Czech University of Life Sciences

Faculty of Economics and Management

Department of Information Technologies

Diploma thesis

Multimedia and Their Usage in Practice

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! ! !

**Místo této strany vložíte zadání diplomové práce.
(Do jedné vazby originál a do druhé kopii)**

! ! !

Statutory declaration

I herewith declare that I have completed the present thesis independently making use only of the specified literature and aids. Sentences or parts of sentences quoted literally are marked as quotations; identification of other references with regard to the statement and scope of the work is quoted. The thesis in this form or in any other form has not been submitted to an examination body and has not been published.

Date:_____ Signature:_____

Acknowledgments

I would like to thank all people who helped me, supported me or provided me all relevant information that contributed to finishing this thesis. Special thanks go to my supervising tutor Ing. Miloš Ulman, Ph.D., who supported me in finding information and reflected my thesis in progress.

Although it is not personal, my next thanks goes to Umberto Eco, who inspired and motivated me with his book *How to write a thesis*.

My next thanks goes to my close friend Jakub Jurenka, who helped me with my English writing and provided me strong feedback about my academic English.

Finally I would like to thank to my family and my close friends who supported me in my studies at university and writing this thesis. To all people who inspired me to keep studying when I was balancing at the edge. To all various persons and characters I met during my studies.

Thank you all.

Multimedia and Their Usage in Practice

Summary

The theoretical part of the thesis is a literature overview of the multimedia topic, describing each element of the multimedia in a historical and current digitally formed context. The theoretical part continues with a description and an analysis of several multimedia theories. The last chapter of this part reflects the current university multimedia information system.

The practical part is a solution for improving the university multimedia information system, designing new parts, templates and features for this system. The practical solution includes a description of rebuilding and connecting the system to other university information systems. Other important parts are description of users, graphical reconstruction and different types of output interfaces.

Keywords: Multimedia, video, animation, interactivity, text, senses, information, visual, acoustical

Multimédia a jejich využití v praxi

Souhrn

Teoretická část diplomové práce je literárním souhrnem tématu multimédií. Popisuje každý prvek multimédií v historickém a současném digitálně formovaném kontextu. Teoretická část pokračuje popisem a analýzou různých multimediálních teorií. Poslední kapitola této části reflektuje současný univerzitní multimediální informační systém.

Praktická část je řešením zlepšení školního multimediálního informačního systému. Návrhem nových částí, šablon a funkcí tohoto systému. Praktická část popisuje přestavbu a propojení s dalšími univerzitními informačními systémy. Další důležitou částí je popis uživatelů systému, grafický návrh a rozlišné typy výstupních rozhraní.

Klíčová slova: Multimédia, video, animace, interaktivita, text, smysly, informace, vizuální, akustické

CONTENT

1. INTRODUCTION

This era is described as primary visual, since people receive the most information using their eyes. Information provided by the multimedia is not only visual or acoustical, but also interactive. A viewer moved from a passive position to an active selector of interest. A passive viewer turned into an active user. Users can select not only relevant information, but also form or device. Users do not receive the information, but they go through it. They can interact with it using different senses and see it from different angles.

The most important point of understanding is to name phenomena of interest. Multimedia theory balances among science, social studies and art. While some parts of this phenomena are easily measurable and describable, a lot of from multimedia theory is intangible. Despite this fact, the multimedia expand to almost every modern area of people's interest and has become a powerful tool for understanding, transmitting and preserving information. The sooner is the multimedia becomes understandable, the more effective process of creating and using it will be.

The theoretical part of the diploma thesis summarizes the history of each multimedia element and describes several multimedia theories, summing up the multimedia theories from Wagner's Gesamtkunswerk up to Tay Vaughan's modern Hypermedia.

The practical part describes a specific existing problem or a situation which could be improved using the multimedia. The author focused on multimedia television screens, the visual information system of the Czech University of Life Sciences. The main idea is to create a concept that could be more effective and reflect the current situation.

The use of multimedia information systems is starting to be gradually more frequent and probably it is one of the possible ways of future development. One part of the information is carried by system output and another by its user, who is in a position of selector. Anybody could reflect the system and it is going to be relevant. Information streams are no longer one-way, but they reflect the receiver, who become an active element of information transmitting.

2. GOALS AND METHODOLOGY

2.1. GOALS

The diploma thesis is thematically focused on the multimedia issue. The main goal is to analyze the current state of multimedia, its development and tools for working and creating multimedia. Partial goals of the thesis are:

- to write literature overview of the topic,

- to analyze the current situation in the historical context and

- to identify obstacles to multimedia presentation of the CULS via multimedia information system and to design possible solutions.

2.2. METHODOLOGY

The literature overview of the diploma thesis will summarize the history of multimedia and description of multimedia parts (text, video, audio, animation and interactivity). Author's on work is focused on elaboration of solution of a real assignment - design of multimedia university system - by the use of multimedia technology. Based on the theoretical research and the results of the practical work will be used for conclusions of the thesis.

3. GENERAL MULTIMEDIA CHARACTERISTICS

Main theme of this thesis is multimedia, phenomenon easy to point at but hard to characterize. Area of multimedia intact is extremely wide. In this part are multimedia describe by all of its elements: text, audio, pictures, animation, video and interactivity. Every element is taken and describe in way important for understanding of its meaning in multimedia context.

In next main part of this chapter are multimedia theories from different authors. This subchapter is summarizing current most relevant theories about multimedia and its elements.

Robert Burnett speaks in foreword of his book, Perspectives on Multimedia, about problem of defining multimedia borders that lies between science, social studies and arts.

> *"[..]In recent years, this specialization of knowledge has been challenged by emerging areas of inquiry, like multimedia cross over the divides between scientific inquiry, social science and the arts. [..] There needs to be dialogue between computer science and its application and use in the multifarious environments and setting in order to make sense of these new technocultural forms."*
>
> *(Burnett & Brunstrom, 2005)*

This chapter is distillation of currently respected multimedia knowledge.

3.1. PARTS OF MULTIMEDIA

There are six main parts of multimedia: text, pictures, audio, animation, video and interactivity. Every element of multimedia has its own history and progress. This part describe their own evolution and point out its importance for multimedia.

Every part is putting current multimedia element in historical context and then focused on actual situation in technological view. In subchapters are mentioned electronic formats of platforms used in multimedia these days or are tested (e.g. HTML 5 that is not fully supported yet). Interactivity is neglect element of multimedia, because it is not passive. This element is fundamental form multimedia, because allows to user to interact with medium, control his or her contact with medium.

3.1.1. TEXT

History of the text, character or script is about five thousand years long. In the beginning there was an effort of man to record memories and remember them in form of simplified pictures, scratches and other forms that they can thousands years ago, use.

First step to reach the symbol, part of the text, was simplifying of the pictograms. These pictograms was humans in different situations, e.g. man hunting animals. Pictograms are converted pictures to a simply form, but we can still understand them without any explanation. With a simplifying process of the graphic part there was a progress in growing of the meaning and usually one pictogram is caring the meaning of whole sentence.

Second step was an ideogram, one symbol with expression of longer or shorter group of characters. For record or read an idea was necessary to know a huge set of symbols and different combinations of using them. Every culture maturate to the different level of using the symbols and text. Main factors are society requirements, geographic area, type of language, determination of previous types of characters or types from nations around.

Spread of text and his knowledge strongly depend on type of recording materials, technology and used tools.

3.1.1.1. INCEPTION OF CHARACTER

Genesis of the character is necessary to seek in river-basin of Euphrates, Tigris, Yangtze River (Chang Jiang), Yellow River (Huang He) or other advanced part of the world. Since that evolved differently in all parts all over the world.

3.1.1.1.1. Cuneiform script, Sumer (4th millennium B.C. until first century A.C.)

Sumerian script evolved from pictograms turned around ninety degrees, thru a reduced form of about one thousand characters in Early Bronze Age up to four hundred unique symbols in Late Bronze Age.

Symbols were imprinted with rattan tool to a clay and then was burned. Cuneiform script should be also marked to the stones or be written on other materials.

Cuneiform script extinct in second century AD, it was replaced by Phoenician alphabet.

3.1.1.1.2. Hieroglyphs, Egypt (4 thousand years B.C. until third century A.C.)

One of the most famous pictographic style, combination of logographic and alphabetic elements There were more than eight hundred hieroglyphs in first decades of ancient Egypt. In Greco-Roman period there were counted more than five thousand.

3.1.1.1.3. Latin alphabet, Romans (around 7th century B.C. until present)

The origin of Latin script is based more on tales than on historical facts. Possibly was derived from Archaic Greek alphabet. There is strong connection between Archaic Greek alphabet and Phoenician. Ancients Greeks adapted Phoenician 24-letter script only with two symbols exception.

Latin (Roman) alphabet was also inspired by 26-letter Etruscan alphabet, which was also strongly connected to the Greek or Phoenician alphabet. Finally Latin scrip derive 21 of this letters.

Figure 1 Venn diagram of intersection between Greek, Latin and Russian alphabet (Source: http://en.wikipedia.org/wiki/File:Venn_diagram_gr_la_ru.svg)

In classical Latin period, exactly in first century B.C., adopted from Ancient Greek alphabet two more letters, Y and Z which has been placed on the end of their previous alphabet.

Original Latin alp.	A	B	C	D	E	F	G	H	I		K	L	M	N	O	P	Q	R	S	T		V		X		
Current Latin alp.	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z

Table 1 - Comparison of original and current Latin alphabet (Source: Author)

It has been developed in Old English script "W" as a double "V" in dark ages (7th century). From the 18th century up today have Latin alphabet 26 letters plus many regional extra letters e.g. German ß, Norwegian Ø Æ, Spanish ñ, Croatian č, š, ž which also have Czech with unique ř, Slovakian ľ or Polish ł.

3.1.1.1.4. OTHER TYPES OF SCRIPT

There are plenty of types of script and alphabet in different parts of the world. Logograms used in Chinese, Japanese, Korean, Vietnamese and other languages. Arabic language typical for reading form right to left and many others, e.g. Bhujimol, Manchu, N'Ko aplhabet, Zaghawa, etc.

3.1.1.2. MILESTONES IN TEXT HISTORY

This subchapter simply describes most important milestones in text history in context of multimedia. Commentary is focused in social impact in historical context.

Before 220 A.C. China, 4st century Egypt woodblock printing

- Independently developed in two part of the world. Wood block printing is a first known printing technique. This technique was firstly used for printing on textiles. It was used for printing of pictures and text. Picture is carved out of wooden block. Originally white parts of the picture/text were whittled and black parts were left untouched. Woodblock printing press uses same principle as many consecutive printing presses.

