Designing a Knowledge Based Puzzle Game

Case: After Now Archeology

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Abstract

This thesis studies knowledge based puzzle games. It defines the small genre of knowledge based puzzles as puzzles, which require using information not available in the game itself as a tool to solve the puzzle.

The study is done by examining a game made for the project: After Now Archeology. The design process of the game is explained, to give an idea of what kind of design decisions has been made when making a game that directs the player to exit the game itself and search for the information outside of the game's magic circle. The game is then examined using various theories and tools of games and game design, to get an understanding of how the game positions itself within the field of games, but also within the context of gaming culture and playing games.

A definition of knowledge based puzzles is made by analyzing the games in the puzzle genre and comparing them to the game made in this project. It is found that knowledge based puzzles are difficult to fit into the genre of puzzles – especially among digital games. The pervasive nature of the game bends the concept of gameplay and magic circle. It is also found that the players divide strongly to those who do not have time and patience to search for information, and them who can spend hours on a single puzzle, searching for information and gaining new knowledge.

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Tiivistelmä

Tämä opinnäytetyö tutkii tietoon perustuvia pulmapelejä. Se määrittelee tietoon perustuvien pulmapelien pienen genren pulmiksi, joiden ratkaiseminen vaatii pelin ulkopuolisen tiedon käyttöä työkaluna.

Tutkimus toteutettiin tarkastelemalla opinnäytetyöprojektina toteutettua peliä After Now Archeology. Pelin suunnitteluprosessi käydään läpi, jotta saadaan hyvä kuva niistä suunnittelupäätöksistä, joita sisältyy pelin ulkoisen tiedon ääreen ohjaavien pulmien suunnittelemiseen. Peliä tutkitaan käyttäen useita pelien ja pelisuunnittelun teorioita ja työkaluja. Täten pyritään ymmärtämään, miten After Now Archeology sijoittuu pelien kentälle, mutta myös sen olemusta yleisemmin pelien ja pelaamisen kulttuurissa.

Tietoon perustuvien pulmapelien määritelmä tuotetaan analysoimalla muita pulmapelien genreen kuuluvia pelejä ja vertaamalla niitä tässä projektissa tuotettuun peliin. Tulee ilmi, että tietoon perustuvat pulmapelit on vaikea sijoittaa yleiseen pulmapelien genreen – varsinkaan digitaalisten pelien kontekstissa. Pelin pervasiivinen luonne koettelee pelaamisen ja taikapiirin rajoja. Voidaan myös havaita, että pelaajat jakautuvat hyvin voimakkaasti niihin, joilla ei riitä aikaa eikä kärsivällisyyttä tiedon etsimiseen ja niihin, jotka saattavat käyttää tunteja yhden pulman parissa etsien informaatiota ja omaksuen uutta tietoa.

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1. Introduction

Puzzling phenomena have always interested humankind. Unexplained and enigmatic topics have been part of our culture as long as we can know. There is evidence of riddles and puzzles from thousands of years before us. In the area of digital games, puzzles have been very important genre for a long time. Re-mediations of earlier puzzles are commonly made in schools and clubs when learning the art of programming. Commercial successes of games like *Tetris* (1987), *7th Guest* (1993) and *The Room* (2012) have proven that people still enjoy solving very different kinds of puzzles.

This thesis is the written part of a graduation work for Master of Arts in New Media, Game Design in Aalto University School of Arts, Design and Architecture's Media Lab. It explains the design and production of the *After Now Archeology* -puzzle game. The game is used as a research object on examining the realm of puzzle games and especially the special case of knowledge based puzzles. *After Now Archeology* is examined from many different angles, thus the topics are not studied in great depth. The purpose for this was to bring visible the multitude of aspects relating to designing and analyzing a knowledge based puzzle game. (See Appendix 2 for internet addresses for the puzzles and installation packages.)

1.1. Research questions

The main goal of making *After Now Archeology* was to make a game that allures the players to step outside of the game's realm and discover new things in the world we live in. During the development of the game, this goal evolved to a question about games as a motivation for learning. Knowledge based game was seen as a contradiction to various educational games, which drown the gameplay and motivation beneath the educational content.

Developing a puzzle game that uses extra-game information as an element of gameplay led to a deeper research of the genre of puzzle games. Using *After Now Archeology* as a kind of a lens, through which the puzzle game genre was examined, the variety and rigidity of puzzle genre was discovered. This discussion of the nature of puzzle games became one of the main themes in the research.

To summarize all these aspects, following topics became the research questions of this thesis:

- Could a game that sets questions but does not give answers motivate players to learn while searching for the answers?

- What is a knowledge based puzzle and how does it fit into the puzzle game genre?

1.2. Structure

The structure of this thesis follows the chronological process of the work. It starts from designing and developing the game. After that the game is studied using various theories of games and game design. In the end the genre of puzzle games is examined to a larger depth, to build up a definition of a knowledge based puzzle, which *After Now Archeology* is. This somewhat unorthodox structure was chosen because it felt easier to analyze the uncommon type of game after its design and essence is explained.

Chapter 2 handles the *After Now Archeology* -game. The motivations, goals and purposes of the game design are explained. The inspirations and previous works of the kind are examined. Then the design process is explained; documenting the ideating process, content collection and designing the game mechanics based on the content. The target group of players is discussed briefly. Different viewpoints to the design problematic are taken, before the development process is documented in the end of the chapter.

Chapter 3 digs more deeply to the theories of games and game design. The aim is to reflect on *After Now Archeology* through the common definitions and theories of games, to see how it fits to the field of games, or can it challenge the theories. First, the game is examined using classical definitions of games. Its core feature of bending the concept of magic circle is discussed, as are the genre qualities of it. In the end the design of *After Now Archeology* is challenged using various game design rules and instructions.

In chapter 4 the genre of knowledge based puzzles is built. First, a look towards gaming literature is taken, to build a picture of how puzzles are seen and presented before and during the digital age. Then different kinds of puzzles are examined and compared to *After Now Archeology*, trying to find a place for it in the genre of puzzle games. In the end a definition of knowledge based puzzle is composed, drawing from the essence of

After Now Archeology and similar games, reflecting on them through other games in the puzzle genre.

Chapter 5 puts it all together and concludes the thesis. The design and development process are summarized shortly. The definition of knowledge based puzzles is explained and the theoretical background is discussed briefly. The rate of success of the project is also estimated. During the design, development and thesis writing, many new ideas have come in mind. These ideas and other unanswered questions are explained briefly, so they can be taken under research later.

1.3. Methodology and theoretical background

The first part of this thesis is rather straightforward explanation of designing and developing *After Now Archeology*. This part serves as a case study of designing a content driven puzzle game. Since the design was done as a personal project of enthusiasm, no specific game design theories or frameworks were used. As a hobby project, the development was also done without any formal project management system or even version control for source files.

Reflecting on the qualities of *After Now Archeology* through different theories of games in chapter 3 is built on the fields of ludology and game design. Classical theories and definitions of games are utilized on analyzing the "gameness" of *After Now Archeology*. A shot on genre theory is also taken, when trying to understand the essence of the game and its place related to other games. The qualities of design are examined using classic game design instructions and theories.

The research of puzzle games and definition of knowledge based puzzles relies on history of puzzles and genre theories. The variety of puzzles is examined using several sources of categorizing for both classical puzzles and digital puzzle games. The qualities of *After Now Archeology* are examined through different theories and definitions. It is also compared to different kinds of earlier puzzle games, trying to find a proper sub-genre for the game, but also challenging the definitions and assumptions of what puzzle games can or should be. In the end the similarities and differences are put together to use *After Now Archeology* as an example game for definition of knowledge based puzzles.

2.   After Now Archeology

As a production part of the thesis, I designed and partly implemented a puzzle game called *After Now Archeology*. This development started even before the idea to do it as a thesis work. Thus, the design and development itself didn't rely on any theoretical background or design ideology. Because of this, I start this thesis by explaining the process of making the game, which lead to theoretical research about puzzles and games, and in the end to the synthesis of knowledge based puzzle genre.

The complete game consists of 19 puzzles, which are divided to three paths: science, culture and myths. Each of the paths consists of four puzzles, plus there are two puzzles between each path (science-culture, science-myth and culture-myth). Each puzzle works as a door between the path segments, and needs to be solved to proceed in the game. In the center of the spiral-formed paths is the final puzzle that combines knowledge from all of the three topics.
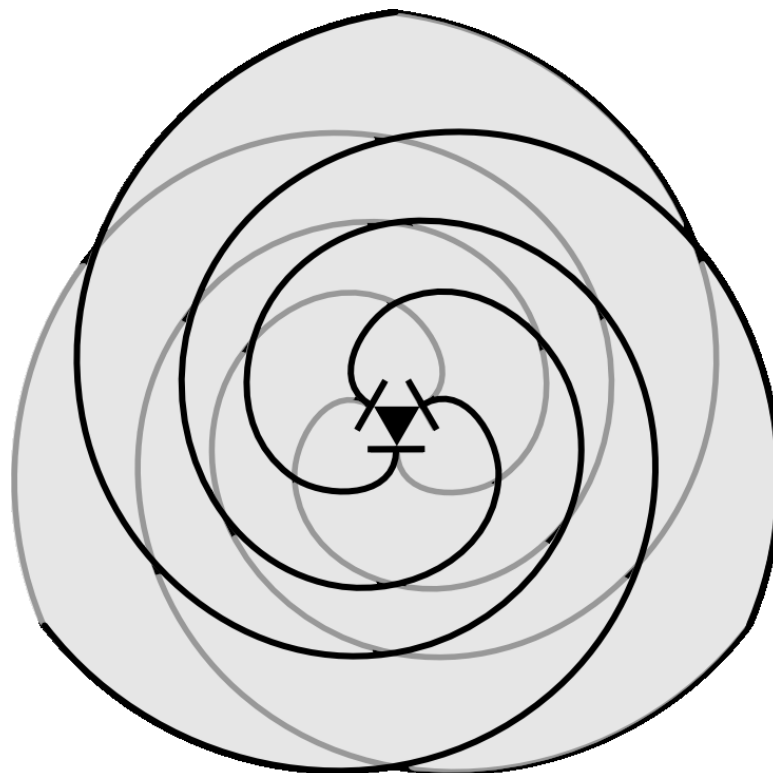
Illustration 1 Logo of After Now Archeology. Also represents the three intertwining paths of content

The player does not need to solve all the basic puzzles. The puzzles between two paths and the last puzzle of each path are mandatory. From those puzzles the player gains items, which are used to solve the final puzzle in the center. This makes it possible for the player to enjoy the game even if he is not interested in all three topics. For example, if the player is not very good at sciences, he can solve the puzzles from culture and myth paths and skip all the science related puzzles, except the ones that are shared with other topics.

2.1. Background

The game roots strongly to my experiences in playing *Timehunt* (2003) back in 2003-2004. When trying to solve the plethora of puzzles, based on alchemy, art, philosophy and other mythical, cultural or scientific real world phenomena, an idea of trying to produce something similar came to my mind. The challenge of *Timehunt* eventually proved to be too much for everyone who played it, since no one could solve the ultimate puzzle within the three years of existence of the game. But because or despite of that, the experience of solving some extremely difficult puzzles was overwhelming.

The idea and material collection for *After Now Archeology* started when I was still playing *Timehunt*. In the beginning, the collecting was rather passive, usually I just wrote down interesting books, films or games if I stumbled on them. Towards the end the information gathering became more goal-oriented and I started searching for sources and topics that could fit into the game. The more organized source material seeking lasted about 3-4 years, and produced enough material for another game of similar scale. The material seeking became kind of a habit, which lead to eternally evolving game design process when new, relevant and interesting topics are found.

After Now Archeology is a personal and rather non-commercial project. Since working in game industry for over 10 years, I wanted to make something that is appreciated by me, my fellow *Timehunt* playing friends and all the other members of largely neglected difficult puzzle solver community. In the early days a couple of friends were also interested in designing puzzles for the game, but when years passed, the project became more and more my personal issue. Thus, so far all the content, themes and topics are selected by me. They represent the things that have been close to my interests for years.

2.2. The Name

The game got its name, *After Now Archeology*, when I was applying for a concept development funding from the Digidemo program of The Promotion Centre for Audiovisual Culture, AVEK. The product needed a name, so I had to think about what the game is all about. Since I hoped the player would spend most of the playing time digging information from the internet, it reminded me of archaeology – an action of digging the ground in a hope for discovering information about lost civilizations (at least that's how I have seen archaeology since I wanted to become a practitioner at the mature age of four). Maybe in the future someone will search for information about our civilization by browsing the internet, thus it is "after now".

This became also kind of a commentary about the relationship between the topics we love to write about in the internet and items the real archaeologists have dug out from different parts of the world. I wanted to ask myself and the players, "what kind of picture do these weird sites and oddities paint of our society?" Many of the topics handled in the *After Now Archeology* are interesting, not in mundane historical sense, but because they are special cases of things we as a civilization have produced. This may also be the case with traditional archaeological findings. We don't always really know, how closely they were related to the everyday lives of the people who made them. In many cases we can only guess the significance of the findings, and many of them have stayed mysteries. Some of them were also brought to *After Now Archeology* as topics or content of the puzzles, which builds an interesting continuum from the physical archaeology towards the information archaeology of after now.

2.3. The design question

The design process of After Now Archeology started already when *Timehunt* was alive, around 2003-2004. Taking *Timehunt* as a spiritual father, the aim of the new game was to make the player to go outside of the game's virtual reality to find clues and hints for the puzzles. The game itself should work as a motivator for information seeking and as a pointer to interesting and probably surprising things in the real world. It can be seen as a "rabbit hole", as the entry point to the game's realm is sometimes called among alternate reality games (e.g. Kim et al. 2009).

As Bolter and Grusin wrote, digital games often re-mediate what is done before on the other fields of cultural productions (1999, 83-103). From the beginning of the project it was clear that the game will not include any re-makes of earlier games. Copying popular game mechanics with small changes is a common practice in the games industry. As a game designer, I am not motivated by straightforward copying something that has already been done. Also, as a content driven project, it would be difficult to build new versions, or re-mediations of earlier puzzles. Although this was the main goal, re-mediation cannot be avoided completely. Concepts of riddles, code breaking and interpretation of different languages can be seen as earlier work, thus casting a shadow of re-mediation over *After Now Archeology*. On the other, hand having *Timehunt* as an influential predecessor already gives an impression of re-making or re-mediation of its puzzles. I tried to keep *Timehunt*, *The First Door* and other similar puzzle games only as inspirations, not as sources of direct copying of ideas or content.

After Now Archeology is rather passive game. There are no time limits for the player. The game suggests the player to spend more time outside the game's realm than using the game application itself. Ultimately, the design of *After Now Archeology* is successful, if the player "gets lost" while seeking for the answer and starts to browse the internet or study subjects that he knows being unrelated to the game's solution. This could be the "focus" of the game design, as Rouse (2005, 70) it describes.

After Now Archeology is designed to take the player to the border between frustration and enjoyment. Since all of the gamers have different knowledge base and experiences, it is virtually impossible to make a game which feels equally challenging but still possible to all players. These difficulty balancing mechanics are discussed more in chapter 2.10. *After Now Archeology* implements a voluntary hint system, where the player can choose when he wants to get a hint and sometimes also to which sub-puzzle the hint should address.

To summarize the main design goals of *After Now Archeology*:

- Challenging puzzles, based on real world content
- The game is unsolvable without searching for information outside of the game

Derived from these main goals, there are a couple of secondary design questions that were addressed during the development

- Managing the player's level of frustration by giving him possibility to use hints when he gets stuck in the game.

- Giving the player a motivation to search for information and learn, instead of trying to pour knowledge into his head.

2.4. Informal design process

There are many books and writings about the formal design process of computer or video games (e.g. Crawford 1984; Rouse 2005; Manninen 2007). With *After Now Archeology* I wanted to explore more organic and informal ways to design a game. Of course, the process was affected by some ten years of experience as professional game designer and doing game research as a hobby.

Since After Now Archeology has been a one man project, I have had no need to do formal documentation of the design for the sake of communicating it to other team members. This made it possible to try new tools and methods, like using *Articy Draft* (2011) for building the game structure or designing puzzles "on-the-fly" during the programming phase.

I have done a good share of game and demo programming with *Adobe Flash* in the past. This has given me rather good programming skills with the tools. With good skills, it has been possible to use *Flash* as kind of "code-stylo", referring to Alexandre Astruc's (1948) "camera-stylo"; using code (or in Astruc's case, camera) the way a writer uses his pen. For me this means using the tool to produce content and structures that are characteristic to the tool, but also being able to take the tool and start sketching things without too much planning, just to see what comes out.

2.5. Sources of inspiration and benchmarking

There have been many books, films and games that have affected the design of *After Now Archeology*. In this chapter I go through the biggest inspirations and idols for the design. These products all have something similar to *After Now Archeology*, which I try to point out. The goal is to provide an insight to the cultural products that have had direct influence on the form and functionality of the game.

2.5.1. External knowledge

The most influential source of inspiration for *After Now Archeology* was *Timehunt*. The game relied heavily on real world information, and players were using a lot of time outside of the actual game, trying to find clues, or sometimes writing computer programs to help solving some of the game's puzzles. The game managed to give the players many pointers to interesting scientific and cultural phenomena.

