Communicating Game Feedback through Pictorial Means

A Case Study of the Game Among Ripples

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Abstract

This thesis studies how one can convey meaning in games by utilising pictorial feedback alone. With the help of Peircean visual semiotics the signs for the case study Among Ripples are assembled and later analysed in detail. As a subtopic the thesis also explores if it is possible to embed pictorial feedback into the game world instead of having it superimposed.

The results showed that it is possible to convey some feedback with pictorial means alone, and that the entry points for understanding are not the same between different people. They look at different cues from the pictorial feedback constructed.

Key words

Pictorial feedback in games, Peircean visual semiotics, graphical user interface, embedded game feedback
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Table of Contents

1 Introduction........................................................................................................................................ 1

1.1 Background.................................................................................................................................. 1
1.1.1 Pictorial feedback of today in games ....................................................................................... 1
1.1.2 Shell menu ............................................................................................................................... 6
1.1.3 Among Ripples ......................................................................................................................... 6

1.2 Theoretical approach: Peircean visual semiotics ......................................................................... 8
1.2.1 Peirce’s legacy ......................................................................................................................... 8
1.2.2 The process of semiosis ........................................................................................................... 8
1.2.3 Explaining the first trichotomy ............................................................................................... 9
1.2.4 Divergent theories .................................................................................................................. 10

1.3 Hypothesis, aim and questions .................................................................................................... 10

1.4 Method, materials and limitations ............................................................................................... 11
1.4.1 Constructing pictorial feedback ............................................................................................... 11
1.4.1.1 Food chain and energy ........................................................................................................ 11
1.4.1.2 Reproduction ........................................................................................................................ 12
1.4.1.3 Substances ........................................................................................................................... 13
1.4.1.4 Other feedback systems ...................................................................................................... 14
1.4.1.5 Transcendence to sinsign .................................................................................................... 15
1.4.2 Test and interview ................................................................................................................... 15
1.4.3 Limitations of the test ............................................................................................................. 16
1.4.4 Ethics ...................................................................................................................................... 17

1.5 Previous research ......................................................................................................................... 17
1.5.1 Pilot study ............................................................................................................................... 17
1.5.2 Visual literacy and structural problems .................................................................................. 21
1.5.3 Games without a heads-up display ......................................................................................... 21
1.5.4 Visual pattern recognition ...................................................................................................... 22
1.5.5 Implicit knowledge .................................................................................................................. 23

2 Results .......................................................................................................................................... 23

2.1 Feedback themes ......................................................................................................................... 24
2.1.1 Substances ............................................................................................................................. 24
2.1.1.1 Pollutants affecting creatures ............................................................................................ 24
2.1.1.2 Removal of pollutants ........................................................................................................ 25
2.1.2 Food chain and energy ............................................................................................................ 26
2.1.2.1 Player introducing new fish ............................................................................................... 26
2.1.2.2 The hierarchal food chain .................................................................................................. 28
2.1.3 Reproduction .......................................................................................................................... 29

3 Analysis and Conclusions ............................................................................................................... 30

3.1 Discussing generalities ................................................................................................................. 30

3.2 Anomalies .................................................................................................................................... 31

3.3 Revisiting Peircean visual semiotics ............................................................................................ 31
3.3.1 Mentioned sub-signs from the interviews .............................................................................. 31
3.3.1.1 Legisign ............................................................................................................................... 31
3.3.1.2 Qualisign .............................................................................................................................. 32
3.3.1.3 Sinsign ................................................................................................................................ 33
3.3.2 The summation of the signs ..................................................................................................... 34

3.4 Themes conveyed through signs .................................................................................................. 35

3.5 Embedded feedback..................................................................................................................... 35
1 Introduction

Games have been with mankind for many a century, from the free play space to ritualistic, folk, sports and board games. And now digital ones, which needs a digital device to be operable. What the analogue ones have in common are that the people involved need to know the rules in part or full in order to be able to play it. Digital ones do usually not have this criteria; a player can fiddle about in the rigid structure of a rule-based digital game without knowing the rules, and the game is still upheld.

Of course, the player usually learns the rules and the ways to interact with the digital game, but it can prove to be a different challenge to learn analogue ones. In analogue games we need to learn the rules in part or in full in order to be able to play at all, as has been previously stated. In a digital game we usually learn the rules as we go along. This can make it a different discovery process where the player can build hypotheses on possible inner workings and then test them out in the game space. If they are falsified the player might go on to other theories, and if it is confirmed the player builds a successful mental model of that part of the game. However, games can be rich in content and rules, which can be easily misinterpreted by the player, who may think they find connections between random occurrences.

A way to try and eliminate this discrepancy between the actual rules of the game and the mental model of the player is to provide effective feedback. There are many ways to convey the input and output feedback of a game, and this thesis covers but one way of feedback: the visual or rather pictorial.

The objective of this thesis is to document the methods and results on how to convey feedback through pictorial means. But also to discuss how one can embed the feedback into the game world. The thesis uses the theoretical approach of Peircean visual semiotics in order to analyse signs, which convey the pictorial feedback.

1.1 Background

In this section a short summary of the history behind pictorial feedback is included. Following that, there is a short description of the game Among Ripples. In order to understand the limitations of the project an introduction to shell menus is also included.

1.1.1 Pictorial feedback of today in games

Many digital games today rely on text and numbers to display different kinds of information alongside the pictorial feedback. This is also true in other media in the western and much of the industrialised world. But it has a brief history in modern times as Scott McCloud (1993) explains:

By the early 1800's, western art and writing had drifted about as far apart as was possible. One was obsessed with resemblance, light and color, all things visible. ...The other rich in invisible treasures, senses, emotions, spirituality, philosophy... Pictures and words, once together in the center of our iconic abstraction charts, have at this point drifted to opposite corners. (McCloud 1993:145)
McCloud also states (1993:146) that: "In a way, pictures and words had reached the end of a 5,000 year journey. If they were to continue moving, where could they go?" Something happened in the 20th century where the old ways found a renaissance.

Figure 1.1. Excerpt from McCloud's book Understanding Comics. This shows 20th century synthesis of numerical, textual and pictorial signs in different media, which McCloud refers to as "the great madness".

Digital games found their conception in the middle of the "great madness". Early games like Pong from 1972 and Space Invaders from 1978 show this synthesis of image, number and text, but in limited form.

Figure 1.2. Pong screen capture. Score count can be seen above which is an example of numerical signs together with the pictorial ones below them.
As the decades went past, new games came to fruition and they sometimes involved more complex interaction and simulations, which in turn needed more textual, numeric and pictorial feedback. The fidelity of the feedback was also increased over time.

*Sim Earth* from 1990 is an example of a more complex game which relies heavily on the previously mentioned means. It is a biological simulation game where the player manipulates different eras of the Earth's history. *Sim Earth* is also a good example of a game which extensively utilises a Heads-up display (normally abbreviated to "HUD"). Oxford Dictionaries (2013) defines it as follows:

a display of instrument readings in an aircraft or vehicle that can be seen without lowering the eyes, typically through being projected on to the windsreen or visor.

As can be seen, the terminology and general functionality have been borrowed from another field. It does however function generally the same way with information layered on top of the game world. You can for example move the two dimensional camera in *Sim Earth* and the heads-up display will remain unchanged. It is thus layered on top, similar to how it would be on a visor, or windscreen.
In many games the heads-up display also intermingles with input elements where the player can click on the screen space and make a selection from there. This can be referred to as a "user interface". Ernest Adams explains (2010:200) that a user interface can be divided into two sections: the output (what the player receives) and the input (which is how the player manipulates the game). The heads-up display should be seen as a part of the user interface, and in Adams' definition it could be called output. The game *Pharaoh* from 1999 gives a clear example of an input interface where you can decide what buildings to build with the help of the user interface.

Figure 1.4. *Sim Earth* screen capture. The right lowermost rectangle on the screen is a clear example of a heads-up display.

Figure 1.5. *Pharaoh* screen capture. Notice the right lowermost corner where several icons (that are similar to hieroglyphs) can be seen. They are all input buttons for choosing different buildings to place in the game world.
For the sake of clarity, consistency, and simplicity in this thesis, from now on I will use the term “superimposed graphical user interface”, meaning a graphical interface which is not embedded in the game world. I think that it is problematic to assign input qualities to heads-up displays, and it would be too cumbersome to refer to Adams' input and output at the same time. I also see no reason why output or input interfaces could not be integrated in the actual game world. As such the concepts can become muddled. The term I will use would incorporate both Adams' two definitions and the definition of a heads-up display.