Printing press half of fifteen century

- Johannes Gutenberg[1], German blacksmith and goldsmith innovate printing press and allow, by special key segments, mass production. Since then were spreading the knowledge much easier than ever before. It started era of general literate.

Digital printing 1993

- offers to small publishers, companies or other individualities to print whatever they wants. Digital printing is usually more expensive than traditional offset printing methods, but savings are on low starting cost. Mostly used technologies are inkjet and laser printers.

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[1] Johannes Gensfleisch zur Laden zum Gutenberg, (1398 – February 3, 1468) German blacksmith, goldsmith, printer, and publisher (source: http://en.wikipedia.org/wiki/Johannes_Gutenberg)

Hyper-text

- non-sequential writing today mostly used on the internet, Janet Fiderio define hypertext in article A Grand Vision:

"Hypertext, at its most basic level, is a DBMS that lets you connect screens of information using associative links. At its most sophisticated level, hypertext is a software environment for collaborative work, communication, and knowledge acquisition. Hypertext products mimic the brain's ability to store and retrieve information by referential links for quick and intuitive access." (Fiderio, 1988)

Plenty of authors are pointing at hypertext that is the biggest revolution since printing press. Reason is simple, because reader (or user) can choose direction of his or her interest. It has changed linear non-interactive reading to different state.

Strongest advantage of the hyper-text is in epistemic way, because reader could easily and quickly find relevant information and can focused only on data important for him or her. Disadvantage is, that could be misleading for some people which could lightly lost in the hyper-text connections.

E-books (readers)

- this currently used technology is next step in spreading text sources like literature, scientific texts, or other even semi-professional or amateur text artefacts. There were plenty of disputants, but it is the same like with any other new technology: firstly these people only looking for arguments why not and after some time they finally looks for arguments to use it. In opinion of author of this thesis books will have place in future similarly like pens. There will be some situations, where will be used (mostly ceremonially), but for everyday reading (newspapers, paperbacks, manuals, etc.) will be used e-readers or any other devices with technology to display text comfortably to read.

3.1.1.3. TREND OF SPIRAL

Korean scientist Kyonam Choo (Choo, Woo, Min, & Jo, 2005) is describing icon language system for people with language disorders. It is based on Korean language and symbols are represented by icons - universal simplified pictures.

> *"The icon language is featured in putting the context-based meaning onto an icon picture, so users are able to communicate the proper meaning by combining relevant contexts through connecting each icons without accurate linguistic expression"*
>
> *(Choo, Woo, Min, & Jo, 2005)*

Choo is using simplified Korean grammatical structure and creates sentences with the icons. The chain of character evolution is going to the beginning. Pictures - ideograms - primitive characters - plenty of alphabets - pictures (icons) - icon language (ideogram). It is not that people became more primitive and that they are degenerating. It means that there is solution how to make e.g. info terminals in various cities with universal icon-based language. It is just a way how to create relevant queries for the system pleasantly for the normal user.

3.1.2. STILL IMAGE

In previous part about text it is mentioned evolution from cave pictures to icons. This is also relevant for this part about pictures.

This chapter is about all types of the still images, from paintings, graphics, photography, icons and all kind of digital image types, differentiate into two groups raster and vector graphic. This chapter is closed by currently most used formats, especially on the internet and other output screens of multimedia information systems.

Pictures represents visual element of multimedia. Information received by visual perception is specific in its high speed of transmission. Receiving enormous amount of information in few seconds is possible only through eye. Other senses or media elements need longer time for transmission an information.

Typical example could be car. If subject look at the car for few seconds, he could possibly describe it later and also could recognize it in comparing with other similar cars. If subject is just listen description, it takes much more time also probability of right recognition is going to be much lower. In short, visual perception is specific sense with fast information transmit.

It is hard to define still images in general, following points summarize several definitions and points that used different authors. Author of this thesis concentrate other definitions or specifications in to the following definition:

> *A still image is a non-moving visual piece of two dimensional information, captured by any technical (e.g. camera, binoculars, etc.), biological (e.g. eye), physical (e.g. mirror, water surface, etc.)device or by a combination of the listed above.*
>
> *(Ondřej Nečas 7 March 2012)*

Important is two dimensional condition, because there could be an illusion of more dimensions. This illusion is not relevant for the still pictures, because an illusion needs specific conditions (two eyes, glasses, time, etc.). Every photography and painting is three dimensional, but for this case this third space is insignificant.

Biological part also includes painters with all skills and techniques they use.

3.1.2.1. PAINTINGS

History of the paintings started thirty one thousand years ago with cave painting. Oldest cave paintings were founded in Chauvet cave[2] in year 1994. Prehistoric cave paintings were discovered all around the world mainly in Africa, Europe or Australia. Most famous painted caves are Altamira (Spain) and Lascaux (France).

Since then there exist or were existed many styles, forms and techniques. For this thesis is important basic concept and current reproduction techniques.

Basic differentiation of painting is: History painting, Portrait panting, Genre painting, Landscape, Animal painting and Still life. Invention of camera, changed view on paint and

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[2] Chauvet cave, located in Ardèche region of southern France

realistic art and started modern era. Painting moves from capturing the reality to expressing emotions, ideas and other more or less concrete things.

From multimedia view is most important, that paintings can be reproduced with several techniques such as scanning, photography, printing techniques and other types of digital paintings capture.

3.1.2.2. ICONS

Word "Icon" comes from Greek *εἰκών eikōn* meaning for "image" and is usually used for paintings of Eastern Christianity. For multimedia or computer science we used other explanation.

Icon is special kind of symbol that usually represents some program, program function or other thing that needs to be marked. First computer operating system Xerox 8010 Star Information System from 1981 changed attitude of computer interfaces. From this historical point icon represents almost every function in any type of computer.

In point of computer science view, we obtain following definition published by Houghton Mifflin Company in The American Heritage® Science Dictionary:

> *"In a graphical user interface, a picture on the screen that represents a specific file, directory, window, or program. Clicking on an icon will start the associated program or open the associated file, directory, or window."*

> *(The American Heritage®, 2005)*

Icons are symbolising functions and some time they have similar meaning as pictograms. On the other hand icons are not so easily understandable. Usually they are parts of tool bars of navigation menus. Mostly are signed by text label or by showing title.

Figure 2 Basic tool bar in Cinema 4D R12 (Source: Captured from running program)

3.1.2.3. GRAPHICS

Graphics or graphic design is a visual art oriented on creating drawings or art accordance with the mathematical rules. In wider attitude it is possible to call graphics everything from page (virtual or physical) layout, engraving, geometric designs, GUI, diagrams, graphs, drawings, geometric symbol, etc. and their combination.

Graphical design of multimedia appear from web design approach and classical graphic design. Many graphical elements became crucial for multimedia or web design. Graphic design is responsible for unity and identity of whole multimedia project.

3.1.2.4. PHOTOGRAPHY

Photography is extremely spread phenomenon based on capturing subjects with light differences. Today used digital photography is based on the evolution from pinhole camera, camera obscura through experimenting silver chlorid and other chemicals up to invention of digital camera chip - image sensor form Steven Sasson engineer from Eastman Kodak in 1975[3].

> *"The science which relates to the action of light on sensitive bodies in the production of pictures, the fixation of images, and the like.*
>
> *The art or process of producing pictures by this action of light."*
>
> *(BookRags Media Network)*

Photography is used in multimedia for its perfect reflection of visual reality. Even in that is photography easily manipulated, people still believe and apperceive photography as a fact.

For multimedia use is photography perfect for illustrations, reports, guidelines, education materials, capturing memories, etc. Photography is a powerful tool that is commonly used by general population.

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[3] Präkel, D. (2009). *The Visual Dictionary of Photography*. AVA Publishing

3.1.2.5. RASTER AND VECTOR GRAPHIC

This subchapter describes these two different attitudes in digital still image formats. First one is based on recording information of every pixel (raster graphic) and other is that every shape, line, etc. is described mathematically (vector graphic). Both have their advantages and disadvantages in different fields.

3.1.2.5.1. RASTER GRAPHIC

Raster graphic is based on keeping information about picture for each pixel (or group of pixels, depends on the algorithm of compression).

> *"A bitmap is a type of graphic composed of pixels (picture element) in a grid. Each pixel or "bit" contains color information for the image. Bitmap graphics formats have a fixed resolution[...]"*
>
> *(Bitmap - Desktop Publishing)*

Raster graphic is better for keeping photos, small image of graphic, buttons, other web components. Most used raster formats are: BMP, PNG, Jpeg, GIF, TIFF, TARGA, PCX, ICO, TGA. Raster formats that also support editing vector elements are: PSD, CPT.

3.1.2.5.2. VECTOR GRAPHIC

Vector graphic is based on mathematical description of every graphical element. Graphic is not fixed on picture size, there is only scale. This format is used in technical engineering (CAD systems), electronic maps and graphic design.

These formats were connected with licensed programs, but open format SVG started to be supported by every internet browser. Other formats are: AI, CDR, CGM, DWF, DXF, ODB++, PGML, SVG.

3.1.2.5.3. OTHER TYPES OF GRAPHIC FORMATS

Graphic formats evolve with a demand. Some new formats are for exchanging graphical data, some were created, because it could not be used any old format and some formats are combination of vector and raster graphic formats.

Raw

- format for saving captured data with minimal processing, mostly used in digital cameras, motion picture scanners or image scanners. Philosophy of this format is based on idea of photographic negative. In Raw format is possible to work in much wilder scales of contrast, colour balancing, shadow gradients, etc. Typical formats are: CRW, DNG, ORF

Compound formats

- these formats allows to combine elements of vector and bitmap graphic, usually they are natively work with one type of graphic and they were extend. Also are usually used for exchange. Typical formats are: CDF, DjVu, EPS, PDF, PICT, SWF

3.1.3. ANIMATION

Animation is special type of visual expression. In this part of work is analyzed several definitions of animation and connection to other media.

