

Game Analysis: Centipede

Richard Rouse III

Context

"Game Analysis: Centipede" is an excerpt from my book Game Design: Theory and Practice. Originally released in 2001 (and recently revised in 2004), the book covers all aspects of computer and video game development, as well as exploring design principles through the detailed analysis of six brilliant games, including Centipede. I firmly believe in game design through reverse engineering, so it was extremely enlightening to analyze Centipede and determine how the interaction of its systems combine to create a wickedly fun experience. Hopefully it will be as enlightening for you, since I consider Centipede to be one of the few perfect video game designs I have ever encountered.

The Player Experience

Game Design Models

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One can think of the classic arcade game as a form of the computer game, the same way that a silent slapstick comedy is a form of film or the hard-boiled detective novel is a form of literature. The classic arcade game form fell out of favor with the commercial gaming companies pretty much as soon as the technology was available to move beyond it. However, many independent game developers still work on classic arcade games either for their own amusement or to be released as freeware or shareware titles. Many of these labors of love are imitations of established classic arcade games, but many others are interesting experiments in new gameplay. There remains something uniquely compelling about the form, and the fact that one does not need to have a sophisticated 3D engine to make a wonderfully entertaining classic arcade game helps to make the form an appealing one in which to work.

It bears mentioning that when I refer to the classic arcade game, I do not mean to imply that all classic arcade games are classics. Many of them are quite bad. As with any media, the old arcade games that are remembered and talked about decades after their release tend to be the best ones, thus creating the false impression of a "golden age." The bad arcade games have fallen between the cracks of history. The term "classic arcade game" refers to the form as a classic one, not to the games themselves, just as one might refer to "classical music." Surely the term "arcade game" is not limiting enough, since this would seem to include every game found in an arcade, including modern racing, gun, and fighting games, none of which are what I consider to be part of the form I am concerned with here.

The classic arcade game form had its commercial and creative heyday in the late 1970s through the early 1980s, when machines exhibiting the form lined the arcades. Looking at the games as a whole, one can come up with a series of traits that they all shared. Some of these aspects of the form may have been arrived at because of the commercial considerations of the arcades. The thought was to get a player to easily understand a game, so that by the end of his very first game he had a good sense of how the game worked and what was necessary for success. Second, a player's game, even the game of an expert, could not last very long, since any one player had only paid a quarter, and if the game only earned a single quarter in a half hour, it would not be profitable to operate. Players needed to be sucked in to replay the games, to keep plunking in quarters. As a result, in some ways the arcade games had to be more refined than home games are today. Once the player has purchased a home game, often for at least a hundred times the cost of a single arcade game play, the sale is

completed. If he is not completely disgusted with the game he is unlikely to return it. Features such as scoring and high-score tables only served to increase the arcade game's addictive nature and encourage players to keep spending money.

In addition, the technical restrictions of the day limited what the games could do, and thereby influenced what the games could accomplish in terms of gameplay. Had the designers had the RAM and processing power to include fully scrolling game-worlds that were many times the size of the screen, they probably would have. If the games had been able to replay full-motion video of some sort, perhaps the designers would have incorporated more story line into the games. But the fact remains that a unique genre of computer games emerged, and if the commercial and technical limitations shaped the form, so be it. Just as early films had to work with the limitations of silence and short running times, computer game designers were limited in what they could create, and were able to come up with brilliant games nonetheless. Often, working within a series of strict constraints forces artists to focus their creativity in a fashion which leads to better work than if they could do anything they wanted.

One key ingredient to many classic arcade games was their wild variation in gameplay styles. *Centipede*, *Missile Command*, *Pac-Man*, and *Frogger* are as different from each other as they possibly could be. Many classic arcade games featured variations on a theme: *Centipede*, *Space Invaders*, *Galaga*, and *Tempest* all revolved around the idea of shooting at a descending onslaught of enemies. However, the gameplay variations these games embraced are far more radical than the tiny amount of variation one will find in modern games, which are more content to endlessly clone already-proven gaming genres. Despite the wild variety of gameplay that can be found in classic arcade games, one can still look back on these games as a collective, as an artistic movement in the brief history of computer games. By analyzing the form's shared traits, modern game designers can learn a lot about how they can make their own games more compelling experiences for the player.

