UPLIFT

Designing for Flow in Action Games

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ABSTRACT

This paper is a description of the action game *Uplift*. *Uplift* is intended to provide interested individuals with not only a compelling game but also a malleable instrument for exploring the mental state known variously as 'flow' or 'the zone'. This state of mind, which has not thus far been documented to a great extent beyond personal anecdotes, has been often associated with dramatic increases in individual task performance, as well as a sense of well-being. Herein I will describe the background and known information on the 'zone' state, relate this to case studies of prior work in the form of popular video games, and discuss how this has influenced the design of *Uplift*. A detailed system description is also present.

1. A BRIEF HISTORY OF 'FLOW'

Whilst the term 'flow' was first coined by Prof. M. Csikszentmihalyi in his 1990 book *Flow: The Psychology of Optimal Experience* [1], a very similar concept is integral to various martial arts, including but not limited to aikido and kendo, dating back as far as the 17th century. The practitioners of those arts, both in antiquity as well as in the present day, strove to cultivate a mental state which eliminated all distractions or trivialities. They emphasized the importance of unselfconsciousness and described this state as "the mind of no mind" - in other words, a state in which one is completely focused on a task without making a conscious effort at concentration. It is important to note that this is the antithesis of the sort of "tunnel vision" in which the individual is so focused on a part of the task as to neglect the remaining parts; in "the mind of no mind", the individual's vision encompasses the entirety of the specific task, but admits little to no external interference.

CSIKSZENTMIHALYI'S CHARACTERISTICS OF FLOW

Probably the first attempt at a scientific treatment of the subject was Csikszentmihalyi's. In *Flow*, he describes the eponymous phenomenon as "order in consciousness" and enumerates eight characteristics which have been observed at various times, retrospectively, by persons experiencing it. These are, in no particular order:

A challenging but tractable task. The vast majority of Csikszentmihalyi's respondents reported that they experienced flow when performing a task or activity which demanded some form of skill or effort commensurate to their level of ability. In limited cases, it has been reported that the only "upper limit" is that the task not be perceived as completely impossible. This activity could be just about anything which challenges the individual, from reading to rock-climbing. Clearly, tasks which have a scalable level of challenge are the most amenable to displaying this characteristic, and it should be considered a virtual pre-requisite for entry into the flow state.

Perfect concentration. As with martial artists, the individual experiencing flow is

perfectly focused on the entirety of the task at hand. Csikszentmihalyi's respondents reported that "the activity becomes spontaneous, almost automatic", and that their senses of self-awareness and self-consciousness were diminished. Indeed, one respondent noted that in this state, "you don't see yourself as separate from what you are doing" - a striking parallel to the kendo concept of *ki-ken-tai no icchi*, literally "unity of spirit, sword and body", but more often translated as "being one with the sword". Perfect concentration can be the result of flow, but often it is also, to a certain degree, one of the requirements for an individual to experience flow. This should be borne in mind when designing tasks which need to induce flow.

Clear goals, and *immediate feedback*. It was found that without a definite objective in mind, few or none of the respondents were able to attain anything resembling a flow state. Attaining the necessary level of involvement in the task at hand required not only that individuals understood what they were aiming for, but also that they could perceive clearly how close they were to reaching it. In some cases this was simple (such as a game of tennis), whilst in others (such as composing music) it was more complex - but it is evident that in the absence of a clear goal, individuals lacked the direction necessary to engage themselves fully in the activity. Again, this is a vital component of any flow-inducing task.

Full immersion in the task. This is not to be understood in the sense of virtual-reality "immersion" - though, to be sure, it is quite possible that that sort of immersion, in the right context, could potentially induce a flow experience - but rather as a result of the individual's level of focus. The result is that external considerations such as problems at work, relationships, and so on become irrelevant to the mind. In effect, the task creates order in the mind. Here I must make mention of the game-studies concept of the "magic circle" (Huizinga, 1938) [2] - when one enters the domain of the activity, any issues which do not affect the activity become irrelevant to it. This sort of immersion, then, can be understood as an extension of the magic circle, in that any issues which are irrelevant to the activity become irrelevant to the individual(s) enacting it. Although it might seem to be a property of the task, this is not quite the case; here the immersion stems

from the flow state, and is an effect of it rather than a cause.

The sensation of exercising control. Csikszentmihalyi specifically notes here that it is not the sensation of "controlling everything", per se, which is associated with the flow experience, but rather the sensation of exerting control where there is a possibility of failure. This goes hand in hand, naturally, with the requirement that the task be challenging but tractable, and may indeed be expressible as a direct result of that characteristic. He further promulgates the possibility that this is why enjoyable activities are often addictive: in such activities, the laws of entropy are temporarily suspended and the enactor is given the opportunity to perfectly control the universe of the activity within the magic circle - in stark contrast to the messy, decaying, impotence-enforcing world outside of it.

The loss of self-consciousness. This is closely bound up with the issue of "perfect concentration"; in fact, whilst Csikszentmihalyi makes a distinction between the two, it is more a case of the former being the *opportunity* to concentrate, as a requirement, and the latter being the *effect* of that concentration. He observes also that when an individual enters into an activity - into a magic circle, as it were - any aspect of her self which is not directly connected to the activity becomes irrelevant. I would venture to add that if the activity's level of challenge is well matched to the enactor's skill, even that skill level as it relates to others' level of ability becomes irrelevant, and hence the entirety of the self becomes external to the magic circle.

The transformation of time. It is not known whether this is an artifact of "full immersion", although this is highly likely. Individuals in the flow state have reported that time often transforms in one of two ways. At a micro-level, time seems to slow down - a ballet dancer reports that when performing a complicated pirouette, a few seconds feel like an hour. However, at a macro-level, the individual feels like time has sped up - that is to say, when they come out of the state, they have no idea how much time has passed, and feel as though the activity took much less time than it actually did. A final possibility is related to activities which are heavily time-dependent, such as racing; individuals experiencing a flow

state whilst engaging in these activities seem to have an accurate and acute rather than diminished sense of the passage of time, since proper time control is part and parcel of them.

FLOW AND MODERN RESEARCH

In general, flow research is currently being pursued in several areas, including game studies, sports science and some branches of psychology. Regrettably, whilst the flow state is a very real thing, it has become bound up with the "positive thinking" movement and certain mystical traditions, and hence does not afford an exceptional degree of credibility in parts of the academic world. (It does not help that few instruments, beside the human mind itself, are capable of detecting the phenomenon in the first place.) Of course, it is to be expected that the open-minded academic would not apply the principle of "guilt by association" to a theory or idea, as long as the idea itself is sound.

Sports psychologists and sports scientists are perhaps the most receptive and active when it comes to flow research, for a number of reasons. Chief among these are (1) that sportspeople appear to experience flow on a very regular basis, and (2) that sports psych people have traditionally had a strong association with "positive thinking" psychology, and hence are far more likely than traditional psychologists to be receptive to anything associated with it. Some of the more interesting results to emerge from this have been the correlation between the flow state and alpha brainwave activity. However, there have been few discoveries representing any sort of substantial information on the flow state over and above Csikszentmihalyi's original work.

Fontaine (1993) notes that flow must be treated as distinct from other similar mental states, including the somewhat-similar phenomenon of "presence"[3].

FLOW AND DIGITAL GAMES

Inexplicably, Csikszentmihalyi makes little mention of digital games in his work, although players of such games tend to produce reams upon reams of anecdotes and reports of flow experiences. The largest segment of the reports has come from

players of “older” or “retro” games, although there remains a steady trickle of reports from players of more recent games, particularly those of a more action-oriented bent, of such experiences. (Possible reasons for this will be explored in section 4, *Factors and Influences*.)

The games studies community, for its part, has been strangely silent. Although one would expect the Scandinavian structuralists at least to take an interest in flow as a function of game structure (as opposed to the representational aspects which interest much of the community), thus far, this has been limited to cursory mentions in support of other explorations. (Juul's essay *Time To Play – An examination of game temporality* is an excellent example.)

The most recent work in the intersection of flow and digital games is being undertaken by sports psychologist Dr. Costas Karageorghis, at Brunel University in the UK [4]. Although some questions have been raised regarding his experimental methodology, the fact remains that the subject is certainly worth investigation.

CRITICISMS OF CSIKSZENTMIHALYI

Several criticisms have been levelled against Csikszentmihalyi's work. In general, they either question his over-reliance on anecdotal evidence or simply reject the whole notion of flow altogether. The latter variety of criticisms can, I believe, be safely discarded; personal experience, as well as the massive body of evidence (albeit anecdotal) which supports the existence of the flow state, are more than sufficient to disprove the assertion that it does not exist. In particular, anecdotes relating to pursuits with fewer physical limitations, such as playing digital games and computer programming, tend to engender reports of substantial increases in task performance over the individual's average or even optimum non-flow performance. [5]

The former variety of criticism is in part responsible for the beginning of this project. It is clear that "flow" is not easily identified in a setting where it does not produce an unmistakably substantial performance increase, such as sports, except by the individual experiencing it. This is, unfortunately, inadmissible as “hard”

evidence. However, if some objective metric were to be furnished - such as score in a video game - in a setting where the performance increase from flow would be more easily distinguished from ordinary skilled play - such as a video game - then a more objective identification of the flow state would be possible.

2. 'ZONE'/'FLOW' IN EARLY DIGITAL GAMES

EXAMPLES AND COUNTER-EXAMPLES

The games in this section are those which appear frequently in accounts of 'zone' experiences. Here I will examine the design of each game and attempt to relate it to the existing flow literature, in order to identify the salient characteristics which contribute to the player's experience.

The selection criteria for the games in this section and the next were as follows: first, they had to have produced some report (preferably multiple ones) of a flow-like experience, or otherwise (especially in the case of very old games where anecdotes are difficult to find) be associated with the phenomenon of “zoning”. Second, the game had to be distinct in some way from other similar games within the same section, and preferably from other games in both sections.

It is arguable that "clear goals", "immediate feedback" and "a sense of control" are essential to any reasonably well-crafted game; certainly that is the case with these games. As such, they will not be discussed, except when they are conspicuously absent.

Pac-Man (Namco, 1980)

Perhaps one of the best-known and most iconic digital games ever, *Pac-Man* is a simple action game with highly abstract and iconic visuals. The emphasis of the game is on evasion and intelligent maneuvering, although it is possible to complete the game relying entirely on pre-planned movement patterns[6].

Whilst the inclusion of this game was more due to Windler's article, J. Frank's review of *Mars Matrix* makes special mention of *Pac-Man* and claims zone-like experiences with it, making special mention of the immersive and loss-of-self-consciousness aspects of the game: “There were days I would stand at the *Pac-Man* machine when I felt like I could do no wrong... All other cares would fall away and I would become the little muncher.”

The game is entirely situated within a static maze consisting of orthogonal corridors. All of the corridors, save for a couple of distinct locations, are filled with dots. The player's main objective is to control the player-avatar, Pac-Man, and move over ("eat") all of the dots, thus traversing the entire maze (except for the above-mentioned distinct locations). The player controls Pac-Man via direct joystick manipulation; Pac-Man will move in whichever direction the joystick is pushed - subject to the constraints of the maze walls.

The maze is also populated by four monsters, whose actions are limited to moving through the maze. The monsters will behave in different ways, although their tendency is to pursue Pac-Man. If a monster comes into contact with Pac-Man, it will eat it and the player will lose one "life". Initially the player has 3 "lives"; when all are lost, the game is over.

Four "power pills" are also located in the maze, one at each corner. If Pac-Man consumes a power pill, for a limited time, it will become invincible and any monsters in contact with it will be eaten, but will reappear at their starting location after awhile.

The game is divided into levels; the first 255 levels are playable, but the 256th level is corrupted and unplayable. Players generally consider this level to be the "end" of the game. When the player completes a level (by eating all of the dots), the positions of all game objects are reset, and the level is repopulated with dots and power pills.

Score is accrued whenever Pac-Man eats a game object. In particular, monsters are worth more points if Pac-Man eats more than one of them under the influence of a single power pill. Also, in certain levels, a bonus point object will appear at a specific maze point. If the player manages to reach this point before the object disappears, a substantial point bonus is earned.

As the game level increases, the power pills become effective for a shorter and shorter duration. Eventually, around level 20, the power pills become completely ineffective, although they still force the monsters to change direction when eaten. Furthermore, the speed of the game increases with each successive level, although it apparently levels off at an acceptable value.

Whilst the game's mechanics are straightforward, the scoring system of the game is predicated upon risk and reward. Moving to a "fruit" (bonus point object) before it disappears tends to be risky, as does an attempt to eat multiple monsters on a single power pill. Both of these are necessary in order to optimize one's score. In

other words, it can be said that *Pac-Man*'s difficulty is directly proportional to the player's goals in terms of score. Since those aims will generally be commensurate to the player's ability, it follows that the difficulty of the game remains fairly constant throughout a game session and, as long as the player is skilled enough to at least play for "survival", is well-matched to the player's ability.