First there is general definition of animation from American critic Charles Solomon:

> *"Technique of single frame cinematography*
>
> *1. Imagery is recorded frame by frame*
>
> *2. Illusion of motion is created, rather than recorded"*

Post-Modern Definition of Animation from Norman McLaren (1914 - 1987, animator, film director, Scottish-born/Canadian):

> *"Animation is not the art of drawings that move but the art of movements that are drawn; What happens between each frame is more important that what exists on each frame; Animation is therefore the art of manipulating the invisible interstices that lie between the frames."*

Prof. Jiří Kubíček´s (1944 - present, scenarist, Czech) definition of animation (Kubíček, 2004) :

> *"Art of animation is creating moving pictures by any technique except live action."*[4]

It is extremely difficult to define simply this type of media that cover blinking buttons, web sites up to full-length movie. Also modern era changed dramatically a creating methods of an animated content. It´s not necessary to create an animation step by step. Modern frameworks and environment such as Flash, Silverlight or HTML 5 (more in chapter XY) allow to creators just define key frames and others are going to be counted automatically. Also frame rate (more in part XY.5. video) depends on the performing platform and not only on authors created frames.

Animation in multimedia projects usually helps to simplify the reality and helped user to understand the problem. This not very precise, because animation is every element in multimedia project which is somehow visually transformed or moved. Borders between

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[4] Translated by author

animation and video are disappearing. Every part of both media is possible to manipulate digitally.

3.1.3.1. ANIMATION TECHNIQUES

Current animation techniques can be divided basically in to two groups, the Cel Animation and the Computer animation. This differentiation was mainly influenced by the modern technology. The technology and a new type of media changed dramatically an utilization and a creating techniques of animation.

3.1.3.1.1. CEL ANIMATION

The Cel is a shortcut for celluloid, in meaning of film strip. The oldest, and is it possible to call it classic, type of the animation. There listed below several types of a classic animation with short commentary:

Type of animation	Explanation
Cartoon Animation	Every frame is drawn (painted) separately. Area of this animation is really wide, from Walt Disney classics up to experimental animated movies. Usually animated in layers, one for each different character/prop/background.
Stop Motion	Animating characters step by step using models. Sub-type of this animation is very popular clay animation. Due to clay it´s easily to animate models.
Cutout Animation	Has very close relation with Stop Motion. Animator moves cutouts frame by frame and capture tem on camera. Special and very famous type is animation of silhouettes - final expression is similar to Shadow puppetry.
Pixilation	Similar to the Stop motion, but instead of moving models, animator use humans.
Progressive Animation	Animation of paintings as it is painted. Painter do not erase previous frame and just paint new step on the previous one.
Direct Animation	Style of animation where artist animated for example liquid on the text of projector. And animation is projected directly to the audience. This highly experimental type on animation used e.g. Pink Floyd on their early shows.

Table 2 - Types of animation (Source: Author)

The main difference between a cartoon animation and the others is that use the key frames for catching the important (key) phases on an animated object, e.g. jumping character is firstly drawn in the moment of bounce, in jump peak and in the moment of fall. Then are drawn steps between these key frames and then between these frames, etc. until is reached desired number of frames.

This is in contrary with other types of animation, where it is gone from the beginning of capturing scene up to the end. It will be extremely hard to animate a models in stop motion using key frames. The key frames begin to be one of the basic elements in computer animation due to a computer potential to compute frames automatically.

3.1.3.1.2. COMPUTER ANIMATION

Flow from previous part about the Cel animation, the computer animation is assuming from a classic animation key frames, but also a layer or tweening. The computer animation is kept in progress and evolution. There are some basic types of the computer animation, but there are also plenty of mixed types. These mixed types are used, when artist needs to be more realistic of there is no rendering capacity and it is necessary to create plainer scene. Also in on-line animated projects is it possible to find amount of these combined styles.

Instead of speaking about the types of computer animation it is better to speak about techniques used to create a final animation. Some of these techniques are parts of a video projects, but they fulfil idea of animation from Kubíček's definition, to create motion without live action.

Figure 3 Illustration figure of computer modeled scene (Source: Author's archive)

Computer animation technique	Explanation
2-D path-based animation	Animator creates path for objects, also type of move (slowing/constant/etc.) and other changes
2 ½ -D animation	It´s very similar to 2-D animation, but uses techniques of 2-D animation to create illusion of three dimensional space
3 - D animation	Created and captured in special programs for animating and modeling, currently is possible to create almost everything.
Motion capture	Currently used technology in plenty of fields, not only in animation. It is used in medicine, computer games, simulations, etc. Motion capture is technique based on transferring real movement coordinates to virtual model. There are several types of technologies for capturing movements. Standard are based on optical capturing, mechanical suits or points sanding their coordinates wirelessly.
Morphing	Technique of transforming one picture to another. Difference between cross fade and Morphing is that, in this technique are taken similar points and areas and those are transformed to another. E.g. eyes, hair, etc.
Kinematics	From view of computer animation and modelling kinematics is technique , when animated figure has define every angle by some equation defining its limitations. That helps to animator in creating more natural illusion of a movement.
Rotoscoping	Tracing captured live action. Animator doesn´t had to re-draw every frame. Number of necessary frames depends on complexity of the movement and required precision. Mainly used in film industry. Walt Disney use rotoscopy for heightening exclusivity of his animated movies.

Table 3 - types of computer animation technique (Source: Author)

3.1.3.2. HISTORY OF ANIMATION

The first device that could reproduce movement was called a phenakitstoscope, developed by Belgian scientist Dr. Joseph Antoine Plateau in 1831. In 1906 J. Stuart Blcakton created the first animated movie called "Humorous phases of funny faces", it was drawn frame after frame. 1914 was year when Earl Hurd patented technique, when drawings are painted on a clear celluloid and photographed later with a different layers, the technique known as the Cel animation.

After World War started era of an animated movies. Between Wars started to produce big companies like Walt Disney, Warner Brothers, Universal, etc. plenty animated movies like Felix the Cat, Alice's Wonderland, The Jazz Singer, Steam Boat, etc.

After Second World War, next to a classical animated movies, started era of an experimental animation (e.g. Harry Smith or Norman McLaren). In the beginning of 60's started development of a computer graphics, in and out devices, hardware, algorithms, etc. The most important initiators were form MIT[5] Steeven Coons and his two students Ivan Sutherland and Lawrence Roberts.

The era of the computer animation graduated in 1995 with the first full-length picture Toy Story. Since then were created tons of a fully or a partly computer animated movies.

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[5] Massachusetts Institute of Technology, Harvard university

3.1.4. AUDIO

The audio element is specific for the longest information transition, on the other hand audio also carry information about a space around. It could be easily created an illusion of different areas. The audio can carry voice, music or noise.

3.1.4.1. BRIEF HISTORY OF MUSIC AND AUDIO

The first device that can reproduce sound invented in 1857 Édouard-Léon Scott de Martinville, it is called phonautograph. This technologically limited device innovated by Thomas Edison in 1878. Phonograph played from cylinders rather than disks that used gramophone. Gramophone patent has Emile Berliner from 1887. Audio disks – gramophone record speed was standardised, also material evolved and stabilised on vinyl.[6]

For casual user were next important format for recording audio was magnetic tape. Firstly 7" reel of ¼" recording tape then from 1963 audio cassette invented by Philips Company.

Digital recording – CDs were used for casual audio archiving and playback. Professional studios work with other digital formats, recorded on special tapes. Also film industry invented several high quality formats recorded on film.

Mp3 digital audio format were introduced in 1990s. Many companies tries to invent better, more secure or just competition for mp3 format but currently it is most supported and used audio format. Other formats used in this era are described in next chapter.

3.1.4.2. AUDIO FORMATS

This part describes historical mediums used for preserving audio records and puts attention to currently most used audio formats. Because of internet, hiring download speed and quality performance, audio formats rapidly evolved.

There are two basic types of digital compression Lossy and Lossless.

The lossless formats usually have bigger size and their compressions are between 50 and 60 percent from original quality (usually CD), the quality is the same but file is smaller. It

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[6]Source: Inventors, About.com
http://inventors.about.com/library/inventors/bledison.htm#phonograph

is the same like with BMP and PNG format. Most used formats are: FLAC, WavPAck, TAK, Monkey's OptimFROG, ALAC, WMA.

> *"Lossy compression is a form of compression that significantly reduce multimedia file size by throwing away information imperceptible to humans."*
>
> *(Hydrogenaudio Knowledgebase)*

The lossy compression uses imperfection of human audio perception and allow to perform several compress algorithms of audio almost without hearing a difference. Due to setting of compression is it possible to control number of information discarded that is affecting final output and future playback. Typical formats are: AAC, AC3, DTS, MP3, VQF, WMA .

3.1.5. VIDEO

The video belongs to elements changed rapidly in digital and internet era. From moving negative through analogue broadcast, Betacam, VHS, first computer formats up to digital broadcast and internet video spread. With internet speed and memory capacity increase, video became more used element of multimedia or more used medium alone.

The video allows to create illusion of movement, use a technique of fast changing of static pictures. This is principle that did not change from the beginning. Even video compression work with key frames and displaying is also dependent on output screen hertz rate.

The video is also element with wide usage. From extremely short clips up to video series. Video element should be entertaining, educational, instructional, it should be used for streaming, life broadcasting or for video telephoning.

3.1.5.1. FILM INDUSTRY BRIEF HISTORY

First may 1896, Lumiérs brothers program has a premiere in Brussels, Belgium. Since that video and film industry began to grow. Until 1923 was film characterised as the silent era. It was only attended by live music, sound effects or live commentary.

Around year 1929 started era of sound movies and many actors from silent era needs to be exchanged because of completely different attitude of film view. Between World Wars were popular in gangster movies also animated fairy tales of dialog comedies.

The 1940s were characterised by war propaganda movies and post war movies also strongly tendentious. Also it was era of comedies and animated movies e.g. Pinocchio (1940), Dumbo (1941), etc. In Great Britain started era of melodramas (e.g. The Man in Grey) and Italian neorealism started in 1943 with movie Ossessione.

Next years were important for esthetical and cultural film evolution, but technology did not grooved so rapidly. First change of watching movies were VCR - Videocassette recorder that allowed to watch movies from homes.

In 1990s started era of independent movies, new special effects, DVD replace VHS and most important were spread of digital technology that allowed more precise video adjustments, colour correction and last but not least drastically lowing budget on capturing stoppage.

Last two decades were showing two ways, the first big 3-D digital distributions and the second low budget, independent and amateur video. Even amateurs have these days tools for creating good looking movie, sometimes same quality level as television production. Very popular are webs for video exchanging, leading with YouTube.com (Czech alternative Stream.cz).

3.1.5.2. VIDEO FORMATS

Video formats could be divided several ways. For purposes of this work are the most interesting digital video formats and codec. Video formats strongly define appearance of the video output. Also there is licensing problems, because every company try to create best codec and made profit on the licensing. Simultaneously with companies evolving also computer pirates made their formats.