Classic Arcade Game Traits

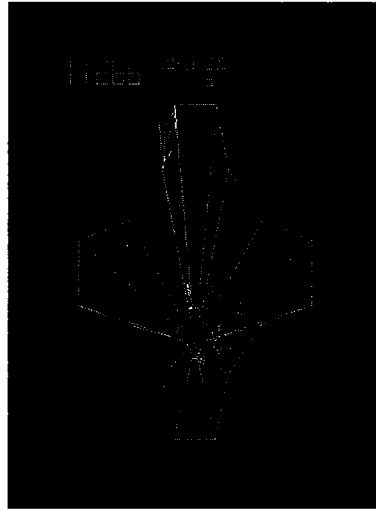
Single Screen Play: In a classic arcade game, the bulk of the gameplay takes place on a single screen, with the player maneuvering his game-world surrogate around that screen, sometimes only in a portion of that screen. This was done, no doubt, in part because of technological limitations. But it also has very important artistic ramifications on the game's design: the player, at any time, is able to see the entire game-world, and can make his decisions with a full knowledge of the state of that

game-world. Obviously, empowering the player with that kind of information seriously impacts the gameplay. Many of the games in the classic arcade game form would include more than one screen's worth of gameplay by switching play-fields or modifying existing ones to create additional "levels." Examples of this include *Joust*, *Pac-Man*, and *Mario Bros*. Though these games may have included more than a single screen in the entire game, at any one time the player's game-world still consisted of just that one screen.

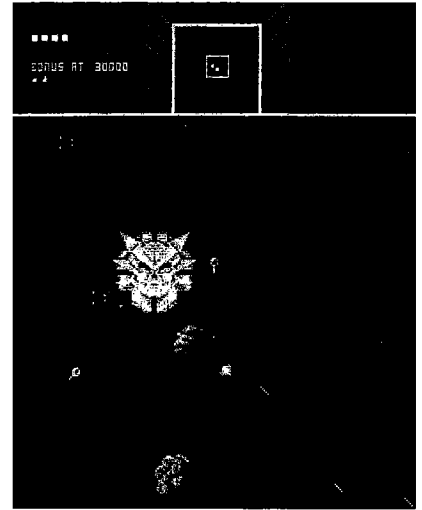
Infinite Play: The player can play the game forever. There is no ending to the game, and hence no winning it either. This was done in part to allow players to challenge themselves, to see how long they could play on a single quarter. Players can never say, "I beat *Asteroids*," and hence players are always able to keep playing, to keep putting in quarters. At the same time, having an unwinnable game makes every game a defeat for the player. Every game ends with the player's death, and hence is a kind of tragedy. Having an unwinnable game also necessitates making a game that can continuously get harder and harder for the player, hence a game design with a continuous, infinite ramping up of difficulty. With the advent of the home market, game publishers no longer wanted players to play a single game forever. Instead they want players to finish the games they have and buy another one. This is one reason why it is rare to see a game with infinite play any more.

Multiple Lives: Typically, classic arcade games allow the player a finite number of lives, or a number of "tries" at the game before her game is over. Perhaps derived from pinball games, which had been providing the player with three or five balls for decades, multiple lives allowed the novice player a chance to learn the game's mechanics before the game was over. Given adequate chances to try to figure out how the game works, the player is more likely to want to play again if she made progress from one life to the next. Having lives enables the game to provide another reward incentive for the player playing well: extra lives. Having multiple lives also sets up a game where dying once is not necessarily the end of the game, and encourages players to take risks they might not otherwise.

Scoring/High Scores: Almost all classic arcade games included a scoring feature through which the player would accumulate points for accomplishing different objec-



Tempest is one of many classic arcade games that is centered on shooting at enemies which keep getting closer. *Tempest* is memorable because of the many unique twists included.



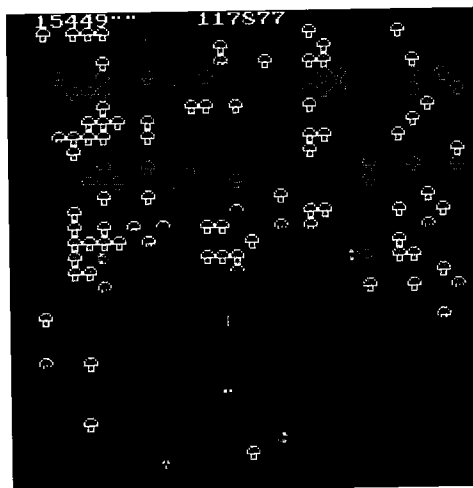
Even though the action in *Sinistar* did not take place only on one screen, it is still considered to be an example of the classic arcade game form.

