

UPLIFT

Enabling Latent Human Capability through Games

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1. STATEMENT OF PROBLEM: A FUNDAMENTAL HUMAN CAPABILITY

Human beings, being living organisms, have an intrinsic ability to change and adapt themselves to the conditions of their environment and society. Occasionally, this manifests itself in the form of a hitherto-unknown, although possibly pre-existing, ability. For instance, humans have been able to read and write for several thousand years, but even in the 4th century AD, the ability to read without moving one's lips was virtually unknown among literate people. Within the last century, there has been an increasing awareness of a phenomenon known variously as "flow" (to psychologists) or "the zone" (to athletes and video gamers). This appears to be a fundamental property of the human mind, although it is not certain whether it is a recent development or pre-existent. It tends to manifest itself during mentally or physically demanding activity, and typically takes the form of a dream-like state or a state of perfect concentration in which the individual's ability to perform that activity is dramatically enhanced. The flow state, as I will refer to it from this point onward, can sometimes disappear very quickly¹; at other times, it can last for hours on end.

Due to the subjective nature of flow, as well as some potentially-negative associations such as mysticism and motivational psychology, it has not been the subject of a great deal of formal study, and is in fact unknown to many people. That a capability such as this should be so little-known is not only odd but profoundly disturbing - it is as if, for example, only one out of every five drivers knew that their car had a fourth or fifth gear. We know the capabilities of our computers, our cars, our possessions - how is it that our own minds remain, for many of us, an unknown?

Hence whilst it is imperative that a research instrument be created to assist formal study of the flow state, it is equally important that something be provided for those individuals who wish to explore and experience it. I would not go so far as to

¹ Dr. Shaw has suggested that a stricter definition of 'flow' or 'the zone' might be helpful. However, whilst it is clear that not all experiences of enhanced performance are flow experiences, I would prefer not to discount those experiences whose properties are in some way dissimilar to those commonly reported.

say that one artifact should suffice for all people, because each individual has different abilities and interests which could potentially be at odds with the activity provided by that artifact. It is my intent in this project, then, to design and build a software artifact which will constitute both an appropriate instrument for institutionalized research into flow as well as a compelling tool for a significant set of people to apply towards individual exploration of the phenomenon.

2. PROPOSED SOLUTION: DISCOVERING THE SELF

Even a cursory examination of individual self-reports will typically show that 'classic' arcade games (those developed in the late 1970s and early- to mid-1980s) have a strong tendency to produce flow experiences. As such, the artifact which I plan to design and build will take the form of a simple action game patterned in part after games from that period.

It is my hypothesis that visual simplicity and clarity is highly conducive to the flow state as it is experienced in games, whereas the requirement for high levels of visual discrimination tends to inhibit the experience of the state. Whilst it is not my intention to test this hypothesis, I do plan to build in the capability to do so - in other words, the ability to display both more abstract/simple representations of the game space as well as more complex/detailed representations.

Given this requirement, I intend the game to be a top-down, 2D game in the general tradition of "shooting and flying" games. I believe that this form best supports variable levels of visual representation as well as simple but challenging gameplay, which I feel would be most appropriate to the overall atmosphere I wish to promote. In addition, having played such games critically and being aware of the genre conventions, I am fairly sure that this is the genre which I am most able to work in.

I have identified three main areas in which the game should prove more conducive to the attainment of a flow state than its predecessors in the genre:

(1) a high degree of mutability in content and gameplay. This is important, I believe, not only because it allows for testing of various hypotheses, as mentioned earlier, but also because each individual is likely to have slightly different "ideal conditions" under which they are most likely to experience flow. Changing the dominant colour scheme, playing different music, altering how the enemies behave: all these could potentially have an effect on the player's capabilities. It is my hope that players of the game will find their own "ideal conditions" through

play, and will then go on to organize their environment so as to replicate those conditions, with the ultimate end of being able to easily attain flow in other spheres of activity.