Illustration 2 Code breaking puzzle from Timehunt

Most puzzles of browser based *Torment* (2007) and *The First Door* games directed the player to go looking for external information. On some parts these games relied on glitches and features of browser technology, just as does *Notpron* (2004) and its imitators. For example, the answer to the riddle can be hidden in the source code of the page, or in some cases a picture on a web page changes when scaled or selected so the answer can be found.
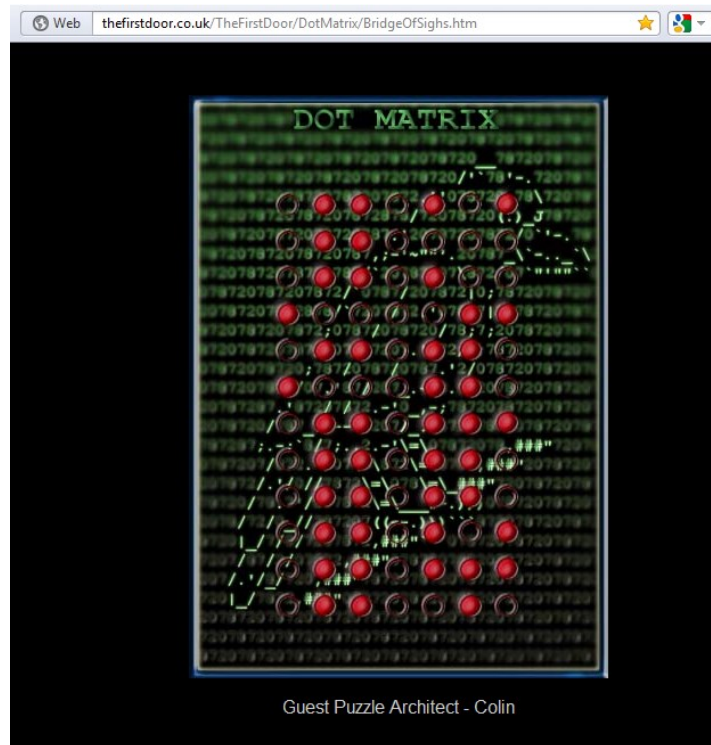
Illustration 3 A puzzle from The First Door -game

2.5.2. Traditional digital puzzles

I have played digital puzzle compilations since 1980s. Loosely, and usually rather stupidly narrated games featured doors with puzzle locks and other irrational ways to block player's progression with puzzles. First notable games of this type I've ever played were *Castle of Dr. Brain* (1991) and *Island of Dr. Brain* (1992). These puzzle collections were built around puzzles of various types. Most of the challenges were logical or mathematical, but there were also musical and linguistic puzzles in the games.

When CD-ROMs got popular, games with rendered 3D worlds, like *Myst* (1993) and *7th Guest* got some wind. The actual gameplay was not different from e.g. Dr. Brain -series, but the amazing audiovisual appeal made these games really something different. The puzzles in *7th Guest* and *11th Hour* (1995) were partly re-mediations of traditional puzzles, but there were some original ones and some that could not be done in non-digital format. *Myst*'s puzzles are famous of being strange and ambiguous, thus also being rather original.

Illustration 4 Chess puzzle from 11th Hour

Very old and famous educational puzzle game series is *Carmen Sandiego*. Personally I never got the games in my hands when they were still new. When doing research for this thesis, I found the games as web versions and played them for a good while. Simple mechanics did not amaze me, but the games relying on intra- and extra-game information was something that was common with *After Now Archeology*.

Illustration 5 Where in the World is Carmen Sandiego (1985)

2.5.3. Easter eggs and external knowledge

Since *After Now Archeology* is based on external information, it is well possible that the gamer "gets lost" in unplanned information sources. If we think that the information that was thought to be used while designing the puzzle belongs to the actual gameplay of *After Now Archeology*, can these accidentally found pieces and emergent clues be seen as "Easter eggs" or hidden secrets of the game. Easter eggs have been part of the gaming culture since Atari 2600's *Adventure* (1979) (e.g. The Easter Egg Archive 1999).

More contemporary examples of Easter eggs can be found in Red Lynx's *Trials*-series (e.g. Melton 2012). Especially *Trials HD* (2009) included very interesting hidden content, if examined through the *After Now Archeology*'s content in mind. The developers had hid for example Leonardo Da Vinci's flight apparatus and references to pyramids and other imagination tickling topics, which have also inspired the content design of *After Now Archeology*. The pieces were hidden outside of the regular paths, thus they could be found only by accident, or by systematical searching. They were also strongly connected to real world subjects and made no sense in the game's internal realm.

A bit different kind of approach to external knowledge and possibly hidden information can be found in some installations of *Assassin's Creed* -series. There are so called Subject 16 -puzzles, which use real world information, like old photographs and paintings as material of the game mechanics based puzzles. It is not necessary for the player to know what the images represent, but if he does, the narrative gets a whole new layer of meanings and hints. There are also hidden graphical elements, like notes and Morse codes that are not part of the puzzle within the game's realm. Thus, they implicate something even more hidden and mysterious being embedded into the game - or maybe outside of the game.

Illustration 6 Hidden message in Assassin's Creed II (2009)

Third and possibly most relevant example of hidden and extra game information is seen in platformer game *Fez* (2012). The game includes many hints written in game's own artificial alphabets. It may be possible to decipher these texts within the game's realm, but most probably they require some statistical analyzing and pen-and-paper methodology. There are also QR-codes embedded in the game world. These "2D bar codes" are designed to be interpreted by computers, so the player actually has to take a screenshot of the game and run it through a QR-code reader to understand what they mean. This information is then used within the game world when solving its rather difficult puzzles. The extra-game puzzle solving loop of *Fez* is very closely related to the *After Now Archeology*'s information seeking process.

2.5.4. Books and films

There are plenty of books and short stories where the protagonist must solve puzzles or riddles to save the world or to perform some smaller acts of heroism. Well known example is Edgar Allan Poe's *The Gold-Bug* (1843), which is built around solving a cipher text. Solving puzzles or riddles are in a central part of all murder mysteries and other stories, which are made famous by writers like Agatha Christie and Arthur Conan Doyle.

Dan Brown gave the genre a boom with his books about Professor Robert Langdon's adventures. *Angels and Demons* (2000)*, The Da Vinci Code* (2003) and *The Lost Symbol* (2009) are built almost in a form of computer adventure games. The protagonist needs to solve the puzzles and riddles in real world surroundings. There is only one possible

solution to each puzzle and the characters usually need to utilize their knowledge of the history and culture of the area they are in. The books (and movies) have some action scenes to build up the tension, but the main stories are about solving riddles.

One of the recent examples of the puzzle solving genre, which is also very closely related to computer games, is *Ready Player One* book by Ernest Cline (2011). The story rotates around a scavenger- or puzzle hunt game that is organized in a hugely popular virtual world. The puzzles in the book's game are based on extra game information that actually is real information from the real world. This makes the book almost an explanation or allegory of playing *After Now Archeology* and other similar games.

Treasure hunting has been a common theme in movies through the history of the medium. *National Treasure* films (2004-2007) are good examples of the genre. They rely on some historical facts, but expand the mystery from there bringing the characters into very imaginative places and events. The recipe is quite the same than in Dan Brown's books.

Thematically treasure hunt films and books are closer to *After Now Archeology* than other types of mysteries. For example Umberto Eco's *The Name of the Rose* (1980) and *Foucault's Pendulum* (1988) are non-treasure hunting mystery stories that rely even more strongly to real historical and cultural facts and topics than Dan Brown's books or *National Treasure* films. Nevertheless, all of these films and books have been an inspiration when making *After Now Archeology*.

2.6. Overall puzzle design process

This chapter includes information that may spoil the fun of solving the puzzles. If you are going to play the game, please ignore this chapter.

The puzzle design process usually started by browsing the material, looking for ideas. For most of the time I tried to find a common theme between different topics. For example, in the case of Metromancy-puzzle (see chapter 2.13.3.), the idea started from understanding the binary number relation between the Chinese I Ching and African geomancy. From there I started adding features from divination techniques, I Ching trigrams and finally got to the connection between metro maps and geomantic figures. The idea of using metro maps as a part of puzzle came into my mind while I was visiting Paris and found out that many of the metro stations had names of other cities (e.g. Rome, Stalingrad and Luxembourg).

Illustration 7 Screenshot of Metromancy puzzle, showing different types of content

Sometimes the overall design process started from the answer. I wanted to give the player a certain prize for solving the puzzle, so I knew the final answer and possibly the prize message and picture I wanted to present to a player who managed to solve the puzzle. Then I started to build layers of puzzles on top of the answer. This way the puzzle mechanics and all topics could easily be built to support the whole, making it more consistent than by other methods.

The gameplay design was probably the most difficult part of the puzzle design. Since the game is heavily based on knowledge and understanding of different information, the mechanics always followed the initial content. I wanted to have at least some level of interactivity on each puzzle, so when I knew the puzzle layers and connections between the layers, I needed to invent ways to give the player something to do, not just something to think about. In the most minimal form, the Synesthetic Mathematician puzzle has two screens with some text to give the player some hints and pointers, a couple of puzzle related images and a text input field where the player should type the answer.
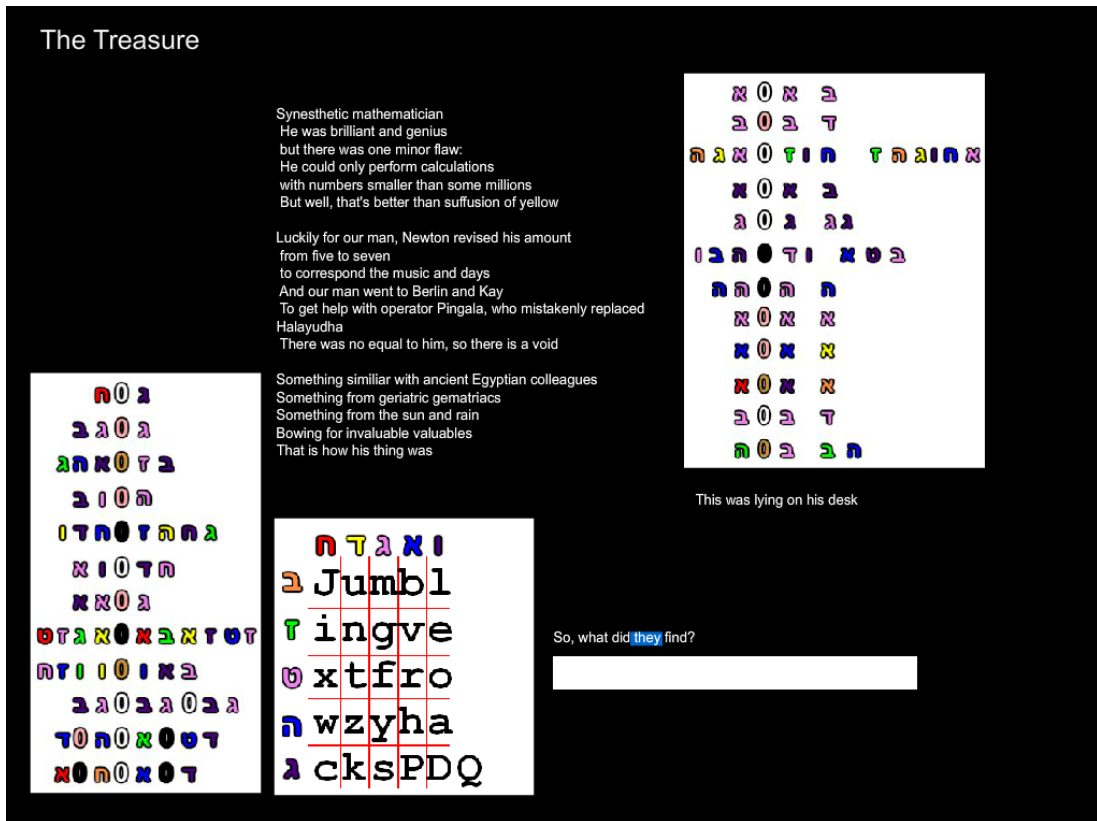
Illustration 8 Second screen of Synesthetic Mathematician puzzle

The most complex interaction model was probably in the Zodiac Bookshelf puzzle. The player was placed in the middle of a room with an old laterna magica. One of the walls had a chalkboard with all the hints for choosing and aligning a correct slide with the ancient projector. Two walls were just for thoughts and inspiration, but the last wall included a bookshelf which is full of imaginary books from other works of literacy. The player should choose the correct slide into the laterna magica and rotate, scale and position it properly over the bookshelf. This way he could find the correct book to click to solve the puzzle.

Illustration 9 Zodiac Bookshelf puzzle, with an ancient stellar map projected over a shelf of fictional books

There are some common nominators that follow the player through various puzzles. These connecting themes or topics are sometimes invented accidentally when designing the separate puzzles. They usually relate to some topic which I have been especially interested. For example Italo Calvino's writings, labyrinths and different languages are present in various puzzles. This can build up some emergent stories or ideas among the players, but they are also partly intentional ways of pointing the player deeper and more complex relations between things in the real world.

2.7. Content design

Since *After Now Archeology* is very heavily based on external content, it was natural to begin the project with a content collection phase. This phase consisted of dozens or hundreds of hours of browsing the internet looking for weird, interesting and beautiful things, watching movies, reading books et cetera. Whenever something possibly usable was found, it was added to a content spreadsheet.

The spreadsheet included the name of the new topic and possibly an internet link, but also a matrix of areas where the topic belonged to. The matrix had columns like "cryptography", "mystery", "art" etc. These attributes helped in the design of the form of

the game, choosing the paths and generally building an image of the whole project (see Appendix 1).

In his book *The Greatest Puzzles of All Time* Matthew Costello (1988), beside of presenting many of the most famous puzzles in the world, also wrote about puzzling phenomena in the nature and culture. He briefly handled the legendary creatures like the monster of Loch Ness and Bigfoot. But in the perspective of *After Now Archeology*, his inspections of mysteries within human culture are more interesting. Costello's book ties the puzzle mechanics and puzzling and mysterious content into single consistent package of amusement of unknown.

In the spirit of Costello's holistic vision, we can think about the relationship between not understood natural phenomena and science. For example magnetism and electricity were strange mysteries of the world before science finally understood the structure and functionality of electromagnetism. In the content design of *After Now Archeology* I decided to focus on the unexplained or strange phenomena of human culture. This does not exclude mysteries of nature, but they are approached through interesting scientific results. For example many mathematical and physical topics have been used as sources for the puzzles.

When the amount of different topics reached reasonable level, I started searching for recurring patterns among them. Slowly different topics started to match and first ideas for puzzles took form. Mixing different thematic topics with gameplay related topics brought out ideas for puzzles. The goal of the design was to build puzzles where all the topics and mechanics support each other. Usually there is some kind of connection between the content and game mechanics, but that is not always the case.

Designing game and interaction mechanics that draw from the information content proved to be rather ambitious idea. In some cases it worked well, for example in Sky Disc puzzle it was logical to break the Nebra Sky Disc apart, since it is made of small pieces which have already partly fallen off. In that case the interaction and puzzle felt almost natural. Sometimes the answer to the puzzle is given by writing a password in a text field, which besides of being repetitive, can also feel unnatural and separate from the content.

2.8. Game mechanics

I want to differentiate game mechanics from interaction mechanics. My definition is that interaction mechanics is something that the player actually does with his hands, gestures or other ways. It is the human part of the human-computer interface. For example, pointing and clicking with a mouse, tilting a Wiimote or pulling gamepad triggers are interaction mechanics.

Game mechanics are actions the player does within the game world. They can also be thought as the rules of the game, like Schell (2008, 41) and Brathwaite and Schreiber (2009, 28) do. These mechanics can include catching, evading, navigating, collecting etc. The interaction mechanics are mapped to game mechanics, so there is a connection between what the player really does and what his actions mean in the game world. For example, turning a controlling stick on game pad is an interaction mechanics, which can be mapped as steering a car or navigating through the streets within the game realm.

Since *After Now Archeology* is designed to be played with mouse and keyboard, all interaction mechanics are related to pointing, clicking and dragging with a mouse, or entering letters or words with keyboard. There are no timing related actions in the game, so the player can ponder the puzzles as long as needed. The game does not punish the player from giving wrong answers, so the player is free to try out different solutions.

Defining the game mechanics for the puzzles in *After Now Archeology* is not necessarily an easy task. Each puzzle is based on different game mechanics. On lower level they may contain similar components, e.g. pattern matching or entering passwords, but on higher level each puzzle is different. The problem with definitions comes from the fact that most of the playing time the player is actually working outside of the game client. I tried to steer the design from mere password typing towards working within the game realm, but it proved to be rather difficult.

2.9. Narrative

After Now Archeology is built as a source of pointers the game gives the player for finding clues for puzzles. Even if the game itself is a game of progression – like most of the story driven games are – the narrative is in a minor role. The game shows the player a small introduction text when he starts to play, but especially in the current form the overall narrative is more or less cursory and rather irrational.

Of course, the player will probably build their own narratives from the subtle hints the game offers. The name of the game suggests that the game happens somewhere in the future. Archeology in the name can lead the player's imagination to ancient Egypt and excavation of the tombs of the pharaohs. The logo and the map of the game somewhat resemble a labyrinth.

The clue pointers the game gives to the player were thought to work also as kind of post-modern textons – pieces of text that produce complete stories, if using Aarseth's ergodic literature vocabulary (Aarseth 1997, 62). In the same manner puzzles that combine different topics and clues can be seen as scriptons – collections of textons that are connected to each other (ibid.). In this case the textons and scriptons are not exclusively defined or produced by the game maker. They can be rather random and vary a lot depending on the player and his interpretation of the acquired pieces of information and story material. In this sense *After Now Archeology* is something Aarseth called traversal function (ibid.). It defines the paths and connections of story elements to some extent, but it does not provide the actual content.

After all, there is some vague overall world and narrative where *After Now Archeology* takes place. The world and story of the game is an intersection of the designer chosen topics and pointers, and the topics the player finds while playing and how he interprets them and builds stories. In optimal situation the gamer experiences a kind of "gamer's journey" while playing *After Now Archeology*. Drawing from Joseph Campbell's theory of mono myth and hero's journey (Campbell 1949), the gamer would face the challenges of the game, turning away in denial. Then he would come back to the game, fight the fight, get some help from the wise players of the forums and conquer the challenges. In the end the player would return from the game's realm as a changed, and developed person.

2.10. Difficulty balancing

Balancing the difficulty of the gameplay is always crucial part of game design. Common thought is that the game should begin on rather easy level, so the player can catch up with the idea. When the player progresses, the game should become increasingly difficult so the player's sense of achievement grows bigger (e.g Schell 2008, 215). It is also easier to provide the player more demanding challenges when he has already invested some time to playing the game and hopefully is hooked.