As an example of a minimalistic approach to a superimposed graphical user interface, one can study the game Lack of Love from 2000. It is just as Sim Earth, a kind of biological simulation game (on a much smaller scale and from a different perspective), but with minimal textual and numerical signs. Most feedback is purely shown via pictorial and aural means.

There is a wide range of possibilities here as can be seen, since the need to convey information is very individual to the kind of game the designers had in mind. A game might have wholly different requirements on how much information the player needs to be informed of, in order to be able to operate the game.

This is in no way an exhaustive history of games as an information transferring medium as a whole, just a small glimpse of what games have done up until now. Biological simulations are also not the biggest genre of games, but it is relevant due to the nature of the case study. One thing which can be seen in several games and other media is the synthesis of textual, numerical and pictorial feedback tied together into one.

And as we go forward into the 21st century I think we will see more examples where a substantial portion of a game's feedback will be delivered by pictorial means and be integrated seamlessly in the game world, just as in the game Lack of Love.

Figure 1.6. Lack of Love screen capture. Notice the lack of numerical and textual signs. Even though there are almost no examples of a superimposed graphical user interface, one can see one example in the left uppermost corner.
1.1.2 Shell menu

A shell menu is often present in a wide plethora of games which can be compared to menus seen in other kinds of media, a film menu for example. Adams (2010:43) explains it this way:

[...]a ‘shell’ around the game, outside of the magic circle). Examples of the kinds of activities available in a shell menu include loading and saving the game, setting the audio volume and screen resolution.

![The Witcher 2 shell menu](image)

Figure 1.7. The Witcher 2 shell menu. Notice the textual signs to the left which fits Ernest Adams' description.

1.1.3 Among Ripples

Among Ripples is the case study for the thesis and has been developed by two people, who both study at Gotland University. I served as the artist on the project, and Oskar Thysell did the programming. We did the game design together.

The game is an ecological simulation in a Swedish inland lake, where a single player can manipulate the game space via indirect means. The interaction involves changing parameters in the lake, such as reducing oxygen or increasing algae, but also other means. The player will have to observe the game world in order to learn how the systems work, so it is as much about observation as it is about action. The lake is however in a state of decline due to contaminants from the human civilisation, so the player will have to intervene at some point. The objective of the game is not to just save the lake, but shape it in a way that the player thinks it should work.

We designed the project with a scope that could be completed in a few months time and practice perseverance and polish in a game project. As such we desired to release something that could be regarded as a commercial product, since we had only been involved in experimental and academical productions up to that point.
The subject matter was chosen because of personal convictions: the environmental impact on nature by humans is an important subject that should be covered in games. We felt that we could broaden our personal horizons on what games could be, and what messages they can convey. The game mechanics were constructed in a way that would lead itself more to simulation, and the feedback was decided to follow that pattern to heighten the naturalistic patterns.

The thesis and case study documented here came to be when Thysell and I met with a problem with the game Among Ripples, which we were working on. To make it function optimally we wanted to embed the feedback in the game world via pictorial means, in order to increase the immersion. We felt that if there were a superimposed graphical user interface on top of the game world the player would be reminded that it is only a bit of software. We wanted to give the impression of an actual lake that the player cares about.

The game will involve sound in the form of ambience, music and effects, but it is meant primarily as mood enrichment and we will not rely heavily on its presence.

The end product is meant to be published independently as commercial software, so some decisions have been made for the good of the product, and not just for the purpose of this academic foray.

Figure 1.8. Screen capture from Among Ripples. The version which was compiled shortly before the test on the 8th of May, 2013.
1.2 Theoretical approach: Peircean visual semiotics

For this project I have chosen to use visual semiotics in order to be able to analyse and construct pictorial feedback. The framework I use is referred to as "Peircean semiotics" by Tony Jappy (2013). In this section I will elaborate on why I have chosen this semiotic system and shortly summarise who Peirce was. After that I will shortly explain the concept of semiosis. Following that I will explain how the system can be used to analyse one of my signs. Finally, a small discussion follows, which explains why I have chosen this method over others.

1.2.1 Peirce's legacy

Charles Sanders Peirce was born in 1839 and lived to 1914 (Stanford Encyclopedia of Philosophy, 2010). He was noted for being a logician, philosopher, and mathematician among other disciplines (Jappy, 2013). He also invented a theory of signs which I have chosen to employ in this thesis.

I have used Tony Jappy's book Introduction to Peircean Visual Semiotics as the main reference since it specifically employs the system in use of analysing visual signs. It should also be noted that Peirce's theoretical framework evolved throughout several decades (Jappy, 2013:55), and that a large body of his work was published posthumously (European Graduate School). So even if Peirce formed his system alone several published books and scholars later have helped unearth and clarify the wealth of information.

1.2.2 The process of semiosis

To understand Peircean visual semiotics one should start with the process of semiosis, which Peirce explains in this way (Peirce, Pragmatism, EP 2, p. 411. 1907, cited on The Commens Dictionary of Peirce's Terms, 2009):

"...by "semiosis" I mean, on the contrary, an action, or influence, which is, or involves, a cooperation of three subjects, such as a sign, its object, and its interpretant, this tri-relative influence not being in any way resolvable into actions between pairs."

I will give one of Jappy's (2013:4) examples to make it as clear as possible.

One well-known case is Robinsons Crusoe's reaction to finding 'the print of a man's naked foot on the shore'. This was a most unexpected sign, made by an absent 'object' - immediately recognized as a man - and left Crusoe 'like one thunderstruck, or as if I had seen an apparition', the immediate effect the print had upon him.

As such Crusoe realised that the sign was made by an object, and the third and last thing that took place was the effect, the interpretant. The interpretant can also lead to an unlimited chain where new signs can be recollected, and the chain starts anew.
1.2.3 Explaining the first trichotomy

In Peirce's system a sign can be divided into many smaller parts. With the help of being able to put pictorial signs into smaller anatomical parts it provides a means to analyse what needs to be done.

There are three sub-signs in the first trichotomy that should be understood: the qualisign, the sinsign and the legisign. Jappy (2013:32) explains: "[...]qualisigns are qualities such as colours, feelings, qualities of sound, etc.". Further down he informs that sinsigns are: "[...]singular, existent occurrences, 'one-off' signs, [...]a sketch is a sinsign, a photograph is a sinsign". Lastly he states (2013:33): "The legisign [...] is like an entry in a standard dictionary, for there is usually only one entry per word, even when the latter is polysemous". One should note that different signs in a sign can co-exist together, and often do.

A qualisign explains a quality in an object, a sinsign shows if it is a singular occurrence or not (as such a sign can be without a sinsign), and a legisign is a generality. I will here show a pictorial example.

Figure 1.9. The process of semiosis.

Figure 1.10. Northern Pike from Among Ripples.
If we analyse the sign above I can conclude that it is a fish, which can be a form of legisign. A fish is a generality, in both image and especially in the English language (the word “fish”). If this would be the only instance of its occurrence it could be called a sinsign. There are several qualsigns, for example the colour green, the silhouette which is a mix of straight and curved lines and also the paper texture. This should be seen as a non-exhaustive list.

One thing should be noted though, and it is that Peirce's system stretches much further than these sub-classes, there are three trichotomies with three sub-signs in each for example. But I decided to focus on the first one in order to be able to balance the practical with the theoretical.

1.2.4 Divergent theories

It should be noted that there are several schools of thought in semiotics, where the two dominant models are that of Charles Sanders Peirce and Ferdinand de Saussure (Daniel Chandler (2013).

Saussurean semiotics or semiology was introduced in this manner by Chandler (2013):

Saussure offered a 'dyadic' or two-part model of the sign. He defined a sign as being composed of:

a 'signifier' (signifiant) - the form which the sign takes; and

the 'signified' (signifié) - the concept it represents.

This dyadic structure is the root of the semiology or semiotic system. Chandler (2013) later explains more on what Saussure thought of signs:

Saussure argued that signs only make sense as part of a formal, generalized and abstract system. His conception of meaning was purely structural and relational rather than referential: primacy is given to relationships rather than to things (the meaning of signs was seen as lying in their systematic relation to each other rather than deriving from any inherent features of signifiers or any reference to material things).

Since I am primarily interested in the material or "referential" I have chosen Peircean semiotics. It divides a sign into much smaller parts, which is a great boon if one is to assemble signs, and not just disassemble them.