tives in the game. For example, in *Centipede*, the player gets 1 point for destroying a mushroom, 10 points for a centipede segment, 100 points for a centipede head, and 1000 points for a scorpion. Another classic arcade game component with origins in the world of pinball, the score allows the player to ascertain how well they did at the game, since winning the game is impossible. The high-score table was introduced in order to allow players to enter their initials next to their score, which would then be ranked in a table of scores so players could see just how good they were. The game would remember the table as long as it stayed plugged in, with some games, such as *Centipede*, even remembering the high-score list or some portion of it once unplugged. The high-score table enabled the classic arcade games to exploit one of the key motivations for playing games—"bragging rights." A player could point out her name in the high-score table to her friends as a way of proving her mettle. Friends could compete with each other (almost all of the games included two-player modes, where players switch off playing) to see who could get the higher score.

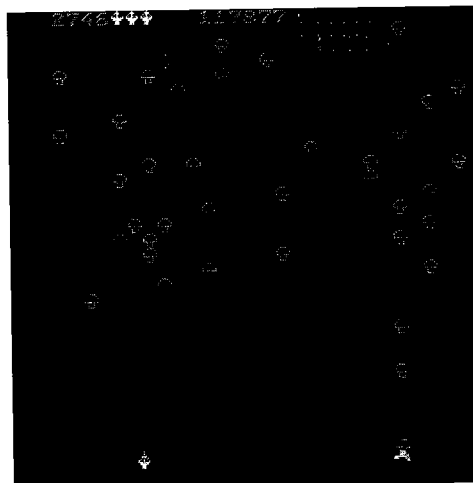
Easy-to-Learn, Simple Gameplay: Classic arcade games were easy for players to learn, impossible (or at least very difficult) to master. Someone could walk up to a game of *Centipede*, plunk in his quarter, and by his third life have a good idea of how the game functioned and how he might play better. Why the player died was always completely apparent to the player. There were typically no "special moves" involving large combinations of buttons which the player had to learn through trial and error. There were few games with tricky concepts such as "health" or "shields" or "power-ups." Again, commercial considerations were probably a factor in making these games simple to learn. At the time of their initial introduction, there was no established market of computer game players and there were few arcades. The games wound up in pizza parlors and bars, where any person might walk up to one and try it out. These novice players might be scared away if the game were too complex or baffling. Of course, simple does not always mean "limited" or "bad" gameplay; it can also mean "elegant" and "refined."

No Story: Classic arcade games almost universally eschewed the notion of trying to "tell a story" of any sort, just as many modern arcade games continue to do. The games always had a setting the player could easily recognize and relate to, many of them revolving around science fiction themes, though others dabbled in war, fantasy, and sports, among others. Many, such as *Pac-Man* and *Q*Bert*, created their own, unique settings, keeping up with the rampant creativity found in their gameplay. The classic arcade game designers did not feel required to flesh out their game-worlds, to concoct explanations for why the player was shooting at a given target or eating a certain type of dot, and the games did not suffer for it.

Of course, some games broke some of the above rules of the form, yet they can still be considered classic arcade games. For example, *Sinistar* and *Defender* both included scrolling game-worlds for the player to travel through, with the player unable to see all aspects of the game-world at any one time. Indeed, on first inspection, *Battlezone* seems entirely the odd man out among early classic arcade games. Yet, if one looks at the traits above, one will discover that it featured infinite play, multiple lives, and scoring, was easy to learn, and had almost no story. All three of these games included mechanics which, by and large, were adherent to



The player's shooter in *Centipede* is more mobile than in *Space Invaders*, since it can move up and down in addition to moving sideways.



In *Centipede*, fleas drop toward the bottom of the screen, leaving mushrooms behind them, while spiders eat whatever mushrooms block their movement.

the classic arcade game form. Thus we can still group them with games like *Space Invaders* and *Asteroids*, games which follow all the rules laid out above.

Being one of the defining games of the form, *Centipede* follows all of the aspects of the classic arcade game form listed above. Though not a very complex game by today's standards, the marvel of *Centipede* is how all of the different gameplay elements work together to create a uniquely challenging game. Nothing in *Centipede* is out of place, nothing is inconsistent, nothing is unbalanced. To analyze *Centipede* is to attempt to understand how to design the perfect game.