HTML 5 used natively supported video format x264. It is GPL licensed implementation of the H.264. Other free or GNU GPL formats are: FFv1, Xvid, HuffYUV.

List of video formats
Recording formats before video tape
Phonovision
Kinescope
Analog tape formats
1" Type B video tape (Robert Bosch GmbH)
1" Type C videotape (Ampex, Marconi and Sony)
2" Quadruplex videotape (Ampex)
2" Helical Scan Videotape (Rank Cintel)
Betacam (Sony)
Optical disc storage formats
Betacam SP (Sony)
Betamax (Sony)
S-VHS (JVC) (1987)
W-VHS (JVC) (1994)
U-matic 3/4" (Sony)
VCR, VCR-LP, SVR
VERA (BBC experimental format ca. 1958)
VHS (JVC)
VHS-C (JVC)
Video 2000 (Philips)
Digital tape formats
Betacam IMX (Sony)
D-VHS (JVC)
D-Theater
D1 (Sony)
D2 (Sony)
D3
D5 HD
Digital-S D9 (JVC)
Digital Betacam (Sony)
Digital8 (Sony)
DV
HDV
ProHD (JVC)
MicroMV
MiniDV
Optical disc storage formats
Blu-ray Disc (Sony)
China Blue High-definition Disc (CBHD)
DVD (was Super Density Disc, DVD Forum)
Professional Disc
Universal Media Disc (UMD) (Sony)
Discontinued
Enhanced Versatile Disc (EVD, Chinese government-sponsored)
HD DVD (NEC and Toshiba)
HD-VMD
Laserdisc (old, MCA and Philips)
Digital encoding formats (basic list)
CCIR 601 (ITU-T)
H.261 (ITU-T)
H.263 (ITU-T)
H.264/MPEG-4 AVC (ITU-T + ISO)
M-JPEG (ISO)
MPEG-1 (ISO)
MPEG-2 (ITU-T + ISO)
MPEG-4 (ISO)
Ogg-Theora
VP8-WebM
VC-1 (SMPTE)

Table 4 List of video formats (Video - Wikipedia)

3.1.5.3. DIGITAL VIDEO COMPRESSION

Digital video compression is vital for normal user video playback. Uncompressed video (depends on the size of frame) is basically picture after picture. In video there is sometimes most of the frame same as previous picture. These segments, based on the used codec algorithm and settings, could be used for compression both frames.

Important aspects for video compression are:

- data storage needs - size of file, supported file format (NTSC, FAT 32)
- data processing speed - video bit rate, do is hard drive or other memory fast enough to playback video in real time
- compression detail - how many details are preserved from original input
- chroma sub sampling - position and motion of luminance difference
- bit depth - usually between 8 and 14 bit, how many shades are available for every supported colour

3.1.5.4. DIGITAL VIDEO STREAMING

Streaming video is based on broadcast principle, one device is streaming through the internet, LAN, Wi-Fi of other technology on it is displayed on other devices without saving on hard drive. Main leaders in digital video streaming formats are QuickTime, Real Video, Windows Media and Flash Video.

3.1.6. INTERACTIVITY

In this section is described most relevant part of multimedia – interactivity. Is this part are described definitions of interactivity, mentioned current most used types of interactivity and of part discuss the most interactive multimedia – video games.

The book Perspectives on Multimedia draws a definition of interactivity:

> *"Interactivity (the ability of the user to directly manipulate and effect her experience of media) is the amount of control the user has over the presentation of information."*

> *(Burnett & Brunstrom, 2005)*

The interactivity allows to passive viewer became active user of the available content. User is still limited about by available data, but controls accepting or refusing different elements. On the internet in nothing that could force user to stay on any page.

The interactivity could be a simple choosing from two or more alternatives up to a changing or creating content, moving in different space, voice recognition, etc.

3.1.6.1. VIDEO GAMES

The video or computer games quickly grown in to strong respected medium with huge economical potential. Regardless there are not enough scientific expressions. Every single text about video games is strongly determinate by terminological absence. To write academic text about computer games may look naive and unprofessional. On the other hand, plenty of universities have a video games development programs. This new media is not a competition for other media, not from perspectives of production managers, but computer games are alternative platform for transmission and forwarding thoughts, information and emotions.

Currently most used platforms are:

PC - personal computer has been from its beginning gaming platform. Main disadvantage of PC gaming is requirement of hardware upgrading. Biggest advantage is the independence of this platform and possibility of playing any computer game developed.

Game consoles - Xbox 360, PS3, Wii, devices specially designed for gaming, they are regular computers with simplified operation systems. Advantages are that user does not have to upgrade their station, on the other hand is user strongly dependent on the developer and consol company. But every console has strong professional background and customer service.

Mobile phones - Fast grooving market with big potential. It is characterized by simple games that usually ripped classical legendary game (Sokoban, Pacman, Supermario Bros, etc.) With new mobile functions (gyroscop, shaking, touch screens, etc.) games have new dimension and became more intuitive for occasional players.

Browser games - Simple or complex games played through a web browser (Opera, Mozzila FireFox, Chrome, Internet Explorer, Safari, etc)

Other gaming - handhelds (PlayStation Vita, Nintendo DS, etc.), virtual reality, etc.; other kind of gaming platforms that are usually created for special event (exhibitions, prototypes, advertisement, etc.)

3.2. MULTIMEDIA THEORIES

This part of the thesis described some theories that characterize world of multimedia from different angles in different time periods. In general, there is no strong and significant theory that is supposed to be held and used. In most cases it is just a summarization of current situation combined with short period expectations.

The next part of diploma thesis describes some of these theories, starting with Richard Wagner ´s theory of Gesamtkunstwerk. Going thru other theories and finished with opinion of author of this work, which is more close to commentary but even with selecting parts and clarify an idea it is possible to create stronger and significant theory.

3.2.1. GESAMTKUNSTWERK

According to William Gibson (Gibson, 2004), the term Gesamtkunswerk created in 1827 K.F.E. Trahndorff (1782 - 1863, philosopher and writer, Geman). Richard Wagner (1813 - 1883, opera composer, German) use this term in his two essays in 1849. There is no proof that Wagner read Trahndorff essay. Term Gesamtkunstwerk is now associated to Wagner ideas about art in general.

He is describing systems or scene for all arts in theatre, where are involved also spectators. He never realized his universal-art-idea to work, he was closest with his Der Ring des Nibelungen[7]

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[7] eng. The Ring of the Nibelung, four epic operas by Richard Wagner from year 1848 - 1874

3.2.2. VISUAL INFORMATION SYSTEM BY H.C.LEUNG

Clement H.C. Leung is mentioning in his symposium (Leung, 1997) is quoting G.B. Davis and M.H. Olson theory:

> *"An Information System (IS) may be defined as an integrated, user-machine system for providing information to support the operations, management and decision-making functions in an organisation."*

Leung is also mentioning also younger work from J.A. Seen about information systems:

> *"Traditionally, information systems are test-oriented which provide reports, documents, and decision-making information for all levels of the hierarchy within organisation."*

Leung description of visual information system (VIS) is described in general and it should be generalized for multimedia content. He is dividing all multimedia system in to two layers: *application layer* and *multimedia layers*. Application layer is basically VIS, it is containing all features that we need to create, organize and use our VIS.

The Second layer described by Leung contains two layers a *MMOS* (multi-media operating system) and a *MM Hardware* (multi-media hardware). The MMOS includes following parts: *MM Server & Networking, Real-time Support, Synchronization, MM Device Drivers, MM Development Support*. In year 1997 the MM Hardware layer include these parts: *Random Access Storage Devices* (hard disk, CD-ROM, LV Disk*),* *Sequential Access Storage Devices* (AV tape, DAT, 8mm tape), *Capturing Devices* (digital camera, scanner, sound & video cards), *Playback Devices* (VCR, LV Player, Audio & Video Players) and *Networking Devices* (Ethernet, FDDI, ATM).

A Visual Information System described by H.C. Leung (the following figure) can be divided into three parts: sources, storage devices and distributing devices. Most of data flows are only one ways. This is most significant difference between current multimedia/visual IS.
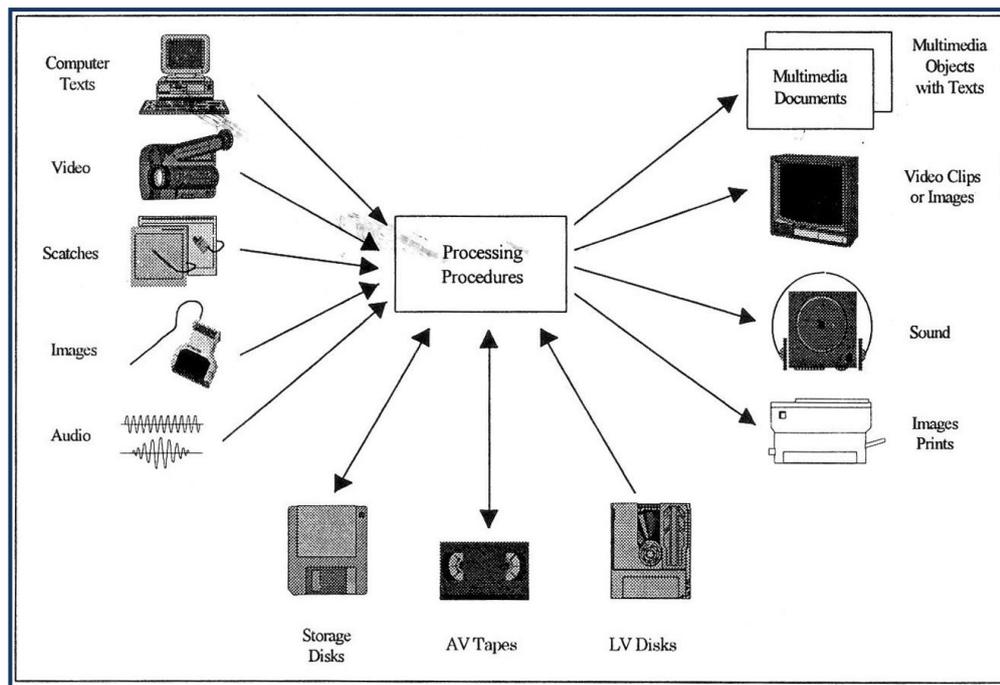
Figure 4 Scan from (Leung, 1997), page 4

The sources displayed in the previous figure are Computer Texts, Video, Sketches, Images, Audio. Clearly most of them are one source device one output type. A computer can be originally a source mainly of text (also it has to be part of Processing Procedures); rendering images, visualizations, generating and simulating programs were not common part of multimedia.

