigger screens and increased computing power, the SSP feature became less favorable to design because of its generally altered economic effects and increased technological difficulties in genres using non-linear design. In the era of internet-connected machines in the 2000s and the proliferation of online games, designing SSP became even less favorable.

Although the presence of SSP remains strong from the late 1990s fifth generation consoles to those of the current eighth generation (see Figure 5[16]), this picture is only 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 clearly are changing the design economy of consoles as well (see Figure 6).[17] In other words, although console videogames with SSP are still doing well in terms of unit sales, their prominence in the overall market has dropped significantly. SSP is a much less viable design choice in the current videogame market than in preceding ones.

16 The sales data figures, collected from various locations in the Video Game Sales Wiki (2018), are merely indicative and not intended to be precise.

17 Note that the typical monetization strategy of free-to-play allows players to install and play without making purchases. Instead, purchase of in-game equipment or implements is encouraged 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," in *Proceedings of the 2nd International GamiFIN Conference,* Spring 2018 (Tampere, Finland: Tampere University, 2018): 115–22, http://ceur-ws.org/Vol-2186/paper14.pdf. In Figure 6, two of the console game titles provide SSP; none of the titles in the PC list provide SSP.

Figure 6
Top grossing videogame titles by category in 2018. Source: Superdata Research (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

The decline in SSP prominence coincides with the increase of broadband Internet connections, which eventually led both the console and the PC videogame markets to incorporate online co-play. Because local co-play using split-screen or other means usually runs on a single sold copy, disregarding SSP features enables further monetization: Each player collaborating online has to purchase a separate copy of the product. As a result, the economic vector starts to provide a strong incentive against SSP. This economic perspective obviously applies to the majority of subscription-based design frameworks too (e.g., massive multiplayer online games) but the specific gains in the console market are worth emphasizing. By forcing collaborating players to purchase individual copies, the dominant platform owners (Microsoft, Nintendo, Sony) also further their machine sales and the membership subscriptions that are currently required, with few exceptions, for online play.

In addition, online play eliminates the technical difficulties related to shared screen design—and to split-screen design in particular. As we 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 developers: They do not have to scale the graphics or animation fluidity or to worry about input interfaces. In fact, being connected to an online server opens the possibility of offloading some of the computing requirements to the server itself, thus making online co-play even more advantageous to design. A look at the current market reveals 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 economic and technological vectors seem to have diminished the use of SSP. The feature is still present in various smaller productions and indie game development, but the

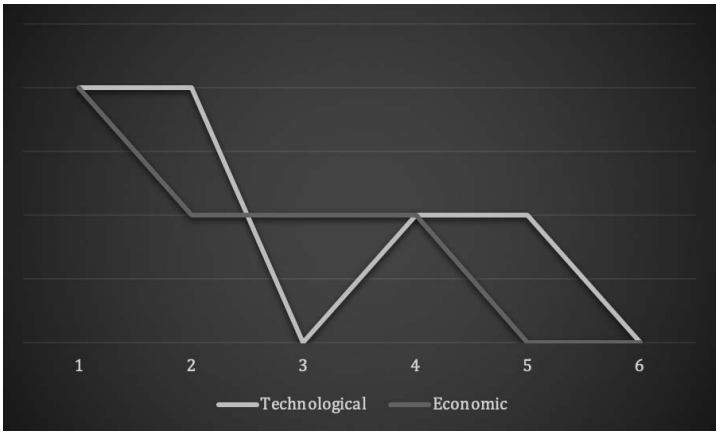


Figure 7
Economic and technological vectors across development eras.

macro-level evolution of videogame culture appears to trend toward designs of social videogame play that includes multi-screen solutions and away from designs involving shared screens. The current trends toward battle arena and open-world designs push the technological vector still further from SSP because creating split-screen solutions in such contexts is extremely demanding technically, including in terms of memory use.[18] Genres that previously contained SSP, such as racing, are tending to replace this option with online play.

Conclusions

Our historical analysis of SSP suggests that the feature was initially a desirable and profitable pattern in mainstream videogame design, but following cultural evolution, it no longer is. We consider this loss of contextual function to be an exemplary instance of *design vestigiality*—momentary loss of contextual function for a design pattern as a result of techno-economic evolution. Through this case study, we hope to open new ways of looking at design history through component-specific vectorial analysis.

The interplay of the forces determining the choice of design patterns, represented in our case by two vectors (i.e., economic and technological), can be presented using a six-point history of design development (see 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, in which the significance of the economic factor shifted but the technological aspect remained intact because of 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 state where implementation of SSP in non-linear design became possible. As shown by Point 5, this period quickly changed during the Internet era: The economic

18 See Samer Al Dafai, "Conventions Within eSports: Exploring Similarities in Design," in *Proceedings of the First International Joint Conference of DiGRA and FDG* (Tampere, Finland: DiGRA, 2016), http://www.digra.org/wp-content/uploads/digital-library/paper_249.pdf. See also 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* (Tampere, Finland: DiGRA, 2017), http://www.digra.org/wp-content/uploads/digital-library/57_DIGRA2017_FP_Therrien_HACS.pdf.

vector turned, and SSP became less profitable compared to its online counterparts (even while remaining technically viable). Point 6 represents the move toward new and challenging design genres, which moves both vectors to a state where the incentive to keep SSP disappears almost entirely.

We note four areas to which our approach can be further applied in the future. First, we chose not to discuss the ongoing mobile gaming culture because of space constraints. However, the changes in this area appear to fit the argument: Despite the proliferation of larger mobile screens, no major trends toward SSP seem to have emerged so far. Second, in another deliberate omission, we ignored the modern independent game phenomenon, within which SSP seems to be relatively popular. We hypothesize that the reasons for this popularity lie in socio-cultural factors. For example, we suspect that small indie developers often lack the infrastructure needed for securing online play. The issue calls for further study. Third, we note the slowly progressing "interactive film" movement. Companies like Quantic Dream might have the potential to reinvent SSP forms. Fourth, Nintendo's recent design philosophy (especially with the Wii and Switch consoles) has 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 interact with the economic and technological vectors of the field.

The evolution of organisms, in Darwin's sense, 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 examined using the same environmental vectors of economy and technology that we have established in this article.

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