1.3 Hypothesis, aim and questions

The hypothesis is that since humans can recognise patterns in the world (and in games) they will be able to understand any or most pictorial feedback if it is consistent. Also, if the feedback will consist of signs which are constructed from the perspective of Peircean semiotics then I can create consistent feedback.

How can one give feedback to the player with the help of pictorial signs only (thus excluding text and numbers)? Is it possible to embed the feedback in the game world instead of utilising a superimposed graphical user interface? If so, then how?
The aim is not to make an antithesis to other games which forge pictorial feedback with numerical and textual. It is rather an experiment to synthesise together meaning (which one finds normally in textual and numerical signs) and pictorial feedback into one.

1.4 Method, materials and limitations

My method is to conduct a qualitative analysis based on interviews with a small adult test group from Sweden. I chose this method because my hypothesis is rooted in the assumption that individuals are different in their interpretations and focus on the data in front of them. With a qualitative analysis I can take time to collect a broad collection of information from each tester and ask as many follow-up questions as I would deem necessary in the allotted time frame. Lastly, it allows me to present them as individuals in the results section.

In this section one can read in what manner the feedback for Among Ripples is thought out, in what shape the test will be conducted and lastly what limitations there are on the test.

1.4.1 Constructing pictorial feedback

In order to achieve an understandable game with pictorial feedback I have followed the hypothesis. But to be able to construct understandable feedback I have structured it and split it into much smaller parts. There are five main areas of feedback which I will summarise in the following sections.

1.4.1.1 Food chain and energy

The player needs feedback on how the food chain in the game works. The game has a food chain that starts in the water where algae thrives. Algae works as the energy reserve for the player as well (in order to create creatures of his/her own). So in order for the player to be able to decide when to share this resource with the inhabitants of the lake he or she has to be able to see the algae.

Figure 1.11. Algae Indication. Showing some of the levels of algae, the left image shows zero algae and the right shows maximum amounts of algae.
The smallest fish called Common Dace and freshwater clam eat algae and if one of the two get eaten after that the energy goes upwards in the food chain (see figure 1.12). When a creature eats it gains size, the creature sign is then resized. And when a creature consumes energy it will get smaller. They have certain thresholds of size however, an European Perch can never become as small as a Common Dace for example.

![Food chain diagram]

Figure 1.12. Explanation of food chain.

In the uppermost left corner you can see Common Dace (top), European Perch (middle) and Northern Pike (bottom). In the uppermost right corner you can see Fresh water clam (top) and Signal Crayfish (bottom). With the help of several qualisigns I can give cues for the player to differentiate them (and become recognisable legisigns). There are differences in: colour scheme (Hue, value and saturation), texture, silhouette, size and animations.

In all of the different creatures I have taken care to differentiate them when it comes to the above mentioned qualisigns. A hierarchical differentiation where the smaller the creature the lesser the value in its colours, texture and movement patterns.

1.4.1.2 Reproduction

In Among Ripples the creatures reproduce at different seasons, the only indication for the player is that the specific species lays eggs then. It can however be tied to the changing of the background layer, which has four seasonal images (which will be explained further in section 1.5.1.4.).

When a species reproduce the game checks how many of its kind there are, and checks the energy reserves of all of them. If they meet the requirements of reproduction a representant of the species swims to the bottom of the lake and lay eggs. The eggs sign size will increase or decrease depending on how many fish will be born. Since some of the predators eat eggs the size is also a representation of the health of the eggs, if a crayfish eats up half of "the" egg the fewer the fishes that will born.
Since the lake is negatively affected by pollutants the species can be affected by impotency and potency (except clams). Thus fewer or more of its kind will be spawned. It is shown with the help of different kinds of egg. Take the different forms of the Northern Pike eggs (figure 1.13). The affected eggs have spots with a colour exactly like the feedback from substances (see section 1.4.1.3).

![Impotent, Normal, Potent eggs]

Figure 1.13. *Potency level of eggs.*

### 1.4.1.3 Substances

Impotency and potency are the substances which affect reproduction. They are indicated by layers that rise from the bottom. The potency share the same visual space as impotency, but the two take out each other so there is no need to show more than one at once. The potency layer is similar but has a different texture and colour (brownish yellow).

![Impotence indication]

Figure 1.14. *Impotence indication.*

Feedback showing how the decrease and increase of energy functions are done by showing oozing effects on the sides of the game space, increasing or decreasing dependent on the actual level.
Substances accumulate in the creatures and when eaten by another it will be transferred into its new "host". This will be indicated by an oozing effect behind the sprites with a corresponding colour to the other substance (see figure 1.15). The creatures can only have two substances in them at once.

### 1.4.1.4 Other feedback systems

Oxygen and algae are linked together, when there are a lot of oxygen there is little algae and vice versa. The oxygen is shown by small bubbles.

Seasons are the biggest shift in the game world where a lot of things happen. Creatures are born on certain occasions, the oxygen and algae have different levels according to season among other things. So for the player to easily tell when these things happen the background layer is changed to a new season. Since it is taking place in Sweden I took inspiration from my own climate and assumed that a Swedish audience would grasp the concept.
In order to differentiate the seasonal layers as much as possible I "painted time", small things that happened in each season. That flowers would bloom in spring and turn to fruit in summer and/or autumn. Small micro stories, all in all. Another thing I did was to change subtle shifts in color and lighting.

If the creatures live until old age they eventually die of natural causes, which is indicated by an animation where they turn gray and dissipate. It was meant from the beginning that the creatures' colour would age just as they did, so the overall value in the colour would transition to gray.

1.4.1.5 Transcendence to sinsign

It was intended from the start that each creature had their own version of the general colour scheme of its species, but due to technical limitations it wasn't included. However, since the creatures are governed by the game they won't succeed in the same way and thus gain different energy and substance levels. So theoretically they can be different, and become sinsigns. However, many times they don't and it is thus a very imprecise delivery method of the original intention.

1.4.2 Test and interview

For the test I will conduct there will be ten adults present, which consist of Swedish testers who all live on Gotland. They are handpicked with the only requirements that they can physically be present on the testing day and that they are adults. The tests takes place on the 8th of May 2013 and are grouped after each other.
They all play the game separate from the others, and I will be the only person present who lead the test. The testers will first be instructed to the controls by me for the personal computer version of Among Ripples. And I will shortly present the game as a biological simulation game where pollutants affect the lake, and that they are free to shape the lake as they see fit.

They will then play the game for ten minutes without assistance and are after that subject to an (approximately) 20 minute interview conducted by me. With the help of interviews it will be apparent if they could build mental models of the game, from the pictorial feedback. And also how they were able to build it.

In the interviews I will see if the testers understood, without making any indication to them that they did or not. After that I will ask them to provide an extensive response on why they answered the way they did (on each question). I will look for indicators that affirm (or nullify) my hypothesis, that the player will have an easier time to recognise patterns in pictorial feedback, rich in qualisigns (and have a clear sinsign and legisign). I will then correlate all the answers and draw conclusions.

1.4.3 Limitations of the test

The test will be conducted with only pictorial feedback, even though sound will be present in the finished product. Pictorial feedback is after all the only aim of the report. The study is also limited to the feedback in gameplay, and not the shell menu (which includes non-pictorial feedback and superimposed graphical user interface elements).

There are five sub-topics in my method, the first three are the main areas and will be explored thoroughly in the questionnaire. 1.5.1.4 and 1.5.1.5 however are supportive feedback that might or might not provide the testers additional cues to the first three main feedback areas. They are not the major part of the feedback and will not be the main focus. They will however be touched upon in the analysis and conclusion, if there is evidence in results that testers used that feedback to build mental models.

Question 5 in the questionnaire could be seen as arbitrary due to its wide acceptance of a right answer. It is however a necessary limitation since it is a interactive experience, where the testers themselves can continue throughout a game session with not all creatures present.

The test used a keyboard control method, as such there are no need to use superimposed graphical user interface elements for input. And also no embedded input. This was done due to time constraints coding-wise since Thysell had more important issues to deal with for the case study version.

One should note that there is a risk of bias since I developed the game. And I also prepared and administered the test and lastly evaluated data and drew conclusions from that.
1.4.4 Ethics

For the test I informed the testers beforehand that it would be an anonymous test on my game but I did not explain further what the test was about. I said however that I would not use any of the data that I eventually observed during their testing session. I deemed it fruitful to be present on the test and observe that the game did not become inoperable since it was still not finished as a final product. But I tried to make myself as invisible as possible in order not to influence the testers.