Storage devices include also AV tapes, which are slowly disappearing in the current media exchange. Even creating film strips after post-production processes is drive out by digital projections.

Distributing devices appear to be similar to current devices for the distribution. Some of them are similar but every device is now close being multi-distributor. Thesis analyze this in following chapters.

3.2.3. TAY VAUGHAN MULTIMEDIA DEFINITION

Tay Vaughan described current multimedia in pragmatic way:

> *"Multimedia is [...] a woven combination of digitally manipulated text, photographs, graphic art, sound, animation, and video elements. When you allow   an end user [...] to control what and when the elements are delivered, it is called interactive multimedia."*

> *(Vaughan, 2008)*

According to Tay Vaughan´s definition, there is difference between multimedia and interactive multimedia. Vaughan is also mention third step - hypermedia. Hypermedia is them firstly used by Ted Nelson in 1963. This differentiation putting difference between multimedia and interactive/hyper media. Other authors usually describe interactivity as an essential condition for multimedia e.g. William Gibson (Gibson, 2004).

This diagram below (Figure XY) is mapping Home media ecology from year 1975 in opinion of several authors Tom Wolzien, Sanford C. Bernstein & Co. Second is adopted by Tay Vaughan (Vaughan, 2008). He is trying to show rapid and unavoidable progress and changes in common multimedia broadcasting.

Figure 5 Scan from (Vaughan, 2008), page xii

3.2.4. HYPERMEDIA AND HYPERTEXT

Term *hypermedia* was formulated by Theodor Holm Nelson (1937 - present, philosopher, sociologist, information technology expert, American) in 1963 (published 1965). Special sub-term was used *hypertext*, more known and used term.

Definition of hypertext published in Webster's New World College Dictionary (Dictionary W. N., 2010):

> *"Text prepared and published in such a way that it is linked together in a non-sequential web of associations that allows the user to navigate through related topics, from one document to another. The author embeds hyperlinks in the text that the user can simply click on to view the related document associated with the link. The World Wide Web (WWW) is a global hypertext system of information residing on servers linked across the public Internet. [...] The terms hypertext and hypermedia are attributed to Ted Nelson, who, along with Douglas Englebart, developed the Hypertext Editing System in 1968. "*

Definition of hypermedia published in Webster's New World College Dictionary:

> *" The extension of hypertext into a combination of media, including image, animation, video, audio, hyperlinks, and other elements that intertwine into a non-linear document presentation in the form typical of contemporary Web documents.The World Wide Web (WWW) is a global hypermedia system linked through the public Internet. [...]"*

> *(Dictionary W. N., 2010)*

From previous definitions it´s possible to derive several relations. Hypertext is just a part of hypermedia, which is more general term. Hypertext is more famous due to it wide spread in several years. One of reasons was internet connection limit. Because of huge amount of data was unthinkable to create multimedia web. Simpler, faster and desirable was to used classical web site, linked by hypertexts. With a faster connection, higher server computing capacity and demands of web users is current web transforming from hypertext based to hypermedia world.

After more than forty years from creating the idea and definition by Ted Nelson in 1963, can current web user use all media linked together connected on-line.

4. MULTIMEDIA INFORMATION SYSTEMS

This part addresses specific systems which can be found all around the world. This chapter is divided into two sub-chapters first about current multimedia information systems (MIS), generally but with concrete solutions and applications. Materials and documentation captured from different part of Europe describing local trends and utilization of different kinds of MIS.

The second part is about multimedia information system at author's university, the Czech University of Life Sciences (CULS). This chapter describes the technical background, visual aspects and other details of CULS information systems.

4.1. CURRENT MULTIMEDIA INFORMATION SYSTEM USAGE

Multimedia information systems are beginning to have strong position in many fields where sending, receiving of exchanging information can be found. Advertising systems are most visible, due to their aggressive attacks on senses of humans and their devices. Advertising systems usually have a noisy effect, but from the theoretical view, they are usually extremely complex and linked together.

Other, very useful and popular, systems are time schedules depicting connections in public transports, organizing visitors in post offices, shops, local offices, etc. Strongly connected to them are navigation information systems, which are able to provide useful information on the current area, transport connection or any other information which is put to this system.

Figure 6 Illustration photo of multimedia information system (Source: Author's archive)

Then there are more specialized systems, which are usually sub-systems of systems described above. They are also mentioned in this chapter because of their importance or special aspects.

4.1.1. TIME SCHEDULES

This chapter is about non-interactive time tables. They are using several types of displaying technologies and is possible to find them everywhere where is adequate to show time schedule. Typical places are public transport stations, train stations, airports, seaports, etc.

There are two basic differences between getting information about current connection time. One, much cheaper, that the system is displaying times of traffic channels from database. If there is no complication and every tram, bus or any other connection is arriving on time, it´s impossible to distinguish these two types.

Second, much expensive but much more precise, is system which is displaying time of real arrival. That means, every transport is (with proper technology) sending data about his situation and eventual delay. Second system we can find in Czech Republic in metro, where is time of arrival actualized. On the other hand this system on bus and tram station is displaying data from database, so if there is some complication time table is not reflecting it.

4.1.2. NAVIGATION INFORMATION SYSTEMS

Navigation information systems, are usually called just "information systems", behind this term is possible to find systems, which has information about local area, history, important places (police station, hospital, monuments, restaurants, etc.), local transportation, email or regular internet connection. Sometimes is possible to print found information.

These types of "automated-guides" are a part of every modern city or any other place with own culture.

4.1.3. OPERATIONAL INFORMATION SYSTEMS

These information systems are usually used on the places where come and goes enormous amount of information. Typical example is fast food restaurants, distributing point of internet shops or the authorities. These operational systems are usually connected with other systems: cash desk, on-line shop database, ticket machine, logistic software etc. and organize work or users and they are making situations more effective.

These systems seems to be quite effective, because allow to work with many people, quickly, effectively and with keeping their anonymity. There is strong possibility that changes technical form of system but will be kept idea of the system itself. This is visual system with anonymously differenced users. System is more or less automatic and could be connected almost with any type of service or navigation.

4.1.4. ADVERTISING

Advertisement and commerce always uses most advanced technologies to impress potential customers. Multimedia screens fit perfectly to this system. It can be changed rapidly, is it possible to show video, etc. With system like this is extremely easy to get an attention of potential customer. In other cities (e.g. London) are installed screens almost everywhere, where are passing people. Whole system of the advertisement it is redefined to speed of potential customer. It is timed with delay that when subject is going through this way, it can see whole advertisement segmented to several screens.

One concrete situation experienced by author of the thesis; year 2009, London, subway. Advertising screens were introducing movie The Dark Knight[8] and trailer to this movie were shorted to five seconds. But even whit this shortening, trailer or short montage was perfectly understandable and contain all relevant information like date of the premiere, name of the movie, main actors, etc.

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[8] The Dark Knight, 2008, 152 min, Action/Crime/Drama, USA/UK, production: Warner Bros. Pictures, Legendary Pictures, Syncopy, et al. (Source: IMDB.com, http://www.imdb.com/title/tt0468569/)

4.1.5. SAFETY INSTRUCTION SYSTEMS

Safety instruction systems are well known from airplanes, boats, sometimes from metro, buildings, trains etc. Basically by laws of each state there are places, where these systems have to be. Different arrays, instruction posters, navigation sign or stickers, etc. are carrying instructions for evacuation or other life saving orders.

First example described in this chapter is multimedia screen template used on the ferry between Denmark and Norway (but there could be founded similar systems in other ferries, boats, etc.). This multimedia system has several instruction templates that are changing with different boat and passengers actions. There is different template when passengers are going on board. Next template appears and shows basic orientation system as well as safety instructions. Photo documentation is attached in picture appendix.

During the cruise, safety instructions are alternate with advertisement, weather information, etc. There are also emergency instruction templates, but they do not have primary navigation priority. Multimedia system has advantage that by movement could simply describes (sometimes hard to understand) evacuation instructions. Just paper or just acoustic instructions are hard to follow.

Other example could be information system in free style ski areal Sportgastain, Austria. It informs skiers about situation in area, weather, avalanche danger, tips, snow coverage, etc. It is extremely flexible and also could be connected to plenty of automated machines or sensors.

Any system, especially safety instruction system, could be switched immediately. This is one of the biggest advances, because safety system used another device or information way that could be crucial in saving lives. Multimedia system also allows selecting different scenarios. Disadvantages of multimedia systems are their dependency on electricity and connection to the server; also it is probably more sensitive in extreme conditions than standard safety systems.

4.2. REFLECTION OF CULS SCREEN MULTIMEDIA SYSTEM

Czech university of life sciences has own functional screen multimedia system. It is based on plenty of wide screen LCD and plasma screens with high scale. Maintenance of the systems is provided by OIKT (Odbor informačních a komunikačních technologií - section of information and communication technologies[9]).

System should be filled with information only from one computer, from special environment for managing the database. Displaying on the screens is developed and shown in Adobe Air[10] runtime environment.

This chapter reflected current situation of the system from the technical view, visual style, information utility and finally it is compared with other similar systems.

4.2.1. CURRENT TECHNICAL BACKGROUND

This subchapter is about technical background of CULS multimedia information system. On table below are basic technical details of the system of screens.

Technical details of CULS Multimedia information system	
Year of lunching the system	2005
Total number of screens	13
Number of screens on FEM	2
Number of different announcements per day	10 - 15 (with different length and form of content)
Allocated server capacity (without database)	virtual server — MS Windows Server 2003 R2 Standard, 1 vCPU, 512 MB RAM
Screen service provided by external company	Yes
Other outsourcing processes	No

Table 5 Technical details of current CULS Multimedia information system (Source: CULS OIKT)

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[9] Translation by Author

[10] The Adobe® AIR® runtime enables developers to deploy standalone applications built with HTML, JavaScript, ActionScript®, Flex, Adobe Flash® Professional, and Adobe Flash Builder® across platforms and devices — including Android™, BlackBerry®, iOS devices, personal computers, and televisions. (Source: Adobe official website, http://www.adobe.com/products/air.html)

4.2.2. CURRENT VISUAL STYLE

Visual style is based on white/gray/black combination. Main background colour is gray, this neutral colour is not wrong selection. Gray is neutral to

ne but for this cause is neutrality not recommended. System visual style needs to attract attention of the viewer. In this case it should not to be so aggressive, but even university should display some identity.