(2) a replay function and possibly some sort of performance metric. The vast majority of individuals who have self-reported being in a flow state whilst playing games have been able to identify when they left the state, but relatively few could tell when it began. With regards to determining the conditions which cause and sustain flow, it is clear that knowing when the flow state begins is as important as knowing when it ends. Given this, I intend to implement a recording and replay function, as well as some means of determining the probability that the player experienced flow at some point during a particular game session. By retracing their steps, players may be able to identify when they entered the flow state.

(3) support for biofeedback devices and potentially some form of brainwave monitoring. It has been observed that the occurrence of the flow state is often accompanied by increases in alpha brainwave activity; if this is the case for most or all individuals, then alpha brainwave monitoring could be a very useful tool for determining when and whether or not the player is “in the zone”.

I don't believe that this game will solve world hunger or end war. I do, however, think that it will allow individual people, as well as humanity as a whole, to learn more about what they are really capable of, and - hopefully - to learn how to harness that capability in their daily lives. This, in a nutshell, is why I feel driven to build it.

3. WIDER CONTEXT: TRADITIONS, CONVENTIONS, GENRES

A number of traditions and fields impinge upon the areas which I will be covering in this project. Among them are psychology (primarily cognitive psychology), sports science, media and game studies and the game industry.

Noted psychologist Mihaly Csikszentmihalyi, who coined the term 'flow', was probably one of the earliest researchers on this subject, although it is quite unfortunate that his work has been packaged and pitched as “motivational” or “inspirational” rather than as a serious study of the phenomenon. Csikszentmihalyi has written a number of books on the subject, ranging from more “accessible” self-help volumes to fairly technical material, but the earliest and arguably most important of his works is 'Flow: The Psychology of Optimal Experience' (1990). It is noteworthy that Csikszentmihalyi set the 'norm' for future research by basing his work heavily on qualitative data and self-reports rather than quantitative data.

'Flow' is a common term among athletes and those involved in sports science. However, the term and associated concepts have come to take on an aura of mysticism and/or superstition, not least because of its association with positive thinking and the whole idea of a coach exhorting players to 'play at 110%'. The department of sports science at Brunel University, under Dr. Costas Karageorghis, is performing a more in-depth study to hopefully quantify the phenomenon and dispel this aura[1]; in addition, it is the only group, to the best of my knowledge, which is attempting to study the effects of video games with respect to the flow state.

The MindGames research group within Media Lab Europe, a research partner of MIT Media Lab, has also been working with the concept of biofeedback games affecting the human mind[2]. Whilst MindGames' projects tend to be slanted towards encouraging relaxation, a couple of them appear to be more interesting in terms of their goals for and requirements of the player - such as 'Mental Leaps' and 'Brainchild'. These two games in particular have a success metric which is not directly related to relaxation - in the first case, the player must concentrate in

order to gain an advantage in the game, whilst the second requires players to perform a series of biofeedback tasks, which might entail concentration or relaxation, and which are conducive to the alteration of their mental state.

There have been a number of commercial games which operate in a fashion not dissimilar to MindGames' projects. The most notable of these is 'The Journey to Wild Divine' (Wild Divine Project, 2003). This is an adventure game not dissimilar to the seminal *Myst*, and requires the player to navigate a strange and graphically lush landscape and overcome obstacles by playing various biofeedback-based mini-games. 'Wild Divine' is quite comprehensive in that it requires the player to achieve tension at certain points and relaxation at others, across several parameters such as heart rate and galvanic skin response. Sadly, the presentation of the game is clearly meant to encourage the sort of mysticism which has given this whole area of research a sort of 'snake oil' aura, and hence it has not apparently found a great degree of success in the mainstream.