A key distinction between *Pac-Man* and many games is that *Pac-Man*'s difficulty scales relatively mildly by level. In other words, if the player's skill is insufficient to survive at a "break-even" level (i.e. the player loses lives faster than he/she gains them), then the difficulty level will never be commensurate to the player's skill level. Conversely, if the player has sufficient skill to play the game at a break-even level, then the difficulty level in a given game session is unlikely to rise to the point where the game's challenges significantly outstrip the player's skills. This is notable in that it uniquely fulfills Csikszentmihalyi's "challenging but tractable task" condition over an entire play session instead of a portion thereof.

It is also notable that *Pac-Man* requires significant use of the player's peripheral vision. "Tunnel vision" is the cardinal sin when playing the game, as it usually leads to the player being trapped by monsters approaching from different directions and losing a life. As I will later show, peripheral vision is quite important when dealing with "zone" games.

Space Invaders (Taito, 1978)

Space Invaders is arguably the prototype for all the "vertical shooting" games which followed it, up to the present day. Even the narrative is instantly recognizable: invaders from space march down relentlessly towards the (human?) player and must be defeated before they reach their goal.

M.G. Jones, in his paper “Creating Engagement in Computer-based Learning Environments”, relates how he observed his college friends experiencing flowlike states: “Once in the game, they could be in a Zen-like state of complete attachment to the task at hand... Despite the fact that there was no authentic problem for them to solve, they found themselves completely engrossed in the task.”

The game's entire environment consists of four barricades, which will stop both the player's shots and the invaders'. The barricades can be eroded by repeated weapon strikes.

The player-avatar is a small object (a tank, spaceship or mobile base depending on who you ask), which is situated at the bottom of the screen and can move along the horizontal axis. In the first-generation machines, this was controlled using a dial, but the dials were later replaced by buttons. Another button, when depressed, fires a shot upwards from the player-avatar. Only one shot can be on screen at a time; until it has left the screen, the player cannot fire again. If a shot

strikes an invader or another shot, both the shot and the object it struck are destroyed.

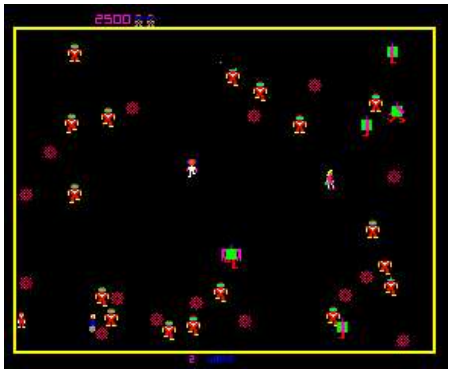
The enemies consist of 55 "invaders", organized in a block formation. They move horizontally in one direction, maintaining their formation, until they can no longer move - then they drop one level and reverse direction. The invaders will also shoot downwards at random intervals. If an invader's shot strikes the player avatar, the player loses one life - as with *Pac-Man*, the initial number of lives is three. If the player loses all the lives, or the invaders reach the bottom of the screen, the game is over.

The player earns points for shooting the invaders. In addition, occasionally a flying saucer will fly across the top of the screen; if the player manages to shoot it, a random but substantial point bonus will be awarded.

Level progression affects the invaders' starting position (the further on the player is, the lower the invaders start), the game speed and possibly the invaders' aggressiveness. However, after Level 9, the difficulty resets to Level 1.

Unlike *Pac-Man*, *Space Invaders*' difficulty ramps up significantly, although the case could be made that it is not an easy game to begin with. The strict time constraint of the game (due to the invaders' advance) is a significant factor. Risk/reward mechanics are minimal; the only "risk" involved which has an associated "reward" other than survival is to engage the bonus flying saucer. I would assert that the game, whilst it still fulfills the "challenging but tractable" condition, does so far less than *Pac-Man*. It is noteworthy, however, that *Space Invaders* also requires extensive use of peripheral vision to gauge one's aim whilst avoiding return fire. (This appears to be a characteristic of a large number of games, especially of the older persuasion, but it is by no means common to all games, or even to all the games I will be discussing.)

Robotron 2084 (Williams, 1982)



The case could be made that *Robotron* is an ancestor of the 3D first-person shooting games of the present day. Indeed, the later *Castle Wolfenstein*, which inspired *Wolfenstein 3D*, widely held to be the first "modern" FPS (first-person shooter), reveals influences from *Robotron*.

In Windler's collection of anecdotes, a contributor identified as “Ron” writes:
“I was playing Robotron for free in a grocery store at 2am in the morning. I started thinking about something else, I was totally unaware that I was playing at all. When I re-entered reality, I was well beyond any level I reached before and had many lives left which I lost quite quickly in my awakened state.” (The section on *Parsec47* (see p. 32) has a discussion on the wandering-mind subphenomenon.)

The entire action of the game takes place within a rectangular arena. At the beginning of every level, the player-avatar (a supposed superhuman) is located at the centre of the arena. Hostile "Robotrons" and traps, as well as human civilians, are scattered throughout the arena. The player's objective is to save the humans (by walking over them) whilst shooting the Robotrons.

The player-avatar is capable of moving in any direction, and shooting in any direction independently of its movement. This is accomplished using a unique two-joystick control setup which is seldom found in games these days. Unlike *Space Invaders*, multiple player-launched projectiles can be on screen at one time, and the player-avatar can fire them rapidly. These will damage or destroy any traps and most Robotrons in their path, but will not harm the humans.

The humans in Robotron are purely there for scoring. Allowing them to be killed will not prevent the player from progressing, except insofar as the lower score that results will make "extra lives" less frequent.

Robotron was noteworthy for its time in that it features a variety of enemies with unique capabilities. Some are invincible but slow-moving, whilst others can shoot at the player or even generate more enemies. All are fairly distinct in appearance and will move around the arena. If the player-avatar comes into contact with an enemy or enemy shot, it dies - again, 3 lives are provided. Only certain enemies, however, will kill the civilians on contact or attempt to attack them.

If the player-avatar, or some types of Robotron, comes into contact with a trap, both the trap and the contacting object (avatar or Robotron) will be destroyed.

Level progression in Robotron is pre-scripted, with each level having a semi-unique distribution of enemies, humans and traps; the game objects' positions are randomized at level start (other than the player avatar). The difficulty of any given level is determined solely by the enemy distribution, but after level 28 it does not become significantly more difficult. After level 255, the game resets to level 1.

Robotron's difficulty varies significantly between its first level and later levels, although the difficulty curve is not excessively steep; this is mainly a function of the first level being trivial to complete. As with *Pac-Man*, there is a significant risk/reward element expressed in terms of passing through a dangerous location or area to obtain a reward which may disappear unless the player hurries to collect it. This tends to ameliorate the game's difficulty, although it is still by no means an easy game, and makes the task significantly more tractable - there is no question that it is, indeed, challenging to all but the most skilled players.

It is, however, questionable whether *Robotron 2084*'s design affords a sense of control. The random layout of the levels means that one's position might be untenable right at the outset. Peripheral vision is tested significantly in *Robotron*, as the rapid identification of threats as soon as they appear is vital to survival.

Defender (Williams, 1980)

The most commonly cited piece of information about *Defender* is that it was originally deemed a flop when it debuted at a Chicago trade show, due to its complexity and level of difficulty. Even by the standards of the time, the game was unforgivingly difficult, and it is not inconceivable that many players of today would consider it wholly unplayable. Still, there are numerous assertions that *Defender* is "the quintessential zone game", although actual anecdotes are not common; one poster to the newsgroup rec.games.video.arcade.collecting has related that he was sufficiently "in the zone" (although it is difficult to tell whether this was a true "zone" experience) to continue playing the game, and obtain a high score, whilst the arcade he was in slowly flooded due to a leak in the room above.

Noted game designer Raphael Koster, in his *Theory of Fun for Game Design* [7], asserts that *Defender* is a direct ancestor of modern 2D shooting games such as *Gradius* (of which more later). A casual observer examining static screenshots of the two games would likely assume that they are topologically identical with regards to gameplay; this is not the case. In fact, whilst *Defender* made significant contributions to future shooting game development, it is quite dissimilar to modern games of the type and in fact included several features which have not been seen in the vast majority of its successors.

The game takes place in a 2D environment viewed from the side rather than top-down. The "world" of *Defender* is an elongated "slice" of earth and sky, although

the player only sees a segment of it (more or less centered on her ship, or player-avatar) on the screen at any one time. However, the entirety of the game world can be seen on a small "radar" display in one corner of the main screen, including the locations of the player-avatar and other game objects. The world is a continuous strip; if the player-avatar flies off one edge, it will "wrap around" onto the other edge. It is normally impossible to tell where the "seam" is. There is a "ground level" with a game effect, but the player-avatar can fly through it at will without colliding with it.

The player-avatar, as with many games of the type, is a small and nondescript spaceship or fighter aircraft. It is always aligned horizontally, and can change altitude according to the player's joystick control (albeit slowly). Two buttons are used to control the ship's flight; one, the "thrust" button, makes the ship accelerate forward, whilst the other ("reverse") turns it around instantly - although it does not change its momentum. Hence the ship's position is only directly manipulatable on one axis, whilst on the other it is indirectly controlled by the flight buttons.

There are three additional controls: the obligatory "shoot" (which can be tapped rapidly to produce a rapid-fire effect), the "smart bomb", which launches the eponymous weapon, of which the player has three at the start of the game, to destroy all enemies on screen, and the "hyperspace" button, which instantly transports the player to a random location in the game world.

Non-player game objects in the world include human civilians (clearly a precursor to *Robotron*'s civilians) and several different types of alien craft, which are placed in random locations in the world at the start of each level. Destroying all the "normal" alien craft in a level will end the level. However, the civilians are notable in that the game is as much about protecting them as it is about destroying the aliens, for a couple of reasons.

First, the most common type of alien craft will attempt to abduct the civilians and carry them to the upper edge of the game world. If the player should destroy the alien craft, the civilian will fall; if the civilian only fell a short distance, it will

survive, but if it fell a long way, it will die on impact. However, the player can save a falling civilian by catching it with her ship and then flying to the ground; this accrues a very large point bonus for the player. The player can also halt an abduction by shooting (killing) the civilian who is being abducted. If the player does nothing to stop the abduction, upon "success", the alien ship performing the abduction will transform into a faster, more aggressive "mutant" type which will actively try to hunt down the player and even possibly kamikaze itself into his ship. Hence there is positive as well as negative reinforcement involved in encouraging the player to save the civilians.

Second, if all the civilians are killed or abducted, the "world" explodes, and a large number of mutants instantly appear at random world locations. They will return every level as long as the world is gone. However, every five levels, the world and the civilians reset themselves.

Defender is not trivial even on the first level. From then on, it gets harder. The second level introduces all the different types of alien craft, and subsequent levels simply make the alien craft more aggressive - in other words, they are more apt to attack the player and attempt abductions. Other than that, each level is the same as the next.

It is difficult to tell how one gets into "the zone" in *Defender*, even though some classify it as the quintessential "zone" game [8]. "Tunnel vision" is a constant threat in the game, which leads me to suggest that only players who have practised the game many times are capable of "defocusing" to the extent necessary in order to achieve the flow state. It is clear, though, that the game's demands on the player's concentration can and will cause the state to be sustained for extremely long periods of time, leading to very dramatic "zone" experiences and incontrovertibly high scores.

Gradius (Konami, 1985)

Gradius typifies just about every shmup (short for "shoot 'em up", now a commonly accepted term for 2-D scrolling shooting games) released thereafter. Whilst it does not make use of a very small number of the genre's conventions, it is still instructive to examine this title.

Although the genre engenders a great number of “zone” associations, it's interesting to note that there are relatively few associated specifically with *Gradius*. One M.Nowak relates an interesting story of having played the game (badly) as a child, putting it away for a number of years, and then later unpacking it out of nostalgia to play again – and immediately being able to clear the entire game. Whilst this alone is not an obvious “zone” experience, few other explanations for his performance – if the anecdote is to be believed – present themselves.

As stated earlier, *Defender* and *Gradius* are visually quite similar, although *Gradius* clearly benefits from the intervening years of advancement in graphics. However, their gameplay is quite different. In *Gradius*, the screen scrolls at a fixed rate, always in the same direction. The player's movement control is limited to moving his avatar (once again, a small starfighter) around the screen with direct manipulation via joystick (although later ports of the game allowed control via a gamepad). The requisite fire button is, as always, present. No smart bombs are

available, in contrast to the shmups of the late 1980s and early 1990s where they were practically de rigueur for the genre.

A notable innovation in *Gradius*' gameplay is the ability of the player to customize her avatar's capabilities. Unlike other games in the genre, which have different types of "power up" items with specific functions, there is only one generic type of "power up" in *Gradius*. Collecting power-ups advances the position of a gauge at the lower edge of the screen. Depressing the "power up" button will purchase a specific, permanent enhancement for the player-avatar, which is dependent upon the gauge position, and reset the gauge. If the player-avatar is destroyed, all enhancements gained in this manner are lost.