After each session was over I informed the current participant the nature of what I wanted to know, that I would ask how they understood the pictorial feedback. I deemed it necessary to not inform them beforehand since I believed that they would register the pictorial feedback consciously on a whole other level if they knew the nature of the test.

For further protecting the testers' anonymity I decided to erase all possible indications of a single person (that does not interfere with the readability of the results section), one of the implications are that I consequently refer to them as genderless and "tester", with a number.

1.5 Previous research

I will here start with explaining the pilot study I did, which led up to this thesis. Following that Donis A. Dondis problematise pictorial literacy and how pictorial language might not be able to act as a substitute to other forms of language. Greg Wilson however argues that it is possible to build feedback with the "less is more" approach. And that it is possible to convey information with other means. After that a study of how humans perceive and categorise pictorial information is included. And finally, Jan G. Hogle argues that players can acquire implicit knowledge by playing, and might not be able to show what they have learned.

1.5.1 Pilot study

For the course Advanced Game Project at Gotland University in spring 2013 I did a small study in the form of the pilot study for Among Ripples. The results gave me an indication that people understood the feedback which contained several sub-classes of signs more efficiently than those without.

The test was conducted via internet where contacted testers downloaded the game, played it and then answered the questionnaire. However, due to poor test results the conclusions are not to be taken in too big of a regard, since several testers answered insufficiently on several questions (see figure 1.21). To get a more dependable test environment I decided to conduct this more thorough test, as my thesis.

The goal of the questionnaire was to see how they had understood the feedback. So after they had played the game they got to watch several images from a random game session and then guess their meaning. They then had to draw from their own mental model they had built and try and answer correctly. See appendix A for the questionnaire.
There were nine participants in the test and I began with asking them what game literacy they had. I borrowed the terminology proposed by Chris Bateman (2007) to supplant the often used terms "hardcore gamer" and "casual gamer".

I therefore suggest that if we are to rescue the crude 'Hardcore versus Casual' partition and make something more worthwhile of it, we should consider the underlying distinction to be game literacy. By this, I mean the individual’s familiarity with the conventions of videogames, and thus by extension their ability to pick up and play new games with little or no instruction.

With this terminology I decided to make it more fine grained and have four kinds of literacy that the testers could choose from: Very literate gamer, Literate gamer, Moderately literate gamer and Illiterate gamer.
The different demographics fared somewhat differently (see figure 1.21), and to my surprise the illiterate gamer didn't fare all that much worse than the very literate gamers. And the peak of comprehension was to be seen in the middle. I had my ideas that it could be understood by a wide spectrum of players, but not that it would actually be understood worse by the very literate. However, as have been stated before some groups had anomalies in their answers and too clear assumptions should be avoided.

![Demographic comparison of answers](image)

**Figure 1.21.** Demographic literacy compared to comprehension of the pilot study.

The testers understood some of the feedback poorly and especially this question (figure 1.23).

![Screen capture for question four in the questionnaire](image)

**Figure 1.22.** Screen capture for question four in the questionnaire.
My conclusion was that the prototype had software bugs which confused the testers. And that it also was hard to convey exact information with pictorial feedback, which numerical signs often do with ease. Nevertheless, interconnectedness and hierarchies was easily distinguished, as can be seen in the next answered question.

Because of the results from figure 1.21 I decided to disregard questions about demographics in my next foray, since I felt that the game surpassed the normal understanding of games.
I concluded that the signs conveyed several qualisigns which gave the testers a wide entry point to understand the concept. But I thought that it should prove meaningful to conduct a more thorough academical undertaking in this field. I also wanted that Among Ripples in its final form would forsake all remnants of superimposed graphical user interface that was present in the pilot study.

1.5.2 Visual literacy and structural problems

Even though there are ample examples of pictorial signs and pictorial language in our world, there can be problems if we draw too many parallels to other forms of language, for example the written word. They might not work as good substitutes, if one is to believe Donis A. Dondis (1973:13):

One thing is certain. Visual literacy cannot ever be a clear-cut logical system similar to language. Languages are made-up systems constructed by man to encode, store, and decode information. Therefore, their structure has a logic that visual literacy is unable to parallel.

It should be noted that Dondis' book is not circling around this conclusion alone, she also states (1973:IX) that there are ways to have a pictorial literacy and a way to decode signs, but there might not be one perfect solution.

1.5.3 Games without a heads-up display

One common way to convey different information is a heads-up display as has been mentioned before. However, Greg Wilson (2006) declares that many elements on the heads-up display are merely there because of convention.

Many elements found on a typical HUD are there not out of necessity, but out of convention; they represent a sort of 'info overkill' that, for the vast majority of players, has no impact on gameplay at all. For every piece of information you offer the player, ask, 'Is this information essential to the game experience?'
After concluding that the designer should reflect on what to include he proposes these alternative indicators:

In a third-person game, player health and/or damage indication can be shown in ways other than through a health meter. In many survival horror games like Eternal Darkness (Gamecube), player health—both physical and mental—is clearly reflected in the player-character model’s onscreen appearance and movements. This can be accomplished through texture, animation, and even camera work. These indicators may not seem initially to be as precise as a counter or bar, but if players are given enough distinctive indicators, the process can become intuitive very quickly.

Even though there are not many heads-up display-, or rather superimposed graphical user interface elements in figure 1.26 which shows Eternal Darkness one can notice two examples in the uppermost left and right corner. However, they are complimentary to the other indicators that Wilson states.

![Figure 1.26. Eternal Darkness: Sanity's Requiem screen capture. The image example is not present in Wilson's article.](image)

### 1.5.4 Visual pattern recognition

There is a notable resemblance between Peircean visual semiotics and visual pattern recognition from Michael J. Tarr’s report. In it Tarr states (2000:1) that you can perceive different levels of categorisation in an object, the three most relevant are quoted below:

> […] we can recognize objects at many different categorical levels. Often, however, it is assumed that objects are first identified at the entry level (Jolicoeur, Gluck, & Kosslyn, 1984)—defined as the name which is generated or matched most rapidly to a given object, e.g., ‘apple’ or ‘bird’

Entry level is the first, but for further identification we arrive to the subordinate- and individual-level. Which is described in this way:

> […] e.g., a ‘McIntosh apple’ or a ‘white-breasted nuthatch.’ Such finer discriminations require additional perceptual analysis and thus typically take longer than entry-level judgments. Beyond subordinate-level recognition, we also recognize objects at the individual- or exemplar-level, e.g., ‘the McIntosh apple I brought for lunch.’
One can easily draw parallels between the categorisations in both Peirce's system and Tarr's examples. I do so in table 1.1, which can be seen below.

<table>
<thead>
<tr>
<th>Visual pattern recognition</th>
<th>Peircean semiotics</th>
<th>My interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entry level</td>
<td>Legisign</td>
<td>The generalities of an object.</td>
</tr>
<tr>
<td>Subordinate level</td>
<td>Qualisign</td>
<td>The qualities of an object.</td>
</tr>
<tr>
<td>Individual level</td>
<td>Sinsign</td>
<td>The singular instance of an object.</td>
</tr>
</tbody>
</table>

Table 1.1. Comparison between visual pattern recognition, Peircean visual semiotics and my interpretation.

With this information one can conclude that Peirce's system is supported by psychological studies. And that one should not forget to have a clear legisign in each sign, since it is the entry level of recognition.

1.5.5 Implicit knowledge

Even though mental models can be built by the testers there is always a risk that they cannot express it verbally. Jan G. Hogle (1996:15) puts it this way:

> [...]the most difficult issue in the assessment of games as cognitive tools is that games may be environments which foster the learning of implicit knowledge. Implicit learning occurs when a subject is not consciously intending to learn, is not aware of what they have learned, and yet they acquire new knowledge (Kihlstrom, 1994).

Hogle is mainly addressing if games can be used as tools of teaching knowledge. However, it can be used as an argument of what one acquires internally from a game as well. Hogle continues (1996:15) with stating that players:

> [...] are not always consciously aware of what they have learned (Berry & Dienes, 1993). Learners often can not describe or readily demonstrate the benefits received from an activity, even when real benefits are achieved (Berry & Dienes, 1993; Kihlstrom, 1994; Reber, 1993). As noted previously when discussing Seginer's work on gaming ability, students in simulation situations often develop and use successful strategies that they cannot verbalize (Seginer, 1980).