Input

One of the great advantages to working on a game for the arcades is that the designer has complete control over the type of device the player will use to control the game. On the PC, the designer can only count on the player having a keyboard and a mouse, while on a console, the designer must work with the standard controller that comes with that particular console. The arcade designer (budget constraints notwithstanding) is able to pick the best type of control for the game, and provide the player with that control system. The designer can then create

the game around those controls, precisely balancing the game to work perfectly with that input method. *Centipede* does this expertly, providing the player with an extremely precise analog control device in the form of a trackball. This is ideally suited to moving the player's shooter ship around on the bottom of the screen. Players can move the ship quickly or slowly, whatever the situation calls for. For many fans of *Centipede*, the excellent controller is one of the first things they remember about the game.

The shooter is extremely responsive to the player's manipulation of the trackball, with the player being able to easily and intuitively understand the relationship between her manipulation of the trackball and the shooter's movement. *Centipede* was no doubt inspired by other classic arcade games, such as *Space Invaders*, which feature the player's game-world surrogate locked at the bottom of the screen, allowed only to move left, move right, and shoot. *Centipede* takes that idiom one step further: the player is still trapped at the bottom of the screen, but the shooter can move within a six-row vertical space. This allows the player to avoid enemies that might be on the bottom row. At the same time, the shooter can still only shoot forward, so enemies that get behind the ship cannot be destroyed. Aside from the trackball, the only other control the player has is a button for firing the shooter's laser-type weapon. The game allows an infinitely fast rate of fire, but only one shot can be on the screen at a time which means the player has to think beyond just holding down the fire button constantly. If the player moves the shooter directly below a mushroom she can hold down the fire button and quickly shoot the mushroom four times, thus destroying it. But at the top of the screen, where the player cannot maneuver the ship, destroying a mushroom takes much longer, since the player must wait for each shot to hit the mushroom before another shot can be fired. If the player's shot is in the midst of traveling to a faraway target, she will be unable to shoot again in order to take out a divebombing enemy. The player must plan her shots carefully, a design element that adds more depth to the game's mechanics.

Interconnectedness

One of the great strengths of *Centipede* is how well all the different elements of the gameplay fit together. Consider the different enemy insects that try to kill the player. The centipede winds its way down the screen from the top of the screen to the player's area at the bottom, moving horizontally. The centipede appears as either a lone twelve-segment centipede or as a shorter centipede accompanied by a number of single heads. At the start of a wave, the

number of centipede segments on the screen always totals twelve. Next is the spider, which moves in a diagonal, bouncing pattern across the bottom of the screen, passing in and out of the player's area. Then comes the flea, which plummets vertically, straight down toward the player. There is nothing terribly sophisticated about any of the movement patterns of these insects. Indeed, the flea and the centipede, once they have appeared in the play-field, follow a completely predictable pattern as they approach the player's area. The spider has a more random nature to its zigzagging movement, but even it does nothing to actually pursue the player. Therefore, once the player has played the game just a few times, he has a completely reliable set of expectations about how these enemies will attack him. Fighting any one of these creatures by itself would provide very little challenge for the player. Yet, when they function together they combine to create uniquely challenging situations for the player. With any one of these adversaries missing, the game's challenge would be significantly diminished, if not removed altogether.

Each of the insects in the game also has a unique relationship to the mushrooms which fill the game's play-field. The primary reason for the existence of the mushrooms is to speed up the centipede's progress to the bottom of the screen. Every time a centipede bumps into a mushroom, it turns down to the next row below, as if it had run into the edge of the play-field. Thus, once the screen becomes packed with mushrooms, the centipede will get to the bottom of the play-field extremely quickly. Once at the bottom of the screen, the centipede moves back and forth inside the player's area, posing a great danger to the player. So, it behooves the player to do everything he can to destroy the mushrooms on the play-field, even though the mushrooms themselves do not pose a direct threat. Further complicating matters, every time the player shoots a segment of the centipede it leaves a mushroom where it died. Thus, wiping out a twelve-segment centipede leaves a big cluster of mushrooms with which the player must contend.

As the flea falls to the bottom of the play-field, it leaves a trail of new mushrooms behind itself, and the only way for the player to stop it is to kill it. The flea only comes on to the play-field if there are less than a certain number of mushrooms on the bottom half of the screen. This way, if the player destroys all the mushrooms closest to him, the flea comes out immediately to lay down more. The spider, the creature that poses the biggest threat to the player, has the side effect that it eats mushrooms. This then presents the player with a quandary: shoot and kill the spider or just try to avoid it so it can take out more mushrooms?