On the “mainstream” game front, several works have addressed, either deliberately or as a byproduct of their design, the idea of “the zone” as well as other design features which I feel are helpful. First among these is 'Zoop' (Viacom New Media; 1995). 'Zoop' garnered quite a lot of press when it first appeared, because the designers claimed that it was specifically designed with an eye towards highly addictive gameplay. Indeed, the overall design of the game seems to not only encourage but require players to attain a flow state in order to succeed, not only because it is quite difficult, but also because it has long been acknowledged among game designers that the ideal (and hence 'addictive') game experience is neither so tense as to be frustrating, nor so relaxed as to be boring; this balance between tension and relaxation is exactly what Csikszentmihalyi prescribes as the ideal mental state for a flow experience[3].

Two of the 'classic' arcade games which I appealed to in an earlier section are 'Tempest' (Atari, 1980) and 'Defender' (Williams, 1980). Both of these appear with a fair degree of frequency in reports of zone experiences. As could be expected from games of that time, both have somewhat abstract graphics and relatively simple

gameplay, and both revolve around shooting evil aliens. There is a fundamental contrast between these two, though: *Tempest* was as simple as games got at the time, as the player's spaceship had only two functions: shoot and use a 'smart bomb', and could only be positioned at one end of a specific number of discrete 'lanes' in each level. However, *Defender's* complexity, for the time, was quite intimidating. In addition to pseudo-analogue flight (incorporating inertia) along the horizontal axis, players also had to manage vertical movement, check their radar for incoming alien ships, turn their ship around in order to fly or shoot in the opposite direction, use a smart bomb or go into hyperspace in order to avoid being overwhelmed, scramble to save humans from being abducted by the aliens, and so on. In fact, it was deemed a failure at a Chicago trade show in 1981 [4], possibly because of its extraordinary complexity (for the time) and difficulty. The fact that it is regarded by some as the 'quintessential zone game' [5] could be considered a minor anomaly, although indeed it is no more complex than modern action games such as *Unreal Tournament 2004* (Atari, 2004).

More recent games have, for the most part, not appeared to be as likely to create flow experiences as their older counterparts. A couple of exceptions which I would like to point out are *Rez* (Sega, 2001) and *Parsec47* (ABA Games/Kenta Cho, 2003). Both of these have engendered reports of zone experiences, and it is interesting to note that both of them also make use of intentionally-abstract visual designs. In the former case, the player takes on the role of a hacker attempting to gain access to a futuristic computer network through a (supposed) virtual-reality interface, and hence the visual 'look' changes from intentionally-simplistic wireframes to more elaborate polygonal and eventually textured graphics. *Parsec47's* visual design, on the other hand, was the product of an intentional homage to 'classic' arcade games. In any case, it is more than likely that the flow-inducing properties of these two games stem not only from their visual design but also from the whole experience of the player.

4. PROPOSED DELIVERABLE: THE STRUCTURE OF THE THING

I propose to design and build a simple action game which incorporates (1) a high degree of mutability, (2) a replay function and possibly a performance metric, and (3) support for biofeedback and possibly brainwave monitoring. This will be based on a prototype which I am in the process of building for the class LCC 6318-A1.

4.1. GAME OVERVIEW

The game will be a vertical-scrolling game played on a 2D plane. The player controls a very small object (potentially a fighter aircraft or something similar, although its representation may be different) and moves it around the screen; 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 and sides (and occasionally the bottom); these will attack the player's avatar by shooting at it or attempting to ram into it, and will leave the screen after a set amount of time. The player's avatar is armed and may counter-attack the enemies by shooting them; its weapons are usually oriented to fire towards the top of the screen, although this may be changed by the user in an options menu, and their “power” may be increased by obtaining certain items (more on this later). The player will be allotted a number of “lives” at the beginning of the game, and can gain more through skillful play (the requirements for this have not been decided yet). Should the player's avatar be struck by enemy fire or an enemy, it will lose a “life”, and when all three are lost, the game is over. The player's avatar will be controlled by means of the keyboard; whilst support for game controllers may be added at some point, the nature of the genre is such that most game controllers would not provide significant gains in usability or playability over the keyboard.