As such it is fully possible that testers will develop "successful strategies" of the biological simulation game that is Among Ripples, without being able to answer my questions.

2 Results

In this section my main question and sub-question from section 1.3 have been answered by the results from my interviews.
2.1 Feedback themes

Ten interviews have here been collected and in appendix b one can refer to the questionnaire which was used in the interview. I have used their answers and put their information into three areas: which tester, if they understood and why or why not. Since the individual answers are important I have included them all in tables.

I collect the information if they have made successful mental models of the feedback. Mental model is here meant as a personal construction which corresponds to the actual hard-coded mechanics of the game in question.

2.1.1 Substances

In this section the results for the substance feedback are presented.

2.1.1.1 Pollutants affecting creatures

These are the collected answers from question one from the questionnaire.

<table>
<thead>
<tr>
<th>Testers</th>
<th>Understood?</th>
<th>Why they did or did not understand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tester  1</td>
<td>No</td>
<td>Everything in the game went too fast for the tester, resulting in an inability to focus and understand.</td>
</tr>
<tr>
<td>Tester  2</td>
<td>Yes</td>
<td>Because of the death animation after the aura behind it had appeared. The tester also interpreted brown (the other pollutants/substance) and purple as a sign for disease. Lastly, the hard shapes of the aura looked menacing.</td>
</tr>
<tr>
<td>Tester  3</td>
<td>Yes</td>
<td>Because of the sickly animation. It did not feel like it belonged in the lake. The tester also registered that fish tended to die after the aura appeared, and that other fish got sick after eating polluted fishes.</td>
</tr>
<tr>
<td>Tester  4</td>
<td>Yes</td>
<td>The radiating aura reminded the tester of radioactivity. Also that the impotence layer which came up from the bottom felt threatening.</td>
</tr>
<tr>
<td>Tester  5</td>
<td>Yes</td>
<td>The tester thought this way because of seeing a big dark aura that was prickly. Also that fishes disappeared when the aura came.</td>
</tr>
<tr>
<td>Tester  6</td>
<td>Yes</td>
<td>The tester felt that it gave the impression of a dark and lifeless area around the creature.</td>
</tr>
<tr>
<td>Tester  7</td>
<td>Yes</td>
<td>The tester felt that it was unnatural and did not belong in the lake. Fishes should not have auras in a real lake the tester reasoned.</td>
</tr>
</tbody>
</table>
The tester felt that it did not belong in the lake, it did not fit with the rest of the inhabitants. The tester noticed that things tended to die when it was around.

The tester drew this conclusion due to the black aura.

This tester also drew the conclusion due to the black aura. When asked what it was that made him/her make that assumption they answered that they looked only at the silhouette.

| Tester 8 | Yes | The tester felt that it did not belong in the lake, it did not fit with the rest of the inhabitants. The tester noticed that things tended to die when it was around. |
| Tester 9 | Yes | The tester drew this conclusion due to the black aura. |
| Tester 10 | Yes | This tester also drew the conclusion due to the black aura. When asked what it was that made him/her make that assumption they answered that they looked only at the silhouette. |

Table 2.1. Collected answers from question one for the case study.

Most understood the feedback and a majority of the testers saw the black aura behind the fish on the image (see question 1 in appendix b) as an important indicator. Seven out of nine had their own interpretations of the aura and took different clues from it.

2.1.1.2 Removal of pollutants

These are the collected answers from question two from the questionnaire.

<table>
<thead>
<tr>
<th>Testers</th>
<th>Understood?</th>
<th>Why they did or did not understand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tester 1</td>
<td>Yes</td>
<td>The tester saw a connection between the algae (the energy system) and the clearness of the water, and also assumed that it cleansed substances as well.</td>
</tr>
<tr>
<td>Tester 2</td>
<td>Yes</td>
<td>The tester noted that algae and substances disappeared when they were there.</td>
</tr>
<tr>
<td>Tester 3</td>
<td>Yes</td>
<td>The tester noted that the water got clearer and that they ate the algae.</td>
</tr>
<tr>
<td>Tester 4</td>
<td>Yes</td>
<td>The tester saw that they ate algae and assumed they ate other things as well.</td>
</tr>
<tr>
<td>Tester 5</td>
<td>No</td>
<td>The tester did not elaborate why but started to be affected by the questionnaire instead, making assumptions on the image. As such I disregarded further data and gave a &quot;No&quot;.</td>
</tr>
<tr>
<td>Tester 6</td>
<td>Yes</td>
<td>The tester understood it due to earlier knowledge, that clams clean water from pollutants in real life. However, their knowledge were reinforced by seeing that there was no potence</td>
</tr>
</tbody>
</table>
Table 2.2. Collected answers from question two for the case study.

A majority understood the feedback about this system. Two of those who did understand had prior knowledge of the subject. Of the five others who understood most noted the disappearance of algae and substance emitters (located on the sides and the bottom) as an important cue. But it would seem that they all did not look at the disappearance of the same substances. Either due to differences in game session (substances come at random) or their attention was focused elsewhere.

The anomalous data which consisted of one answer was due to the tester being affected by the question and image. The tester's initial response was a negative, the anomalous data which has been discarded was his/her reasoning why they said no. They never gave a reason why they thought "no" but started discussing why it should be yes, if they looked at the bigger picture outside of their own mental model and experience.

2.1.2 Food chain and energy

In this section the results for the food chain and energy feedback are presented.

2.1.2.1 Player introducing new fish

These are the collected answers from question three from the questionnaire.

<table>
<thead>
<tr>
<th>Testers</th>
<th>Understood?</th>
<th>Why they did or did not understand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tester 1</td>
<td>No</td>
<td>The tester answered &quot;no&quot; but started making assumptions regarding the question. I disregarded</td>
</tr>
</tbody>
</table>
The tester had no knowledge of the energy economy but thought that algae (energy indication) was bad. The tester drew parallels to aquariums, which should not be as "dirty".

The tester reasoned that if the lake had a lot of algae (energy indication) then there was no way of getting creatures. The tester reasoned that the lake was overgrown.

The player answered "no" but started making assumptions due to the question. I disregarded further data.

The tester saw that buying fish only worked when there was algae. Though the tester noted that the feedback could have been more precise with showing the actual value of the energy.

The tester said that it worked and made connections to the algae. However, the person thought they saw a hierarchal pattern in it as well. If the lake was empty the tester thought you could only buy algae-eating creatures. And after that you could buy fish-eating creatures, if you had creatures such as clams or common dace.

The tester thought that creatures did not fare too well in water rich with algae.

The tester saw a connection between a creature-less lake and the ability to be able to buy creatures.

The tester noted that the environment changed when they bought creatures, but could not understand that it was linked to how many creatures they could buy.

The tester saw that there was a connection between a lake full of algae and the ability to purchase creatures.

A majority did not understand the feedback, and some who did not were affected by the questionnaire giving anomalous data which I had to disregard. Many of those who did not understand reasoned that algae was dirty and hindered the fish to be brought to the lake.

Table 2.3. Collected answers from question three for the case study.
Those who understood the feedback had similar reasons why they understood it, which were tied to the existence and amount of algae.

The anomalous data which consisted of two answers were due to the testers being affected by the question and image. Their initial response was a negative, the anomalous data which have been discarded was rather their description why they said "no". They never gave a reason why they thought "no" but started discussing why it should be "yes", if they looked at the bigger picture outside of their own mental model and experience.

### 2.1.2.2 The hierarchal food chain

These are the collected answers from question five from the questionnaire.