There are two moving text elements, each in different direction. This is very disturbing, because it can distract viewer and he or she will not able to read neither of them. Also text area on the left is displayed with small font size, for a viewer is necessary to stop, while he or she tries to read the small announcement.

Figure 7 Photo of CULS information screen (Source: Author's archive)

Font selection, except for main announcements text which is in form of bitmap pictures, is sanserif Arial. It is perfect selection, because sanserif fonts are better for reading on screens. Also high contrast black and white combination is perfectly readable.

Announcements itself are too independent on the systems and on other information systems. They are heterogeneous and depend on the graphical sense and skills of the announcement authors.

4.2.3. CURRENT INFORMATION UTILITY

From beginning of working on this thesis goes information utility slightly up. In academic year 2010/2010 was every announcement static picture with unreadable long text. In times of finishing this thesis (February 2012) some features and displaying techniques were changed.

List of features changed in time when this diploma thesis were written (Dec 2010- Feb 2012)

- Time left until start next class
- Animated picture gallery
- University video promotion
- Animated green label with schedule information

Some of the announcements creators reflected that plenty of text on one screen is contra productive and for their announcements created more pictures (connected as gallery) with a sequential information ration.

On the other hand, there is no methodology for creating an announcement and limitation is strong (only bitmap picture form). A lot of time there are just photos from important events from university, but information utility is extremely low.

4.2.4. COMPARING CULS AND OTHER SIMILAR SCREEN MULTIMEDIA SYSTEM

In comparing with other similar systems, CULS system has big potential, because of arrangement of the screens and university server solution. Also system is functional and operates mostly without errors. On the other hand every system change take a lot of time, because there is not enough employees to maintain and improve multimedia information system.

Other attitude will be make extra budget for the system improvement, but this is on managers and school leaders. Every modern technology evolve fast and go out even faster, so there needs to be found optimal solution that is going to be financially acceptable and also do not appears cheaply or technically old.

On the other universities is system similar or is there no screen multimedia information system at all. On the other hand Municipal Library in Prague reconstructed their screen

system and has several very potential features. Also in Prague Municipal Library there is perfect graphical solution as well as good use of social engineering. Timing of the system and respecting of viewer movement is on high level.

Other multimedia information systems are almost incomparable, but it is possible to use a lot of elements. Inspiration for any newly used element in practical part is described from which system inspiration came.

CULS Multimedia information system	
Advantages	**Disadvantages**
Technical	
System is functional, with all used elements	System is filled by one person from one computer (by one person)
Location of the screens	
No dependency on external companies	
Structural	
Separated database could be in some causes advantage	No connection with any other database information system
Picture looks (not colours) on every screen similarly, there is no problem with composition formatting or any other scale/font/problem	Main announcement is always a picture, it is very hard to correct/edit announcement
	No archive
	No online access
	No direct connection to mobile devices (e.g. QR codes)
Esthetical/Graphical	
New features: image gallery	Gray no visually attractive GUI
Video streaming in progress	No corporate (faculty) identity
	Not market advertisement (everything looks like university announcement)
	Missing concept and methodology of creating announcements

Table 6 Advantages and disadvantages of current CULS multimedia system (Source: Author's research)

5. CONCEPT OF UNIVERSAL MULTIMEDIA SCREEN SYSTEM FOR UNIVERSITIES

Creating some new concept is risky and underestimate problem. People usually like to have thinks same as usual. To be understandable on first sight and finally quite original. But it is what they really expects? What they really wants?

Upgrading, changing or making new systems is challenge and connecting, combining, utilization of academic knowledge in theoretical problem is a dignified conclusion of university studies.

In last part is emphasized engineering and system approach. Every improvement is based on theoretical or empirical knowledge. For verification of new system will be necessary to implement system and reflect it with suitable studies.

5.1. INTRODUCTION

Current technological background allows to prepare and create relatively cheaply complex and professional systems. In this work is description of multimedia system for universities, but some parts of this systems are or should be applicable in other multimedia systems.

Concept described bellow is try to be as general as possible. In possible implementation are shown current technologies, but main idea is to create system independent on present technologies.

Author selected systems for universities because of its strong necessity to quickly, transparently and globally give and receive huge amount of information. Every information needs to be precise but brief. Every announcement with concrete target group needs to receive it.

5.2. CONCEPT

Chapter about concept begins with summarizing of participants in new multimedia information system, continues with corporate design and identity of each faculty or department and how they will be represented in the system. Concept part is crucial for every system integration process, because helps to find key problems.

5.2.1. PARTICIPANTS OF THE MULTIMEDIA SYSTEM

Most important is to realize who will be target group who will work with described system. In cause of this work it is all persons on premises of a university. That include teachers, students, potential students, keeping services, technical services, visitors, etc. Every one of them will be in contact with our system but priority for using this system will be different. Table bellow describe every person (generalized to groups as actors) and his potential in using our multimedia system.

Actor	Description of potential interactivity with system
Technical service	Maintenance of the system, receiving global information, suggestions about new technical opportunities
Designer	Preparing new concepts, reflecting system, applying new features
Manager	Providing feedbacks, preparing concepts, creating budget
Teachers	Preparing announcements, reports, etc., receiving global information, control their reports
Students	Receiving global information, receiving information target on specific students groups, reflecting their experience thru feedbacks formularies
Students clubs	Preparing announcements, reports, or other types of propaganda
Visitors/Potential students	Basic instructions or navigation on the university, checking reports
Advertising companies	Advertisement for students, controlling advertisement time
Administrator	Providing settings, filling the system

Table 7 - Actors of multimedia university system, basic description (Source: Author's design)

USE CASE DIAGRAM OF MULTIMEDIA UNIVERSITY SYSTEM

Figure below displays general description of actors and their role in the system. On the left side of the system are actors who are behind the multimedia system and on the right side of the diagram are actors who are on the receiving/passive side. They receive information, practically use system and they are asked to reflect the system. Exception has student´s clubs and teachers, which are allowed to create announcements and teachers are also allowed to edit announcements, reports, etc. In cause of student´s clubs, there is defined mechanism for confirming their announcements or reports.
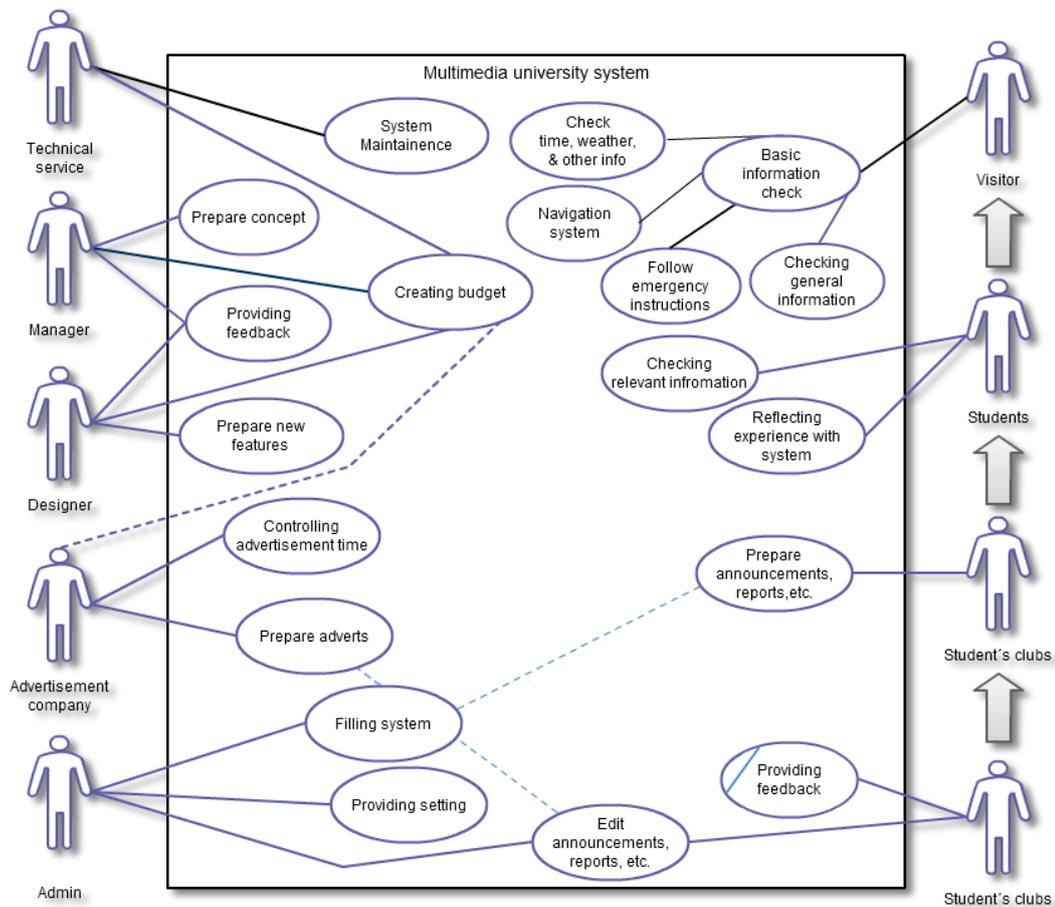
Figure 8 Use case diagram of Multimedia university system (Source: Author's design)

Table below is an description of each use case in the system in details with all relevant information needed to understand their role. There is no restriction of numbers of each actors. For example, designer should be one person on part time, external company or teacher with extended agency.

System is ready to work on any number of participants, but there are always technical limits. Second big limitation is time schedule (described in chapter 5.2.4 Time).

Actor	Use case	Description
Technical service	System maintenance	Usual system technical maintenance
	Creating budget	Technical service it has their own part in creating budget, because they have view of current technologies and money needed for regular maintenance of the system.
Manager	Prepare concept	Creating of concept, functions, elements, peoples involved in project, etc.
	Providing feedback	Providing feedback of the system; mostly focused on effectively functioning system
	Creating budget	Cf. technical service
Designer	Providing feedback	Cf. manager
	Creating budget	Cf. technical service
	Prepare new features	Reflecting other systems and look for elements that could be used
Advertisement company	Controlling advertisement time	Checking if their requirements are fulfilled
	Prepare adverts	Prepare adverts in system interface, put their elements to the system
Admin	Filling system	To fill the system with relevant information
	Providing setting	Setting of time scheduler, number of viewing of each announcements, selecting of faculty screens, etc.
	Edit announcements, reports, etc.	Editing, changing, deleting announcements, allow to make changes in the announcements
Visitor	Basic information check	Every visitor of the university can see information displayed on screen.
Student *Inherit from Visitor*	Checking relevant information	Students are looking also for important information for them; important dates, changes in scheduler, other announcements.
	Reflecting experience with system	Manager prepares feedback options for students. They voluntary reflect the system. Based on these data, manager and his team can make some changes or can avoid any non-relevant functions.