Once again, the player-avatar will be destroyed with a single shot or collision, although a "shield" can be purchased using the power-up system which will absorb a small number of shots. In addition, there are collidable obstacles (such as walls) in *Gradius*. As always, a variety of enemy types are present.

A convention which *Gradius* uses, which has been adopted by just about every shmup since, is that of the "boss" enemy - a single extremely powerful enemy, or a series of very powerful enemies, whom the player encounters at the end of a level and must defeat to continue (see Appendix A). Clearly, this is used as a method of imparting a sort of crude dramatic arc to the game. It also presents a design problem in that the whole concept of the "boss" sets up expectations on the part of the player which must be fulfilled lest the encounter be rendered anti-climactic. (Certain games since have played with those expectations, notably *Earthworm Jim* [9], which introduced a deliberately anti-climactic boss encounter as a humor element.)

By simplifying the player's control system (compared to *Defender*), the developers of *Gradius* have, to a certain extent, lowered the barriers to entry, at the risk of rendering parts of the experience trivial for seasoned players. As such, it would theoretically be less amenable to the flow experience. Experience with the game, however, suggests that this is not the case due to the level structure and power-up

placement. At the start of most of the levels, the player is beset by a number of formations of small enemies which are trivial to avoid, but difficult to destroy completely. Destroying a complete formation, however, yields a power-up item. Hence even experienced players will try to aim for the more difficult goal of destroying as many enemy formations as possible in the early part of the level and collecting more power-ups. Design-wise, this is an interesting way of balancing the game's challenge - using an increasing-power "hook" rather than score bonuses as the "carrot".

Another feature of the game which must be called into question is the "boss encounter". In my experience, such encounters tend to encourage "tunnel vision" on the player's part. Often, however, games will introduce subsidiary "henchmen" for the boss during the battle, preventing the player from focusing entirely on the boss; this is one way of mitigating that effect. To the best of my knowledge, however, this has not been done in *Gradius*.

There is a final "feature" of *Gradius* and other games of its ilk which I originally called into question, but on which I have, at the time of this writing, recanted my position. That feature is predictability. Unlike games such as *Defender* or *Robotron*, *Gradius* presents the player with a largely static experience. Each level contains a precise sequence of enemies, challenges and hazards, and the bosses can be defeated by employing specific patterns of movement and attack. It is arguable that this reduces the challenge to one of memorization, but I would venture to assert instead that the challenge of the game is not only of memorization but also of enactment and adaptation. Undoubtedly, memory is an asset in certain sections of the game, but it will do the player no good unless she has the requisite skill to actually enact the pattern. Furthermore, it is probably impossible to memorize the exact sequence of movements required to clear the game - even though that may exist - and so adaptation and reflexes are required for those interstices where the sequence cannot be remembered. In some ways, it is quite possible that memorization may actually be conducive rather than detrimental to flow; I say this because of Csikszentmihalyi's point on 'perfect concentration'. If the mind is focused on a single type of task (e.g. dodging

bullets), it follows that only a segment of the brain is being used, and the rest is lying idle. This often leads the player's mind to "wander" (i.e. use up excess mental capacity in other areas), which has a tendency to break concentration. However, if the task domain requires several different but related skills (dodging bullets, remembering a sequence, enacting that sequence), the tendency to attempt to "fill up" one's consciousness with extraneous tasks is somewhat alleviated.

Tetris (Atari,1988)

Another household name, *Tetris*' gameplay places it quite firmly within the "puzzle" genre. It is unique among the games under discussion here in that there is no player-avatar.

There is some argument over whether *Tetris* makes a “good zone game”, but in general the consensus (among those who are interested) seems to be that, at least at intermediate levels, it is capable of creating a flow effect. No specific anecdotes, sadly, could be found.

The gameplay of *Tetris* is fairly simple. The "world" of the game is a narrow vertical well. Small blocks, each composed of four squares, fall from the top of the well one at a time. The player's control over the game is limited to manipulating the block currently falling, by rotating it, moving it from side to side with the joystick, or making it fall faster. The well is 10 squares wide, and the blocks can only be manipulated into positions aligned to the underlying grid. When a block can fall no further due to being supported by the bottom of the well, it stops and the next block is dropped into the well. The player's task is to form complete rows of squares from the left edge of the well to the right edge; when a row is completed, it disappears from the screen and all the blocks above it move down to fill the gap. As the levels increase, the speed of the game increases and additional rows of "junk" (blocks with empty space in between) may be present at the bottom of the well. Scoring is based on the number of rows cleared in a single move. If the

stacked-up blocks reach the top of the well, the game is over.

The clearest feature of *Tetris* is its risk/reward system, which is probably even more pronounced than that of any other game in this section. Attempting to keep the screen clear is very easy, but results in the player completing only single rows at a time; this tends to have a pronounced effect upon the player's score. However, although setting up multiple-row moves will increase the score, it also tends to be risky - often the sides of the well will be stacked high with "unwanted" blocks, greatly reducing the allowable margin of error. As I have stated earlier, risk/reward systems work to mitigate a game's challenge level for beginners whilst increasing the challenge for experts.

However, it has been asserted [8] that *Tetris* cannot support the "zone" experience as well as some older games. This is due to the fact that on the highest level of play, it is physically impossible to manipulate the falling blocks rapidly enough to reach the player's intended position. This not only results in a loss of control-feeling (Csikszentmihalyi's 6th point), it also destroys the tractability of the task (1st point).

3. MORE RECENT EXAMPLES

Having examined some reports of more recent 'zone' experiences, I must conclude that it would be irresponsible to focus on older games to the exclusion of newer ones. As such, this section will examine several examples from disparate genres and/or with different visual styles.

Virtua Fighter 4 (Sega, 2001)

Virtua Fighter 4 is structurally typical of the "fighting" genre of video games, which traces its roots back as far as 1984's *Karate Champ* and possibly beyond. As with nearly all other games of the genre, it consists of a series of one-on-one "fights" between a player-controlled character/avatar and one controlled by either a second player (in two-player mode) or the computer (in single-player mode). In general, the computer characters possess statistics and capabilities comparable to those of the human-controlled characters.

Dr. Karageorghis of Brunel (see p. 9) has conducted some studies which appear to suggest that skilled Virtua Fighter players are capable of achieving flow during gameplay, apparently to nearly the same extent that professional athletes do. As one of the few games which is being used for empirical research into flow, it would be remiss on the part of this writer not to include it.

The world, or environment, of each fight is a square arena. Characters can move around the arena freely, although the movement system is a polar coordinate system using one's opponent as a center point. The camera typically displays the game's action from a side view relative to the positions of the two characters. It is

also possible to move in the third dimension by jumping or crouching.

Before the game starts, players choose a character to act as their avatar in the game. Each character has a different, but roughly comparable, set of statistics and abilities. If the game is running in single-player mode, the computer characters generally are drawn from the same selection as player characters, and challenge the player in a fixed order.

Each fight consists of a number of rounds. At the end of each round, the winner of the round gains a point, and the first character to reach 3 points, or to have 2 points more than his/her opponent, wins. Rounds are won by either forcing one's opponent out of the arena or reducing his/her "health" to zero, thereby knocking him/her out.

The basic controls for the game are straightforward: the stick moves one's character, whilst one button each is assigned to making the character punch, kick or guard against attacks. In addition, as with virtually all games in the genre, a wide range of moves can be accessed, either through rapid stick movements, "chording" combinations of button presses, or some combination of both.

Whilst to a layperson it might seem simple, *Virtua Fighter 4* (as with many other fighting games) in fact requires a wide variety of tactics. Characters can only guard one area of their body at a time, meaning that it is possible to "read" and thereby break through a guard. Attacks can be countered by other attacks or evaded entirely, guarding characters are vulnerable to being thrown, and whilst it is possible to perform an unbreakable chain of moves (a "combo" in fighting game parlance), a single mistake will leave the player open to a counterattack.

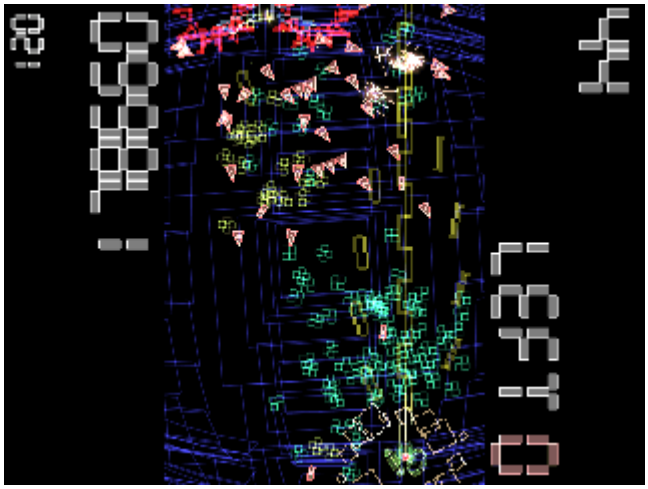
As such, the game, at least at higher levels of play, is quite demanding. A skilled player must not only memorize the moves and combos available to any character she wishes to use; she must also know what her potential opponents are likely to do and how to counteract them. Furthermore, all this must be at the player's fingertips (literally); "reading" and reacting to the opponent's moves rapidly, as

well as performing one's own moves correctly, is vital. As I have noted in the case of *Gradius*, this is conducive to flow because it leaves the player little room for extraneous and potentially distracting thought.

The rigid difficulty of the game, however, must be counted against it; score is typically not considered important to a fighting game, and hence there is little incentive to take risks over and above those presented to the player in the course of the game. Hence the difficulty level is not variable, unlike *Defender* et. al. The corollary to this is that the single-player game becomes nearly trivial once one has reached a certain level of skill, and only playing against a human of comparable skill will provide sufficient challenge for a player to experience flow. Whilst multi-player capability is usually a good thing, the fact that a skilled player can only gain real satisfaction through multi-player play must, unfortunately, be held against the genre as a whole. (It must be noted that home console versions of *Virtua Fighter 4* and other fighting games suffer from this less, as they usually have a "difficulty" setting which allows the player to set the competence level of his opponents.)

Finally, *Virtua Fighter 4* suffers to some degree from the "tunnel vision" problem, although less so than many other fighting games. It is mitigated by the possibility of being forced out of the arena (requiring that the player be aware of his surroundings) as well as the relatively short camera distance during a close-in fight.

Parsec47 (ABA Games, 2003)



Parsec47 is unique among all the games discussed here in that it is a freeware game developed by a single individual. Although its graphics use 3D acceleration, the overall visual design is a clear homage to the days of vector graphics in the arcades, and invite comparison to the classic *Asteroids* and *Battlezone*. The design of *Uplift* was based quite closely on that of *Parsec47*.

Several bloggers have remarked on the zone-inducing qualities of *Parsec47*; *1UP*'s Scott Sharkey describes it best. In reference to this game as well as others by the same developer, he writes: “It's that trance-like state you slip into where your mind merges with the game and no matter what it throws at you, you're going to survive...where time slows down and you start whirling through swarms of bullets without taking a scratch.” Whilst Sharkey's prose may be a little over-romantic, it is perhaps excusable in the light of the phenomenological qualities of “the zone”.

The game can be considered a distillation of the essence of the shmup into its purest, most concentrated form. Genre conventions used include levels, boss enemies and the general format of the game itself. However, a couple of conventions have been intentionally discarded. Firstly, the player has no way of increasing the player-avatar's capabilities: no power-ups are present in any form. Secondly, no screen-clearing "smart bombs" are available. Finally, there are no fixed level sequences; each level is randomized within certain fixed parameters.

As with *Gradius*, the world of *Parsec47* is limited to the bounds of the game screen - or, more precisely, to a vertically-oriented rectangular subset thereof. Unlike *Gradius*, however, there are no environmental hazards in *Parsec47*, and the player can fly through enemies without colliding with them. Game objects include the player's avatar or ship, a variety of randomly-generated enemies, enemy projectiles, and point items - of which more later.

Whilst the composition and movement patterns of the enemies in *Parsec47* are random, the overall structure of each level is the same. The level is divided into four segments: first, a long flight sequence where the player encounters and must destroy or avoid various enemies. Second is a "mid-boss" encounter. Following this is a second and often more difficult flight sequence, and in the fourth segment the player must defeat the boss of the level. Bosses, whilst they are all visually quite similar, tend to have highly variable game properties and attack patterns.

The enemy-launched projectiles in *Parsec47* deserve mention simply because there are a lot of them. Often the screen is flooded with more than a hundred projectiles. Whilst the player cannot shoot them down, the ship's collision hull is in fact miniscule, allowing a skilled player to weave through the projectile formations. In fact, this is the most important gameplay element of *Parsec47*, more so than even the act of shooting at the enemies.