Finally, the scorpion, a creature that travels horizontally across the top half of the screen and hence can never collide with and kill the player, poisons the mushrooms it passes under. These poisoned mushrooms affect the centipede differently when it bumps into them. Instead of just turning down to the next row, the centipede will move vertically straight down to the bottom of the screen. So when a centipede hits a poisoned mushroom, the centipede becomes a much more grave threat than it was before. Once a scorpion has passed by, the player must now expend effort trying to shoot all the poisoned mushrooms at the top of the screen or be prepared to blast the centipedes as they plummet vertically straight toward the player.

So we can see that each of the creatures in the game has a special, unique relationship to the mushrooms. It is the interplay of these relationships that creates the challenge for the player. The more mushrooms the flea drops, the more mushrooms the scorpion has to poison. The spider may take out mushrooms along the bottom of the screen, getting them out of the way of the player, but it may eat so many that the flea starts coming out again. If the player kills the centipede too close to the top of the screen, it will leave a clump of mushrooms which are difficult to destroy at such a distance, and which will cause future centipedes to reach the bottom of the screen at a greater speed. However, if the player waits until the centipede is at the bottom of the screen, the centipede is more likely to kill the player. With the mushrooms almost functioning as puzzle pieces, *Centipede* becomes something of a hybrid between an arcade shooter and a real-time puzzle game. Indeed, some players were able to develop special strategies that would work to stop the flea from ever coming out, thus making the centipede get to the bottom of the screen less quickly and allowing the player to survive for much longer. It is the interplay of each of the player's adversaries with these mushrooms and with each other that creates a unique challenge for the player.

Escalating Tension

A big part of the success of *Centipede* is how it escalates tension over the length of the game. The game actually has peaks and valleys it creates in which tension escalates to an apex and, with the killing of the last centipede segment, relaxes for a moment as the game switches over to the next wave. One small way in which the game escalates tension over a few seconds is through the flea, which is the only enemy in the game the player must shoot twice. When it is shot just once, its speed increases dramatically and the player must quickly shoot it again lest the flea hit the shooter. For that brief speed burst, the player's tension escalates. In

terms of the centipede itself, the game escalates the tension by splitting the centipede each time it is shot. If the player shoots the middle segment of an eleven-segment centipede, it will split into two five-segment centipedes which head in opposite directions. Sure, the player has decreased the total number of segments on the screen by one, but now he has two adversaries to worry about at once. As a result, skilled players will end up going for the head or tail of the centipede to avoid splitting it.

Most of the game's escalating tension over the course of a wave is derived from the centipede's approach toward the bottom of the screen and the player's often frantic efforts to kill it before it gets there. Once a centipede head reaches the bottom of the screen, a special centipede head generator is activated, which spits out additional centipede heads into the player's area. If the player is unable to kill the centipede before it reaches the bottom of the screen, which has already increased tension by its very approach, that tension is further escalated by the arrival of these extra heads. And those extra heads keep arriving until the player has managed to kill all of the remaining centipede segments on the screen. The rate at which those extra heads come out increases over time, such that if the player takes her time in killing them, additional centipedes will arrive all the faster, making the player still more frantic.

Once the player kills the last segment, the game goes to its next wave, and the centipede is regenerated from the top of the screen. This provides a crucial, temporary reprieve for the player, a moment for her to catch her breath. The player will feel a great rush at having finally defeated the centipede, especially if the extra centipede head generator had been activated. In addition, the newly generated centipede at first appears easier to kill, since it is generated so far from the player's area.

Over the course of the player's entire game, the mushrooms inevitably become more and more packed on the play-field. Once there are more mushrooms toward the bottom of the screen, the player feels lucky if he can just clear all of the mushrooms in the lower half of the play-field. He has no chance of destroying the mushrooms toward the top, since the lower mushrooms block his shots. Similarly, if the scorpion has left any poison mushrooms toward the top of the screen, the player has no chance whatsoever of destroying them, and as a result the centipede dive-bombs the bottom of the screen on every single wave. Far into a game, the top of the play-field becomes a solid wall of mushrooms. As the mushrooms become more and more dense, the centipede gets to the bottom of the screen faster. When the centipede