After Now Archeology is designed to be rather difficult. When reflecting on through Csikszentmihalyi's flow theory, playing the game may often cross the line between flow channel and anxiety. This can clearly be seen when the game was given to test for different kinds of players. People who were interested in the game and had played similar games earlier could spend hours on solving the puzzles. More casually oriented players started feeling strong anxiety within few minutes. This was caused either by lack of understanding of what to do in the game, or by unwillingness of searching for information.
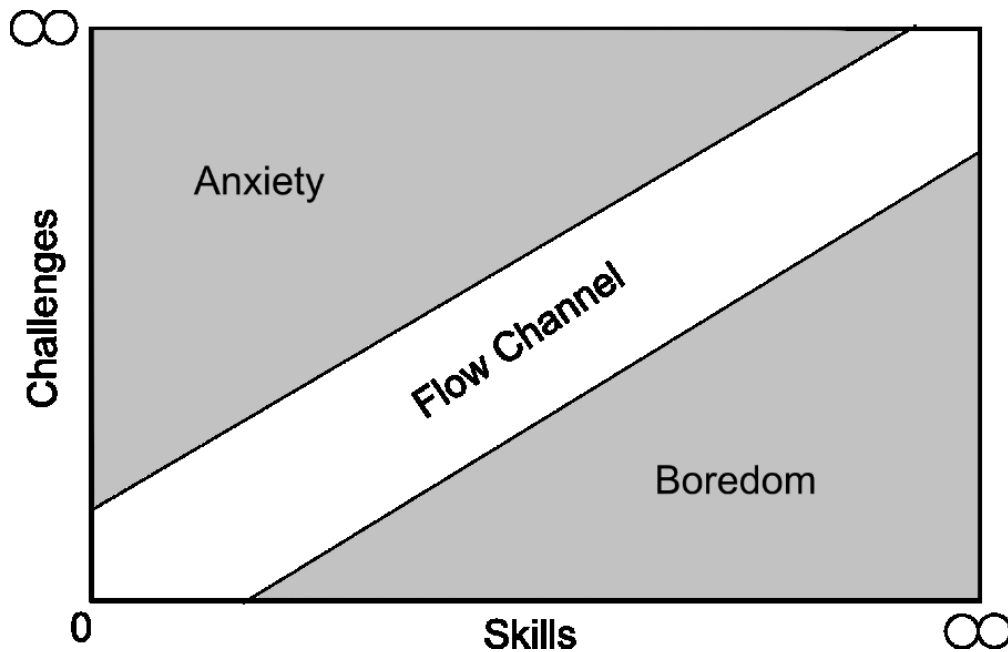
Illustration 10 Diagram of relationship between difficulty of challenges and development of player skills in Csikszentmihalyi's flow theory. (from Csikszentmihalyi 1990).

Strong polarization of test players' interest towards the game was not a surprise. It was clear from the beginning that the game will be appealing only for certain types of players. Thus, there are no plans for extending the balancing system to please larger audiences. But for the enthusiastic players of this kind of games, different difficulty balancing systems were considered. The range varied from selling hints (and monetizing the game by not-so-good players) to personally discussing with players about the puzzles.

In other games difficulty balancing has been handled in various different ways. For example following methods have been identified when analyzing a personal gameplay experience of various different games:

- Choosing the difficulty in the beginning: Affects amount and toughness of enemies, time limits. In *Mass Effect 3* (2012), choosing action, role-playing or

story mode affects the difficulty level of battles and amount of choices the player can have during conversations.

- Automatic balancing during playing the game: Rubber band effect in racing games, the director in *Left 4 Dead* (2008), letting the player keep the ammunition and weapons after dying

- Suggested balancing during playing the game: "You died many times, do you want to try this battle with an easier difficulty?"

- Voluntary balancing during playing the game: Choosing a new difficulty level, choosing easier or harder route, taking hints

- Involuntary hints and during playing the game: Giving hints after certain time without asking the player

- External balancing: Reading walkthroughs, strategy guides and discussion forums.

Carl Therrien has studied the assistance paradigm in video game design. He divides the ways of assistance and helps in following groups:

- Tutorials: playing instructions in the form of booklets or in-game interactive tutorials, mainly usable before or in early phases of playing the game.

- Hints: messages shown to the player while playing the game.

- Spatio-narrative guidance: in-game maps representing the game world.

- Variable difficulty: both voluntary and involuntary adjustments to difficulty levels.

- Pause function and save systems: means of phasing the game and offering trial-and-error methods.

(Therrien, 2011).

These methods are somewhat in line with my own findings, but they get on a more pragmatic level. In the case of After Now Archeology, voluntary balancing during playing the game was designed, in the form of hint system. One could say the parallel thematic paths and possibility to leave some of the puzzles unsolved could be an implementation of voluntary variable difficulty.

The difficulty balancing is so large a topic, it could require a thesis work of its own to be properly explored. For example, Hunicke (2005) has done research on dynamic difficulty adjusting (DDA), which is also addressed by Jenova Chen (2007). Although some work is done on the subject, many of the aspects presented here could be studied further.

2.10.1. Progression of difficulty

Quite often difficulty progression curve has a generally rising trend, but there are local maxims and minims during the progression (e.g. Brown 2010). The maxims often mean level bosses or similar harder obstacles. These though pieces are usually followed by calm periods, so the hard action feels even harder, but also because then the building of the next difficulty ramp can start from a bit lower level, thus making the cumulative rise of difficulty not so steep.

Since *After Now Archeology* is strongly based on external knowledge, which is difficult to measure, it is also rather difficult to plan for the difficulty progression. In most traditional and digital games it is easier to diminish the error toleration of player's actions towards the end of the game, add more simultaneous enemies or add the speed of the action, when increasing the difficulty.

The following paragraph includes some information about the game, which may spoil the joy of playing.

In *After Now Archeology* the question was usually handled by adding more elements to the puzzles. For example, the first puzzle of culture path is based on mental associations between different works of art, design and architecture. There is just one level of required actions: recognizing the picture and figuring out the association linked to it. The last puzzle of the art path requires the player to recognize several Finnish films, find out their directors, applying Cantor's diagonal argument to the list of names, doing the IBM-> HAL conversion (ROT -1 decrypting) and finally finding the correct film from a group of films.

2.10.2. Paths

After Now Archeology is built around three themes: culture, science and myths. Not all players are interested in all three areas, so solving all of the puzzles was made unnecessary. If the player is a math genius, but does not understand anything about culture, he can

choose to avoid most of the cultural puzzles and progress towards the main goal by solving all science based puzzles and all bi-thematic parts. This serves the function of parallelism, as it lets the player to have a rest with a difficult puzzle while trying to solve something easier (Schell 2008, 216).

This design decision of not requiring to solve all the puzzles was made after first player tests. Some of the testers were quite good with art path puzzles, while others did not understand them at all. Requiring all players to solve all puzzles would drive many players away from the game, so I decided to let the player choose which puzzles he wants to solve. The mandatory puzzles are still there for all players.

2.10.3.   Hints

The hint system plays an important part in balancing the game. It is designed to balance the difficulty level between different players. The player can choose when he wants to use a hint. The hint system is kind of a trade-off between the super hardcore players and not so achieving-oriented players. (Schell 2008, 217). Bernard De Koven also writes about the art of giving hints. He points out that it is important that the hinted player can choose when he wants to receive a hint (De Koven 2013, 21). Hint given too early spoils the joy of exploration and discovery. Hint given too late causes frustration towards the game.

The need for a hint system became clear after the first playtests. Only a few players had enough enthusiasm to solve the given puzzles completely. Quite many players got stuck at some point. This was usually related to a certain sub-puzzle. Possibility to get some help with a certain sub-puzzle could keep these players playing and getting a feeling of progression.

The problem with hinting system *in After Now Archeology* is that many of the puzzles work on parallel levels. There are several different things the player can examine, and when he gets stuck on some aspect, he can start a research on another topic. For example in Art Mindmap -puzzle there are almost all the time at least two different input fields open, waiting for player's input. When giving hints to the player, these parallel possibilities can cause problems, if the player hoping for a hint on certain aspect of the puzzle gets a hint for another part, which he would have liked to solve himself.
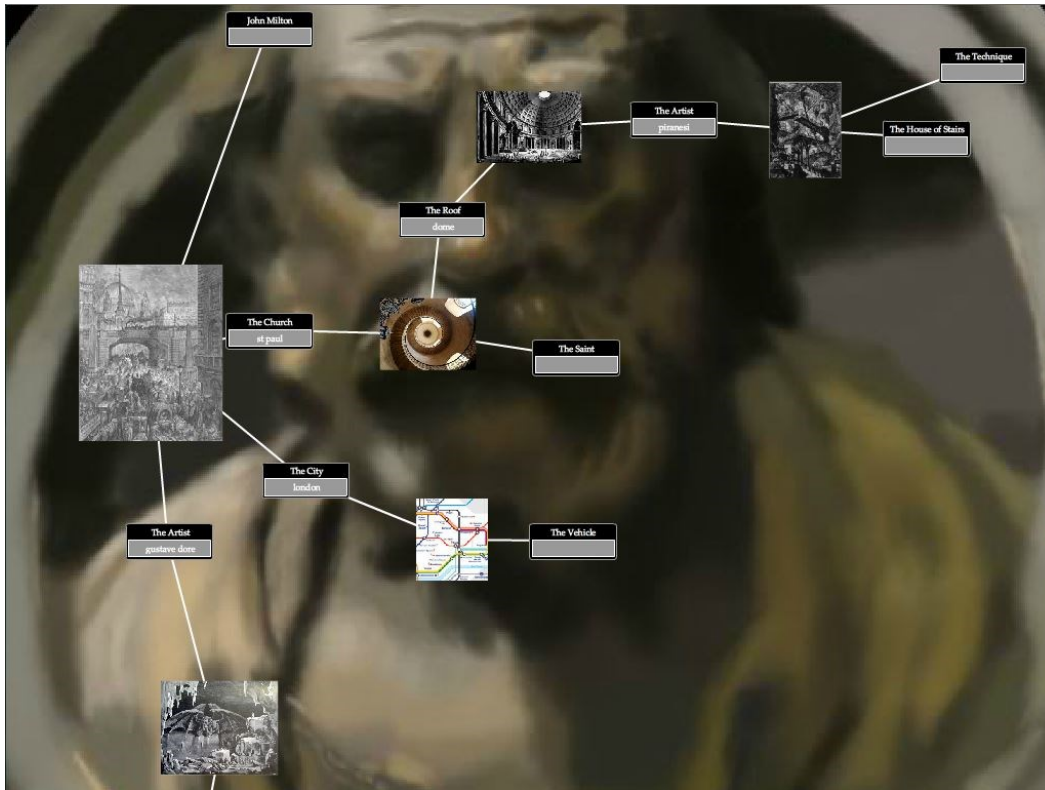
Illustration 11 Screenshot of Art Mindmap -puzzle, showing multiple open branches of inputs

2.10.4. Player community and hackers

Examples of earlier games have proven that enthusiastic players are willing to put their own time and effort on building tools for communal communication between the players. All examples of similar previous games have spawned multiple discussion forums, where players can share hints and opinions about the puzzles. These forums are usually well moderated and the participants have a high level of self-regulating over their writings. Thus, hints and solutions that could spoil the fun of exploration from other players are very rare and these forums can "safely" be used when getting stuck in the game.

Another view to the spoiling of fun can be found among players who use some debugging or other tools to break into the game's code, searching for clues or solutions. Salen and Zimmerman write about hacks as spoil-sports in multi-player environments (2004, 280). They also classify using walkthroughs on the same level with hacking the system for winning the game. But in the context of single-player information seeking game, hacking into the system cannot be seen as a big threat.

Since there is no official competition between players, and most of the game consists of searching for information outside the game's realm, hackers and system crackers are only breaking the game for themselves. Thus, the program code of *After Now Archeology* was not encrypted in any way. It could even be thought that if the player is interested enough to break the system to get past too difficult puzzle, he is very interested and dedicated to the game. As De Koven would say, the game tries to play well with the gamer, providing him a possibility to work around an obstacle. This reflects also MacBride's studies of cheating in multi-player environments (2007). Also Galloway discussed cheating as a non-diegetic operator, somewhat similar to pause-menu or gameplay settings of games (Galloway 2006, 21).

2.11. The problem of enlightenment and solving the puzzle

After Now Archeology – as quite many of the similar puzzles – has one significant design problem: the actual labor of giving the solution. Most of the fun of the game comes from trying to figure out or understand the mechanics of the puzzle. Opposite to the teachings of game design theory (e.g. Schell 2008), these puzzles don't necessarily tell intuitively what is needed to solve the puzzle. When most games try to hold the player's hand and tell them the basic mechanics and goals, these puzzles try to keep them hidden. Figuring out the mechanics is an important part of the puzzle setup.

When the mechanics of the puzzle is solved, the game is already over. The player needs to enter a laborious and sometimes boring anti-climax phase, where he has to utilize the mechanics to solve the puzzle, in order to progress in the game. During the early tests this phase was sometimes found out to be too much for the players. The testers told that they had found out what to do, but they had no time or energy to actually solve the puzzle. This was considered rather big design issue and I tried to help it by reducing the work after the method to solve the puzzle had been found. For example, in Serious Fun puzzle the text area in the bottom right corner of the screen was modified to show the possible answer in real-time, when it originally was input box for the player to enter the password he has to figure out by ordering the leftover pieces of the series.

2.12. About the development process

During the working years in game and IT industry we usually used some kind of formal planning and implementation process. Quite often game companies use some agile

method, like Scrum, as a framework for the development. Since the production teams are usually rather big, and the costs need to be calculated, development includes a lot of formal planning and documenting.

I wanted to do things a bit differently with *After Now Archeology*. Since I had no constraints of budget, schedule or anyone else needing my input, I could experiment with more free development process. There was no commercial pressure, nor was there any need for keeping the project secret, although publishing the solutions for the puzzles would ruin the game.

2.12.1.   Tools

The topic collecting for the game was done using a spreadsheet program. By using spreadsheet program, it was easy to keep the list of topics in order. It also enabled a clear layout of columns of extra information, like classification of the topics in different groups. Documenting the puzzles and their solutions (see appendix 2), I used regular word processor.

The main design phase of the puzzles was done using *Articy Draft*. It is a program mainly for writing interactive and branching stories, but it suited perfectly to designing the puzzle structures of *After Now Archeology*. In *Articy Draft* the user can draw boxes of content that can be connected to each others with arrows. The content boxes can be just lines of dialog, but also scenes or in this particular case, different puzzles. *Since Articy Draft* is very spatial tool, it is easy to quickly get an understanding of the structures and relationships within and between the puzzles. Newer versions of *Articy Draft* an export the data as *Word* document or in specific XML format, which could be directly parsed to dialogs and scenes in the game. These possibilities were not used in this project.
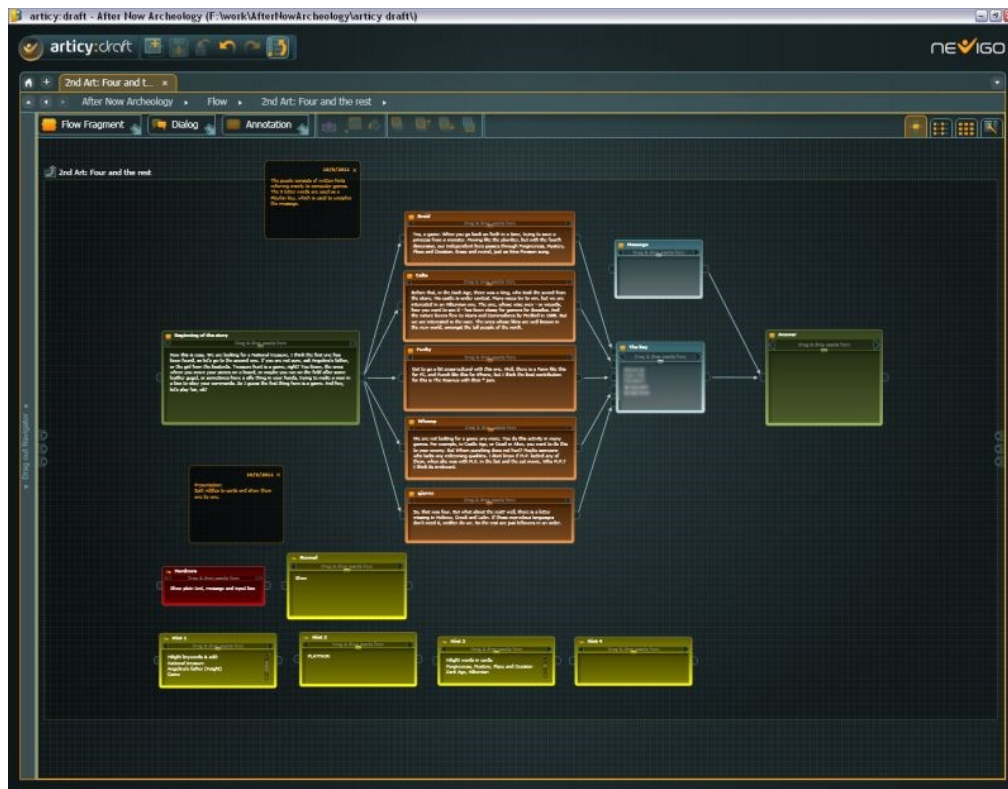
Illustration 12 Screenshot of a puzzle structure in Articy Draft

After Now Archeology is programmed and composed in *Adobe Flash* (1996-2014). I chose *Flash* as my production tool, since I have worked years as a *Flash* programmer, so it was easy for me and did not require me to learn any new programming language or tool. After all, the process was more about game design than game programming. *Flash* is a good tool for rapid development, especially when there is only one programmer and no need for code branching, version control or other modern development techniques. Each of the puzzles took me about one or two days of programming and testing. I left all transitions rather clear cut and effects to minimum, because I wanted to focus on the puzzles and content.

For graphic design and asset production I used freely available tools: *Paint.net* (2004), *Inkscape* (2003) and *Mypaint* (2010). The original thought was to produce all of the graphics in "digital painting"-style, either by producing completely original assets or re-painting the artwork and source images that are crucial to the puzzles. Since I have not done too much art production since the days of *DeluxePaint* (1985-1994) in 1990's the re-painting and original production took really a lot of time. This lead to a decision to use some borrowed images as production time placeholders. These images were edited with Paint.net, which offers easy to learn and quick to use tools for basic image manipulating.