The scoring system of *Parsec47* is also noteworthy. Whenever an enemy is destroyed, it releases a number of point items - sometimes 20 or more in the case of larger enemies. These float down to the bottom of the screen and then bounce back to the top, similar to Cave's 1998 arcade shmup *Dangun Feveron* [10]. Flying near to point items causes them to be picked up by the player. The first point item picked up is worth 10 points, and each subsequent point item is worth 10 points more than the previous one, for a maximum of 1000 points per item. However, if a point item floats off the top of the screen, or if the player dies, the point value is reset to 10 points. This is perhaps the epitome of risk (flying in a hazardous manner) vs. reward (collecting more points), although the "risk" is somewhat tempered by the fact that scoring enough points gives the player an extra life -

making it almost compulsory for the player to at least attempt to let as few items escape as possible. This system, however, tends to temper the game's difficulty, which would otherwise fluctuate wildly due to its random nature.

"Boss battles" in *Parsec47* tend to be less likely to engender "tunnel vision", by virtue of the fact that the bosses' attack patterns often send projectiles at the player from several different parts of the screen at the same time.

The main concern I have with *Parsec47* is that it often violates Csikszentmihalyi's second point ("perfect concentration"). As I stated with *Gradius*, memorization could well be an aid to achieving flow in the game, and *Parsec47* does not rely on any such skill on the part of the player. Interestingly, I have noticed that it is possible to encourage a flow experience whilst playing *Parsec47* by exercising one's imagination or memory in a disciplined manner - such as constructing a simple imaginary scene, or singing along to a song, whilst playing – which has led me to believe that the addition of memory-based tasks might aid the attainment of flow. Experiments in reciting poetry whilst playing the game have thus far proven inconclusive.

Ikaruga (Treasure, 2000)

Ikaruga is the second of the three modern shmups I intend to discuss. Like *Parsec47*, it is an attempt at reinventing the genre, but unlike *Parsec47*, it does so by adding on a new game mechanic with a significant impact on gameplay.

A straw poll on Google indicates that a sizable number of reviews of Ikaruga (as well as individual anecdotes, blogs, comments, &c.) make reference to “the zone”. Interestingly, *GMR* magazine's reviewer is one of the few voices of (minor) dissent, observing - quite rightly - that players of *Ikaruga* are forced to move towards some projectiles whilst avoiding others, “against every shooter instinct in [their bodies]”. Although the relatively recent vintage of the game has no doubt contributed to the number of reviews available (and hence the number which mention the zone state), that statistic has impelled me to include it in this series of studies.

As with *Parsec47*, the designers of *Ikaruga* have discarded the power-up mechanic, and they have also significantly toned down the "smart bomb" concept, as we will see in a moment. The new game mechanic is the "polarity" system. Most objects in the game, as well as enemy projectiles, are either white (with blue accents) or black (with red accents), and the player's ship can freely switch between the two

colors at the press of a button. When the player's ship is black, it possesses an energy shield which will completely absorb black projectiles, and the reverse is true for when it is white. Apart from this system, the game possesses the requisite elements of most shmups: a scrolling screen, fixed level layouts, enemies, three lives, the conspicuous lack of a "health" meter (one hit will destroy the player's ship), and environmental hazards (i.e. walls). The player's ship has a miniscule collision hull, following the trend in recent shmups.

The polarity system, however, has several interesting wrinkles. Attacking an enemy of the opposite polarity will do twice as much damage to it, creating something of a tactical dilemma: defense vs. offense. If the player destroys an enemy of the same polarity, assuming Normal difficulty, the enemy will release a burst of projectiles of the same polarity. Finally, absorbing projectiles of the same polarity charges an energy gauge. The energy can be released at any time in the form of a series of laser beams which home on enemy vessels - something similar to the "smart bombs" of the genre, except that they do nothing to save the player's ship from incoming gunfire. All these factors combine to make *Ikaruga* a game which requires a very different mindset from that of a traditional shmup.

And then there is the "chain" scoring system. In a nutshell, players who shoot enemies down in groups of 3 of the same polarity will accrue significant point bonuses, which increase with every consecutive group shot down. However, if the player is halfway through collecting a group of (say) 3 white enemies, and accidentally shoots a black enemy, the point bonus resets itself. This adds significantly to the game's difficulty if adhered to, as the player must break his "shoot everything that moves" conditioning and instead take his shots carefully, sometimes sparing enemies even though they might constitute a threat. The rewards, however, are substantial enough to encourage reasonably skilled players to attempt to use the system; it makes the game a challenge even for highly skilled players.

The main issue with *Ikaruga* is that it becomes quite difficult around the later part of the third level, and only gets worse from then on. As with *Tetris*, this does not

inhibit short-term "zone" states, but will naturally tend to break the state as soon as the challenges outstrip the player's level of ability. It is interesting to note, however, that a significant part of the game's challenge is to establish patterns of behavior which can be enacted with partial reliance on "muscle memory" - in effect, retraining oneself to tackle the unique systems presented by the game. If this is not done, the game remains almost completely inaccessible.

Half-Life: Counter-Strike (Valve/CS Team, 2000)

Counter-Strike is a very popular "mod" for the first-person shooter game *Half-Life*. Whereas the original *Half-Life* had a near-future science fiction theme and slightly less realistic gameplay system, *Counter-Strike* is set in the present day and its game system is marginally more realistic in terms of individual endurance and movement speeds.

Anecdotes pointing to “zone” experiences in *Counter-Strike* have been observed on a couple of occasions. One player notes on *Slashdot*: “I remember playing CS and getting ripped on because everyone was absolutely sure I was using an aim/wall hack; when in reality it was me on a gaming "high"...” Whilst these claims cannot be verified without significant research, personal experience indicates that it is quite possible to reach a “zone” state in the game.

CS, as it is widely known, adheres to the basic principles of multi-player FPS (first-person shooter) games. The "world" of the game is a 3D "map", actually a 3D model of some environment such as an Italian town or an oil rig. Players choose either a terrorist or counter-terrorist avatar (which determines which team they are on) and navigate this map from a first-person view, attacking enemy avatars with a variety of weapons and attempting to accomplish set objectives which vary depending on the map. The game requires equal parts of teamwork and traditional action-game-style coordination.

As is conventional for FPS games, *CS*' default, and most popular, control setup relies on the combination of mouse and keyboard. Moving the mouse allows the player to turn her avatar and look around. The mouse buttons are used to control the player's chosen weapon - usually a handgun or rifle - whilst the mouse wheel lets the player select a weapon from her arsenal. The keyboard keys W, A, S and D control the actual movement of the avatar - forward, left, back and right relative to the avatar's current orientation. There is a variety of other keys with different specific functions.

The most common reports of "zone" experiences in *CS*, however, are of very short experiences lasting for a few seconds, and typically do not involve the more complicated game functions. These seem to be an exception to the "transformation of time", but in fact are not; nothing is explicitly stated in that section about any lower limit to the actual duration of the experience. A typical narrative involves an apparently average player, outnumbered and outgunned, displaying exceptional marksmanship under severe pressure. I would like to suggest that this is potentially related to the fact that the player's teammates in these narratives have often been eliminated, and thus anything that moves is a target - this would likely allow the player to spot a moving object in his peripheral vision and immediately engage it without having to worry whether it is friend or foe. However, it tends to be true that more skilled players can accomplish this without the clarity provided by the absence of teammates.

The main issue I have with *CS* is that excessive focus is often needed to select a target, aim and shoot. This encourages players to concentrate on the centre of their crosshairs - creating a "tunnel vision" problem. Furthermore, as with *Virtua Fighter*, the difficulty level of the game is inflexible within the context of a single gaming session, and typically depends on the skill of one's opponents. This tends to inhibit the matching of skill and demand which is necessary to fulfill Csikszentmihalyi's first point.

Mars Matrix (Takumi, 2000)

Visually, *Mars Matrix* is typical of the arcade shmups of 2000. Its gameplay system introduced a few minor atypical elements, but nothing on the scale of *Ikaruga*'s polarity system; as such, it is an instructive example of the prevailing design trends at the time.

When I was looking for specific anecdotes about “the zone”, I found that few people actually mentioned a specific game. The ones which came up most often were *Parsec47* and *Ikaruga*, neither of which were outstanding representatives of the vast majority of top-down shooting games. As such, the third most commonly-cited game was *Mars Matrix*.

Most of the assertions which are true for *Parsec47* hold for *Mars Matrix* as well, with the exception of the static levels, power-up system, and control scheme. In order, (1) the levels progress in a fixed manner, with destroyable structures and other environmental objects in addition to explicit "enemies", (2) there is a power-up system not dissimilar to *Parsec47*'s scoring system, except that it increases the player-avatar's firepower as well as the score, and (3) the control scheme has been considerably altered.

To wit: whilst the movement controls are pretty much a universal constant, *Mars Matrix* makes use of only one button to control all non-movement-related functions. If the player waits a second between shots, depressing the button fires a

powerful but short-ranged laser weapon. Tapping the button results in a rapid-fire machine gun effect. Holding the button down for less than 3 seconds generates a defensive shield ("Mosquito Barrier") which will catch enemy bullets; these tend to float around the periphery of the shield when caught, and respond to player movement (which can be used to "aim" them). Releasing the button within the 3-second limit will launch the collected bullets, damaging enemies on contact. Finally, holding the button down longer than 3 seconds activates a "smart bomb" which will severely damage everything on the screen and eliminate all enemy bullets. These last 2 functions take time to recharge after being used; the recharge time depends on the duration for which the button was depressed.

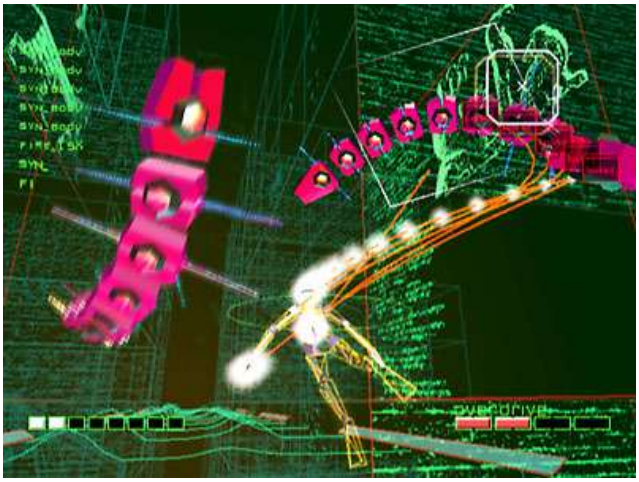
The key to success in *Mars Matrix* is the chain system, which in turn is predicated on the use of the craft's different weapons. Instead of resetting the score/power-up counter whenever a power item floats offscreen, in Mars Matrix the score/power counter is reset whenever the player spends more than a second or so without picking up a power item. Hence a continuous "chain" of power items must be picked up. Oftentimes, the player will have to use the laser in order to knock an enemy craft out and thereby continue the chain (as is the case quite early in Stage 1), whereas there are times where better results will be obtained by using the Mosquito Barrier. The latter is relevant to chaining as any successful hit on an enemy with an enemy projectile (launched using the barrier) will cause an additional power item to appear. In areas where the enemies fire large numbers of projectiles, this can add up quickly.

Mars Matrix's risk/reward mechanic is a little less effective at tempering the game's difficulty level, because the rewards are substantial enough that even a casual player is likely to take unacceptable risks in the hope of obtaining them. The infinitely-rechargeable smart bomb system is quite the opposite - novices will be more likely to use it, thus making the game easier for themselves at the expense of score, than intermediate or expert players.

The key issue with *Mars Matrix* is that the whole display is colorful enough to make threat-identification fairly difficult. The background in the first stage is the

blackness of space, thankfully, but after that it's all red and blue and green and yellow ships launching colorful projectiles against the backdrop of a red Martian landscape. Whilst the game mechanics discourage tunnel vision, the visual design is unfortunately hostile to any other means of playing the game. This is the case for many of the shmups found in the arcades from the late 1990s up to the present day.

Rez (Sega, 2001)



Whilst the uninitiated have at times classified *Rez* as a shmup, nothing could be further from the truth. This iconic title is, at its core, a 3D "rail shooter" not dissimilar to Sega's own venerable *Panzer Dragoon* series. In terms of gameplay, *Rez* is not excessively remarkable; the player-avatar moves along a static course and encounters a series of targets - it is difficult to consider them 'enemies' when most do not pose a threat to the player-avatar. The player's input consists of moving a targeting cursor to aim at the targets, locking on to them with the ever-present 'fire' button, and then releasing the button to shoot them; if she should come under attack, a 'smart bomb' is available (although stocks are, as usual, limited) to dispatch all targets on screen. Score rewards are accrued for hitting multiple targets with a single lock-on. In addition, destroying specific targets within a level will unlock certain game features for future play.