<table>
<thead>
<tr>
<th>Testers</th>
<th>Understood?</th>
<th>Why they did or did not understand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tester 1</td>
<td>Yes</td>
<td>The tester said that they saw that the creatures ate in a hierarchal fashion, from top of the lake to the lower layers. Also, they noted that food scraps (or &quot;trash&quot; as they referred to it) landed on the lake floor and that the crayfish ate them and thus were connected to the food chain in that way.</td>
</tr>
<tr>
<td>Tester 2</td>
<td>Yes</td>
<td>The tester saw the connection due to the animations that was played when hunter and prey met. The tester also noted that fish corpses (food scraps) were produced and went downwards.</td>
</tr>
<tr>
<td>Tester 3</td>
<td>Yes</td>
<td>The tester said that they saw that the creatures ate downwards.</td>
</tr>
<tr>
<td>Tester 4</td>
<td>Yes</td>
<td>This tester also drew the connection between eating downwards and the hierarchy.</td>
</tr>
<tr>
<td>Tester 5</td>
<td>Yes</td>
<td>The tester said that they based it partly on his/her own former knowledge, and logic. However, the tester said that they saw that the creatures ate downwards. As a final note they added that they assumed that small fishes could not eat a fish bigger than its own size.</td>
</tr>
<tr>
<td>Tester 6</td>
<td>Yes</td>
<td>The tester saw that the creatures ate downwards and that the hunter moved to the prey's location. Also that when a creature was eaten it dropped food scraps, which was further distributed down the food chain.</td>
</tr>
<tr>
<td>Tester 7</td>
<td>Yes</td>
<td>The tester drew the connection when seeing that creatures ate food scraps on the bottom.</td>
</tr>
<tr>
<td>Tester 8</td>
<td>Yes</td>
<td>This tester also saw the connection between food scraps and the hierarchy.</td>
</tr>
<tr>
<td>Tester 9</td>
<td>Yes</td>
<td>The tester saw a connection between eating downwards and that dead fish also moved down, which became food for other creatures.</td>
</tr>
</tbody>
</table>
The tester saw the connection that crayfish ate food scraps.

10 out of 10 built successful mental models from the feedback.

Table 2.4. *Collected answers from question five for the case study.*

Everyone understood the feedback and they all looked at several different cues understanding the food chain in part or in full (and both are regarded as acceptable). A majority of them however noted the fish food scraps as an important cue to understanding. But there are several other unique interpretations as well.

### 2.1.3 Reproduction

These are the collected answers from question four from the questionnaire.

In this part all testers answered "No" and most gave the reason that they could not keep creatures alive long enough for them to reproduce. I have therefore marked the answers which are basically the same with "X".

<table>
<thead>
<tr>
<th>Testers</th>
<th>Understood?</th>
<th>Why they did or did not understand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tester 1</td>
<td>No</td>
<td>The tester did not see the seasons change in the background but focused on the creatures.</td>
</tr>
<tr>
<td>Tester 2</td>
<td>No</td>
<td>X</td>
</tr>
<tr>
<td>Tester 3</td>
<td>No</td>
<td>The tester thought that you could only buy creatures.</td>
</tr>
<tr>
<td>Tester 4</td>
<td>No</td>
<td>The tester did not draw the connection between seasons and creatures, also the player noted that all creatures died too quickly.</td>
</tr>
<tr>
<td>Tester 5</td>
<td>No</td>
<td>X</td>
</tr>
<tr>
<td>Tester 6</td>
<td>No</td>
<td>The tester answered that they never saw a creature reproduce.</td>
</tr>
<tr>
<td>Tester 7</td>
<td>No</td>
<td>X</td>
</tr>
<tr>
<td>Tester 8</td>
<td>No</td>
<td>X</td>
</tr>
<tr>
<td>Tester 9</td>
<td>No</td>
<td>X</td>
</tr>
<tr>
<td>Tester 10</td>
<td>No</td>
<td>X</td>
</tr>
</tbody>
</table>

0 out of 10 built successful mental
models from the feedback.

Table 2.5. Collected answers from question four for the case study.

Due to the unbalanced nature of the game, no player could keep creatures alive long enough for them to reproduce, as such no one understood the feedback. It is unclear if it would have been understood or not. However, one person noted that they did not look at the background so they missed that important cue to be able to make the connection.

The unbalanced nature of the game was due to the fact that the creature's energy consumption was bigger than the rate energy could be introduced into the ecosystem. Energy was also required to be used in order to reproduce, but since they had none or died shortly after they came to life they never had the chance to reproduce. Thyssell and I had not anticipated this during production and it was something I noted on the testing day after observing several of the testing sessions.

3 Analysis and Conclusions

In this section I will analyse my findings from the result section. It begins with summarising generalities, going forward with addressing the anomalies more fully and lastly referencing back to my theoretical approach: Peircean visual semiotics.

3.1 Discussing generalities

To reiterate my hypothesis I can conclude that I assumed that humans can recognise patterns, and will be able to understand pictorial feedback if it is consistent. As my main question I asked how one could give feedback with the help of pictorial signs only. My solution was to use the game objects and signs in the game to transmit vital information. But in order to be able to transmit several cues from the same sign I needed the help of Peircean semiotics which gave me the ability to assemble them in parts with legisign, qualisign(s) and sinsign.

Further down I will show how successful mental models have been compared to constructed signs. I will here summarise the amount of successful mental models below in table 3.1.

<table>
<thead>
<tr>
<th>Feedback themes</th>
<th>Successful mental models</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pollutants affecting creatures</td>
<td>9 out of 10</td>
</tr>
<tr>
<td>Removal of pollutants</td>
<td>7 out of 10</td>
</tr>
<tr>
<td>Player introducing new fish</td>
<td>4 out of 10</td>
</tr>
<tr>
<td>The hierarchal food chain</td>
<td>10 out of 10</td>
</tr>
<tr>
<td>Reproduction</td>
<td>0 out of 10</td>
</tr>
</tbody>
</table>
Table 3.1. Successful mental models compared to feedback themes.

In total there were 50 answers on the different themes and 32 of those were indications of successfully built mental models from the feedback. As such there were 18 answers which showed that people did not build successful mental models of everything.

3.2 Anomalies

There were a few anomalies in the test, some of those were due to earlier knowledge of the subject, while the others were due to the testers being affected by the test itself. Out of 50 answers there were 6 anomalies.

Regarding previous knowledge I had purposefully not chosen people who were outspokenly well-read about the subject but it seemed that a few knew a lot about it even so. The anomalies which were right answers should still be seen as worthwhile data since their previous knowledge was acknowledged by the game, succeeding in making the game experience coincide with their own successful mental models. There were 3 answers indicating successfully built mental models from the feedback, which fall into this category.

The other incidents of anomalies were due to the fact that a few testers were affected by the image questionnaire, of the total of 18 there were 3 answers which did not indicate successfully built mental models from the feedback. It is impossible to say if they were really just affected or if it was a misinterpretation on my side on their own mental process. They could have answered "No" as a gut response, but later thought more about it. It was unclear however and I chose to disregard it since the data had been contaminated. They clearly stated "No" none the less.

I have chosen to include the anomalies in my analysis and conclusion. They were clear yes or no answers since what was anomalous were their reasoning on why. They still show if a certain theme gave a bigger understanding.

3.3 Revisiting Peircean visual semiotics

I will here in tables analyse my feedback cues with the help of semiotics. What is important here is not just if they understood or not but also which sub-signs (and how many) are mentioned.

3.3.1 Mentioned sub-signs from the interviews

In this section one can read about how I collected and analysed what sub-signs have been mentioned in the answers to the different themes.

3.3.1.1 Legisign

In this section I collect all the legisigns I have seen discussed by the testers.
Regarding legisigns, theme two and three contained the most mentioned legisigns, and theme one contained the least.

I think theme two and three contain the most mentioned legisigns because of the interconnectedness of those concepts. A lot of signs were tied together by game mechanics and as such you could have several entry points for a similar mental model. It could also be that testers had different creatures in play and/or focused on them differently.

I am convinced that legisigns are needed for a sign to be legible, since it is comparable to the entry-level in visual pattern recognition. However, many of the concepts in the game were not tied to legisigns alone. As such I cannot draw any solid conclusions on the impact of this game.

### 3.3.1.2 Qualisign

In this section I collect all the qualisigns I have seen discussed by the testers.
There were plenty of mentioned qualisigns in all of the themes, but the most frequent mentions were in theme one, two and four. In reproduction there was no mention of qualisign, since no one had seen the qualisigns due to the errors of game balancing.

I think that the mentioned qualisigns show that the testers looked at the signs differently, some recognised the colour, others the shapes and so on. Just as in the pilot study the signs which had the most qualisigns were understood the best. The most surprising findings were the reasoning of some who said that the aura looked alien to the setting, which was not my intention at all. Rather, that Thysell and I had to improvise before the deadline and come up with something that would work. It exceeded our expectations.

### 3.3.1.3 Sinsign

In this section I collect all the sinsigns I have seen discussed by the testers.

<table>
<thead>
<tr>
<th>Feedback themes</th>
<th>Mentioned sinsigns</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pollutants affecting creatures</td>
<td>Substances move to other hosts, the impotence substance emitter</td>
</tr>
<tr>
<td>Removal of pollutants</td>
<td>Amounts of algae (different levels of algae are unique), Substances move to other hosts</td>
</tr>
<tr>
<td>Player introducing new fish</td>
<td>Amount of algae</td>
</tr>
<tr>
<td>The hierarchal food chain</td>
<td>Not available</td>
</tr>
<tr>
<td>Reproduction</td>
<td>The background, season</td>
</tr>
</tbody>
</table>

Regarding sinsigns, the most sinsigns were mentioned in theme two and in the hierarchal food chain there was no mention of a single instance of a sign.