For the map, logo and some other vector graphics I used *Inkscape*, which is another easy to learn and quick to use graphics program, for vector images. For some development time quick sketches I also used *Flash*, since it was already open and with a drawing tablet it can produce decent looking paint brush-like vector shapes.

2.12.2. Blog

I started writing a blog about the development. I have written a couple of blogs earlier, but this time it was a personal learning experiment. My initial goal was not only to tell people about the game, but also write about theoretical aspects. As the time passed by, the blog got as stagnated as did the production of the game. But when I wrote new posts, the blogging worked as intended.

The blog also worked as a public notebook for my thoughts. Writing down some academic references and learnings from other games, the blog proved to be a good way to have some comments on the ideas and theories behind the game. I also shared the first version of the knowledge flow theory in the blog, gaining a couple of good comments and ideas for the theory.

When the development time extended, and the process got less intense, the blog was left behind. It had given its best as a tool for organizing thoughts and getting some visibility for the project, but later on there was not enough interest and time for updating the blog. (See Appendix 2 for further information about the blog.)

2.12.3. Early testing

I felt it was crucial to the game to get the puzzles in the hands of the potential players as soon as possible. First puzzles were actually given to a very limited test even before the game had a name or it was a thesis project. The first puzzles got very positive feedback, encouraging me to continue the project. Going public in an early phase was an interesting test – I haven't done that earlier in this scale. It was good to see how the early testing could affect the design and development.

Early testing also revealed some bugs, but most importantly, it gave a lot of information about the difficulty level and ways of solving the puzzles. Since the testers were good friends of mine, I got very precise explanations of their thought processes and ways they tried to solve the puzzles. This helped enormously with the further design. Discussions

with the players revealed that the logical paths I had designed to the puzzles did surprisingly well match the player's actions and thoughts about the puzzles. Despite of this, almost all puzzles proved to be somewhat flawed at some point. Usually all the players pointed out the same flaw, so it was quite easy to fix these problems. For example, in Four and the rest –puzzle, some test players didn't have a clue about what to do in the puzzle. Thus, I changed the design completely, adding a grid for inputting letters, and small lines pointing the row where the answer to the current riddle should be written.
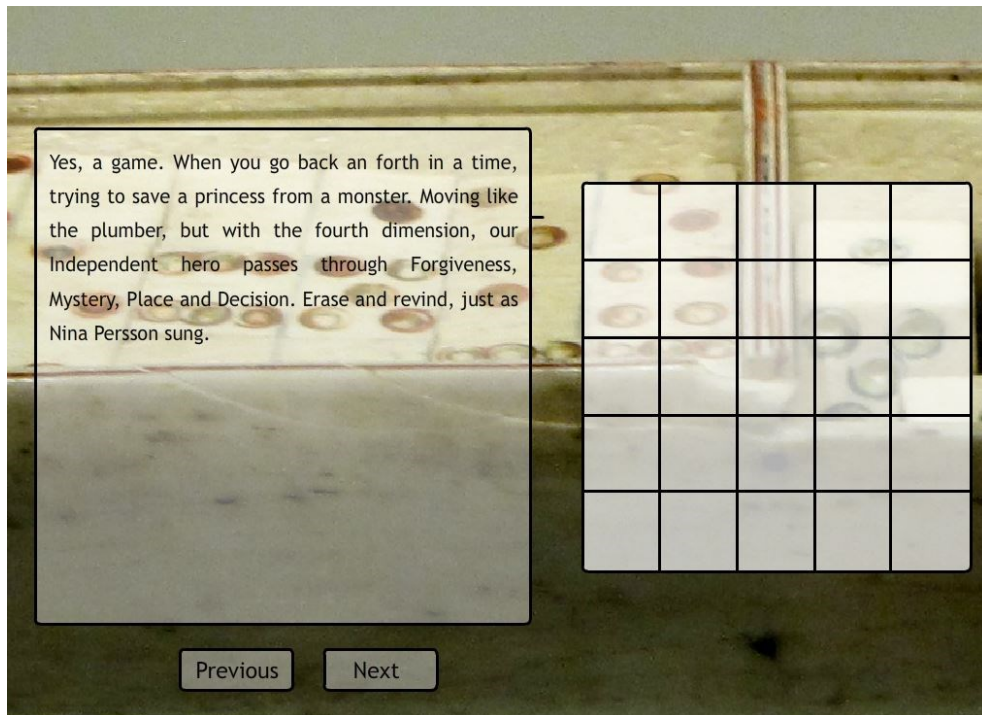
Illustration 13 Hint for the first row of Four and the Rest -puzzle

2.12.4.   Level of implementation

For the purposes of this thesis, only nine puzzles were implemented to playable condition. The reality of designing, programming and artistically implementing 19 different puzzles proved to be too ambitious. On average, programming a puzzle took 1-2 days, including post-testing bug fixes. As a non-graphic artist, painting and assembling all graphical assets for a single puzzle could take 2-3 days. When adding average of 3-5 days of data collecting and puzzle design, making a single puzzle could take 1-2 work weeks.

The overall design of all 19 puzzles is in rather good shape. Beside the implemented puzzles, there are complete designs for five other puzzles on the level of content, goals, user interface and interaction styles. Last four puzzle designs are so complex that

estimating their playability and implementation difficulty requires some prototyping. It is highly possible that those four need to be re-designed, if the planned gameplay proves to be too difficult to implement or play.

There are no exact records on how much time was used for the content collection, but within last two years at least 40-60 hours was used just for searching and selecting the potential material for the game. Processing the collected material to game content and sketching the initial gameplay ideas based on the content has taken at least 40 hours. The design of the 14 puzzles that are implementation ready has taken approximately 100 hours.

Implementing the nine puzzles took about 3 weeks of time. Most of the puzzles use photographs and drawings as placeholders for final graphics. The smoothness and appearance of user interfaces are on "minimum viable product"-level, thus requiring quite a lot of work to qualify as "release free". The game saving system does not save the state of individual puzzles, just the information of which puzzles have been solved and which not.
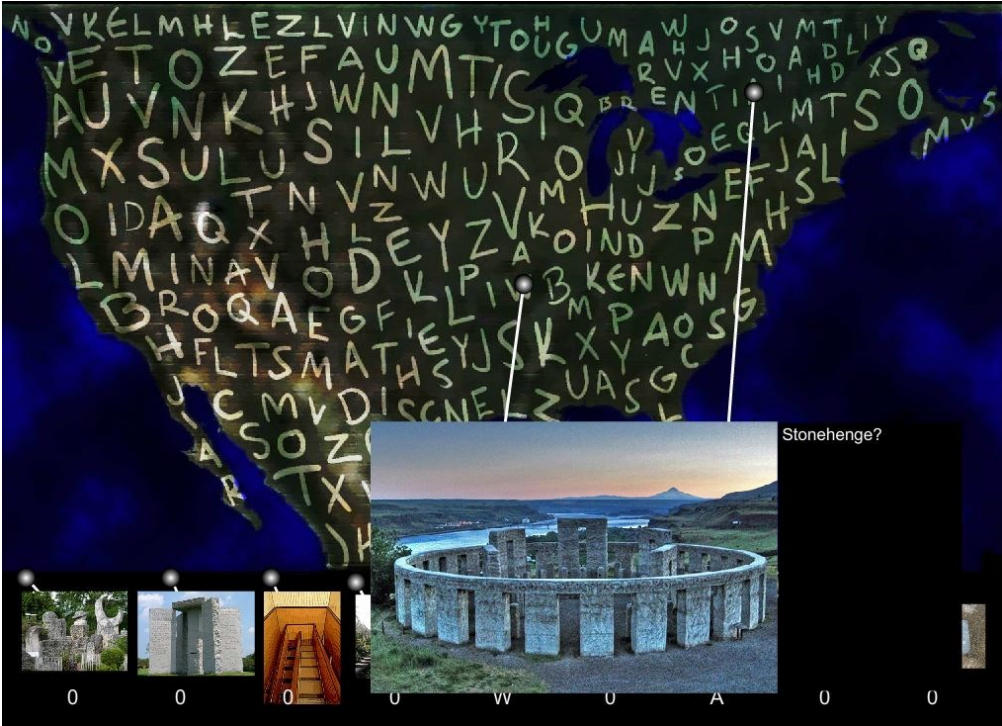
Illustration 14 Lettermap-puzzle with placeholder photographs and sketchy map.

2.13. Examples of puzzles

To open up the design process and layered puzzle design of *After Now Archeology*, a couple of the puzzles in the game are now explained. This part contains a lot of information about the puzzles, so reading this before solving the puzzles can spoil the fun of finding out the solutions for the puzzles.

2.13.1.   Ancient Skies

Ancient Skies is the first puzzle of the Myth path. It is also one of the simplest puzzles in the game. It is based on an ancient artifact known as Nebra Sky Disc. This round plate was found in Germany, near the town of Nebra and it is thought to represent sky with additional mythical elements. This is the only puzzle that has only one source for content and one level of gameplay.
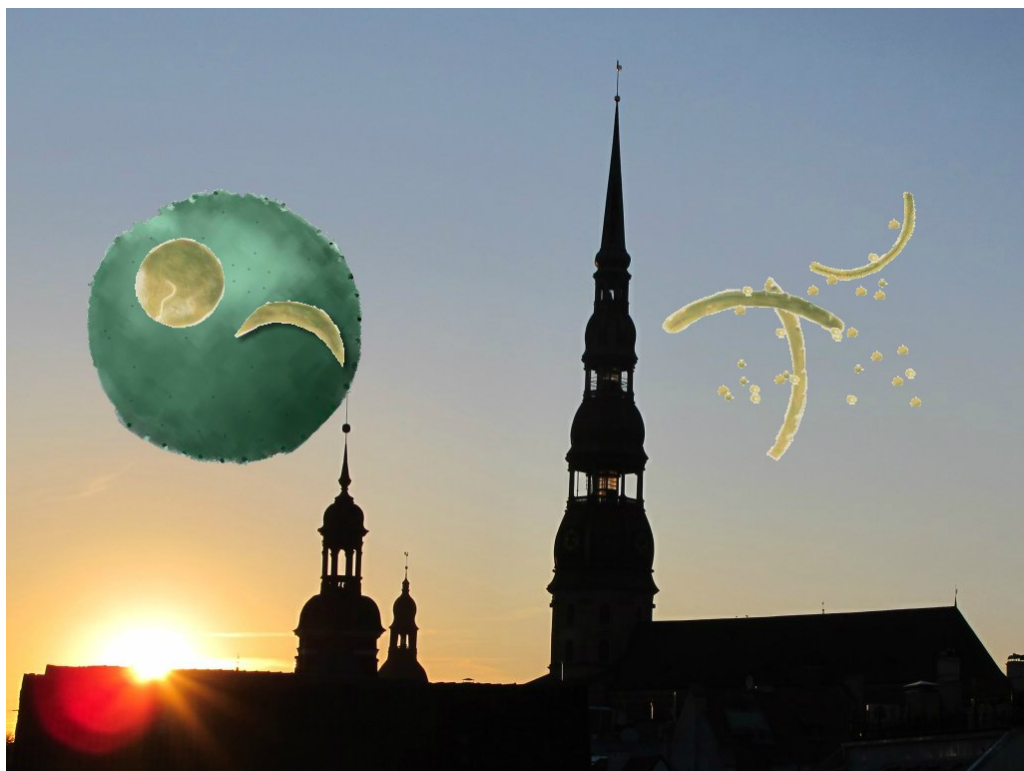
Illustration 15 Screenshot of Ancient Skies -puzzle

The gameplay of the puzzle is quite simple. The celestial objects that are normally attached to the bronze plate are detached and the player's mission is to put the pieces to their correct places. The player can drag the pieces with mouse and when she releases the mouse button, an icon for rotating the piece is shown. The player can then click the icon to change the rotation of the piece, or click somewhere else to hide the rotation icon. The

pieces can be rotated 20 degrees at a time so there are 18 possible positions for each of the rotatable pieces.

There are total of 19 round star pieces and five bigger elements that need to be correctly placed to solve the puzzle. The stars are interchangeable and they cannot be rotated. The pieces will snap to correct positions from a maximum distance of 10 pixels. It proved to be too difficult to require the player to have more precise placements. After testing, small dots for the locations were added to make the puzzle even possible to solve.

The challenge with this puzzle comes from the fact that it is really difficult to guess the correct places for the pieces without any knowledge about the original artifact. The name of the artifact is not revealed in the beginning, so the players who do not want to use hints must try to find a picture of the disc without having the name. There are three levels of hints on this puzzle, revealing GPS coordinates to the place where the disc was found and the name of the town the disc was named after, but not directly.

Planned solving procedure for the puzzle goes as follows:

- The player moves the pieces and figures out they can be moved and rotated. Brute force tactics for the placements are most probably being tried.

- Since two pieces remind a crescent moon and sun, the player might try searching the internet for ancient sky maps or sky disk. The background image also suggests that the item is related to sky.

- Searching for "sky disk" reveals the image of the disc, with which the solution needs just hard work.

Ancient skies may be one of the few puzzles that can be evaluated using Wang, Wang and Sun's puzzle rating method (2011). Since all of the pieces and possible positions for them are visible for the player from the very beginning of the puzzle, it actually can be solved using brute force mechanics. Ancient Skies is also one of the few puzzles in *After Now Archeology* that "locks" the correct answers. This makes the solving and evaluation much easier.

2.13.2. Serious Fun

Serious fun is the second puzzle on the science path. It relies on mathematics and history. The player needs to connect series of numbers written in different languages to names of

mathematical series. The series names are scrambled, so the player must solve the anagrams before he can do the actual connecting. The alphabetic mappings of the leftover numbers form the answer to the puzzle. The answer is updated automatically when the player progresses in the puzzle.

Illustration 16 Screenshot of Serious Fun -puzzle

The interaction of the puzzle consists of dragging the letters of the series names and number pieces with a mouse. The letters of the names cannot be dragged outside of their containing area. The number pieces can be dragged to areas beside the series names or anywhere on the initial area in the bottom of the screen. When the numbers are dragged to the series containers, they organize automatically, so they will always be seen side by side. So, when a player drags a new number on top of earlier ones, the others make room for the new one. This happens also with the letters of the names of the series. When the numbers are dragged on the initial area, they can be placed freely. When dropped outside these areas, the numbers return automatically to their previous position.

The puzzle contains following topics:

- Six different mathematical series

- Anagrams

- Six different number systems, from six different languages

- The background image is a repaint of an old world map

The optimal path for solving the Serious Fun puzzle goes as follows:

- The player solves the anagrams of names of mathematical series

- The player figures out the languages for the numbers and finds out the values of the pieces

- The player tries to match the numbers to the mathematical series and notices that none of the series is presented as is, but there are extra numbers with the pieces

- Placing the correct numbers to correct series the player orders the leftover pieces in the ascending order in the same order the series are presented. This shows the correct answer in the bottom right corner of the screen and solves the puzzle.

This puzzle, too is possible to solve with brute force mechanics, thus it could be evaluated using Wang, Wang and Sun's (2011) methodology for estimating the complexity of a puzzle game. The difficulty for brute force solving comes from the uncertain amount of numbers used in and left over from each series. The solver needs also to order the left over pieces correctly, which is not clear if the solver does not have understanding of the series names and numbers they include.

2.13.3.   Metromancy

Metromancy is one of the puzzles with many levels of information. The main theme is old divination techniques which are based on binary systems. The name of the puzzle comes from African method of predicting the future, geomancy, and metro maps of different European cities. The connection between these two comes from the fact that geomancy was done by throwing sticks or other items on the ground, which gave the method its earthly name. Metro trains naturally travel underground, so the geospheric connection is made.

Fortuna Major	R
Latetia	P
Fortuna Minor	N
Conjunctio	A
Puer	P
Puella	T
Acquisitio	L
Tristitia	V
Rubeus	R
Cauda Draconis	E
Carcer	I
Via	I
Amissio	S
Albus	I
Caput Draconis	E
Populus	M

Just a sidenote

What Stillman did in the City of Glass was not just a story.
I think he really tried to tell us something.

Playlist of the day:
http://www.youtube.com/watch?v=V9Wv4SCBiTE
http://www.youtube.com/watch?v=WIUAC03YMlA
http://www.youtube.com/watch?v=pYImEf_-km0
http://www.youtube.com/watch?v=ymNFyxvIdaM

WHAT I AM SEARCHING FOR ?

Illustration 17 Screenshot of Metromancy-puzzle

There are 16 geomantic figures, which are represented with four rows of dots. Each row can contain either one or two dots, which makes the method binary. There is a clear connection to Chinese I Ching, which consists of six rows of either one or two lines. These figures are split to two trigrams, which can represent directions, elements and other things. Four of these trigrams, the ones for the main directions, are also seen on South Korean Flag.

The puzzle itself contains 19 movable, separated pages from an unknown man's notebook. The pages are numbered with Morse code numbers, which have a binary nature, too. Each of the pages includes some hints for the solution of the puzzle, but the main thing is eleven pages that include journal-like stories about travels in different European cities. The city names are not given, but the stories include names of metro stations. When the player plots the stations on metro maps, they form geomantic figures, which are then mapped to letters. The letters form the answer to the puzzle, which is then fed to a text field on one of the pages.

The elements, hints and references in the puzzle are:

- Geomancy, an African divination method with 16 different figures

- Metro maps of different European cities

- Morse-codes for page numbers

- Braille alphabets for encoding one hint

- Chinese I Ching trigrams showing directions

- Mention of Paul Auster's City of Glass, where a man walks in a city and his route draws letters on map

- The background image of the puzzle is a geomantic machine.

The planned solving procedure goes as follows:

- The player browses the notes. He sorts the notes to the ones with city stories and other hints.

- The player searches for the names of geomantic figures, which are mapped to letters on one note

- The player notices some metro station names and searches for the metro map for each of the textual notes

- The player searches for the stations and finds them on map. He figures out the connection between the stations and geomantic figures.

- The player orders the letters by the Morse numbers of the note pages.

The answer to Metromancy puzzle is given as written words in free text input box. Since the answer is two non-English words, solving the puzzle with brute force methods could prove to be slow and difficult. If the brute force solver understands to use the letters given in one of the cards, the task turns significantly easier. Especially, if the solver counts the hint cards, and takes them as the number of letters in the answer, using brute force methods could almost be done manually, without raw computer power.