Although the term “zone” has not been used to describe *Rez*, some phenomena associated with the flow state have been reported in the game, including the transformation of time and complete immersion in the task. A more common sight in descriptions of *Rez*, though, is the rhetoric typically applied to the flow state: “hypnotic”, “completely absorbing”, and so on. As the game appears on the surface to have achieved the goal of creating flow without attacking the problem of game difficulty, I felt it was important to examine it.

Rez's challenge level is not high. In fact, it could be asserted that it isn't high

enough to sustain a flow state, except for beginners. However, the game has its own unique way of keeping the player's focus and concentration: through synaesthesia. Locking on to targets generates a unique and pleasant tone; so does hitting them, and all of this is timed such that it's in step with the techno-industrial background music. The visuals are also quite hypnotic, ranging from the vaguely representational to wholly abstract constructs, and synchronise well with the music. To add an additional dimension to the sensory experience, the controller vibrates in time with the music. The result is a highly immersive experience.

Ultimately, however, the experiences generated by *Rez* are only peripherally related to its interactive or "gamelike" qualities. Whilst it is an interesting and welcome enhancement to an otherwise fairly dated genre, such a distinct visual and aural aesthetic should best be pursued only when the underlying gameplay is sound and provides a solid challenge; *Rez* does not, in my opinion, deliver in that department as its challenge level is quickly outstripped by the user's skill.

Frequency (Harmonix Music, 2001)

Superficially and visually, *Frequency* resembles *Rez*. However, the two games are very different beasts. The chief difference is that *Frequency* falls under the category of "rhythm games", and as such the gameplay experience is quite different.

Frequency and its sequel *Amplitude* have both been cited as “zone” games before, but more importantly they, as with all rhythm games, require the exercise of muscle memory – which makes them interesting in the context of how the flow state works, and thus merited inclusion in this study.

In *Frequency*, the player is tasked with "playing" a song to the best of his ability. Each level in the game is, in fact, a song, as represented by a cylindrical track not dissimilar to that of the classic arcade game *Tempest*. As with that game, the player-avatar is a starship-like object which can move between discrete "tracks" on the inner surface of the cylinder. The interesting thing about *Frequency* is that those "tracks" in fact correspond to audio tracks as parts of the song: one could be the vocals, another the drums, another the guitar, and the player's avatar is constantly moving forward at a rate corresponding to the song. There are background tracks which are playing at all times to give the player rhythm cues, much like the music in a karaoke video.

Each track is further divided into segments, representing a phrase in the song, and

within each segment are small objects representing the "beats" of that track. The task of the player is to press a specific controller button whenever the corresponding beat passes under the player's avatar. If the player successfully hits all the beats in a segment, the corresponding track is "unlocked" and will be played over the background tracks for awhile. If all the tracks should be unlocked at the same time, the music will sound something like the original song.

However, if the player repeatedly fails to unlock tracks, an "energy gauge" will decrease. If this gauge reaches zero, the game ends prematurely; unlocking tracks will fill the gauge back up. Several kinds of "power-ups" or accessories are available when the player completes specific segments, giving the player the ability to (for example) gain score bonuses, or automatically clear a specific track.

As with all rhythm games, *Frequency* relies very much upon conditioned reflexes, making it a good 'zone' game. Peripheral vision and memory are also tested in the higher levels. Although the difficulty within any given level is somewhat rigid, the variety of different songs, each possessing unique challenges, ensures that most players will be able to find appropriate material for their level of skill. However, it is entirely likely that any 'zone' state engendered by the game will not last beyond a single song.

4. SUMMARY OF PRIOR WORK

The following tables list the games examined in the above section and their salient features; some explanation may be in order.

In terms of "risk/reward", the "Degree" indicates how large the risks and/or rewards are, whilst "Advantage Conferred" indicates whether the reward is simply point-based with no possibility of rewards for higher scores ("None") or grants the player some advantage (extra lives, etc.). "Difficulty Curve" refers to the difficulty scaling within a single session. "Peripheral Vision" and "Memorization" refer to the extent to which the game requires and supports the player's use of those abilities.

Game	**Risk/Reward**		**Difficulty Curve**
	Degree	Advantage Conferred	
Pac-Man	Medium	Low	Low
Space Invaders	Low	Low	Medium
Robotron 2084	High	Low-Medium	Medium
Defender	High	Medium-High	Medium-High
Gradius	Medium-High	High	Medium-High
Tetris	High	None	High
Virtua Fighter 4	None	-	Medium-Low
Parsec47	High	Medium	Medium
Ikaruga	High	Low	High
Counter-Strike	Low	None	None
Mars Matrix	High	High	Medium-High
Rez	Medium-Low	None	Low
Frequency	Medium	Low	Very Low

Table 1 – Summary of Prior Work

Game	Peripheral Vision	Memorization	Notes
Pac-Man	Medium	High	Memorization only common among "expert" players.
Space Invaders	Medium-High	Medium	
Robotron 2084	High	Low	Difficulty jumps between levels 1 and 2
Defender	High	Very Low	High concentration demand
Gradius	High	Very High	Use of boss encounters
Tetris	Low	None	
Virtua Fighter 4	Medium-Low	High	Memorization not of game sequence, but of potential moves (both player and opponent).
Parsec47	Very High	None	Use of boss encounters; difficulty fluctuates due to randomness
Ikaruga	High	Very High	Use of boss encounters
Counter-Strike	Low	Medium	Difficulty is not controllable due to multi-player nature of game
Mars Matrix	Medium-High	Medium-High	Use of boss encounters; often-poor visibility
Rez	Medium	Medium	Use of synaesthesia; boss encounters; limited player engagement
Frequency	Medium-Low	High	Use of music as an audio cue for gameplay

Table 2 – Summary of Prior Work, Continued

5. FACTORS AND INFLUENCES

Whilst Csikszentmihalyi's characteristics of flow are instructive, it is likely that they present only a portion of the picture. Here I wish to expand upon the characteristics described above so as to identify some design factors which might affect the flow state.

THE ROLE OF THE SUBCONSCIOUS IN FLOW

The term "flow" comes from respondents' reports that they were "going with the flow" - in other words, not in explicit conscious control of their actions. This is not to say that flow is a dreamlike state or a hypnotic state - although both of those terms have been used to describe the experience. I would, rather, prefer to draw an analogy to the way in which one controls a computer, a car, or one's own body.

Heidegger (1927) asserts that when one is first learning to use a new instrument or other tool, there are two phases which one passes through: *present-at-hand* and *ready-to-hand* [11]. In the present-at-hand phase, one must be directly conscious of one's action - this is quite clearly illustrated by watching a less techno-literate individual attempting to use a mouse for the first time. The individual directly controls the mouse's movements in an explicit manner, and the slowness thus engendered is almost painful to watch. Once users have become accustomed to the mouse and have had practice in using it, it becomes ready-to-hand - instead of explicitly controlling its movements, they "think" of a point on the screen, and presto! somehow the pointer is there, although the action of their hands only registers on their consciousness after they have actually moved the device. Although mouse movements are a very simple example, it is clear that more complex actions such as typing on a keyboard or driving a car can be similarly relegated to the user's subconscious.

I would like to propose the possibility that this sort of intention-action coupling operates at multiple levels. Consider the player of a simple action game such as *Uplift*. If our player is a complete novice, the lowest level of conscious action will be pressing a key - "Oh, I need to press the left arrow key to fly left". Once the act

of "flying in a straight line" becomes a subconscious act, then the player progresses to the next level - "Oh, I need to fly left to dodge that bullet." And the next level - "Oh, I need to dodge that stream of bullets to collect the power-up items." It is clear, of course, that at some point the analogy breaks down - but then, the analogy breaks down on occasion in the case of typing, too, as when one has to type a seldom-used character such as |, the pipe sign. It is quite possible that a player in flow has progressed to the highest possible level of conscious action - "Oh, I need to win" - and that everything below that level has been delegated to subconscious processing. Which is not to say that "positive thinking" will encourage flow at all, but rather that if one is sufficiently practised to enact the necessary movements under subconscious control, then the conscious intention of the player should not need to focus on the mundane stuff of dodging bullets and scrabbling for power-ups. It turns out that this offers a very convincing reason to avoid encouraging "tunnel vision" when designing a game; we will examine that shortly.

THE VISCERAL SUBCONSCIOUS

Upon examination of certain reports, it turns out that "flow" is not the only state where a user can potentially be in subconscious control of an artefact. Other factors may move the user to take certain actions subconsciously, actions which might be less than helpful. Tentatively I have termed this the visceral-subconscious, as opposed to the conditioned-subconscious reaction which is associated with flow. It would appear that this response has a tendency to conflict with the conditioned responses involved in flow, and that it is hence inimical to flow; this possibility is supported by relevant literature in martial-arts fields, although it has not been widely discussed.

The visceral subconscious is driven by "fight or flight" responses; the actions it engenders tend to be borne out of a desperation to avoid a negative result. Whilst I would otherwise prefer to avoid such references, the classic example comes from *Star Wars*: anger, fear, and aggression. It is questionable as to whether this is merely a detrimental side-effect of the flow experience, or a completely unconnected phenomenon, but its effects are quite tangible. In an informal poll conducted online, one of my respondents noted, in reference to *Parsec47*, that "it's

the fear of 'things escaping my grasp' that... kills me. Before I know it, I'm lunging to try and grab the pinwheels (score items) back, and I run straight into bullets."

Although this is only peripherally related to the issue of "design", the phenomenon of the visceral subconscious may need to be addressed in some manner. On the one hand, narrative elements of an action-based game might seek to avoid scenes which engender this sort of response in the player - indeed, the curious phenomenon of "cute-'em-ups" (see Appendix A) may be partially a result of this. On the other, it could be possible to make use of this response as a gameplay element, perhaps to add a layer of challenge ("player vs. self").

PERIPHERAL VISION AND FLOW

In their paper "The Visual Brain in Action" [12], A.D. Milner and M.A. Goodale build upon work by Ungerleider and Mishkin (1982) to isolate 2 distinct kinds of vision. This was in turn built upon work in the 1960s which termed the 2 visual types "foveal vision" and "ambient vision". "Ambient vision", or peripheral vision, is typically considered to be a preconscious/subconscious system responsible for spatial orientation, as noted by the U.S. Air Force Research Laboratory [13]. In an experiment reported in *Nature* and referenced in the paper, Milner and his colleagues examined a patient suffering from visual form agnosia, a neurological disorder which renders patients incapable of any sort of visual discrimination, including distinguishing faces or simple geometric shapes. They found that this patient, despite her disorder, was able to carry out functions such as inserting a card into a narrow slot without any trouble whatsoever - even though she was incapable of reporting the orientation of the slot. As such, whilst the patient's conscious ("ventral" in Milner et. al's literature) visual system was nonfunctional, her preconscious ("dorsal") visual system was almost perfectly operational with regards to spatial orientation.

This leads me to suggest that flow, being a response which relies greatly upon the subconscious, would rely much more on peripheral/ambient vision than on foveal vision. To further extend this, it is entirely probable that the phenomenon of "tunnel vision" is a result of limiting one's consciousness to focus on the inputs

provided by foveal vision – as well, of course, as a result of adrenal buildup - and that this would severely impair ambient vision and hence inhibit the flow response.

TASK AND REPRESENTATION SUITABILITY

Although Csikszentmihalyi seems to claim that any challenging experience can potentially induce flow, I would venture that some such experiences are more amenable to the flow experience than others - due both to the factors he lists, as well as to the individual's competencies and preferences. If the visual component of an experience is profoundly disturbing to an individual, no matter how much the rest of the experience appears to induce the flow state, it is frankly unlikely that that individual is going to experience flow. If the enactor has no interest in the task domain (e.g. due to theme), flow is not likely to occur either, even if the representation hides a game that would otherwise interest him/her. In other words, representational practice cannot be completely discarded.

At the same time, three key points must be observed. The first is that the material effect of the representation upon the task must be taken into consideration. If *Uplift* were to have its enemies firing orange-red bullets at the player-avatar against a sunset background, the player's task would take on an additional dimension: to visually distinguish bullets from background image. Hence the representation informs the task.

The second is that the task informs the representation. This is no more apparent than in the myriad games of the 1980s and early '90s which attempted to shoehorn a bewildering variety of representations, from Bible stories to Barbie, into existing and quite inappropriate genres (in the former case, a first-person shooter where the player takes the role of the Biblical Noah [14], and in the latter case, a wholly unremarkable platform game [15]). Whilst most tasks will afford a fairly wide array of representational possibilities, the most likely problem when attempting shoehorn tactics is that the task will create a contradiction in the representation. (Consider *Arm Joe* [16], a fighting game created by an amateur Japanese developer with a substantial 'cult' following, which features characters drawn from the musical *Les Miserables*. Whilst the game itself is interesting enough, it seems to

have been excused from any requirement for consistency due to its freeware nature. A commercial release would doubtless leave the player wondering why e.g. Cosette harbours an irresistible urge to beat Jean Valjean to a pulp.)