Student´s club *Inherit from Student*	Prepare announcements, reports, etc.	Preparing reports for their actions, events, etc. This information has to be in normalized form described below in chapter XY
Teacher *Inherit from Student´s club*	Edit announcements, reports, etc.	Cf. admin
	Providing feedback	Cf. manager

Table 8 Description of use cases in diagram (Source: Author's design)

5.2.2. CORPORATE DESIGN

Corporate design is graphic design approach that helps to create identity of selected subject as well as keeping it in mind. In case of our university is differentiation of every faculty. Current corporate colours:

Faculty	**Colour name**	**Colour**	**Pantone**
Faculty of Economic and Management	Red		1807C
Faculty of Agrobiology, Food and Natural Res.	Beige		152C
Faculty of Engineering	Blue		072U
Faculty of Environmental Sciences	Teal		321C
Faculty of Forestry, Wildlife and Wood Sciences	Green		363C
Institute of Tropics and Subtropics	Orange		179C
Institute of Education and Communication	Brown		4625C
Czech University of Life Sciences Prague	Yellow/green/white		137C/7484C

Table 9 Faculty corporate design on CULS (CULS OIKT, 2011)

Colour differentiating is well prepared and differences are significant, except for Faculty of Agrobiology and Institute of Tropics and Subtropics, this orange/beige is easily interchangeable.

There were also concept for creating corporate design for every department, some of them are trying to create some identity, but for most of them is colour of their office highest level of differentiating. Also there are too many departments and few colours. Better solution for them is to create strong and special logo for brand recognition.

Czech University of Life Sciences has inner document about graphics. This graphics manual has no ISBN but it is significant for school presentation.

5.2.3. ADDITIONAL FUNCTIONS

For creating system more useful is necessity to create several additional functions. Some of them are passive, some of them are interactive and some of them are used only in special occasions or emergency situations.

Linking functions

These functions allow to the user to record given information or provide link to more detailed information. These functions are strongly connected to plain technologies used by most users. These days is most used social networks (Twitter, Facebook, MySpaceetc.), typical internet formats (www, email) or direct clients (Sykpe, ICQ, Google Talk, MSN messenger, etc.) or device information exchange (QR code, streaming, etc.)

Archive

Data are on the server and it is not hard to supply them to viewers on-line. This archive should be more or less graphically and user friendly, but should became centre of announcements in university.

Emergency templates

Emergency templates are instructions that could be switched on in occasion on danger or emergency exercise. This system should extend classical emergency system, but probably will never substitute it, because of technical limits in extreme conditions.

Other functions

Digital systems evolve in time rapidly. It is necessary to find relevant functions for given situation. Other functions could be video-streaming, empty rooms, lunch menu, etc. There should be strong reflection and feedback in preparing and creating new functions.

5.2.4. TIME

Strong name is representing humongous problem. This chapter is about timing the system and other time limitation problems. It is about peaks, priorities, scheduling and advertisement difficulties.

By unifying length of announcement is possible to find optimal duration for every announcement. Also is important timing other features and elements. Because each of them is focused on different viewer and timing for walking or standing viewer is different.

Other problem is with adverts, because usually submitter of the adverts would like to have displayed advert X times per hour/day. But system timing is different and does not allowed to simply display something X times per hour.

Also there should be different timing during the class and during the break. Because peak is during the break and most of the viewers (students) are moving from one class to another, so there is big potential in spreading information.

5.3. STRUCTURE OF THE SYSTEM

This chapter is about design database structure, structure of the announcement and displaying difference on different device (TV screen, bulletin board, mobile, computer, etc.)

5.3.1. SYSTEM DATABASE

System database is reflecting possibility of using an online archive. This solution is general, it could be implemented in relational or object oriented paradigm. Author's recommendation is object oriented database, because it is simpler to make changes and is easier to make queries.

List of fundamental attributes for database of announcements		
Attribute	**Type**	**Description**
Input date	Date	Date of input the announcement
Event duration	Set	Set of from until pairs of dates
Displaying instructions	Set	Set of necessary instructions for displaying on screens e.g. duration, priority, etc.
Title	String	Title of an announcement
Main information	String	Text of main information, with limitation described in chapter 5.4.1.1.
Details	String	Text of details information with no strict limitation, probably in HTML formatting
Pictures	List	Set of pictures with priorities of displaying
Tags	Set	Set of tags relevant to an announcement
Department	Set	Department or departments that are reporting announcement

Table 10 List of fundamental attributes for database of announcements (Source: Author's design)

Displaying instruction will possibly be special class defined by used software and necessary instructions for perfect system running.

Details should be file in HTML format, but it could be also simple text. This will strongly depend on the implementation and other features used in the system. Details are be available only from other devices not from TV screens (mobile, computer, etc.).

Pictures have their list priority and are displayed in order. There should be problem with QR code or other similar image based system, because if user is already used QR code with his mobile device, he or she does not need to see QR code on his or her device.

5.3.2. DISPLAYING ARCHIVE ON USERS DEVICES

This chapter describes a concept for displaying a database (archive) on other devices than on TV screens. Concept is focused on two currently most used possibilities. These are standard web with connection to the archive database. From information displayed on TV screens it could contain also *detail information*. In this element could be all relevant information, links, pictures, videos, etc.

On the right side are pictures and below them there is area called *other buttons*. There should be all currently used buttons from external services (these days: Google+, Fabcebook, Twitter, etc.).

Figure 9 Concept of on-line archive composition (Source: Author's design)

Figure 10 Concept of composition for mobile devices (Source: Author's design)

Second figure describes interface composition for mobile devices. *Detail information* is a scrolling element and could contain pictures, but it is not necessary for mobile devices. *Other buttons* can contain also button add to calendar that will record event to mobile calendar. *Prev. and next* buttons, allow to user fast simplified linear orienting in archive.

This concept is described in more details in chapter 5.4.2. Web interface and 5.4.3. Mobile devices interface.

5.4. USER INTERFACE

User interface described in this chapter contain concept of the output screens. User interface for filling the system is irrelevant for this concept. For this cause can be used standard web-based forms. There is also assumption, that all of the users that will fill the system with information , will be able to work with this system.

End user interface is the most important part of the thesis. There is concentrated authors improvement based on research of current systems more than two years long. Many of the elements used in practical part of the thesis are existing in different systems. Author's elaboration is combined system that tries to fit as best as possible to conditions on university. Is reflecting current technical background as well as expectation of students. There also left space for possible advertising, because of higher operational cost and big commercial potential.

Every function is formed to create system more efficient from all points of view than current system on Czech University of Life Sciences. Only aspect that determine current situation is that there is no time and sources to improve current information system.

5.4.1. SCREEN INTERFACE

Screen interface of multimedia university system is main and most visible part of the system. Because will be visible most of the time. Basic colour determination is based on currently used corporate design of every faculty on CULS (described in chapter 5.2.2.). For demonstration of all output parts is used colour of author's home faculty - Faculty of Economics and Management with red / light red design.

Author's design is based on co-temporary graphical and web design development approach. Every element of this system is described below with all necessary details for its application.
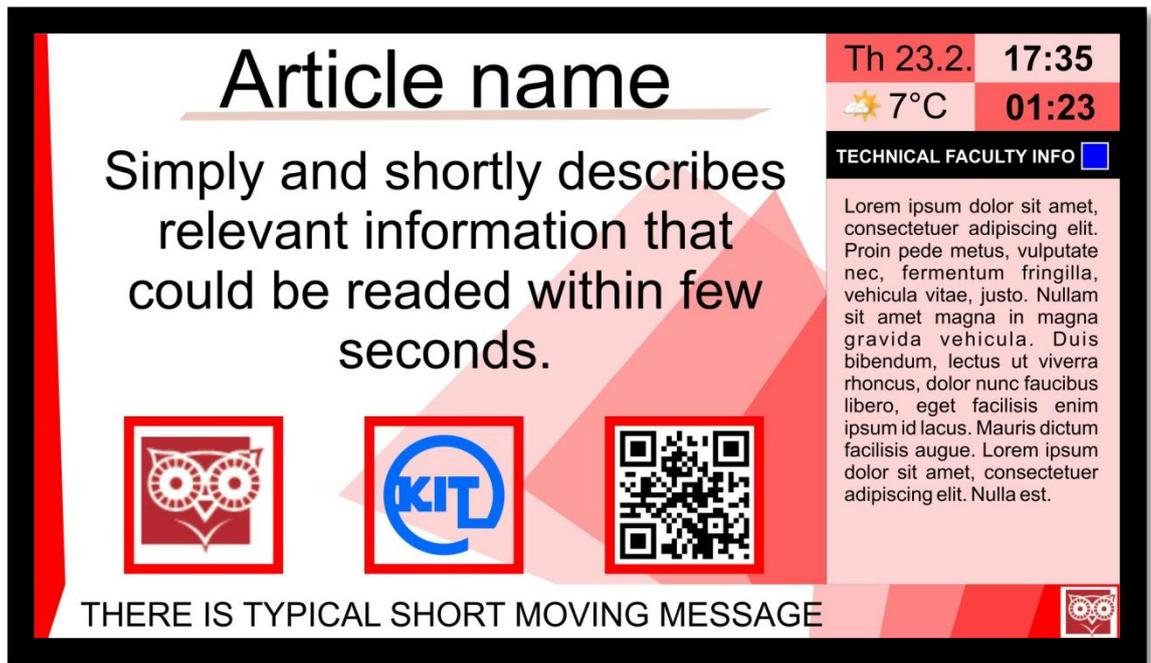
Figure 11 Final design of MIS main output screen (Source: Author's design)