2.14. After Now Archeology summary

After Now Archeology was designed and developed as a personally interesting puzzle game. The game combines various aspects from game design and life in general, that I have been interested in for over a decade. The game was not designed with commercial release in mind, although different monetization and financing possibilities were thought during the process.

The final form of *After Now Archeology* would include 19 puzzles from areas of myth, art and science. Within the timeframe of this project, only nine puzzles were implemented in playable form. There are designs for the rest of the puzzles, but some of them need to be refined. Each of the designed and implemented puzzles incorporate different game mechanics and are based on different content.

The main goal of the game's design was to provide the player interesting pointers to knowledge in the "real world". To solve the puzzles the player needs to get out of the game's magic circle to search for information and clues for the puzzles. Since playing the game is almost completely based on finding and processing information, or knowledge*, After Now Archeology* may stand as an example of knowledge based puzzles. This kind of games have existed for a long time, but the definition or explanation of their functionality and motivations stand undocumented. This discussion is continued in chapter 4.

3.   Is it a game – the theoretical background

In this chapter we look at *After Now Archeology* through the theories of game studies. It was known beforehand that the game breaks many of the conventions of computer game design and usability. By analyzing it with the basic theories as tools, we try to find a place for After Now Archeology in the vast and diverse field of games.

3.1.   Puzzles, games and other pastimes

Salen and Zimmerman have collected various definitions of games in their book "Rules of Play" (2004). They combined definitions by Parlett, Apt, Huizinga, Caillois, Suits, Crawford, Costikyan and Avedon & Sutton-Smith to formulate their own definition of games. In their mind "a game is a system in which players engage in an artificial conflict, defined by rules, that result in a quantifiable outcome" (Salen and Zimmerman 2004, 73-80).

When analyzing After Now Archeology with this definition, it does seem to match the definition rather well. There is an artificial conflict, since the player wants to overcome the puzzle obstacles the game's developer has given to him. Playing *After Now Archeology* is "voluntary effort to overcome unnecessary obstacles", as Bernard Suits has defined act of playing games (Suits 1978). The game has clear and programmed rules, which cannot be broken without hacking the game code. There is always a quantifiable outcome, both in every puzzle and in the whole game. Thus, *After Now Archeology* seems to fit the definition.

Salen and Zimmerman discussed briefly the relationship between puzzles and games. They notice that many puzzles and other borderline cases of games do not fit well into the strict definition of games. The main difference between puzzles and games is said to be the single solution of puzzles. Nevertheless, Salen and Zimmerman include all puzzles into the family of games, regardless their differences in uncertainty and variable outcomes. (Salen & Zimmerman 2004, 80-81).

Chris Crawford, in his classic book *The Art of Computer Game Design* (1984), draws a clear line between games and puzzles. In his definition games are rule based systems in which the goal is to win the game. The players and / or performances can be put in order on how well they have performed. Puzzles, on the other hand, are rule based systems, too.

They have a goal, just as games do, but the goal is to find the intended solution for the puzzle (Crawford 1984, 9). Puzzles are not emergent systems that could create surprising events from limited set of rules.

In this light *After Now Archeology* does not qualify as a game. Each puzzle has a certain solution, which needs to be found, not generated. Playing the game is more about trying to understand the mindset of the designer, trying to combine the clues and knowledge the designer has included in the game. There is no emergent or systematic way (except using brute force in some puzzles) to go through the game space, trying to overcome the designer's ideas.

Jesper Juul has collected six features that define a game:

- Fixed rules
- Variable outcome
- Valorization of outcome
- Player effort
- Player attachment to outcome
- Negotiable consequences

(Juul 2005, 36-42)

According to Juul's definition*, After Now Archeology* matches most of the features. It has fixed rules. It requires player's effort, but the player must want to solve the puzzles, thus he needs to be attached to the outcome. The outcome of solving the puzzles can be valorized – at least by other players of the game, who understand the challenges of solving the puzzles. But the outcome of the puzzles do not vary, there is only one solution to each puzzle. The negotiable consequences can be negotiated, but basically the game does not affect the world outside the game, unless the growing of player's knowledge is not count as such.

Sid Meier once said that "games are series of interesting choices" (Rollings & Morris 2000). Usually the player needs to make choices of different levels and kinds when playing a game. For example, when playing a first person shooter, the player must decide, whether to rush and attack to the enemy flag, or stay defending his team's home base. On a lower level, the player makes multiple decisions every second: should he run or stay in cover. Should he aim longer for a head shot, or try to get a lucky hit from the hip.

In *After Now Archeology* the choices are not that clear. Usually the player starts a puzzle by trying out different possible interactions: clicking buttons, dragging elements et cetera. When the player figures out some kind of idea of where to start, he makes a decision of where to go looking for information. When playing *After Now Archeology*, the decision making process is thought to happen when choosing the next potential link for information. In some puzzles there are choices the player must make, based on the information he has gathered from the extra-game content. For example, in Zodiac Bookshelf the player need to choose a correct celestial map, based on the clues the game gives him. It can be negotiated, if these choices are even real choices for the player. Since there is only a single solution to each puzzle, the player needs to make the exact choices the game's designer has wanted him to make. Thus, the gameness of *After Now Archeology* can be questioned once again.

3.2. Genre of After Now Archeology

The topic of game genres have been discussed in various sources. There is a more or less canonized genre classification, which is used widely across different services and media. The most commonly used genres are:

- Action (& Adventure)
- Adventure
- Role-playing games
- Strategy
- Simulation
- Sports
- Racing
- Puzzle
- Shooter

Puzzle games form about 14% of all game titles sold in various on-line game stores. (Kemppainen 2012).

Instead of digging deeper into the puzzle game genre (which is done more thoroughly in chapter 4), let's take a look to three different kinds of game taxonomies or classifications. These models do not rely on the commonly used game genres, but try to present different views to understanding the definitive qualities of different games.

Chris Crawford divides games into two super groups: skill-and-action games and strategy games (Crawford 1984, 21). Either of these categories includes puzzle games. That may

be because earlier Crawford declared games being different from puzzles. But if we try to apply these two categories to puzzle games, we can see that action puzzles belong to skill-and-action games, since playing them requires motoric skills and time related actions. Traditional puzzles, instead, fall to the category of strategy games. As Crawford writes, "these games emphasize cogitation rather than manipulation" (1984, 29). This is also the case with *After Now Archeology*.

Very classical game classification comes from Roger Caillois' book *Man, Play and Games* (1962). He does not divide games into categories, but rather explains four aspects that can or can not be experienced when playing games. Agôn means competition, alea means chance, mimicry stands for role playing and ilinx represents sense of altering perception. (ibid.). When applying these attributes to non-time critical puzzles and action puzzles, we can see that agôn and alea are more clearly present in action puzzles, while other kinds of puzzles may lack both or at least the element of chance. Also, role playing is almost never seen within realm of puzzles, but ilinx or vertigo may in its widest interpretation resemble the state of flow, when the sense of time and space distorts. That could happen, when the player is so immersed into the problem solving that he loses a sense of himself. Caillois' typology's relation to puzzle games can be seen as both, puzzles not being clearly games and difficulties of classic game models in explaining the variety of games.

Espen Aarseth's and others' multidimensional typology of games gives us interesting views to the nature of knowledge based puzzles. Aarseth et al. have found 13 attributes that can be used to categorize all games, although they say clearly that this list may not be complete and new attributes could be found. (Aarseth et al. 2003). In following list, the attributes are used in analyzing knowledge based puzzles, but notes are made about other kinds of puzzle games, especially action puzzles.

Perspective: Usually in puzzle games, no information is hidden from the player. Thus, they implement omni-present perspective. But in lateral thinking puzzles and knowledge based puzzles it is quite common that not all information is given to the player. Thus, their perspective can be thought as vagrant.

Topography: Very many puzzle games happen in some kind of grid or rigid structure, which means they have topological topography. Physics based puzzles and some first person perspective puzzle adventures may utilize geometrical topography. But how to

define the topography for games, which are based on information in the surrounding world? The interactive puzzles in the game usually implement topological, rigid spatial structure, but the topography of the extra-game information can not be defined in this context.

Environment: Usually puzzle games happen in static environments, which do not change during gameplay. Physics based puzzles may be an exception, since for example in *Angry Birds* (2009) the player's mission is to destroy the environment. With puzzles that rely on external information, defining the environment is again somehow complicated. Within the game's own software the environment may not change. But outside of the game's realm the sources of information may born and die, servers may be down etc. Thus, the environment can be seen as dynamic.

Pace: Action puzzles are real-time, other kinds of puzzles implement kind of turn-based systems, where the game does not advance without player's actions.

Representation: can be either arbitrary or mimetic. This depends on game's theme and audiovisual style.

Teleology: Puzzles by definition have a solution and the player can solve them for good. Thus, their teleology is finite. There are implementations of action puzzles, which have infinite mode, so their teleology naturally is infinite.

Player structure: Some action puzzles have two player modes, but generally puzzles are single player entertainment, although they can be worked on as a group activity.

Mutability: Usually there are not any kind of power ups or leveling up in puzzle games. Power ups are quite common in action puzzle games, and some action puzzles also implement permanent improvements of the game mechanics (sometimes called new skills).

Savability: Action puzzles sometimes save player progression in between the levels. In some action puzzles the game can not be saved. Traditional puzzles, like crosswords or Sudoku kind of save the game every time the player writes something down. In *After Now Archeology* the player can save the game between levels, if he wants.

Determinism: Puzzles are strongly deterministic, since there is usually only one correct solution. Once again, the situation is different with action puzzles, since they may incorporate random ordering and placement of game items.

Topological rules: The games may or may not include topology based rules.

Timebased rules: Excluding action puzzles, puzzle games usually don't include timebased rules. Action puzzles usually include them, since the games advance even without player actively plays the game. The player can also run out of time, which may lead to ending of the game session.

Objectivebased rules: Both action and non-action puzzles often have objective based rules. Player's scoring in action puzzles may depend on the way the player performed in the game. Puzzle collections like *7th Guest*, *Dr. Brain's Castle* and *After Now Archeology* block the player's advancing in the game until the player manages to solve the puzzles in some order.

It can be discussed, if *After Now Archeology* is "game enough" to point out weaknesses in the multidimensional game typology. It may be that pervasive games do not fit into Aarseth's classifications, but also the field of games has grown towards many different directions during past few years, so the typology may be outdated. On the other hand, Aarseth calls the researchers and developers to expand the typology, but also exploring the combinations of attributes that are not yet filled with games (ibid.).

3.3. Emergence and progression

When talking about systems of emergence and progression, Jesper Juul's book *Half-Real* (2005) is used here as a landmark. In Juul's definition games can be divided to games of emergence, where small rule set creates many different situations and possible solutions (ibid., 66-73), and games of progression, where the succession of playing is seen as progression of the story (ibid., 73-83). There are also many games, which share elements from both of these worlds. For example *Grand Theft Auto* –series (1997-2014), where the player can follow the progressive, narrative plot, but most of the gameplay happens in an emergent sandbox, where laws of physics and behavior of characters create surprising effects and gaming situations.

In the light of emergent and progressive gameplay, *After Now Archeology* is definitely progressive as a system. The game does not create unexpected moments of gameplay. All puzzles have only one acceptable solution and the success in playing the game is measured by the amount of solved puzzles. But even if the game is progressive as a system, it encourages the player for emergent behavior. As the focus of the design defined, the

game design has been successful, if the player starts to search for clues for the puzzles, and ends up browsing the web finding new topics, interesting sites and mind-bending realities. This is clearly emergent behavior, since the game designer has not defined where the player can and can not go when searching for information.

3.4. Magic Circle

Pushing the player out of the game wakes up a question about the magic circle of *After Now Archeology*. The origins of the term "magic circle", in the context of games come from Johan Huizinga's book *Homo Ludens* (1955). In Huizinga's book the magic circle was used among other playgrounds (e.g. card table, and arena), where the act of playing takes place. Salen and Zimmerman elaborated the idea towards the concept of cognitive frame of playing the game (2004, 95). Perron and Arsenault developed the idea even further, expanding the magic circle to magic cycles, in which the player engages the game's realm more and more deeply (Perron and Arsenault 2009).

After Now Archeology bends the definitions of magic circle as a location in space, time and virtual space. Since it strongly directs the player to go outside of the game's own virtual space, it breaks the magic circle of virtual location. The game can also be accessed in different physical locations, in arbitrary times, to there is no actual connection to a special physical space or time.

If the game works as designed, the player spends most of the playing time outside of the actual game. The puzzles will follow the player in his thoughts through the mundane work and tasks. The player will spend time every now and then browsing for information, until he finds the solution for the puzzle in hand. The question is, is the player within the magic circle of *After Now Archeology*, when he is not actively doing things in the game client? My answer is yes, in the case of *After Now Archeology* and other similar games, the magic circle is located in the player's mind, rather than anywhere in – real or virtual – time-space continuum.

This kind of passively engaging puzzles can be seen as played while doing something else. They keep the player's mind occupied to solve the puzzle, if the player just allows his mind to wander into the non-mundane thoughts about the topics the puzzle in hand includes. The situation is somewhat similar to playing a massively multiplayer role-

playing / space flying game *Eve Online* (2003), which takes place in a persistent virtual world.

Most of the playing time the player's space ship is doing something really boring, like digging ore from asteroids. This is done automatically in the game's permanent world, without active role of the player. Every now and then the player can log in (or change the focus to the game window) to see how much experience and money his character has collected while the player himself was doing something else. When the player is actively playing the game, i.e. logged into the game world and has the game client under active focus, he can plan his next actions, do some space exploring or fighting, or engage to some other actions, which require more active role in the game world.

Using the
game client

Searching
for clues

Thinking about
the answers
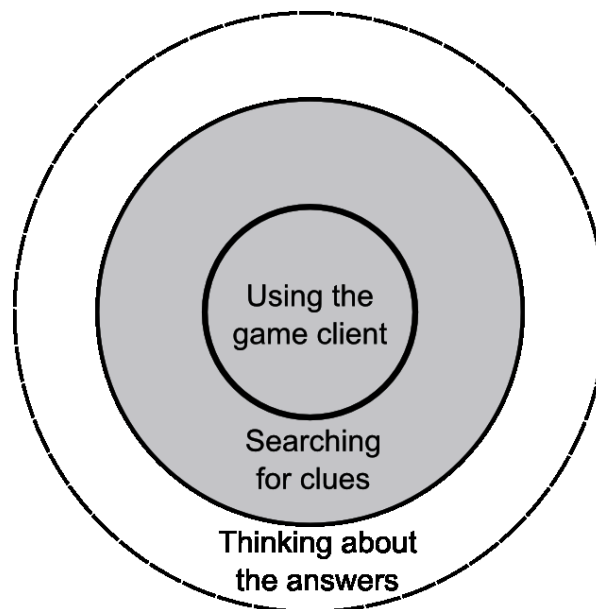
Illustration 18 Levels of engagement into the game

Comparing *to Eve Online*'s passively multi-player nature, *After Now Archeology* is more active, since the progression in the game does not come automatically without any effort from the player. Instead, the game will infiltrate the player's everyday life, capturing a bit of passive brain capacity even when not actively solving the puzzles. This is not a unique feature of *After Now Archeology*. Players tend to think about the games they are currently playing, pondering the challenges in the game or trying to invent ways to perform better in the game. It is not rare to see people watching gameplay videos of *World of Tanks* (2010) or *League of Legends* (2009) as a way of learning new gameplay tactics and tricks from them.

In this sense, *After Now Archeology* actualizes Montola's definition of pervasive games. Montola explains three ways how a game can bend the boundaries of magic circle: spatial, temporal and social expansion (Montola 2005). After Now Archeology was designed to lead the player away from the game's virtual realm, thus breaking the (virtual) spatiality and a sense of location of playing. The passive gameplay explained earlier implements the temporal expansion of the magic circle. The social aspects of the pervasive games stay untouched by *After Now Archeology*, since it does not incorporate non-players into the game.

3.5. Rules of design – broken or not?

As shown earlier, *After Now Archeology* is a borderline case of a game. It lacks quite many features that are often understood as integral parts of games. But on more practical side of game design there are certain rules and principles that need to be handled when trying to find *After Now Archeology*'s place in the field of games.

3.5.1. Rouse's practical advices

In his acknowledged book *Game Design Theory & Practice* (2005) Richard Rouse gives the reader lists of things the players want and expect in games. The wanted things are the reason why people play games. According to Rouse these reasons are:

- Challenge
- Socialization
- Dynamic solitary experiences
- Bragging rights
- Emotional experience
- Exploration
- Fantasizing
- Interaction

(Rouse 2005, 2-8)

When looking at *After Now Archeology* through these ideas, it actually looks quite promising. The challenge of the game is obvious, since it was one of the main design principles of *After Now Archeology*. Although, sometimes it seems the game has a bit too much challenge, but since there are fewer too difficult than too easy puzzle games in the world, this has to be taken as a design decision.

Solving the puzzles alone is not very social experience. But when looking at the player community activities of other similar puzzle games, there clearly is a possibility to deep social connections. The game itself does not persuade the player to socialize with other players, but pondering the puzzles with other players can help the player over some frustrating parts of the game.

Social actions are clearly connected to the bragging rights. If the player manages to solve the challenging puzzles of the game, he surely deserves the rights to brag about his achievement. But the bragging rights work only among fellow players, who can understand the value and can appreciate the player's efforts of overcoming the difficult, unnecessary obstacles. The players can also solve the puzzles together. There are many forums focused on puzzle games, where players share hints and information, but usually not pure solutions, since that would ruin the game from others.

After Now Archeology can be seen as somewhat dynamic solitary experience. The game does not support any multi-player features. Even if it is possible to solve the riddles together with other players, there is always only one player per installation to feed the answers and complete the procedures. The player interacts with the game and searches for information, which can lead to emergent behavior, although the game's mechanics per se are not very dynamic.