The third is that there are as many "ideal" representations, and as many "worst possible" representations, as there are players. One approach to resolving this point is to choose a single sufficiently inoffensive representation. This has its advantages, but often leads to a bland sort of visual experience. Another is to create an open architecture which supports user-created representations, but this is equally problematic in that it abdicates the function of representational creation to the user. Since, as we have seen, the representation informs the task, this method in fact equates in some degree to abdicating task-creation to the user.

TRANSFORMATION OF TIME VS. EXTENDED TIME

As stated previously, although Csikszentmihalyi names the transformation of time as one potential feature of a flow experience, the specific length of any given experience is not stated, nor is 'sustainability' among the conditions named for an experience to be considered 'flow' or 'in the zone'. Furthermore, many game-players who have had a zone experience report 'snapping out of it' at some point during the execution of the task itself, and not after it. As such, the logical conclusion is that the duration of a zone experience conforms neither to the task duration nor to an absolute time limit (either lower or upper).

Why, then, do we hear so much about players 'in the zone' with older games as opposed to newer ones? I have listed some other reasons, but it is quite possible that the main reason for this is that most 'retro' games have no real ending and few interruptions (*Pac-Man* being a minor exception on the second count). Players of such games can stay in the zone, under the apparent spell of the game and not noticing the passage of time, until something interrupts their concentration. Contrast this with 'modern' games, which are fundamentally segmented: matches in multiplayer games end in a matter of minutes, whilst single-player games are punctuated by cutscenes (the descendants of the mini-movies in *Pac-Man*) and dips' in the action, often to create a sense of narrative ebb and flow, and eventually

end completely. In such situations, the difference between the player's performance in the zone and out of it is not as striking, and players can sometimes be left wondering whether they were, indeed, 'in the zone'.

NON-REALTIME GAMES

If Csikszentmihalyi is to be believed, then there is no question that non-realtime games can induce a flow state. Why, then, do we hear few or no reports of people getting really 'into the zone' and (for example) conquering the world by A.D. 1700 in *Civilization*?

This is a difficult topic to address, because so much of the literature about the flow state relates to time-based activities such as sports. There are few studies, if any, of people who get into flow whilst reading a good novel. Whilst this is somewhat outside of my scope, I will attempt a response.

First, real-time elements in games add a layer of challenge. Very often, in non-realtime games, a problem can be solved by simply taking the time to think it through - although this is not always the case - and therefore the challenge level can easily dip below the player's level of skill. Of course, many players short-circuit this process with good reason; a player would have to be somewhat perverse to, when given a choice of which new technology to research in *Civilization*, conduct a lengthy feasibility study considering all known factors.

Second, a 'flow experience' in a non-realtime activity can be easily interrupted by any number of external concerns. This is perhaps also another factor in favor of classic games and/or arcade ones over others - the former categories have no 'pause' function. It is highly improbable that such an experience could be sustained whilst the activity in question is 'on hold' for a meal, or sleep, or work, or a bathroom break. If the player is drawn back to the game after an interruption, this must be understood not as a continuation of the earlier experience but as a desire to enter the 'zone' once again - or, perhaps, as being driven by some other factor of the game's holding power.

Finally, the performance-enhancing aspects of flow may not apply to the sort of 'deep cognitive' task which is entailed by many non-realtime games. At the very least, there has been no evidence that has shown such an enhancement. The closest possible thing to evidence would be that many programmers report experiencing flow whilst working on code - a non-realtime, cognitive task, but one which may not be exactly analogous to the kind of task presented by a non-realtime game.

6. THE DESIGN OF *UPLIFT*

Uplift is a simple action game in the "shmup" mold. It incorporates a high degree of mutability in both the visual and gameplay domains, as well as support for biofeedback. Although the original design spec. called for a recording feature, this has been omitted as excellent alternative means of recording a gameplay session are commercially available at low prices.

GAME OVERVIEW

Uplift is a vertical-scrolling game played on a 2D plane, although it does afford 3D representation. The player controls a very small object, which in the default representation has a vaguely bird-like shape, and moves it around the playing area; the background will generally scroll downwards to give the impression of forward flight “up” the screen. Enemies/targets enter the playing field from the top; these will attack the player's avatar by shooting small projectiles at it, and will leave the playing area after a set amount of time. The player's avatar is armed and may counter-attack the enemies by shooting them; its weapons are oriented to fire towards the top of the screen in an arc of varying width, and their “power” may be increased by obtaining certain items. The player will be allotted a number of “lives” at the beginning of the game, and can gain more through skillful play. Should the player's avatar be struck by enemy projectiles, it will lose a “life”, and when all three are lost, the game is over. However, in accordance with popular current genre conventions, the player's avatar tends to have a very small collision hull, resulting in the ability to maneuver through tight and intricate patterns of enemy gunfire. The player's avatar is controlled by means of the keyboard.

The reasons for choosing this genre are as follows: first, being set within the context of an existing genre with iconic examples (such as *Space Invaders* and *1942*), the game system will be immediately familiar to the audience. Second, the choice of genre was determined by the visual latitude it could potentially support: a "first-person shooter" game, for example, does not lend itself well to wireframe representation in general, because a player standing immediately behind a large wireframe obstruction will often fail to see the obstruction entirely (a problem

with the classic *Battlezone*). Furthermore, the tractability of delivering a functional prototype within a limited period of time had to be considered. A complex game involving a 3D environment would have been significantly more time-consuming to develop whilst not offering significant additional functionality. Finally, the conventions of successful games in the genre are well-known, well-established and relatively straightforward to implement, whilst those of many other genres are subject to significant debate.

As for input-device support, whilst support for game controllers is a potential future addition, the nature of the genre is such that most game controllers would not provide significant gains in usability or playability over the keyboard. The mouse is an even more difficult device to use for such a game, and would in all probability actually decrease the usability and playability of the game.

STAGES AND GAME PROGRESSION

The game is divided into “stages”; at the end of each stage the player is challenged to defeat a large and powerful enemy (“boss”). Enemies, when destroyed, drop “power items”. When the player moves the avatar over a "power item", it is automatically collected and increases the avatar's weapon power gauge by 1 point. As the weapon power gauge passes certain threshold values, a beneficial effect is gained - see Table 3 for the schedule of power effects. If the power gauge drops below a threshold value, the associated effect is lost.

“Power items”, if not collected, will float to the bottom of the playing field, then reverse direction and float back up. If they are not collected by the player before they leave the top of the playing field, the avatar will not only fail to gain their benefit, but has a 1/3 chance of suffering a 1-point decrease in the power gauge. A regulatory mechanism is needed to encourage tactical decision-making on the part of the player; this has been implemented as follows: as soon as the avatar's power gauge exceeds 32 points, it will begin to decrease at a rate proportional to the current power level. This encourages the player to continue collecting power items even after the avatar reaches its full ability, and in so doing introduces a risk/reward system which makes for more compelling play and balances against random "peaks" in difficulty.

Power Level	***Effect***
0-7	Single bullet stream (forward)
8-15	Three bullet streams; side streams fire much less rapidly
16-23	Increases rate of side streams
24-31	Increases overall fire rate
32-47	Increases rate of side streams
48-63	Increases overall fire rate
64-95	Doubles the damage done by the central bullet stream
96-111	Score multiplier x2 – all score accrued is doubled
112-119	Score multiplier x4 – all score accrued is quadrupled
120-127	Score multiplier x4 – all score accrued is octupled

Table 3 - Schedule of Power Effects

The rationale for this risk/reward system is as follows: if it were not implemented, the optimal playing strategy would be for the player to locate his avatar at the lower edge of the playing area and only move when a bullet is headed directly towards him. Experienced players, then, would quickly find their skills outstripping the challenges posed by the earlier game levels, and hence be unlikely to enter flow until much later in the game - by which time they would probably have lost interest.

The player gains “score” by shooting enemies down. The score which the player

accrues for shooting an enemy down is dependent on the player's proximity to the enemy, and ranges from "normal" score (far away from the enemy) to eight times the normal score (for shooting the enemy down at point-blank range). This may further be multiplied by the bonuses listed in Table 3.

To add an additional level of challenge, a special reward is available: if the player successfully survives a stage without firing a single shot (“pacifist mode”), a very substantial score bonus is awarded at the end of the stage, greater than the score which the player could have achieved by playing through the stage normally. The bonus is, however, diminished if the player should lose one or more lives during that stage.

At certain score levels – 50,000, 100,000 and every 100,000 points thereafter – the player is awarded an “extra life”. This serves to encourage calculated risks, which as we have seen are a common and effective difficulty-balancing mechanism.

ENEMY GENERATION, CUSTOMIZATION AND MECHANICS

It would not be an exaggeration to assert that modern shmups, in general, are most often classified not according to the protagonist or the representation, but according to the antagonists. (For details on classification, see Appendix A.) The behavior and nature of the antagonist is what most often drives the player's actions, and hence proper design is a necessity.

In this version of *Uplift*, only three types of enemies exist. Their movement patterns are fixed, but the firing patterns they adopt are highly varied. The three types of enemies are “small enemies”, “large enemies” and “bosses”.

“Small enemies”, like the player, are destroyed when struck by a single shot. Unlike the player, however, their collision hulls are of a size comparable to their actual visual representation. They appear in staggered-row formations of between 3 and 6 ships, and fly straight down towards the bottom of the playing area.

“Large enemies” can absorb significant damage before being destroyed. Being

larger, however, they are also easier to hit. They appear singly, in pairs, or in 3-ship formations. As they fly towards the bottom of the playing area, they pick up speed, making it difficult to destroy them after they have passed the center of the playing area.

“Bosses” fly to a location at the top of the playing area. From there, they move laterally, reversing direction whenever they reach the edge of the playing area. They are hardier than large enemies, and will not leave the playing area until destroyed. In addition, if a “boss” stays in the playing area for 60 seconds without being destroyed, it will self-destruct and the player will gain no points for it. The reason for this is twofold: first, it ameliorates the challenge level in the case of very difficult bosses. Second, it makes “pacifist mode” a possibility, where otherwise the player would be stuck facing off with the boss, unable to progress to the next level.

The enemies are generated as follows: every few seconds of game time, depending on the game speed, a new wave of enemies will be generated. The interval between waves starts at an average of approximately 2 seconds (a fairly long time in the game!), and decreases gradually. It bottoms out at level 15, at approximately 1.5 seconds. Whilst this does not sound like a significant variation on paper, when playing the game, the effect is very tangible. When a wave of enemies is generated, it has an equal chance of being made up of small enemies or large enemies. After a certain period of time has passed since the beginning of the level – 2500 game cycles, or about 100 seconds – the boss of the level will be generated; thereafter no waves of enemies will appear. When the boss has been defeated or self-destructs, there is a short “rest period” lasting a couple of seconds, and then the next level begins.

Upon launching a wave, the game will assign all enemies in the wave a “template” which determines their attack properties. This is done using a point-based system: the template is given a certain number of “points” depending on the type of enemy and the current game level, and “spends” them randomly to improve various characteristics. There is only one type of projectile, and the enemies will always

aim the overall pattern of their shots towards the player. They will fire a “burst” of several shots in quick succession, then wait, then fire another burst. Each shot in the burst may consist of one or more projectiles. If it has more than one projectile, the firing angle of the projectiles will be spread such that they radiate outwards from the enemy – this curtails the tactic of bullet-hoarding (see Appendix A).

The variable properties include the angle of the spread (for patterns where there is more than 1 projectile per shot), the speed of the projectiles, the number of projectiles per shot, the number of shots per burst, the rate at which the burst is fired, and the delay between bursts. Of these, the spread angle and the rate of burst fire were deemed to have little effect on the overall effectiveness of the attack; they merely necessitate different but not more difficult movement patterns on the part of the player. As such, they are completely random and no points are assigned to them.

Points are assigned to the remaining four characteristics, and will increase their effectiveness. There are “caps” on the projectile speed, the number of projectiles per shot, and the delay between bursts, as these variables could make the game unplayable if raised to extreme values. However, the number of shots per burst is only limited by the point system, there being no “hard limit” for that variable. All the initial variables, the “caps”, and the stat improvements per point are configurable.

USE OF BIOFEEDBACK

Several vital game parameters may potentially be affected by biofeedback; the exact relationship of game-parameter to feedback type is configurable by the user. The types of input data available include breathing (measured via chest expansion/contraction) and galvanic skin response. This data is gathered through a Procomp Infiniti biofeedback encoder. In all cases, the minimum and maximum possible values are user-configurable.

The alterable parameters include the following:

- Game speed

This is probably the simplest way of regulating game difficulty, and may be used to set up either a negative or a positive feedback loop. For a negative loop, the game speed should decrease as the player's tension level increases (detected via GSR or breathing rate), thus regulating it. Conversely, a positive loop would increase the game speed as the players' tension increases, challenging them to relax and thus break out of the loop.