4.2. STAGES AND GAME PROGRESSION

The game will further be divided into “stages”; at the end of each stage the player will be challenged to defeat a large and powerful enemy (“boss”).

Certain enemies, when destroyed, will drop “power items” which increase the avatar's weapon power (thus enabling it to shoot enemies down with fewer shots, and/or widening the “spread” of its shot pattern so it can hit enemies at an angle).

“Power items” will leave the playing field after a short time; if they are not collected by the player before then (by flying the avatar into contact with them), the avatar will not only fail to gain their benefit, but may (dependent on regulatory mechanism) suffer a decrease in power. A regulatory mechanism will be needed to encourage tactical decision-making on the part of the player; the choice of mechanism will be changeable, but one possible example is as follows: as soon as the avatar’s power exceeds a certain level, 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.

The player will gain “score” by shooting enemies down. Score bonuses may be accrued under certain conditions, the specifics of which are still up in the air.

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”), an extra life and a very substantial score bonus will be awarded. The bonus will, however, be diminished should the player lose one or more lives during that stage.

The game will be programmed in Java. Control will be through the keyboard; support for game controllers is a possibility but not a given.

4.3. USE OF BIOFEEDBACK

Several vital game parameters may potentially be affected by biofeedback; the exact relationship of game-parameter to feedback type will be configurable by the user.

The types of input data available will include heart rate, breathing (both depth and rate of change), galvanic skin response and potentially brainwave frequency. The first 3 will be gathered through a Procomp Infiniti biofeedback encoder; some research will be necessary to determine the best item of equipment for brainwave monitoring.

The alterable parameters will include the following, and potentially more:

4.3.1. 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 (via GSR, breathing rate or heart rate), thus regulating it. Conversely, a positive loop would increase the game speed as the players' tension increases, challenging them to break out of the loop.

4.3.2. 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.

4.3.3. Avatar collection-radius.

This determines how close the avatar has to be to a power-item in order to “pick it up”. The larger, the better.

4.3.4. 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.

4.4. GAME SCHEMES

The mutability aspect of the game will be accomplished through the use of 'game schemes'. Each of these is a package of settings, such as the tendencies of enemy objects, the avatar's available attacks, the visual design and so forth, which together define the overall game experience and potentially the difficulty. Three default schemes are to be provided with the game, with the idea that individual players will adapt one or more of them to create the “ideal conditions” for experiencing flow.

4.5. RECORDING AND REPLAY

The game will support recording and replay of game sessions. After each session, players will be prompted to save the replay of that session; should they assent, the replay will be saved in a proprietary file format and may be accessed at any time. Data to be saved will include not only the game state and game scheme but also data from any biofeedback devices in use at the time.

The replay function will support play, pause, fast-forward and rewind functions. A bookmark feature is under consideration.

4.6. PERFORMANCE MONITORING

One of the more commonly-observed properties of the 'flow' or 'zone' state is that individuals in such a state exhibit greatly enhanced abilities. As such, an overall performance metric might help to determine whether the player was 'in the zone' at any given point in the game session. This is, however, non-trivial to compute, given the complexity of the game environment with respect to heuristics, and hence it will require a certain degree of study and user testing. The capability to monitor the user's dominant brainwave frequency would be extremely helpful in this regard, and might indeed obviate the requirement for performance measurement.

5. SPECIFIC DESIGN PROBLEMS: A BALANCING ACT

Whilst the broader aspects of the design have been more or less fleshed out, there still remain several specific issues which will need to be settled. The first of these is that of balancing the player's control. In different game situations, the player will usually need to exercise either fine control (which predicates slow movement) or execute violent evasive maneuvers (which predicates rapid movement). Several means have historically been developed for addressing this issue, including the possibility of making the avatar gradually accelerate as the player presses the directional controls, or having the player explicitly alter the avatar's speed via a toggle or other such controls. The choice of method, in itself, will constitute something of a design problem.