When thinking about the possible emotions the player can feel when playing *After Now Archeology*, the first ones are curiosity, anxiety and joy of achievement. The game is made to wake curiosity. It is designed to be a borderline too difficult to solve, thus causing anxiety and frustration. But when the player manages to solve a puzzle, he hopefully feels a lot of joy from the achievement of solving the puzzle. It is not possible to know what kind of feelings the player gets from the content and topics he finds while searching for information. In this sense *After Now Archeology* differs from many other games, which have been designed to produce certain emotions. For example in *Wing Commander* (1990) the game plays victorious music after a battle, but if the player's wingman dies in a battle, a sad funeral animation is played after the mission. It can be said these features are designed purely as emotional experiences.

After Now Archeology is a game of exploration. The information gathering process is nothing but exploration. The game itself functions as a "rabbit hole" – a gateway or

pointer that only gives the player the first steps on the way. The player has to explore the space of possible hint information to find out the important bits and pieces. After that he has to fit them together to build a key to solve the puzzle. When comparing to traditional, "self sufficient" video games, the navigable space of *After Now Archeology* is much bigger, since it is not restricted by the resources and skills of the game developer.

Although the in-game spatial navigable space of *After Now Archeology* is rather small, just 19 nodes, the space of possible solutions is vast. As Manovich wrote about the non-organized nature of hypertext space (1998), it is also very difficult to build any structure or order to the After Now Archeology's information space. This leads to a parallel with the design of immersive game worlds. As Chimelarz wrote, "immersive game worlds are indifferent to player's actions and the player needs to feel like an intruder" (2014). If *After Now Archeology*'s game world is the whole information space of possible clues and solutions, it surely is not built just for the player and thus it is indifferent. But feeling like an intruder when browsing through public web sites does not sound really believable.

It is not easy to see how a player could fantasize during playing *After Now Archeology*. The game itself does not build up large narrative or interesting virtual worlds. On the other hand, the player can find some of the puzzles and clues interesting and they can drag the player into daydreaming. For example, the books in the Zodiac Bookshelf puzzle got many players think about their memories about books where they have seen the artificial literature presented in *After Now Archeology*. One can also think that if the player "gets lost" while searching for information, he kind of falls in to a dream or fantasy world, or in some kind of meditative trance which can be seen as a state of fantasizing.

After Now Archeology is not very interactive game. There are not many different ways to affect the game world, nor are there parts that require the player to perform quickly and accurately within time limits. The interactivity part was something that was felt lacking and it was tried to improve by adding different ways to give the player the clues for the puzzles. For example, in Metromancy puzzle the hints were spread in pages that the player can drag around the screen. The dragging feature was added to give the player something more than just list of information.

Rouse's list of things the players expect from games are rather direct advices for game designers. These things are there to prevent the player from frustrating to the game, which is mentioned to be "the nemesis of all game designers". The list includes following items:

- Consistent world
- Understanding the game world's bounds
- Reasonable solutions to work
- Direction
- Accomplish a task incrementally
- Be immersed
- Some setbacks
- Fair chance
- Not need to repeat themselves
- Not get hopelessly stuck
- Do, not watch

(Rouse 2005, 8-18)

When looking at After Now Archeology with these items in the other hand, it seems the game breaks quite many of these rules. For example there are no well defined bounds in the game world, since the game happens mostly outside of the game client. The player may sometimes get hopelessly stuck, since the solutions can be difficult to figure out. This is also related to setbacks, which may occur en masse when the player tries to find clues and answers. The hint system is designed to help meeting these expectations. There are also too many puzzles, where the player can't actually do much inside the game, thus the expectation of doing instead of watching is questioned.

But there are also many qualities that meet these expectations. The game is designed to give player pointers (directions) to interesting information. They may not always be immediately clear, but the hint system provides additional directions. The puzzles can be solved one part at a time, thus meeting the expectation of incremental accomplishment. The puzzles also have different content and game mechanics, so the player usually don't need to repeat himself too much.

Some of the expectations are somehow invalid in the case of *After Now Archeology*, or they can not be determined. Since the game is based on the real world information, it is quite difficult to tell if the game world is consistent. That depends greatly on the information sources the player finds, and how he connects the clues in his mind. That is closely related to immersion, which may or may not happen when the player ponders the

questions. Since there are no random features in *After Now Archeology*, the question of fair chance is rather trivial, as it includes no such thing as failure through game mechanics.

3.5.2. Schell's elements of a good puzzle

In his book *The Art of Game Design – A Book of Lenses* (2008), Jesse Schell touches the question of designing good puzzles for games. He is not talking about designing mechanics based action puzzles, but rather about mental challenges in games.

In the chapter, Schell gives 10 principles for puzzle design:

1. Make the goal easily understood
2. Make it easy to get started
3. Give a sense of progress
4. Give a sense of solvability
5. Increase difficulty gradually
6. Parallelism lets the player rest
7. Pyramid structure extends interest
8. Hints extend interest
9. Give the answer!
10. Perceptual shifts are a double edged sword

(Schell 2008, 211-219)

When looking the design of *After Now Archeology* through these lenses, it is clear that something was done right - and something wrong. From the first test version of the first puzzle to the last plan of the last, the design exposed some clear violations of these principles.

Often the goal of the puzzles in *After Now Archeology* is not easily understood. As Schell also writes, sometimes figuring out what to do is a part of the puzzle (ibid. 211). This rule was often intentionally broken in the design phase, but after some play testing the design was sometimes changed, due to too much difficulty in the puzzle. For example the last phase of Serious Fun-puzzle was automatized and the clues of Finnish Films –puzzle were made clearer. None of the puzzles points the goals out explicitly, but usually the final step to solve the puzzle is rather clear and easy to understand.

Most of the puzzles are rather really easy to get started. This relates to the principles 5, 6 and 7. Usually there are only few things the player can do. She just needs to start exploring the navigable space from the first, intuitively possible angle and continue to different

directions from there. After a while, the puzzles start to become clearer. Since most of the puzzles have many different parts or layers, the player can do many things at the same time. This rule was intentionally broken in the beginning of the design process, but when the players tested the game, it became clear that many puzzles needed to be made simpler to start with.

Another rule intentionally broken is the rule of giving a sense of progress. There are only few puzzles (Art Mindmap and Ancient Skies as examples) that clearly tell the player when he is progressing in the game. Many of the puzzles have only one input, where the player needs to write the correct answer. In these puzzles it is difficult to tell the player how his thought processes are progressing. Often the game also does not tell about the correct answers, due to prevent brute force methods in solving. This makes it difficult to gradually solve the puzzle, since the game gives the player feedback only when the correct answer is given.

The premise of *After Now Archeology* gives the player a sense of solvability of all puzzles. But as the first test revealed, small graphical glitches or minor flaws in presentation, instructions etc. can make the puzzle feel unsolvable. For example a Chinese number in Serious Fun –puzzle resembled too much another number, making it difficult to know which one is correct. The first image of Art Mindmap was also from a wrong part of the source material, thus causing frustration with some players. In content based puzzles the correctness of the content is crucial to the solvability and playability of the game. This also relates to good user interface design and transparency, since the UI is the player's window to the game's world and after all, the difficulty of the game should depend on the game itself, not how difficult it is to use.

The core design of *After Now Archeology* aims to increase difficulty gradually. The puzzles of the game are tried to be organized in a way they are in increasing difficulty order. Also different parts within a puzzle should be in increasing difficulty. This was rather hard, since the game is based on the extra-game knowledge, and different players have very different knowledge basis. For example, if the puzzle consists of lingual part and mathematical part, there is no way to ensure that all the players feel the lingual part easier than the mathematical part.

The biggest reason to have three different paths *in After Now Archeology* is to give the player parallelism. If the player gets stuck on one path, he can continue on another path. In the very beginning the player can choose from three different puzzles. After solving one of them, he has 4 choices and after solving one of them he has at least 5 possible puzzles to continue with. The player also doesn't need to solve all the puzzles to solve the last one, although it might help.

The whole structure of *After Now Archeology* is kind of a pyramid, which is said to extend interest. There is the final puzzle, for which the player needs to solve at least 9 of the other puzzles and there are some non-mandatory puzzles, too. Many of the individual puzzles in the game consist of several parts, leading to the final answer. Building the puzzles around three different main themes can bring in players interested in different areas, leading them to explore the other areas too.

Hints were one of the cornerstones of the design. Personally I love difficult puzzles. But I hate to get stuck in them. Small hints every now and then could help the player to continue playing. Well designed hints in right places can keep the player in the flow channel without spoiling the fun of solving other parts of the puzzle by revealing too much information about them.

The only principle I strongly disagree in the case of *After Now Archeology* is giving the answer to the player after he has struggled with the puzzle for a long time. The internet will have them anyhow. The progress *in After Now Archeology* is based on solving the puzzles and if the answers were given, there is no game at all. The internet will give the answers, but that is something the game developers in general can do nothing about. It is up to the player if he wants to spoil his experience by going to some forums to look at the answers. On the other hand, quite many of the similar games have player created forums for discussion, and these forums are very nicely self-regulated. People do not want to spoil another players' game. Hints are usually quite subtle and I have not accidentally stumbled on complete answers on these forums.

Last and heavily intentionally contested principle is about perceptual shifts being double-edged sword. *After Now Archeology* is designed for a rather small and specialized audience. Puzzle game enthusiasts can be thought to be familiar with perceptual shifts, so the goal was to offer them as many shifts as possible. Figuring out a perceptual shift gives

the player a great "a-ha" moment. The first perceptual shift is to leave the actual game and go searching for information somewhere else. Many of the puzzles in the game also require the player to "think outside of the box" in order to be solved.

As a conclusion, *After Now Archeology* follows the puzzle design principles of Schell rather well. Some of the principles were broken constantly, but intentionally. This was sometimes due to prevent the use of brute force methods in solving, but also because the small subgenre of challenging puzzles has already constructed some conventions for the games. Although, sometimes the design was changed due to the test players' feedback.

3.6. Game of Learning

One of the big and interesting questions during the design of *After Now Archeology* was "how to motivate the player to learn new things?" This is a central question of all educational games and applications. Personally it usually seems that the makers of educational applications are too interested in pushing their content and message in "front line" and leaving the interesting qualities of games in behind. Thus, a lot of earlier "edutainment" is not as motivating and fun as it could be (e.g. Bogost 2012, 242; Klopfer and Purushotma 2012). Adding a bad game on a subject does not make the subject more interesting or easier to learn. But adding some educational substance into a good game can make the player interested in the subject and possibly get her to search for more information herself.

Raph Koster handles the question of playing games as process of learning in his book *Theory of Fun* (2005). He says that if the player is interested in the game so much she wants to get better and better in playing it, she is actually studying the game and trying to learn its inner functionality. This was one of the principles in mind, when starting designing *After Now Archeology*. The idea of playing a game as a learning experience relates closely to the concept of knowledge based puzzles.

If playing of knowledge based puzzle is compared to, for example playing a first-person shooter, elements of learning can be found in both games. For example Kearney (2006) explains the developed cognitive skills of the players of first-person shooters. But when the player of first-person shooter gets better in the game – beside of the development of the cognitive skills – by learning the gameplay mechanics and in-game strategies, the player of knowledge based puzzle is not getting better in playing the game, but he is

learning hopefully interesting things about the world itself. It can be argued that searching for information is important skill in playing knowledge based puzzles, thus the player gets better when learning new strategies for searching information.

Even though trying to motivate the players to learn new things by solving the puzzles was set as the main research question in this project, it remained unclear if the game managed to do it. The group of test players were enthusiastic to play the game and solve the puzzles, so they were already motivated to research new things. The players had also played a lot of similar games earlier, so they already knew quite a lot about the information research techniques required to find the answers.

After Now Archeology proved to be too challenging and on the level of topics, too specialized to interest larger audiences. Players who had no previous experience on playing content based puzzles – not to mention knowledge based ones – dropped out of the game rather quickly. Thus, the game's ability to motivate people to learn can be questioned. This may be an example of boring subject with dull gameplay flavor.

4.   Knowledge based puzzle

When the design of After Now Archeology started, there was no thought about the special genre of the game. During the theoretical research and comparing the game to other games and puzzles, an idea of a genre definition for games such as *After Now Archeology* started to take a form. In this chapter we try to understand the essence of the genre of knowledge based puzzles. To do this, we take a look at different kinds of puzzles, riddles and also games incorporating different puzzle content or mechanics. From this research we continue to qualities of knowledge based puzzles that are essential to the concept. In the end we summarize the aspect and formalize the definition of knowledge based puzzles.

4.1.   Many types of puzzles

Puzzles and riddles have been around for thousands of years. There have been a lot of books, movies and other media, where puzzles play an important part. One of the earliest known puzzling riddles is the Sphinx of Thebes' classic question: "what walks on four legs in the morning, two legs during daytime and three legs in the evening". Now days, crosswords and sudokus are very commonly played forms of puzzles. In the area of digital games, puzzles have gained a very special form of time critical action puzzles. Puzzles are also integral part of modern adventure or action adventure games.

The puzzle categories presented here are not commensurate or explicit. They do overlap, since their classification is based on different attributes. Many traditional puzzles are game mechanics based puzzles, and many of the augmented reality games are based on external information or game's internal realm. The variety of puzzle types is vast, but it resembles the variety of game genres as discussed in (Kemppainen, 2012). In fact, the different types of puzzles mentioned here can be used when researching the sub-genres of puzzle games.

4.1.1. Previous puzzle discussions

In this chapter different classifications and sub-genres of puzzles are studied. This is done to build a basis for the genre discussion of *After Now Archeology*. The hypothesis for the discussion was that the genres and classifications of puzzles and riddles do not fit very well for knowledge based puzzles.

Matthew Costello writes that the wonder of mysterious things is more than just human invention. There are puzzling phenomena all around us, from mysterious monster of Loch Ness to a hoax fresco in a medieval German church. (Costello 1988, 101-105).

Before digital games, the puzzles were usually not time critical. Invention of computer technology brought the action into the puzzle genre. Computers are able to move pieces, generate randomness very quickly and also track time while the player was trying to solve the puzzles.

Wikipedia

As a widely used reference, Wikipedia's take on puzzles needs to be handled. The definition of puzzle in Wikipedia is: "A puzzle is a game or problem which tests the ingenuity of a would-be solver. In a puzzle, one is required to put pieces together, in a logical way, in order to arrive at the correct solution of the puzzle." (Wikipedia 2014a)

Wikipedia lists several kinds of puzzles, ranging from very wide "lateral thinking puzzles" to extremely specific "sokoban". (Wikipedia 2014a). This exposes the variety of different puzzles, which also directly links to the difficulty of defining the overall meaning of puzzles. This article's list of puzzles includes only rather traditional puzzles, that are not time-sensitive, and they all can be implemented without aid of computers.

Many of the puzzle types listed in Wikipedia have own articles for their sub-types, for example computer puzzle games. Short listing of the computer puzzle types includes action puzzles, hidden object games, reveal the picture games, physics games, tile-matching and traditional puzzles (Wikipedia 2014b). This kind of listing reflects the game types that are popular during the writing of the article, thus can not be understood as exclusive categorization of digital puzzle games.

Notable thing in Wikipedia's view to puzzle categories is that only puzzles of lateral thinking can be seen including elements of extra-game world. As an example of lateral thinking puzzles, Wikipedia tells a story about a man going to a bar, asking for a glass of water. The bartender pulls out a gun and points the customer with it. The customer thanks the bartender and leaves the bar. Answer to the puzzle lies in the assumption that the man wants water because he has hiccups, but the bartender manages to cure the hiccups by frightening the customer. (Wikipedia 2014c). To be able to solve the puzzle, the reader must know the traditional ways of curing a hiccups.

It is also interesting that the collectible card game *Perplex City* (2005-2007)*,* which includes many extra-game information based puzzles, is actually presented as an augmented reality game. The description of the game explains the basic principles of the puzzle cards in the game, but it lacks handling of the topic of extra-game information. (Wikipedia 2013). This is another example of the need for knowledge based puzzle definition or explanation.

Allgame

Allgame is a digital games information database. It collects information about digital games, including descriptions, screenshots, hardware platforms, developers and publishers. It has built a two-tier game genre system, where, for example main genre of puzzle games is divided to subgenres of action puzzles, adventure puzzles and maze puzzles.

Allgame defines puzzle games as follows:" Puzzle games require the player to use both skills and smarts to solve problems. They are often played using colored shapes or other simple on-screen objects, with a goal of piecing together patterns to clear the field and advance to the next stage. While many puzzle games feature cute characters or fantasy settings, such particulars are seldom crucial to the actual gameplay." (Allgame 2014a).

As a digital game database, Allgame's definition is based on the selection of digital puzzle games. The requirement of using both, skills and smarts excludes many of the traditional types of puzzles. In fact, Allgame categorizes *7th Guest* as a first-person adventure game (Allgame 2014b). This categorization seems to be based on the game aesthetics rather than types of challenges or gameplay, since *7th Guest* is completely based on non-time critical solving of different kinds of puzzles.

Allgame's view to what is puzzle and what is not also resembles opinions of many game developers and players, with whom the definition of puzzles and essence of *After Now Archeology* have been discussed with. The timing related action puzzle genre of digital games have been so overwhelming, that players of digital games don't often even think about the traditional types of puzzles.

Puzzle Instinct

Marcel Danesi has listed several types of traditional puzzles in his book *The Puzzle Instinct* (2002). He places the puzzles under five categories:

- Language
- Pictures
- Logic
- Numbers
- Games

These categories are further split to many subcategories, which build a comprehensive picture of the variety of traditional puzzles. First four categories consist of puzzles in the sense of single solution, non-surprising way that e.g. Crawford (1984) also spoke of (see chapter 4.2). They are divided to subcategories, like riddles (language), mazes (pictures), paradoxes (logic) and magic squares (numbers). Selection of different categories is rather exemplary than exclusive.

Interestingly, the last category is about games like chess, checkers and go. Here Danesi breaks the typical classification of puzzles and games. These games clearly have some logic-puzzle-like qualities, but the competitive nature and uncertain outcome is something that differentiates them from "actual puzzles". They also have "interesting choices" – something the player can do that can change the whole outcome of the game. This is something that the puzzles in very strict mind lack.