- Avatar hit-radius

Here is another parameter with a simple correlation. The “hit radius” of the avatar determines how close it has to be to an enemy or projectile in order to be hit by it. If the hit radius is very small, then the avatar will be able to squeeze through tight spaces unharmed, whereas a large hit radius would be highly detrimental as even a near-miss would be counted as a hit. As such, a small hit radius is highly desirable.

- Arc of fire angle

This determines how "wide" the angle between the avatar's stream of side shots is. It does not have an ideal value; instead, the best value at any given point is dependent on the tactical situation. In general, a wide angle allows the player to better engage large numbers of small enemies, whilst a narrow angle is best when tackling one or a few large enemies.

- Avatar speed

Avatar speed is more complicated than it seems. Whilst it would seem that faster equates to better, this is not necessarily the case; in situations where the playing area is densely packed with enemy shots, high speed can in fact make it difficult for the player to maneuver the avatar between the shots.

REPRESENTATIONAL PRACTICE AND GAME SCHEMES

The mutability aspect of the game is accomplished through the use of 'game schemes'. Each of these is a package of settings, such as the enemy settings

mentioned above, the biofeedback parameters, the visual design and so forth, which together define the overall game experience and potentially the difficulty. Three default schemes are provided with the game (see Appendix B), representing different levels of visual detail, with the idea that individual players will adapt one or more of them to create the "ideal conditions" for experiencing flow.

Developing an appropriate representation for an action-based game such as *Uplift* is, in general, a nontrivial enterprise. As such, two of the default representations provided have taken the route of using "abstract" imagery. It is not difficult, of course, to make the game appear superficially like any of the recent or less recent entries in the shmup genre.

The game supports the replacement of just about every in-game graphic image with one of three types of visual object: a recolored wireframe (the specific colors can be defined in configuration, although the wireframe model is defined in code and thus cannot be changed), a 2D sprite in an appropriate format, or a 3D textured model in the common .ASE format. However, the explosion images, since they are particle-system dots, cannot be replaced; they can only be re-colored. The criticism could be levelled against *Uplift* that this open architecture constitutes an abdication of responsibility (see p. 48). Having packaged 3 disparate and carefully-considered representations with the game, however, I feel that this criticism is somewhat unfounded in this case.

7. EVALUATION, FEEDBACK, THOUGHTS

EVALUATION

In the proposal for *Uplift*, I enumerated four approaches to evaluating the deliverable artifact, and stressed that it should be evaluated primarily as a game rather than an HCI project or a piece of art. In the end, the approach I used was to examine the biofeedback readings in conjunction with self-reports.

The sample size for the evaluation was 20 people, split over 2 phases. Phase 1 was conducted using an early alpha build of the game, whereas Phase 2 was conducted when the final prototype was close to completion. The main substantive differences are as follows:

	Phase 1	**Phase 2**
Display used	Medium-size TV screen, placed approximately 6 feet away from player	Flatscreen computer monitor, placed approximately 3 feet away from player
Visual representation	Wireframe only	Wireframe in some cases; polygons in others
Biofeedback display	Via game effects only (slowing down/speeding up; arc of fire)	Via game effects and gauges (the latter displayed at the lower right-hand corner of the screen)
Biofeedback type	Negative feedback loop (tension causes the game to slow down)	Positive feedback loop (tension causes the game to speed up)

Table 4: Differences in Evaluation Phases

The environment for both evaluation sessions was not identical but substantially similar. There was some degree of human traffic behind the testing station. Whilst this could be considered to potentially skew the results, it is arguable that it replicates the arcade environment in which such games are often played. Each player was allowed between one and three rounds (a round consisting of the player

playing until he has exhausted all his “lives”) depending on their performance: players who displayed poor performance in the first game were allowed a second or, on occasion, third game to compensate for the possibility that they needed time to adjust to the game.

The methodology used was to examine and record biofeedback readings (heavy use of feedback, light, or none) in the final round of play, as well as the player's eventual score. In addition, freeform questions were asked following the whole session – the specific questions asked were dependent on the player's overall performance as well as their style of play.

Unfortunately, my sample size for the evaluation proved to be fairly small, and hence the number of reports of actual flow experience was commensurately low. It was found that the biofeedback readings did not show a direct correspondence to the flow reports. Instead, the exploitation of the biofeedback system seemed to be less prevalent among experienced game-players than among novices. This is an interesting and somewhat unexpected result; it implies that such systems could constitute a difficulty-levelling mechanism which would help to encourage flow states, although the small sample size precluded any sort of statistical correlation.

Another issue observed was that players, especially in the first test session, would tend to “play” the biofeedback by consciously adjusting their tension level in order to slow the game down. Three of the five players in the first session who were observed to use biofeedback extensively responded that they had attempted to do so. This is the main reason why a positive rather than negative feedback loop was used in the second session. Still, one of the respondents in the second session did acknowledge that he had some conscious control over the feedback loop.

In general, I found that novice players, especially on their first round, would lose the game too quickly to make use of the biofeedback system. Intermediate players tended to make extensive use of biofeedback, whilst highly experienced players often (but not always) disregarded the biofeedback entirely. The highly-variable readings garnered from experienced players are troubling; they suggest that the

correlation between biofeedback and skill (or flow) may not be a strong one. On the other hand, it is possible that these players were not in flow whilst playing.
One issue I faced was the volatility of the testing group. I was unable to gather a group of consistent testers who would gain experience with the game. I am well aware that in the game industry it is considered unprofessional at best and anathema at worst to not test a game with "new blood". On the other hand, it is probably not likely for a player to experience flow unless he/she has had significant experience in the activity, due to the ready-to-hand/present-at-hand dichotomy (see p. 45). This could also have explained the lack of positive self-reports from the testing group.

ISSUES

Due to the limited time available to develop the artifact, as well as my own limited experience (i.e. none whatsoever) with game development and other factors, there are a number of issues with the game which I should mention. Some of these will be recapitulated in the next section.

- Engine constraints. Whilst I do not regret the use of Java3D as my development platform, I found it to be somewhat limiting. In particular, the Java3D scenegraph has limitations on the number of nodes it can render at any given time. This caused me to have to limit the number of onscreen objects, and resulted in the experience being a little less than it could have been. Furthermore, Java3D suffers performance issues when one attempts to overlay 2D elements onto the 3D scene – a technique used by some modern games to reduce overhead and work around the problem of object-count limits (such as the limit I have just described!). Also, my grasp of the intricacies of the Java3D API is not perfect, which resulted in certain visual enhancements being unavailable to me.

- Repetitive gameplay. This has always been cited as a problem with 'classic' games, and so I am not overly bothered by such a description. If the accusation were of repetitive, *dull* gameplay, then there would be a very serious problem indeed. However, I would like to address the problem in two parts. If one speaks of repetitive gameplay across multiple sessions, then the problem has been already

dealt with: a simple variable change in the configuration menu can have a fairly significant impact on gameplay, and using a different game scheme will make the experience quite different. If, on the other hand, repetitive gameplay within a single session is the problem, then perhaps the difficulty level wants adjustment – also possible via the configuration menu.
Ultimately, though, a greater variety in possible configurations could be of help to the game; these are detailed in the section on future development.

- Uneven difficulty. I found that certain aspects of the game needed some slight balancing. For example, small enemies tended to be unable to attack more than once, as the player could easily wipe them out whenever they made their appearance. As such, the "delay between bursts" value had little impact on smaller enemies. However, when large enemies were present, they would often act as "meat shields" to distract the player, allowing the small enemies to fire multiple bursts. This led to another observation: that an overabundance of either large or small enemies is not a good thing. Because the selection of enemy type is random, sometimes the game will generate a "run" of several waves of exclusively small or large enemies, causing the difficulty to fluctuate in unpleasant ways. The best solution would probably be to manipulate the probability of generating a particular enemy type based on the history of the last few waves.
However, uneven difficulty does not limit itself to the question of enemy types. The very fact that the properties of each enemy are random means that difficulty can vary across sessions and even within a session depending on the enemy types. I have attempted to address this to some extent by means of the point system, although some fine-tuning could still be done. Certainly, if one uses a game scheme where the point system is set up in a more restrictive manner (such as "Springtime Blossoms"), then the difficulty will be reduced at the expense of some variety in enemy behavior.

- The question of randomness vs. memory. As with *Parsec47*, *Uplift* has the disadvantage that its task requirements are very "one-sided" and do not engage certain aspects of the player's capacity. This is a shortcoming of the initial design concept and of my initial analysis, and suggestions for rectifying it will be

addressed in the next section.

In general, the current version of *Uplift* can be said to be a successful prototype. Whilst the items listed under “Future Work” would make it even better, it is well-suited to its designated purpose as it is.

8. WHAT COMES NEXT?

If one were to examine all the possible ways to improve *Uplift*, the sheer volume of material generated would probably be sufficient for a second comprehensive design document. Here, then, are some of the more obvious possibilities for improving the system without straying out of the design space of the original design. Here I also aim to look at the future of 'zone' games and of “retro-modern” games in general.

Neurofeedback. This was originally listed as a possibility in the original proposal, but due to the constraints of time could not be implemented. If I were to choose and implement only one of these possibilities, it would have to be neurofeedback. Since research has shown some correlation between the flow state and the predominance of certain specific brainwave frequencies, neurofeedback could be used as a fairly reliable indicator of the flow state.

Session recording. Although I eventually took this out of my design spec because its function could be handled by third-party software such as FRAPS, there are specific features which would be made possible by the addition of in-engine recording that would not otherwise be possible. One is to plot the user's bio/neurofeedback trace as a graph that is updated in real time – this would be an invaluable tool for parties seeking to use *Uplift* as an experimental instrument. Another is to save the random numbers used to generate the session data, and then use those numbers to let players “re-play” the exact same session, with the same combinations of enemies and the same parameters. I believe this would allow users to manipulate the combination of experimental variables with fixed constants, thus making the results more reliable and partially addressing the question from the previous section of randomness vs. memory.

Scripted sequences. This is another feature which would help to address the question of randomness vs. memory – if the game could be pre-scripted rather than relying on random variables. In fact, it would probably be very interesting to take a randomly-generated script (perhaps generated by session recording, as above) and then hand-craft it to make it a more compelling and varied experience.

Sound. I originally decided not to make sound an aspect of my design after observing that many players, when playing action-based games, preferred to turn the sound off and listen to their favorite music instead. Also, I have limited experience in music and no sound engineering experience whatsoever. The fact remains, however, that sound is an important part of a game design and could indeed be a factor in getting players 'into the zone'.

A potential possibility related to audio would be to explore the idea of synaesthesia, similar to *Rez* but from the opposite direction. The computer could be given a piece of music, say, and then construct a pattern of enemy waves and formations as adversaries for the player, to be introduced in time with the music. This sounds like a pipe dream, but in fact has been done before, albeit in a simple fashion, with the 1999 rhythm game *vib-ribbon*.

Variety of configurations. As noted in the preceding section, the repetitive nature of *Uplift* could be a potential problem, although not necessarily a very serious one. Still, the game could stand some improvement with regards to the system capabilities. Here are some potential changes that could be made:

- Large and extra-large ("mid-boss") enemies. This change would entail decreasing the resilience of the current medium-class enemies, and introducing new large and extra-large enemies. Large enemies would appear as one-ship "waves" which could be randomly generated. Extra-large enemies would only appear at the midpoint of a stage, to provide a secondary climax preceding the actual climactic boss encounter. Alternatively, the mid-boss of a stage could simply be a less powerful version of the final boss.

- Multipartite enemies. This change would mostly affect enemies of size Large and up. Instead of having one very strong attack pattern, they would have two or more parts, each with a slightly weaker attack pattern. In the case of boss-type enemies, those parts could potentially be destroyable, presenting the player with the conundrum of whether to weaken the boss by destroying its parts or to "go for the jugular" and risk stronger counter-attacks.

- Alternative appearances for the same class of enemies. This was already implemented to some degree in the default game scheme, which randomizes the colouring of the wireframe enemies and their projectiles. However, it would definitely be interesting to have visually-distinct enemies of the same class, as well as being an aid to players in the form of a visual cue to suggest that the enemy pattern has changed.

- A greater variety of enemy attack patterns. Currently, the enemy attacks are limited to “spread” or “linear” patterns pointed directly at the player-avatar. It would be interesting to see alternative patterns, such as patterns aligned in a certain direction (straight or oblique) relative to the world, or “all-round” radial patterns, or projectiles with interesting qualities – such as bouncing off the edge of the playing area, splitting into more projectiles, being affected by “wind”, or being stirred up by the enemy's movement like a water wake.

- A greater variety of enemy movement patterns. This was in the original spec, but was removed because of time constraints and the fact that it was not expected to add a great deal of interest to the game. Still, apart from “ordinary” patterns like flying in circles and changing direction, it is quite possible to produce some interesting results. Enemies could possibly try to dodge the player's shots, or get close to the player to release their attacks, or avoid the player and attack from a distance. Formations could split up to try and engage the player from multiple angles. Of course, the thing to bear in mind throughout all this is that the designer and player of the game are ultimately on the same side!