Other issues include the size of the avatar's hit-radius and the speed and volume of enemy fire. With regards to these parameters, several 'traditions' exist in this genre of game design, but I do not believe that any given one of them is necessarily an absolute match for this design - neither do I believe that abdicating responsibility to the user on the grounds of customizability is a good idea at all. These will, again, require balancing, as will the overall difficulty of the game.

It is entirely possible that each of the three default game schemes I intend to provide will represent different solutions to the above problems. Indeed, they will more or less need to have substantially different visual designs, each of which will be an exercise and an issue in and of itself.

6. METHODS AND APPROACHES

I plan to build the final deliverable in Java, using the Java3D extension library and potentially some interface for reading raw data from the computer's serial port. Depending on whether or not support for a brainwave-monitoring peripheral is added, as well as the specific peripheral type, it may be necessary to build the game, or at least the brainwave-monitoring portion of it, specifically for Linux, since there is no satisfactory Java interface for reading raw USB data under any variant of Windows or MacOS.

Upon the completion of a prototype, alpha testing will be conducted among a small user group. I plan to request the use of a station in the IDT Game Lab for the purpose of "open" alpha testing during the lab's open hours. In addition, I have identified a number of acquaintances who would probably be interested in assisting in the testing process.

Beta testing will begin when the game is mostly complete. The goal at this point will be slanted towards resolving balance issues with the specific game schemes rather than finding and fixing bugs. In addition to the alpha testing group, I intend to contact a couple of online communities whose members could potentially be willing to assist with such testing.

7. TIMETABLE

2004.10.11 - Work on the game engine begins.

2004.11.15 - First pre-alpha build of the game engine is complete and playable with placeholder graphics. Most features are non-operative, but avatar movement and control, enemies with fixed properties, and level progression are in place. No scoring is implemented.

2004.12.01 - First biofeedback-enabled build is complete, with refined graphics, scoring and randomized enemies in addition to the 11.15 featureset. This is the **final LCC 6318-A1 deliverable**. Graphical assets from this build will be carried over for use as placeholders in later stages of development.

2004.12.31 - Customization partially implemented.

2005.01.10 - Alpha testing period begins and will continue throughout this development phase.

2005.02.15 - Replay mode and customization are fully implemented.

2005.02.28 - Beta version 0.8b is complete. This will be a **feature-complete version** with all the features listed in section 4, above. However, the game schemes at this point will not have been built. Beta testing begins at this point.

2005.03.15 - Testing of game schemes begins. At this point the game schemes will be functionally complete, although they will still be using partial placeholder graphics.

2005.03.30 - Game schemes are complete. At this point the **final deliverable** is complete and the remaining time is to be used solely for finding and fixing bugs.

2005.04.11 - Project defense week. **Final deliverable is complete and bug-free.**

8. RESOURCES REQUIRED

8.1 LABORATORY RESOURCES

For purposes of user testing, a station in the IDT Game Lab will be needed, during open lab hours only, for the duration of Spring Semester 2005. No other resources in terms of laboratory space are likely to be necessary.

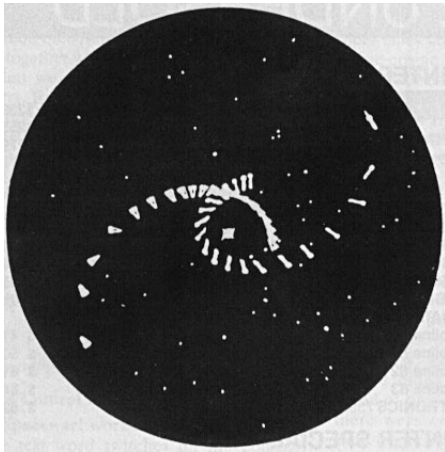
8.2 EQUIPMENT RESOURCES

I intend to utilize Prof. Gromala's Procomp Infiniti biofeedback encoder as the primary biofeedback device for this project. In addition, it may be necessary to acquire some form of neurofeedback device for brainwave monitoring. The BrainMaster 2E (www.brainmaster.com) is fairly representative of this class of devices.