Since most signs in the game seldom contained sinsigns except in passing I do not think that they had a huge impact on the game. What it could have provided was a finer nuance in economy indication for example as noted by one tester.
3.3.2 The summation of the signs

If we refer back to table 3.1. we can see that most people understood theme one, two and four the best. They were the ones who had the most legisigns and qualisigns. Regarding the sinsigns it is more undecided. And the themes which had a low rate of successful mental models were theme three and five.

In the table below I have collected the exact amounts of mentioned sub-signs.

<table>
<thead>
<tr>
<th>Feedback themes</th>
<th>Successful Mental models</th>
<th>Amount of sub-signs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pollutants affecting creatures</td>
<td>9 out of 10</td>
<td>2 Legisigns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9 Qualisigns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 Sinsigns</td>
</tr>
<tr>
<td>Removal of pollutants</td>
<td>7 out of 10</td>
<td>3 Legisigns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 Qualisigns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 Sinsigns</td>
</tr>
<tr>
<td>Player introducing new fish</td>
<td>4 out of 10</td>
<td>5 Legisigns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4 Qualisigns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 Sinsign</td>
</tr>
<tr>
<td>The hierarchal food chain</td>
<td>10 out of 10</td>
<td>3 Legisigns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6 Qualisigns</td>
</tr>
<tr>
<td>Reproduction</td>
<td>0 out of 10</td>
<td>3 Legisigns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 Sinsigns</td>
</tr>
</tbody>
</table>

Table 3.5. Summation of the sub-classes of a sign.

From this table one can see that the two themes which gave the most successful mental models were the ones who had the most qualisigns. Legisigns did not have a clear difference when it came to successful or unsuccessful mental models. Take for example theme three with 4 out of 10 successful mental models which had 5 legisigns, to theme four who had 10 out of 10 successful mental models but only had 3 legisigns. There are no sure correlations between sinsigns and the building of successful mental models, since four out of five themes had 2 sinsigns. For example theme four contained no mentioned sinsign but everyone understood it and theme three had 1 sinsign and only 4 out of 10 understood it.

The people who did not develop successful mental models for certain themes could generally be split into two categories: people who missed sub-signs and people who had other connotations than the ones that I hoped they would infer from the sign themselves.
Regarding the misinterpretation of sub-signs it can generally be attributed to qualisigns. I would argue that they inhabit the biggest ambiguous interpretation space of the three sub-signs. Of course people surely must have different connotations on legisigns (or entry-level) such as "fish", but it did not seem to interfere with the internal logic of the game world. Compare that to the interpretation of algae as something dirty and unwholesome for the creatures, since the colour and texture made some people feel like it should not be there. My intention was not to make it look dirty and unwholesome, as such one can conclude that my expectations differed from several testers' interpretations.

3.4 Themes conveyed through signs

The two themes which were understood the most had the most qualisigns. It answers my main question for this thesis in the regard that if I provide several cues that can be interpreted, I can make the player understand pictorial feedback. And if the programming is consistent then it will create the same repeatable pattern each time.

I also believe that qualisigns are the easiest way to fill a sign with additional cues without making the sign "over-laden" with information. Since as can be seen from the interviews the testers looked at different things, and a certain tester (Tester 10 in section 2.1.1.1) even mentioned that they usually ignored colour and preferred looking at silhouettes, I believe that the testers pick up certain information differently and disregard other portions. That tester did not use colour as the main queue, but so did another tester (Tester 2 in section 2.1.1.1).

A legisign as I have mentioned is a generality, the entry-level of recognition. It serves no purpose to give the sign "Northern Pike" another legisign or sinsign (or individual level). Qualisigns can more so be temporary states of mind and matter than its sub-sign brethren in the first trichotomy, which fits with an interactive and changeable environment that games usually exist in. In Among Ripples a fish can have several states: healthy or sick and the many values in-between, and these are shown with qualisigns.

This game demanded of the player a general view on the ecosystem and game space as a whole while other games might need more sinsigns for example. Many creature signs in Among Ripples never transcended to a sinsign and could only be seen as a larger whole.

3.5 Embedded feedback

As my sub-question I asked if it was possible to embed feedback instead of having it superimposed. One of the solutions was that the game did not contain any pictorial input method, but relied on keyboard controls told from outside of the game experience. This was due to limitations of the time budget so initially it was intended that the case study would have had the planned pictorial input method, which was not superimposed. The end product however will continue with this original vision.

Another solution was to use the actual game objects/signs in the game world as transmitters of pictorial feedback. If a fish is sick, it glows with an aura. Instead of using a superimposed health display with numerical values for example.
3.6 Revisiting previous research

In my pilot study I had a more thorough questionnaire when it came to demography, for example how literate gamers they were. I decided that I would not draw conclusions from demography in the main survey since there really was no big difference in answers. For this thesis I can conclude that it did not matter either. Even though I did not record any such demographical data I noted during the tests that everyone was as new to the experience and the little pre-existing knowledge some had was mostly drawn from areas such as ecology, and not game literacy.

I also felt that it was wise not to tack on superimposed graphical user interface elements just for the sake of the input, but rather keep it outside of the experience. I cannot prove that those few superimposed elements would have garnered too much focus from the rest of the experience, but that was my belief in eliminating them.

Dondis (1973:13) stated that visual literacy can never be a clear-cut logical system. It might have been correct from her time and perspective. However, I would argue that in the computer software milieu visual elements can be grafted on top of logical systems, binary ones to be exact. Games and software then have an unique opportunity since they can have a front end and a back end that talks widely different languages, but conveys the same thing in the end, if they have working bridges.

But, in the defence of Dondis one can state that some things can be lost when translating images to the written or spoken word, since they are not the same thing. This also harkens back to Hogle's study that players can know something intuitively but can't convey it. In my belief that people could remember more of their game session I included images as well. However, it also proved that it could create anomalies where testers started to make assumptions, and not from their own experience.

I think it is fascinating that visual pattern recognition overlapped most profoundly onto Peirce's first trichotomy, since there are no mentions of him or semiotics in the bibliography or text. To me it gives this semiotic system a more tangible meaning since there are other fields that support it as well.

Wilson stated that in games many elements on a heads-up display (or superimposed graphical user interface) were there out of convention and not out of necessity. I would agree that these elements can be thought out and planned in wholly different ways. But it is also dependant on the kind of game you are making (but in his defence he specifically refers to console gaming in the headline of the article). Some of the games in the background section were heavily based on simulation and in order for the player to be able to assess the situation they would need a lot of information. Among Ripples 1 fell in the simulation genre as well, but it is on a very small scale just like Lack of Love2. Both of them contained little to no superimposed graphical user interface elements or numerical or textual feedback. Among Ripples also had a limited amount of actions, compared to Sim Earth3 and Pharaoh4.

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1The case study for this thesis.
2Ecological simulation game from 2000.
3Ecological simulation game from 1990.
4Construction and management simulation game from 1999.
I would argue that the scope of the game and the role of the player influence the choice of feedback display. A player who does not need a lot of data would quite easily do without superimposed feedback. And games might not need the same immersive requirements either.

3.7 Further research

I think it would be worthwhile to delve deeper into Peirce's semiotic system and employ all of his three trichotomies in game related studies. Both as production based theses but also ones focused on game studies.

It would also be interesting to see academic projects that tried the scalability of pictorial feedback that does not employ a superimposed graphical user interface, case studies that tried to convey a lot more feedback than what was conveyed in Among Ripples.

I would advise making careful plans and small pilot studies so the time budget coincides with what you can research as an artist (or the field you are coming from). What you can achieve graphically must coincide with what can be implemented in code.

For testing I would think that it would be interesting to observe and have an interview as part of the test, to see if there were any discrepancies between what they say and what they do. Or just get a better overall view. Watching people play a game teaches as much in my opinion, but I think it required too much of me with my current skill set.

3.8 What the future might bring

I believe that a lot of games in the future could employ pictorial feedback on a much grander scale than today. They might not be able to do so without all superimposed graphical user interface elements if they have a big set of data that they need to convey. However, as Wilson argues: less is more. The designers should ask themselves whether they need that much information in the first place in order for the player to build successful mental models.