- More tactical options for the player. Without wishing to over-complicate matters, it would be interesting to add the possibility of e.g. a second weapon for the player-avatar with special qualities, such as homing on enemies or inflicting area damage. This could be implemented either in place of the side shots which the normal player-avatar fires, or as a secondary mode which must be explicitly activated during gameplay.

Whither, then, the zone and its games? The decreasing occurrence of self-reports may not mean that players are getting 'into the zone' less with modern games. However, it may well mean that they are not recognizing, or learning from, their flow experiences. Was Player A in the zone that last game, when he took out three opponents using the humble Glock pistol? What is the zone anyway? Does it even matter anymore?

I think it does, because fundamentally, the 'zone' is a function of a particular sort of pleasure: the pleasure of being challenged - but not overwhelmed. It seems, these days, as though many designers forget this. In any given popular game, there are innumberable ways to short-circuit the challenge of the game – including, but not limited to, the almighty Quick Reload function. Games with so-called "RPG elements", as well as pure digital RPGs, run the very real danger of allowing the player to "power-level" through every obstacle. Multiplayer games suffer from a different sort of challenge-related issue: the problem of matching up players with comparable skill levels. Yet every player who finds a game too easy, or too hard, because of these factors is missing out on one of the most essential pleasures of game-playing.

But the game isn't over, not by far. The Web is now providing players with an abundance of uncomplicated Flash games, richly reminscent of the early days of gaming itself. Independent developers and hobbyists are taking over the concept of "simple games", even as the monolithic game-publishing corporations abandon that idea and marshal their legions of coders in the hopes of creating the next big-budget blockbuster. As long as there are good simple games, games that can be played forever and that people enjoy enough to *want* to play forever, there will always be new generations of "wizards" and "zoners", and people who study them. It is my hope that *Uplift* will prove useful in discovering what makes the 'zone' truly work, beyond the motivational speeches and pie-in-the-sky thinking – and, maybe someday, how to apply that knowledge to the rest of human life.

In the meantime, *Uplift* has reached a developmental plateau. The best I can do at this point, then, is to be praying, be praying, and be praying [17].

APPENDIX A: THE MODERN 2D SHOOTING GAME

Perhaps the greatest misconception about 2D shooting games is that they are primarily about shooting. Any idiot can shoot; most of them can even hit their targets, but it takes practice and skill in order to shoot and *not get shot*.

The modern shmup, or 2D fixed-scrolling shooting game, is usually defined by the following elements.

First, the screen scrolls in a particular direction to give the impression of flight or other movement. It may pause at dramatic moments or scroll in different directions, but it is typically not under player control. If there is player control, it is limited to "panning" the view a little to encompass a playing area which is slightly, but not substantially, larger than the viewable area.

Second, there is a player-avatar which can move anywhere in the 2D plane which constitutes the playing area, via direct manipulation, and can shoot projectiles. It may not be capable of doing so at all times, but one of its main abilities is the ability to shoot.

Third, there are enemies which enter the playing area, either from off the screen or by moving from a different 3D "level" into the 2D plane of the playing area. (This last occurrence is an old tradition in shooting games, as well as a perennial source of frustration for simple-minded players like this writer.) The enemies will shoot at or, occasionally, attempt to ram the player-avatar.

Fourth, the game is divided into levels, each typically more difficult than the last.

Clearly there is so much potential depth within this framework that the genre is far from dead, despite the assertions of naysayers inside and out of the game industry. There are, however, some genre and representational conventions which I will attempt to outline briefly here.

The boss enemy. This is by no means specific to shmups, but is in many ways more developed in the shmup genre than in any other. There are several traditions relating to the "boss enemy", but one of the most common is its ability to transform itself into a more powerful form. Whilst this has been done in other game genres before, most notably the console RPG, it has only reached its ultimate expression in shmups. For instance, Ran Yakumo, the final boss of the Extra stage

in *Perfect Cherry Blossom*, has 20 different forms, each with a unique attack pattern which is challenging to learn and even more challenging to defeat. The bosses in *DoDonPachi*, by contrast, appear static apart from having some destroyable components, but their attack patterns become more dangerous and desperate as they draw closer to defeat at the hands of the player.

The player's collision hull. This is the most obvious difference between "old" and "new" shmup designs. "New" designs usually give the player-avatar a very small collision hull, encouraging precision flying and greater risk-taking. "Old" designs, as well as the handful of shmups made outside of East Asia, often tend to make the player-avatar's collision hull as large as the avatar itself – or larger still. Typically, Western shmups attempt to resolve the resultant rise in difficulty by providing the player with a health meter, but this is by no means a solution; it generally leads only to sloppy play. An interesting compromise was wrought by famous shmup developer Treasure when they created *Gradius V*; when the player-avatar has no shields (as is the case at the start of the game), its collision hull is a miniscule sliver, but when it gains an energy shield, its collision hull becomes precisely as large as the shield.

Increasing powers. In a typical shmup, there are items of various types which the player can acquire by flying the player-avatar into contact with them. Much like the power-ups of *Uplift*, these items most commonly increase the player-avatar's destructive capabilities.

The panic button. Many shmups give the player a limited stock of "smart bombs", which trace their lineage all the way back to *Defender*. Activating a "smart bomb" typically wipes out all enemy projectiles on screen and severely damages all enemies, but this is by no means always the case. This is usually the mechanism of choice to "smoothen" a game's difficulty level and provide a lifesaving way out for less-skilled players, and it can also be considered a resource-management mechanic for those players who are long on experience but short on skill. Certain games play with the idea of "smart bombs" and "panic buttons" to interesting effect, such as *Mars Matrix* (see p. 39).

Lives and extra lives. These are a holdover from the old age of arcade games. It is difficult to guess where the convention of "3 lives" originated, though *Space Invaders* is a very likely suspect, but nearly every shmup adheres to it. "Extra lives" are generally given out as rewards for scoring a certain number of points, although in some games they can be found as items.

Continuing. Another holdover from the arcades, "continuing" is a game feature which allows a player to continue the game after losing all the lives. Typically this action will give the player 3 new lives, but reset the game score to zero. In the community of shmup fans, continuing is often frowned upon, and a player who finishes a game using continues is not considered to have truly conquered the game. A related term is "credit feeding" - playing through a game whose challenge level is far higher than one's ability by repeatedly continuing.

Options. Not to be confused with the sort of "options" one finds in a menu, these small game objects are also known variously as "drones", "bits", "funnels", "pods", "multiples" and "the Force" (which is not to be confused with a similar term in a very popular science-fiction movie). Originating with *Gradius* (see p. 22), they have 3 main defining characteristics: (1) they are allies rather than enemies of the player, and will not harm the player-avatar, (2) they can usually move independently of the player-avatar, although most will follow the player-avatar or orbit around it, and (3) they cannot be destroyed unless the player-avatar is. Typically, defensive options such as the Force in *R-Type* will act as a shield and absorb enemy fire, whilst offensive ones such as *Imperishable Night*'s Myon will shoot at enemies. They may either be given to the player at the start of the game, or acquired during the course of the game.

Bullet hoarding is a tactic used when players are under heavy attack by aimed enemy fire. It involves feinting to one edge of the playing area to attract fire, then slowly moving across the screen to lead the stream of enemy projectiles.

There are also several subgenres of shmups, some of which intersect:

“Old-style” or “retro” shmups are those where the avatar's collision hull is large and will be destroyed by a single hit. As such, gameplay is more about avoiding large masses of gunfire completely as opposed to threading through them. This was the first type of shmup, but now relatively few examples exist. One recent one is *R-Type Final*, which marries 3D graphics with this style of play.

“Puzzle” shmups, such as *Ikaruga* (see p. 35), have game elements which require strategic thinking and a light trigger finger.

“Memory-based” shmups, such as *R-Type*, tend to require foreknowledge of the game layout or the enemies' proclivities in order to prevail. These games often use tactics which in any other game would be considered “cheating” on the designer's part: doors which slam shut suddenly and trap the player, laser cannons which fire without warning and instantly destroy the avatar, and so on. Oftentimes, memory-based shmups use a “side view” perspective.

“Reflex-based” or “manic” shmups are the opposite of memory-based shmups. Whilst these games can be played using memory as an aid, they are much more about the exercise of one's dodging skill. *DoDonPachi* and *Parsec47* are classic examples of this subgenre.

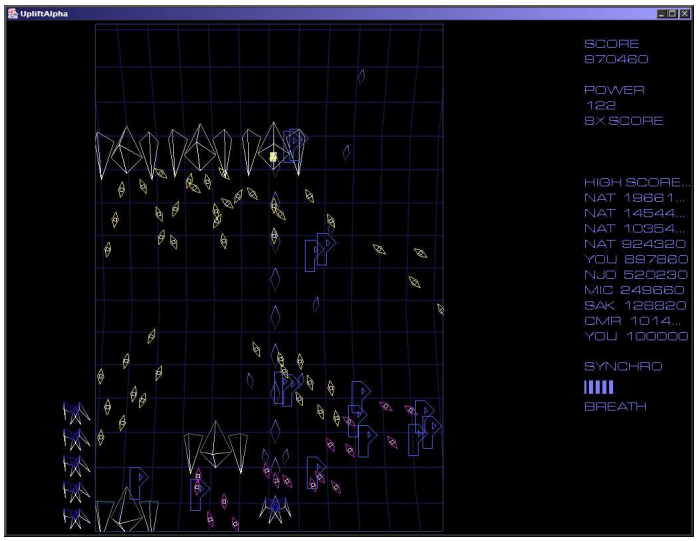
“*Danmaku*” (“curtain fire” or “bullet curtain”) shmups are distinguished mainly by the ludicrous amount of enemy projectiles onscreen, especially during boss battles. In this subgenre, the player is usually required to thread a path through the eponymous curtains of gunfire rather than finding a way around them, and a small avatar collision hull is all but mandatory. *DoDonPachi* and *Perfect Cherry Blossom* are among the more well-known *danmaku* games.

“Cute'em'up” is a non-derogatory term used to describe a shmup which is thematically light and possibly humorous in tone, with appropriately cute imagery. This is a purely representation-related designation; a classic example of the cute'em'up is *Marchen Adventure Cotton 100%.*

APPENDIX B: GAME SCHEMES

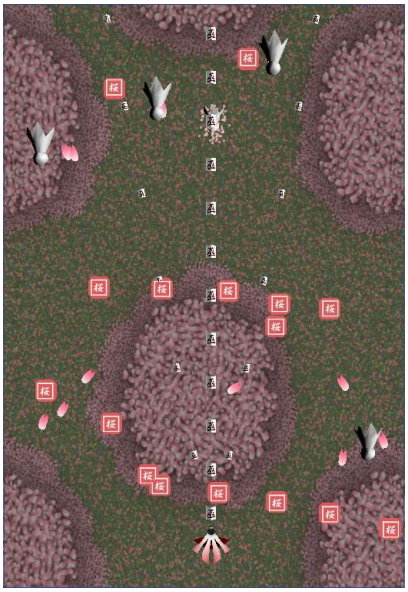
Three different "game schemes" were created for the purposes of this project, to illustrate the mutability of the artifact and to give players a basis from which to work.

Highwire



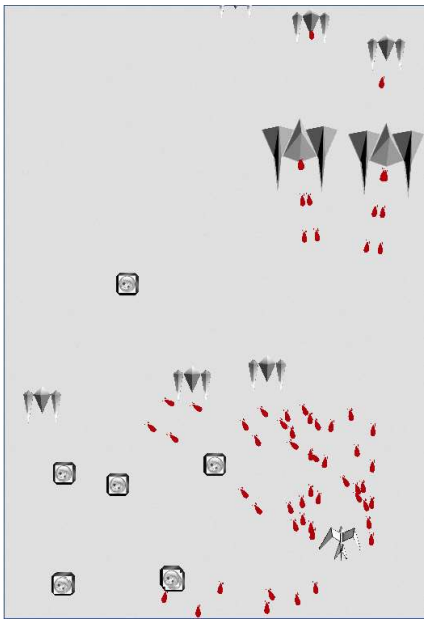
This, the first and default scheme, uses all the standard game settings. The visual design is drawn to a great extent from *Parsec47* and *Tempest*, although the "glow" effects are entirely original.

Springtime Blossoms



The title belies this scheme's inspiration: *Perfect Cherry Blossom*. In a world where most of our environment is gray, techno-industrial and dismal, do we really need more of the same techno-industrial grayness in our games? I intentionally slowed the pace of the game down for this scheme, whilst raising the bullet count; this makes for a much more deliberate experience – though no less hazardous!

Tabula Rasa



The inspiration for this came, oddly enough, from a blank sheet of paper and a few pieces of origami. This is probably my favorite of the three in aesthetic terms – but at the same time, it is a perfect illustration of how aesthetics and playability can clash in rather nasty ways. Enemy fire is less concentrated here, but faster.

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