9. PERMISSIONS REQUIRED

Permission will be required to perform testing on human subjects. Although I have been certified to perform approved human-subjects testing, it will still be necessary to apply to the Georgia Tech IRB for a review of the testing process. According to the IRB website, the scope of testing I intend to conduct will most likely fall under the category of 'Expedited Review'[6] and hence should take approximately 14 working days. In view of this I intend to apply for IRB approval at or about December 1st, with a view towards obtaining the requisite approval substantially in advance of the beginning of the testing process.

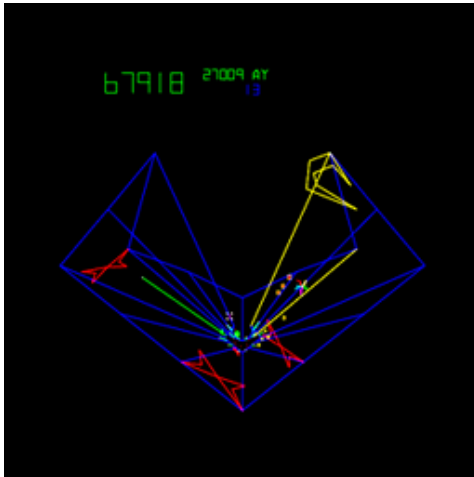
APPENDIX A: FIGURES



Spacewar (1962)



Defender (1980)



Tempest (1980)



1942 (1984)



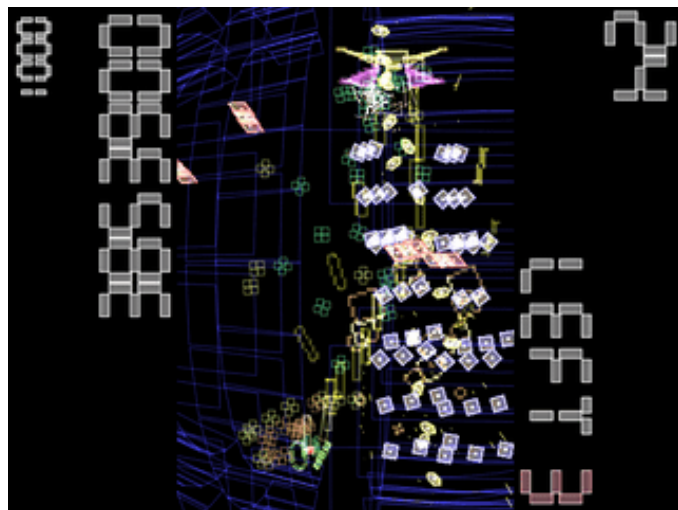
DoDonPachi (1997)



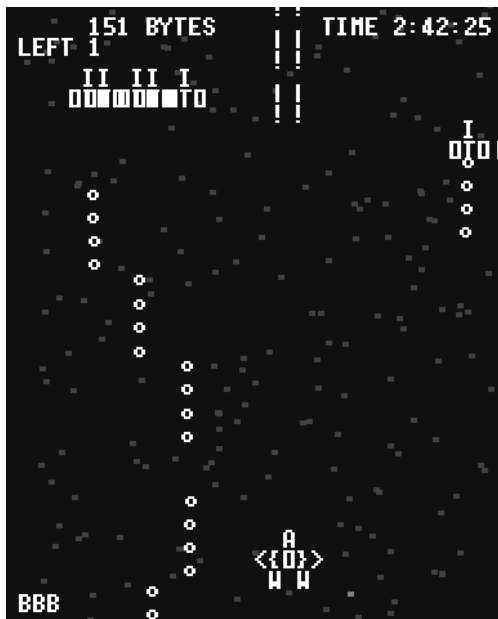
Ikaruga (2000)



Perfect Cherry Blossom (2003)



Parsec47 (2003)



VAX11 (2004)

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