3.9 Further development of our own game: Among Ripples

As our own game production progressed I became more convinced of the concept of having a game without numerical and textual signs. I have definitely become bolder in the production and have started to inject more cues into the signs as it continues. The creatures will contain at least double the amount of qualisigns than of the case study read here. Thysell and I have also planned to implement sinsigns more thoroughly to see if it can have a positive effect in observing feedback, since the data presented in this thesis was inconclusive.

As I have stated I believe that the clearest evidence from this thesis is that people do not look at signs in the same way, which is something I will take note of when finishing Among Ripples. I will also try to embed pictorial feedback more, to try and send several cues from the same sign and not worry of overburdening the signs. As long as they are embedded I believe that I can send away a lot of data, without overstepping the threshold to "information overkill", as Wilson put it. If feedback is embedded in the world I think the player can more easily navigate by help of visual cues in an intuitive way, which can both be a curse and a blessing. But the more you can embed the more you can transmit from the game world, without superimposed layers.
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Literature


Internet resources


Games


Table of figures


Figure 1.3. Space Invaders screen capture. Wikipedia. 2013. Available at: <http://upload.wikimedia.org/wiki/en/e/e5/Pharaoh_screenshot.png> [Accessed 13 April 2013].


Figure 1.5. Pharaoh screen capture. Wikipedia. 2013. Available at: <https://upload.wikimedia.org/wiki/en/e/e5/Pharaoh_screenshot.png> [Accessed 19 May 2013]

Figure 1.6. Lack of Love screen capture. We Hype. 2013. Available at: <http://www.wehype.com/fileadmin/user_upload/hypes/images/790_images_4.jpg> [Accessed 11 April 2013]

Figure 1.7. The Witcher 2 shell menu. Mike rambles about stuff. Available at: <http://1.bp.blogspot.com/9tcjvqwq9b8/Tenca7wD5I/AAAAAAACGo/hfXsu1Qf7UE/s1600/The-Witcher-2-Menu.jpg> [Accessed 24 April 2013]

Figure 1.8. Screen capture from Among Ripples. Among Ripples Team. 2013.

Figure 1.9. The Process of semiosis. Illustration made by the author. 2013.

Figure 1.10. Northern Pike from Among Ripples. Creature sprite by the author. 2013.

Figure 1.11. Algae Indication. From Among Ripples. Among Ripples Team. 2013.

Figure 1.12. Explanation of food chain. Illustration made by the author with creature sprites from the game. 2013.

Figure 1.13. Potency level of eggs. Illustration made by the author with egg sprites from the game. 2013.

Figure 1.14. Impotence indication. From Among Ripples. Among Ripples Team. 2013.

Figure 1.15. Feedback of decreasing energy. From Among Ripples. Among Ripples Team. 2013.

Figure 1.16. Oxygen levels. From Among Ripples. Among Ripples Team. 2013.

Figure 1.17. Seasonal shifts. From Among Ripples. Among Ripples Team. 2013.
Figure 1.18. Size difference. From Among Ripples. Among Ripples Team. 2013.

Figure 1.19. Screen capture from pilot study. Among Ripples Team. 2013.

Figure 1.20. Gaming literacy demographic. Diagram from report Understanding through feedback. 2013. Gotland University. p. 9.

Figure 1.21. Demographic literacy compared to comprehension of the pilot study. Diagram from report Understanding through feedback. 2013. Gotland University. p. 13.

Figure 1.22. Screen capture for question four in the questionnaire. Among Ripples Team. 2013.

Figure 1.23. Question four answers from the pilot study. Diagram from report Understanding through feedback. 2013. Gotland University. p. 12.

Figure 1.24. Screen capture for question three in the questionnaire. Among Ripples Team. 2013.

Figure 1.25. Question three answers for the pilot study. Diagram from report Understanding through feedback. 2013. Gotland University. p. 11.

Figure 1.26. Eternal Darkness: Sanity's Requiem screen capture. *Let's Play (Eternal Darkness HD) - Chapter 4 [The Gift of Forever]*. 2012. Video which a screen capture was taken from. Image was then manipulated by the author (saturation and value changes), making it more discernible. Available at: <https://www.youtube.com/watch?v=dn82zx24tBg> [Accessed and edited 25 April 2013]
Table of tables

Table 1.1. Comparison between visual pattern recognition, Peircean visual semiotics and my interpretation.

Table 2.1. Collected answers from question one for the case study.

Table 2.2. Collected answers from question two for the case study.

Table 2.3. Collected answers from question three for the case study.

Table 2.4. Collected answers from question five for the case study.

Table 2.5. Collected answers from question four for the case study.

Table 3.1. Successful mental models compared to feedback themes.

Table 3.2. Mentioned legisigns from the interviews.

Table 3.3. Mentioned qualisigns from the interviews.

Table 3.4. Mentioned sinsigns from the interviews.

Table 3.5. Summation of the sub-classes of a sign.
Appendix A - pilot study survey/questionnaire

The correct answers are here emphasised with a **bold font** for the reader's convenience. Also, the pilot study was called a "prototype" in the earlier report and questionnaire.

The Lake Prototype Survey

This is the survey for the game prototype. In it I want you to look at several screenshots, interpret them and give an answer of what you think is going on in the picture. In order to make the most optimal answer you should draw from your acquired knowledge of your testing. Do not go back and play the game during this survey, it will hurt the test data. Since images can't be attached directly to this document you will have to visit the image links (hosted on Flickr) I provide for each question.

There are three things to do in order to answer a question correctly:

1. Read all of the options.
2. Pick one of the options.

Explain why you chose that option (one of four alternatives) in the "other" category, underneath the options (for each question). Try to be concise. You can pick one option AND "other".

**Question 0: How much of a player do you identify yourself as?**

Very literate gamer is the most experienced and Illiterate gamer is the least experienced.

- Very literate gamer
- Literate gamer
- Moderately literate gamer
- Illiterate gamer
Question 1: What kind of fish will reproduce during this season?

- Northern Pike (XL Fish)
- **European Perch (L Fish)**
- Common Dace (S Fish)
- No one
- Other:

Question 2: What does this do?

- Regulate the winds
- Regulate oxygen
- **Regulate oxygen and energy/algae**
- Regulate energy/algae
- Other:

Question 3: Who ate the European Perch (L Fish)?
- No one ate nobody
- Common Dace (S Fish)
- **Northern Pike (XL Fish)**
- They ate each other (cannibalism)
- Other:

**Question 4:** How many Common Dace (S Fish) can you purchase here?

- 1
- 2
- 3
- 4
Question 5: How do the oxygen and energy/algae level affect the fishes in these circumstances?

- **Status quo for all**
  - The European Perch (L Fish) are negatively affected
  - The Northern Pike (XL Fish) and Common Dace (S Fish) are positively affected
  - The Common Dace (S Fish) are affected
  - Other:
Appendix B - Case study questionnaire

The questionnaire was written in Swedish and an English translation will accompany each question for the reader's convenience. I will also provide the "right answers".

Fråga 1:
Vad händer i denna bild?

Question 1:
What is happening in this image?

The fish is being consumed by the pollutants.
Fråga 2:
Varför finns det inga miljögifter på denna bild?

Question 2:
Why are there no pollutants (substances) in this image?

The clams keep the lake pollution free.
Fråga 3:  
Kan man köpa fisk i denna spelsession?

Question 3:

Can you purchase fish in this game session?

Yes you can.
Fråga 4:
Är det någon fisk som reproducerar under denna säsong, och i så fall vilken/vilka?

Question 4:
Are there any fish who reproduce during this season, and if so which/who?

The Perch reproduce in this season.
Fråga 5:
Vem har ätit vem i denna bild?

Question 5:
Who have eaten whom in this image?

This is intended as a general question to see if they understood the food chain. As such, any answer that points to parts or the whole is counted as a right answer. But it goes as follows:

Algae -> Common Dace -> European Perch -> Northern Pike -> Crayfish (who eat fish food scraps and fish eggs)

Algae -> Clams -> Crayfish
Appendix C - Case study controls

These are the keyboard controls which was told (and printed out on paper) to the testers. Further information on what they meant were not divulged to the player.

Q = Buy Dace  
W = Buy Perch  
E = Buy Pike  
A = Buy Clam  
S = Buy Crayfish

1,2,3,4,5 = Regulate Oxygen/Algae

Escape = Quit