Amusements in Mathematics

H.E. Dudeney was an acknowledged inventor of various mathematical and logical puzzles. In his book *Amusements in Mathematics* (1917) he divided the puzzles in following groups (which were divided to several subgroups):

- Arithmetical and Algebraical Problems
- Geometrical problems
- Points and lines problems
- Moving counter problems
- Unicursal and route problems
- Combination and group problems
- Chessboard problems
- Measuring, weighing and packing puzzles
- Crossing river puzzles
- Problems concerning games
- Puzzle games
- Magic square problems
- Mazes and how to thread them
- The Paradox Party
- Unclassified problems

Since the book is about "amusements in mathematics", the list does not contain word puzzles or riddles requiring lateral thinking. The Paradox Party chapter includes some challenges that may not even have correct answers, thus they are called paradoxes. Still, they are built on logic, not on linguistics or external information. All of the puzzles in the book are also "self sufficient", meaning that they can be solved using only information gained from the puzzle setting.

The puzzles of Dudeney belong into Danesi's logic and number puzzle categories. The combination of these classifications shows the versatility of puzzles. Each of the Danesi's categories could be divided to multiple sub-categories, which can sometimes divide to other sub-categories. Notable thing in Danesi's and Dudeney's puzzle categories is that the puzzles are self-sufficient. None of the categories include puzzles or riddles derived from the extra-game information.

What is interesting, in some cases Dudeney's categories are rather strict (e.g. river crossing problems) while others are very generic (e.g. geometrical problems). This may reflect the "hot topics of the day", when he was writing the book, meaning that the most fashionable and popular types of puzzles gain more visibility, thus rising on the same level of importance with more sustainable and generic categories. This seems to be analogical to the problematic game genre listing of Wolf (2002).

4.1.2. Riddles

When researching the area of puzzles, a question about the border between riddles and puzzles occurred repeatedly. Especially when talking with gaming people about *After Now Archeology*, they often didn't think the challenges in the game as puzzles, but rather some kind of riddles with interaction mechanics. This reflects the relationship between digital puzzle game genre and puzzles in more traditional sense.

Danesi classified riddles as a part of linguistic puzzles. He uses many examples of riddles when discussing the nature of linguistic riddles. Interestingly, many of the riddles seem to include an element of lateral thinking. For example, following riddle requires the solver to know something more than is told in the riddle: "What we caught, we threw away. What we could not catch, we kept." (Danesi 2002, 38). In this mind *After Now Archeology* can be seen as a riddle, requiring the player to use lateral thinking to solve the puzzles.

Paradoxes are a special category of riddles. They are logic or mathematics puzzles that do not necessarily have a clear answer. Usually they are presented in linguistic methods. Finding the answer to a paradox – if it has one – usually depends on finding the flaw in the question setting. For example, in Zeno's "Achilles and the Tortoise" paradox the reader is lead to think about the geometrically converging series of distances between Achilles and tortoise, but deceived to forget the distance as a function of time, which also converges geometrically. But in the real world (based on basic Newtonian physics) the time advances linearly. (Poundstone 1988).

4.1.3. Game mechanics based puzzles

Game mechanics based puzzles rely usually on mathematical-logical skills of the player. These puzzles do not require any extra-game knowledge, beside normal understanding of reading and counting. Solving these puzzles often require the player to move game pieces in a certain order, connecting different objects to each others, or using some logical deduction mechanics to find out the correct answer. Solving of many of the puzzles in Danesi's and Dudeney's collections rely on using some kind of patterns of actions (i.e. game mechanics).

There are plenty of digital games that are based on collections of mechanics based puzzles. Especially two pioneers of the CD-ROM era, *7th Guest* and *Myst* were built on the idea. Both games included many small games that are based on game mechanics, which were sometimes re-mediations of traditional puzzles (e.g. eight queens chess puzzle), but usually designed just for the game. The puzzles had some meaning in the game world and narrative, but under the thin layer of theming they were rather disconnected from the story.

Story wise these kinds of games are difficult. There is no reason in the real world to have doors or other passages locked with logic based puzzles, or machines that require the user to perform extensive amount of switch flipping, button pushing or other unrelated activities. Thus, these games often tell stories about strange, distant cultures (*Myst*-series) or mad scientists (*7th Guest*, *Dr. Brain's Castle*), whose intention is to put the player's character to a test before he can reach the ultimate redemption or other kind of victory.

4.1.4. Action puzzles

Action puzzles are games that combine puzzle mechanics with time critical actions. In these games the game progresses automatically even when the player is not interacting

with it. The player's mission is to solve the puzzle parts within given time limits. The pace of these games is usually increasing, building up the player's stress and making surviving more and more difficult.

Action puzzles are a subset of game mechanics based puzzles. They are usually based around rather short and simple gameplay loop, which is repeated over and over again. There usually is just one main mechanics, like swapping the places of adjacent pieces on the game board. Sometimes the games include some advanced mechanics, which are handled as special cases or bonuses of gameplay (e.g. special candies in *Candy Crush Saga* (2012)).

The significant feature of action puzzles is that the player does not have unlimited amount of time to think his moves. For example, in the classic tilting maze game the player need to time his actions properly to prevent the ball from falling through the holes in the maze floor. Thus, the basic gameplay is kept very simple, and the engagement and rewarding of the player comes from getting better scores or advancing to more challenging levels by learning to make quicker decisions and figuring out different ways to build compos and gather more points.

Very classical example of action puzzles is *Tetris*. In *Tetris* differently shaped game pieces fall down from the top of the screen. The player needs to rotate the pieces and move them horizontally to positions, where they form horizontal lines with previous pieces. On the easiest level the piece takes some 10 seconds to fall from top to bottom. When the player progresses, the speed increases and on the level 10 it takes about a second or two for a piece to fall all the way down. The player needs to make quick decisions if he wants to succeed in the game. (Rouse 2005, 142-144)

When talking with game industry professionals about *After Now Archeology*, and mentioning it being a puzzle game, people almost always thought about action puzzle games. It seems the action puzzles have become a synonym of puzzle games within the gaming culture. They are also one of the most common genres of games designed for casual audience. (See Kuittinen et al. 2007 for definitions of casual games and casual game audience.)

4.1.5. Embedded puzzles

Many games have puzzles as a subset or mini games beside or within the main gameplay. Majority of action adventures have some small puzzle-like elements, where the player must for example figure out how to get to new places, open doors etc. Embedded puzzles are in very minor role in these games, which usually focus on fighting, exploring or other action. These puzzles are usually quite easy to solve and function more as small resting times between more hectic fighting.

Nisil (2013) has analyzed the embedded puzzles in various games and compiled a list of different puzzle categories in

- Exploration
    - Locks & Keys
    - Procedural generation
    - Experimentation
    - Fake Walls & Invisible Portals
    - Easter Eggs & Secret Areas
    - Alternate paths
- Action
    - Timing
    - Aiming
    - Cooperative play
- Puzzles
    - Pattern recognition
    - Physics
    - Inputs
    - Light & Shadow
    - Environmental effects
    - Rhythm
    - Dimensions
    - Gravity
    - Magnetic fields
    - Tweaking time
    - Setting
    - Other genres
    - Cooperative play
    - Timing & Aiming

When analyzing *After Now Archeology* with these types of embedded puzzles, it can be seen they do not have that much in common. There are some parts, which require e.g. pattern matching, but mostly the challenges in the game do not include the elements Nisil discusses. In narrative sense the puzzles in *After Now Archeology* can be seen as locked doors, since they block the player's advancing in the game. If so, the key to open the locks is formed as utilizing the extra-game information to solve the puzzle.

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The Riddler quests in *Batman: Arkham Asylum* (2009) and *Batman: Arkham City* (2011) are good examples of embedded puzzles. Especially in *Arkham City* the puzzles can be really difficult. They are mostly based on excelling in timing and aiming or other gameplay mechanics, giving the player an ultimate challenge of using Batman's skills and devices. Solving the puzzles is also required to open some of the side quests in the game, so if the player wants to experience all of the stories, he needs to collect 400 of 440 green question marks the Riddler has spread in the world. Additionally the player needs to figure out dozens of cryptic messages and what game world elements they are related to.

Assassin's Creed II and *Brotherhood* (2010) had specific puzzle scenes that were not embedded into the regular game world. When a player found a "Subject 16 glyph", he entered a completely separate puzzle sequence. These puzzles were game mechanics based, but the content and audiovisual material was taken from the real world and then adjusted to fit the game's narrative. The game presented different renaissance paintings, photographs from the cold war era and other material that was used to build the alternative history line for the game's storyline.

Interestingly the puzzles also included some extra elements embedded in the pictures. Many of the images and scenes contained Morse codes, musical notes and other markings that had nothing to do with solving the actual puzzle. This way the games built another meta-level of puzzle solving on top of the two in-game levels.

As a last example of embedded puzzles, the puzzles in *Fez* earn their special treatment. The game has many embedded puzzles that can be solved with just the information the game provides. But there are some puzzles that require the player to not only go outside the game's box to search for information, but to take screenshots of the game and use external tools to solve the codes embedded in the pictures. This information is used in the game to proceed. *Fez* creates a mandatory loop that brings the player first out of the game world and then back in.

4.1.6. Adventure games as puzzles

In so called point-and-click adventure games the player must figure out what he needs to do to proceed in the game's story. These games are rarely restricted in time or require the player to act quickly, except in some special situations where the player needs to, for example, react to a potential threat or play a mini game. They are more about the player trying to guess what the designer wanted him to do. The puzzles usually have only one

correct solution, which quite often is not too logical when compared to the ways we operate in our everyday lives. These qualities match exactly to Crawford's qualities of puzzles (Crawford 1984, 11).

The puzzles in these games are embedded into the game's story. They are often based on some humorous or illogical, thus funny, solutions to simple problems. Many times these puzzles require the player to examine, manipulate and combine different objects in the game world. In modern games the player usually can not make fatal mistakes leading to dead ends, but in the early days it was not rare that the game required the player to do some obscure thing in the very beginning of the game, that only had consequences in the very end. In that time the games didn't give the player too many hints, so the player could easily miss some important items or tasks, putting the whole playing process in vain since the game became impassable.

4.1.7. Content based puzzles

Content based puzzles rely on the information content of the games. They require the player to either guess the answers or gather information from the puzzle itself or elsewhere if he wants to progress in the game. This is the superset of the knowledge based puzzles. The difference between content and knowledge based puzzles is that the content based puzzles can provide the necessary information within the game itself, while knowledge based puzzles can require the player to utilize information external to the game.

Carmen Sandiego games are examples of content based puzzles. In these games the player needs to track different criminals all around the world. The game hints about the criminal or her location in a cryptic way. For example, the player can be given the colors of a flag of the country where the criminal is. The player needs to figure out, which of the given countries is correct. *Carmen Sandiego* games do not require the player to go explore outside of the game, but the player definitely benefits from some external knowledge.

Content based puzzles are often deduction problems. The player has a limited and well defined solution space, in which he must rule out the impossible answers to finally find the correct one. For example, in the popular board game *Cluedo* (1949)*,* the players need to rule out suspects, places and weapons that have not been used in a murder. This is also the structure of detective stories. When Sherlock Holmes enters a crime scene, he first thinks everyone as possible murderers. But by collecting clues he can get closer and closer

to the murderer, which usually is someone we readers as non-detectives could not guess in the beginning.

Timehunt and *Torment* were games that required the player to go explore outside of the game. Both games presented the player some pointers to external knowledge. For example, a song in *Timehunt* had an embedded Morse code, which was the solution to the puzzle. Someone might know the Morse alphabets already, but it still is knowledge derived from outside of the game. Another example from *Timehunt* includes a slightly misprinted excerpt from a well-known classic piece of literature. It was virtually impossible for the player to figure out the misprinted parts without finding the original text. The typos in the text formed the solution to the puzzle.

The classic puzzle of getting a goat, wolf and a cabbage is both logical, but also content or knowledge based puzzle. The problem itself is logical, but the player also need to know the relationships between the three game pieces: if left alone, the wolf eats the goat and the goat eats the cabbage. The puzzle setting can provide this information, thus the game becomes content based. But if the information is not given, the puzzle requires the player to understand the food chain functionality between the puzzle elements.

4.1.8. Trivia games

Trivia games are special games of knowledge based puzzles. In typical trivia game (like *Trivial Pursuit* (1982) or *Buzz!* (2005)) the players are given a question of a specific area. Sometimes the player is also given a few options for the answer, but usually the player needs to give the complete answer without any hints. These games are often multi-player games and they usually have some kind of time constraint to prevent players from cheating and to put them under a bigger pressure.

Trivia games and knowledge based puzzles share the use of extra-game knowledge as a part of the gameplay. The difference between trivia games and knowledge based puzzles is that in trivia games the information is the answer, while in knowledge based puzzles it is a tool to solve the puzzle. For example, knowing that geomancy is an African divination method may be enough for trivia games, but in knowledge based puzzle the player needs to use some aspect of geomancy to find the answer to the puzzle.

4.1.9. Augmented and alternate reality puzzles

There is a small sub-category of puzzle games, which expand outside of the computer or other media. These games are built as multimodal, more immersive experiences, which sometimes blur the border between the real world and the game realm. There is a certain distinction between games that are spread around in different media, but include only material the game designers have created, and games that utilize material that already exist in the real world. Augmented or alternate reality puzzles play an important role in the design and essence of *After Now Archeology*.

Montola, Stenroos and Waern discussed the question of augmented reality, or pervasive games in their book *Pervasive Games. Theory and Design. Experiences on the Boundary Between Life and Play* (2009). They define pervasive games as having "one or more salient features that expand the contractual magic circle of play spatially, temporally, or socially". Referring directly to Johan Huizinga's concept of magic circle, which kind of surrounds the players when they agree to follow the rules of the game and enter the realm of the game (Huizinga 1938).

In Memoriam (2003) is otherwise rather normal computer game, but its way to expand outside of the actual game and CD-ROM media makes it different and interesting. The game is sold on a CD-ROM, which includes all the story events, movies and the actual game program. But when the player starts to play, he needs to register himself to the game's server. When the player works to solve the strange crime in the game, he needs to go to the internet to search for more information. The game does not utilize real world data, but there are several different websites and other services built just for the game. The game can also send real e-mail to the player's own address (the game story tells them coming from other researchers).

Another good examples of augmented reality games with puzzles are Nokia's *Nokia Game* (1999-2005) and *Conspiracy for Good* (2010). The Nokia Games were multi-modal game events organized in a certain point of time. The games contained a web site with multiple mini games, where the actual action and puzzle solving happened. But in addition to that the games could make phone calls to the players giving hints for the next game events, show television commercials about the story and otherwise surround the player into the game world for the whole event time.

Conspiracy for Good was also Nokia sponsored event, where the players started playing on internet, but soon the story pulled the players outside on the streets to search for clues. The game ended in a big event and a party in London, where all the major players were invited. This game was structurally closer to traditional adventure games than earlier *Nokia Games*, since the gameplay and story was more focused on solving the one big question rather than performing on smaller mini events.

Makers of *Portal 2* (2011) took an interesting experiment in guerilla marketing when they hid hints of their upcoming game into an update of the first *Portal* (2007) game. They hid clues and secret messages into radio transmissions of the patch. When the players found out something had changed, they quickly started working together to solve the mystery. People were hacking audio files to find out codes and images. The clues included in the patch directed the players to use old telephone modem system to call to a phone number, from where they could download ASCII art images and information about the upcoming game. (Foster 2013). The Portal puzzle is a great mix of Easter egg and some kind of augmented reality or -virtuality experience.

The secret messages and codes of Portal resemble the Cicada 3301 puzzles. These puzzles are organized by an unknown instance and they rely heavily on cryptography, data security and steganography. Since 2012, once a year a series of puzzles is revealed on some popular message service, like 4chan or Twitter. The puzzle clues usually include many similar topics with *After Now Archeology*, like Mayan numerology and art of William Blake. They also spread outside of internet, as posters with QR-codes and references to ancient materials. The final meaning of the puzzles has remained mystery for the public, since no end result of information of the inventor has been revealed. (e.g. Wikipedia 2014d; Bell 2013).

The curious case of Easter eggs in *Trials*-games requires one more shot. In the Finnish video game magazine Pelaaja, the creative director of Red Lynx studio, Antti Ilvessuo, reveals his long term puzzle project, which starts from the *Trials*-games. Beside of hiding clues and hints in his studio's games, Ilvessuo had hidden hints and keys for the final goal in different locations all over the world. The last part of the puzzle will be available, not sooner than in year 2113, when a box which can be opened by one of the hidden keys will be delivered to the base of Eiffel tower (Pyykkönen 2013).

4.2. Single solution

As Crawford pointed out, puzzles have a single solution that the player, or the solver tries to find out. Solving the puzzle means that the solution for the problem in the puzzle is found and there are no more answers to be found, or no more logical or mechanical actions to be made. If the puzzle has a single solution, it means there is only one possible ending condition. (Crawford 1984, 11).

When comparing the solving of a puzzle to playing another type of game (e.g. action-adventure or strategy) "through", a couple of differences emerge. For example, one can play an action-adventure, like *Tomb Raider* (2013) through in story mode, but the game can still be considered completed only 50%. There are many hidden secrets and side missions which are not required for completing the main storyline, but can be count as important parts of the whole game. The player can also continue playing the game even after all the secrets have been found or all the enemies are destroyed. For example, *Civilization V* (2010) is famous for its "One more turn"-button in the winning/losing screen.

Having only designer determined amount of solutions is also the case with knowledge based puzzle games. There can be several ways to approach the solution, for example in *After Now Archeology*'s Metromancy-puzzle the player can start solving the puzzle by:

- Searching for the metro stations mentioned in the cards

- Ordering the cards based on the Morse code numbers on the cards

- Searching for information about the geomantic figures named on one card.

Quite many logic and game mechanics based puzzles can be solved in various ways. They are not straight rails that the player must follow, but they give the player an opportunity to try out and test different strategies. What is fixed, when talking about the strict definition of puzzles, is the single possible outcome (or some, if so designed). There is nothing to negotiate if the puzzle is solved or not.

This is not the case with the "action-puzzle"-games, which seem to represent the most of the digital games of puzzle-genre (Allgame 2014c). In these games there is not just single solution. They usually continue, until the player either runs out of time, or fails to solve the time-critical, repetitive, mechanics based puzzle the game is built around. For example, in *Tetris* the player repeats the learned patterns of best moves she knows until

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she fails to build full horizontal lines and the construction reaches the top of the screen. This kind of action-puzzle solving is more "busywork" than "mental work" (McGonigal 2011, 30), since when the mechanics are learned, playing the game can become almost automatic, trance-like state, instead of constant new challenges for the brain.

4.3. Scoring

Giving a score for solving a knowledge based puzzle is a difficult or even obsolete task. It is possible to measure the time used to solve the puzzle, the amount of wrong answers or in some cases the amount of hints used to solve the puzzle. Quite often this is pointless, since the game is not about how fast or well the player can solve the puzzle, it is more about the trip the player must take to solve the puzzle – just like in old saying of the trip being more important than the goal. There is no player score in *After Now Archeology*, *Timehunt*, *The First Door* or *Torment*, while in action puzzle games the score is often the main goal of the game.

Knowledge based puzzles are more of progression than emergence (see Juul 2005, 67-92). Thus, the player's success in the game can be evaluated by the amount of puzzles or puzzle elements he manages to solve. This can tell us the percentage of the game the player has solved. This is different from the puzzle games of emergence, which do not have a clear solution and can continue as long as the player manages to keep on with the emerging puzzles.

4.4. Replay value

Since knowledge based puzzles are based on finding the single solution to the puzzle, they bear none or little of replay value. Unlike in logic puzzles or especially action puzzles, randomization of the initial setting brings not much difference to solving a knowledge based puzzle. Repetitive or laborious work of actually solving the puzzle is not the core essence of knowledge based puzzles. Finding the tools for solution is the fun and important part of the game. After the first play through, the player already has the tools and all there is left is just the dull labor of using the learnt tools.

Somehow, there still can be some kind of re-playability value also in knowledge based puzzles. After time has passed, the player could want to re-live the moments she went through when solving the puzzles for the first time. This bears an analogy with playing

an adventure game again, just for the story or for the jokes, or reading a book to refresh the memories about the story. This is not a case of improving the performance, it is rather a case of going back to the game and – hopefully in the case of *After now Archeology* – getting back to the pointers the game offers the player, so she can re-find the unnecessary information and interesting sources of knowledge the game points out.

4.5. Player group

Every gamer has his or her own favorite games and genres, and each game has a certain target group of players. Different gameplay features attract different players. This does not mean that players of strategy games don't play shooters, or puzzle fans couldn't play sports games. *After Now Archeology* was designed for people who are willing to spend a lot of time researching new things and trying to match different topics together. The game is not made for people wanting to engage in fast paced action, which require fast responses and accurate motoric controlling.

Richard Bartle's four player types of multi-user dungeon (MUD) players is rather widely used when designing games. Even though Bartle's model is based on player behavior in multi-user environment, it can be applied to other types of games too. Bartle divides players to four groups: killers, achievers, explorers and socializer. Socializers and killers are more interested in inter-player acting. Achievers and explorers focus more on interacting with the game itself. (Bartle 1996).

Bart Steward combined Bartle's player types with other psychological personality types and game models from various sources. In his unified gamer model Steward derives player motivations, problem solving and overall goals form these models. Interestingly, knowledge, or logical rule-discovery is mentioned as one of the motivations. (Steward 2011).

Keirsey	Bartle	Caillois	Lazzaro	GNS+	MDA+	Handy	Gallup	Covey	Motivation	Problem-Solving	Overall Goal
Artisan (tactical)	Killer [Manipulator]	ilinx	serious fun	[Experientialist]	[Kinetics]	Power	Impacting	Power	Power (manipulative sensation)	Performance	Do
Guardian (logistical)	Achiever	agôn	hard fun ("fiero")	Gamist	Mechanics	Role	Striving	Security	Security (competitive accumulation)	Persistence	Have
Rational (strategic)	Explorer	mimesis	easy fun	Simulationist	Dynamics	Task	Thinking	Wisdom	Knowledge (logical rule-discovery)	Perception	Know
Idealist (diplomatic)	Socializer	alea	people fun	Narrativist	Aesthetics	People	Relating	Guidance	Identity (emotional relationships)	Persuasion	Become

Illustration 19 Different personality and gamer types mapped in Steward's unified gamer model.

When looking at *After Now Archeology* through this model, we can say, that the game is very strongly aimed for people of the third row. The whole game is about searching for knowledge and understanding (Keirsey's rational strategic, Gallup's thinking and Covey's wisdom). It is strongly focused on the task in hand (Handy), rather than interacting with people or showing one's power. Information seeking is an act of exploring, but also interacting with the world instead of acting on players (killer) or acting on world (achiever).

Some of the models do not seem to offer perfect matches for *After Now Archeology*. Caillois' mimesis means not only role-playing or acting (as in theatre play), but also simulating or constructing secondary realities. Lazzaro describes "easy fun" as immersion seeking, which feels difficult to match with After Now Archeology. Simulationist of GNS+ (gamist / narrativist / simulationist / [experientalist]) and dynamics of MDA+ (mechanics / dynamics / aesthetics / [kinetics]) are not exact matches, too, but the models do not offer better alternatives to describe *After Now Archeology*. This implies that the unified gamer model does not yet describe all possible game audiences.

Steward also suggests how to use the unified model when designing new games. As *After Now Archeology* seems to be a game for rational / explorer / simulationists of unified model, he suggests that the best gameplay features to associate with these players are: puzzles, creative building, world-lore, systems analysis, theorizing, surprise. *After Now Archeology* is designed to include all of these, except creative building. This does not mean that other kinds of players couldn't enjoy solving *After Now Archeology*'s puzzles. It only means the game is designed with certain players in mind, filling the wants and needs of those players.

4.6. Having fun motivates players

As voluntary activity, playing a game or solving a puzzle needs to be somehow fun or interesting to the player. Pierre-Alexandre Garneau has listed fourteen forms of fun that he has been able to distinct within games. Those forms are:

- Beauty
- Immersion
- Intellectual Problem Solving
- Competition
- Social Interaction
- Comedy
- Thrill of Danger
- Physical Activity
- Love
- Creation
- Power
- Discovery
- Advancement and Completion
- Application of an Ability

(Garneau 2001).

Hunicke et al have also discussed on what makes games fun. They collected eight types of game "aesthetics", that can create the feeling of having fun:

- Sensation
- Fantasy
- Narrative
- Challenge
- Fellowship
- Discovery
- Expression
- Submission

(Hunicke et al 2004).

As can be seen, Garneau's list also includes all elements of Hunicke's research, only with a bit different names. When searching for these qualities in *After Now Archeology*, it can be seen that there are three forms of fun that are easily applicable: intellectual problem solving, discovery and advancement and completion. More questionable matches could be found with immersion and social interaction, although social interaction does not happen within the game, but possibly between the players in forums and social media.

Applying immersion to knowledge based puzzles does not mean the commonly understood spatial or narrative immersion, where the player can feel like "being there". Instead, according to Adams, the immersion is more of strategic kind. When the player concentrates to a mental challenge very deeply, he can be said to be strategically immersed (Adams 2004). This corresponds to Björk and Holopainen's cognitive immersion pattern, where the player is involved in abstract reasoning and which is usually achieved by complex problem solving (Björk & Holopainen 2005, 206).

The mental challenges puzzles and riddles offer us can be compared to the physical challenges of sports. Achieving something difficult - solving a puzzle or climbing a mountain - can be really rewarding. Michael Kubovy (1999) handled the pleasures of humankind, starting from the pleasures of body and building on top of that a basis for theory of pleasures of mind. He does not go very deep into taxonomy of pleasures of mind, but he handles the topics of curiosity and virtuosity (ibid.). The relationship between these two forms of pleasure resembles the relationship between action puzzles and knowledge based puzzles. When playing action puzzle games teaches the player to play them better, by understanding the tactics and strategies and developing motoric skills, the player can start feeling virtuosity. Knowledge based puzzles rely on player's curiosity. If the player does not want to search for new information, he can not get pleasure from playing that kind of games.

4.7. Definition of the knowledge based puzzle

In this text, for puzzle being knowledge based means that the solutions for the puzzle require using some kind of extra-game information as a key to solve the puzzle. The puzzles can not be easily solved by trial-error, or brute force methods, since the amount of possible answers is way too big. There is a certain difference to e.g. logic and action puzzles, which rely on applying certain gameplay patterns. Being knowledge based does not exclude using repetitive logical patterns as game mechanics, but the requirement of using information outside of the game world as a gameplay component, drives the game mechanics more towards information rich than process intensive nature.

In this text other types of puzzles are called as "self sufficient", since they provide the player all necessary information for playing the game or solving the puzzle. Knowledge based puzzles rely on extra-game information. This information is used as a tool to solve the puzzle, unlike in trivia games, where the information is the answer. If the puzzle relies

on narrative or informative content which is provided by the game itself – being "self sufficient" – the puzzle is called as content based. Knowledge based puzzles are a subset of content based puzzles.

Drawing gameplay components from outside of the game's realm resembles puzzles that are based on lateral thinking. But where puzzles of lateral thinking often rely on common logic and knowledge, knowledge based puzzles may require using of knowledge that is not commonly known, and may even require the player to learn and understand new skills, like Morse code or Chinese alphabet. Using of lateral thinking also ties the knowledge based puzzles closely to traditional riddles, but where riddles are usually verbal and use the extra-game knowledge as an answer, knowledge based puzzles can be interactive audiovisual presentations using the knowledge as a tool or only a part of the whole solution.

5.   Conclusions

This thesis handled the design and essence of knowledge based puzzle game. It is based on the design and development process of *After Now Archeology* - a collection of knowledge based puzzles. *After Now Archeology* is also somewhat a borderline case of being a game at all. It breaks many definitions of games and game design principles. But in the field of modern digital game market there are many products and services that do not obey the traditional or theoretical definitions of games. Especially artistic indie games sometimes lack all the features that make a digital experience a game. Thus *After Now Archeology* can be seen as a game, although when separating puzzles from games it belongs to the group of puzzles.

After Now Archeology does not fit well into the puzzle genre either. Usually puzzles are defined through their game mechanics, e.g. arranging, deduction or pattern detection. But the game mechanics *in After Now Archeology* are secondary to the content, which comes from the real world. There are certainly some elements of riddles, but they are usually based on words and require more wits than sometimes laborious clue collecting and problem solving.

5.1.   Evaluating the project

The original goal of the project was to make a puzzle game collection, consisting of 19 knowledge based puzzles. There were no commercial goals, although different monetization mechanics were pondered during the development. The game ought to direct the player to search for information outside of the game's realm. This was hypothesized to motivate the players to voluntarily learn new things so they could advance in the game.

Making 19 puzzles within the given timeframe proved to be too ambitious goal. For the purpose of this thesis, only nine puzzles were made into a playable condition. Five more are ready on the design level, and the rest of the puzzles may still need some tuning or even re-design. The graphical design and development was the biggest obstacle during the development, due to the designer's inexperience on the field of graphical production. Thus, the produced puzzles still include a lot of placeholder graphics, which is borrowed from other sources, and can not be used in a final product.

The people who tested the game divided clearly into two polarized groups: the ones who didn't understand the game at all and those who could spend hours on solving the puzzles. The intentional difficulty of the game did appeal to the intended player group, but it also made it somewhat impossible to evaluate the players' motivation to learn more in order to advance in the game. Thus, the hypothesis of making better educational games by using extra-game information was left unproven.

Even though the development and research process did not reach the goals set to it, it was personally very educational and successful project. Designing a game which is based on extra game knowledge was fun and it also gave new tools and ideas for content based game design. This has already been a great accomplishment, and it has helped in designing serious games for different clients and audiences.

5.2. Knowledge basedness

By analyzing the goals and process of designing *After Now Archeology* we found the essence of knowledge based puzzles. Knowledge based puzzle is a rather rare sub-genre of puzzle games. The most important and distinctive feature of knowledge based puzzles is that solving them require using some kind of extra-game information. This way the knowledge based puzzles are not "self sufficient", meaning that the player does not get all required information from the game itself, but she needs to search for the knowledge outside of the actual game. This is related to popular trivia games, but in knowledge based puzzles the extra-game information is just a tool for solving the puzzle, not the answer itself.

The most typical puzzles in the digital realm are action puzzles, which are usually based on repeating certain game mechanics over and over again within a restricted time space. Other typical puzzle mechanics include word plays, mathematical-logical problems and spatial arranging puzzles. All these mechanics can be used as an interactive part of knowledge based puzzles, but knowledge based puzzles rely mainly on content, not mechanics.

5.3. Motivating to learn

Beside puzzle design based on real world information, the main design questions of the game included also learning aspects. The hypothesis was that if the game is interesting

enough, the players are motivated and willing to learn new things to get better or to advance in the game. The division of the test players was already discussed in chapter 5.1.

This kind of division was already presumed in the beginning of the design, so it did not jeopardize the research question. But it did render making any conclusions about learning and motivation too vague. To better test the hypothesis of games as motivation for learning, the game should be more easily accessible and generally easier, to get larger groups of players to engage in the game for a longer period of time.

One important thing on learning and also playing games is keeping the player in a "flow channel". This means the tasks the player performs in the game must not be too easy or too hard, or the player gets bored or anxious. *After Now Archeology* is designed to be a borderline case of being too difficult, which it most probably is for most of the players. But it is said people learn best when they are performing on the edge of their abilities. Thus, *After Now Archeology* works rather well among its niche target group.

5.4. Further research

During the process of designing and implementing After Now Archeology, and especially when writing this thesis, many possibilities for further research were found. Some aspects were considered to be part of this thesis, but they proved to be too large to be discussed in here.

The question of different ways of balancing the difficulty in games could be examined more. Different kinds of tutorials, hint systems and difficulty level selections are common practices within game development. There are some articles written about the topic, but much more could be done.

There are a lot of possibilities for further research within game genre theory. As was said in this thesis, there are several categorizations of puzzles, but they are not very consistent or commensurate. The situation is same with all game genres. For example the "Genremetsä"-article (Kemppainen 2012) could be used as a basis for building up a multi-dimensional game genre theory.

The aspect of content driven game design has not been handled very thoroughly in game design theory and literature. Designing games from other viewpoints, like character or business model based design has gained some attention, but the special case of starting the design by having the content in hand could add nicely to the available material.

Maybe the biggest drop out from this thesis was handling of educational aspects of games. Especially interesting viewpoint would have been motivating the player within the game, but not offering him any answers. Comparing "self sufficient" educational games to pointer offering knowledge based games would be really interesting.

Another big drop out was a "knowledge flow through magic circle"-model. The first version of the model was already built, but researching for theoretical background proved to be too much for this thesis' scope. The model explains different levels of knowledge and information the player brings into and out of the game. For example in the case of knowledge based games, the game requires the player to bring in information, which is necessary to play the game. On lower level, the player could acquire new musical knowledge by playing guitar playing games.

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List of illustrations

All screenshots were taken by the author. Illustration 10 was re-drawn by the author.
Illustration 19 by Bart Stewart
(original: http://www.gamasutra.com/db_area/images/feature/6474/chart.png [accessed 6.4.2014])
Other drawn illustrations drawn by the author.

Appendix 1: Extract of the matrix of topics

Nimi	Esimerkki	Materiaali														
		Taide	Elokuva	Kirjallisuus	Musiikki	Arkkitehtuuri	Kryptografia	Taivas	Helvetti	Muut puzzlet	Matematiikka	Mysteeri	Historia	Uskonnot	Muut tieteet	Sota
Willam Blake		x						x	x							
Hieronymus Bosch	The Seven Deadly Sins and the Four Last Things	x						x	x							
Dante				x					x							
John Milton				x				x	x							
Thomas Cole	Voyage of life – sarja	x														
Sedlec Ossuary (Bone church)	http://en.wikipedia.org/wiki/Sedlec_Ossuary	x												x		
Gustave Doré	Jumalainen näytelmä kuvitus	x							x							
Kryptos		x				x	x									
Torment	http://www.grngecko.com/torment.html								x							
Timehunt									x							
M.C. Escher	Print Gallery	x									x					
Clay Mathematics Institute	Millennium prize problems										x					
H.R. Giger		x														
Poe	Korppi			x												
Darren Aronofsky	Pi		x								x					
Nostradamus	Ennustukset			x								x				
Pietarinkirkko	Pietarin patsaan kuluneet varpaat	x				x										
Voynich manuscript	Voynich manuscript	x		x			x					x				
Nine Inch Nails	Year Zero				x											
Apostolos Doxiadis	Petros-setä ja Goldbachin hypoteesi			x							x					
Sagrada Familia						x										
Perplex city										x						
Phaistos Disc													x			
Piri Reis Map	http://en.wikipedia.org/wiki/Ancient_world_maps						x					x	x			
Erich Von Däniken																
Flammarion woodcut																
Dyatlov Pass Accident	http://en.wikipedia.org/wiki/Dyatlov_Pass_Accident											x	x			
Coral Castle	http://en.wikipedia.org/wiki/Coral_Castle					x						x				
Douglas Hofstadter	http://en.wikipedia.org/wiki/Gödel,_Escher,_Bach	x		x							x					
Flatland: A Romance of Many Dimensions	http://en.wikipedia.org/wiki/Flatland			x							x					
Charles Fort	http://en.wikipedia.org/wiki/Super-Sargasso_Sea			x								x				
Droste effect	The Stefaneschi Triptych	x									x	x				
Rene Magritte	http://en.wikipedia.org/wiki/René_Magritte	x														
Boy's surface	http://en.wikipedia.org/wiki/Boy's_surface										x					
Cryptids	http://en.wikipedia.org/wiki/Cryptids											x		x		
Duga radar	http://deputydog.wordpress.com/2007/08/27/the-duga-3-radar/					x									x	x
Prinzhorn collection	http://www.prinzhorn.uni-hd.de/	x										x				
Kuelap	http://www.kuelap.org/kuelap/index.html					x						x	x			

Appendix 2: Locations of After Now Archeology

Although After Now Archeology is planned to be distributed as an installable software, the playable puzzles are also made available as separate. These puzzles can be found in the address *http://www.afternowarcheology.net*. The installation packages for Windows and Macintosh systems will also be available there.

The blog written during the development of the game can be found in address *http://afternowarcheology.blogspot.fi/*.

If the servers or domains happen to disappear from the internet, the game files can be gained by sending the designer a message to *jakemppa@gmail.com*.