On following figure is described graphically differentiation of elements of MIS and then is every element described in more details.
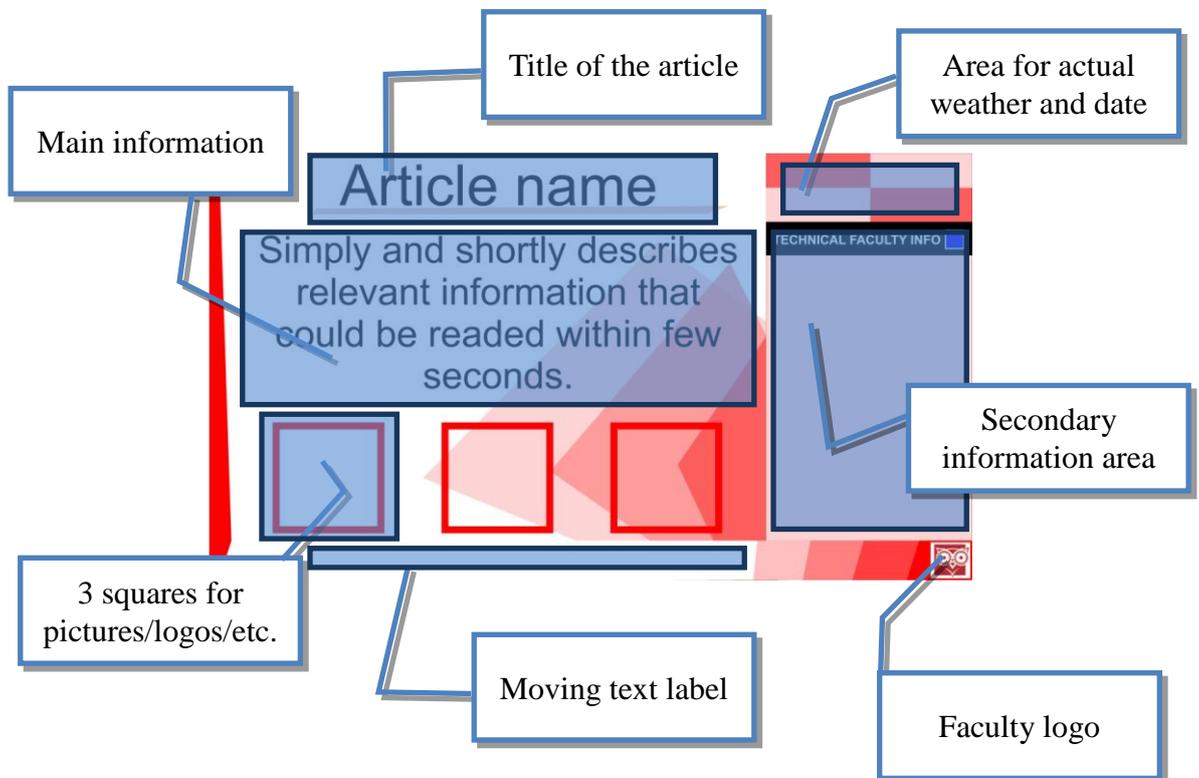
Figure 12 Description of elements of MUS (Source: Author's design)

5.4.1.1. ELEMENTS DESCRIPTION OF MULTIMEDIA INFORMATION SYSTEM

This sub-chapter of thesis is describing all elements of university MIS design. Description is explaining utilization of each element and its potential to for the future.

Title of the article

With current design and setting could me maximally seventeen characters long. It is not only space limitation but also time limitation, because viewer has usually around three seconds for reading whole information. As font is used sanserif type - Arial. Sanserif fonts are easily readable on screens than serif face font.

There is no need for using bold or outlined font. Accent is based on colour contrast black and white. It is a biggest possible contrast from all colours.

Small graphical element creates underline in corporate colour but not in full saturation, it is used lighter tone. This element has irregular shape, but when it will be easier or faster regular rectangle is going to be sufficient.

Main information

Under the article name is main information text. Character limitation is, like in article name, strongly restricted on one hundred twenty. For same reasons as in article heading, shorter information is easily readable in movement and also shorter information is possible to absorb without paying full attention to the text. Font is again sanserif.

It is recommended to use small letters, because they are easily readable. There should be created more specific recommendations for authors of the articles. Because in current situation there is no methodology, how to prepare such article.

It is important to avoid any unnecessary highlighting of the text, because it is short enough to be every single word important. Highlighting of any word should distract viewer and he or she will be enable to absorb whole information in this specifically short time.

Most of the background is white or filled with light-grade colours. This shade of colours do not disturb, distract or make hard to read the information. Font colour is black, so highest contrast is made also.

Three squares

Three squares is most experimental part of author's design. Main idea is based on fact that by eyes is fastest way to receive huge amount of information. Three squares is experiment, that could be changed or dismissed.

Every square should bring information to viewer. One or two squares should bring recognizing information (e.g. corporate logo). The rest should be photos, other kind of graphic attributes (e.g. question mark, exclamation mark, arrays, etc.) of QR code.

QR code is currently very potential element, because allow to link the viewer with relevant more detail information.

For department information is recommended order of pictures:

First - Logo of the faculty (or logo of the university, if it is a general information)

Second - Logo of the department, most of the departments has their own logo and the rest should be thinking about their identity.

Third - QR code with link to on-line version of the article - archive. This is important, because web-article could have more information and also have other features like sharing links of function to move information to viewer electronic calendar.

There should be created list of symbols with specific meanings (e.g. important, up to date, long term, etc.) but this improvement is going to lower the intuitiveness of the system. Because without knowing specific symbols, new-viewer will be strongly handicapped and he or she should misinterpreted the information.

Moving text label

Moving text label is well known element from television screens. Current viewer is used for receiving information in this form. Moving text is only on white label, black colour, sanserif. Area of moving text is simply as possible, because in every movement (50Hz means 50 changes per second), this area needs to be recalculated by computer. Text shadows or other highlighting effects are not recommended.

Moving text label is specific element and information in this panel are focused on viewers which are not in move and they are going to wait for whole information. There is no text limitation, but for staying focused is recommended two hundred characters.

Area for actual information

This is also well know and used element. Number of fields in this part is adjustable. In author's design is two on two table with all information used on current university system: time, time left to next class, weather and date. Importance of the weather is in author's opinion low, but plenty of people likes it.

Location of this panel is in right top corner, because it is secondary information and viewer is reading from left to right, so this detail information do not disturbed him or her.

Text is on not so contrasted background, because if viewer need this information he or she is going to focused on this area. Also lowering the contrast in this part leads attention to main article.

Secondary information area

Secondary information area has also easily readable heading and text, but contrast and basic colour settings is different because of lower importance. Heading is on black background and text is white, bold, sanserif. That makes it easy readable, but location of this element is on the right site, so it do not disturb attention from main information area.

Background of this area is light tone of defined corporate colour. It fits in to the whole concept but information text is still easy to read. For faculty identity is there small square, that can change colour.

This area can contain longer information focused on viewer which is not moving. There is also advertisement potential.

Faculty logo

This is small graphical element that underlines all corporate design of multimedia information system screen.

5.4.2. WEB INTERFACE

Concept for web interface is described in chapter 5.3.2. Displaying archive on users devices.

Web interface is important element of described new concept and design of university multimedia information system. For purposes of archive is enough standard web site with described layout. If there will be bigger change in whole information system and one server become centralised for all announcements than will be necessary to add new features. Web standard of information this site is very high and university needs to reach this standard.

Idea of centralisation of all information sources is almost impossible, so author skip the idea of central website. For purposes of multimedia information system is going to be archive of announcements sufficient.

 For creating website could be used graphical design of output screen with respect to corporate design and other features. From chapter 5.4.1.1. Elements description of Multimedia Information System.

5.4.3. MOBILE DEVICES INTERFACE

Concept for web interface is described in chapter 5.3.2. Displaying archive on users devices.

Mobile displaying have to accept small size of mobile devices screens. Also has to respect different control mechanisms. Most of mobile devices with internet access have touch screen, but not all of them. Also memory and computing capacity is limited. On the other hand many mobile devices can without any problems browse on regular web pages.

Balance this part of multimedia information system is not easy and final realisation will strongly depend on budget of whole project. There are not exact prognostics, but possibly in few years will most of the students have mobile device with sufficient computing capacity. So creating mobile interface will be inefficient.

5.4.4. TEMPLATES AND OTHER FEATURES

This part describes pre-prepared templates that features, that could be useful in specific situation. Displaying these features in specific situation could be useful for the viewer but also crucial.

5.4.4.1. TEMPLATES

Templates are different settings that are switched on in special occasions that are prepared for. It could be divided into two groups, expected and unexpected (emergency situations). In both occasions it is non-standard situation that needs different attitude. Potential student on entrance examination is probably not interested in dates for checking blue book. It is important to bring him or her relevant information in this special situation.

Entrance examination

Entrance examination is seasonal situation essential for university. Student is not only in position of accepted/declined but he or she is also sometimes selecting from different universities or possibilities. Functional information system carrying relevant information for him or her could be sign of good communication between school and students.

Relevant information during time of entrance examination is:

- Navigation upon building
- Where and when could be found results
- Conditions on entrance examination (what is allowed, what is needed for identification, etc.)
- Actual situation (time left to examination, examination in progress, etc.)
- Interesting points of study program/ about university

Conferences

Conferences are similar situation as entrance examination. University or its part has many visitors which do not know the object. Also they are expecting some navigation and schedule information. This could be realised by printed documents or by

multimedia information system (or both). Special element used during conferences could be video streaming. Video streaming element allows more smooth movement of visitors during seminars. This could be connected with voice transcription described in chapter 5.4.4.2 Features.

Relevant information for displaying during conferences:

- Navigation upon building

- Conference details, program, etc.

- Actual situation (seminars in progress, schedule, etc.)

- Interesting points about university/ university research

- Adverts

Evacuation

Evacuation template should be switched on during evacuation exercise, smaller or dangerous emergency situations. System should provide information about escaping the building effectively until system be functional. Idea came from ferry boat, where is during cruise shown escape roads and are animated simulations for escaping. This feature should be applied during classes, when is changed viewer interest and also it is vital for him or her.

Evacuation template should be connected to emergency system or could be switched manually. Second solution is highly dependent of human factor, bud could be more precise and relevant for emergency situation.

5.4.4.2. FEATURES

Features are other systems that could be connected with multimedia information system. These systems supposed to be relevant with current situation and system. These features are strongly connected to current technical background, devices used be users and connected systems.

Free rooms

Free rooms are feature focused on students who are looking for empty room for study purposes. Special occasion is looking for empty computer room, when student needs to work with internet, licensed or other programs. System should be connected to hroch.czu.cz[11] and for more precision there should be possibility adding also empty rooms in situation of cancelling classes or earlier ending.

Voice transcription

While will be video streaming used, streaming of audio is possibly noisy. Voice transcription features are better and usable these days. Figure is showing possible application. Part of video could be covered by black square with set opacity (from 30 to 50%). In this area will be moving white sanserif text. This captured and transcript text could be used also for documentation such seminars.

**Figure 13 Video transcription preview (Used photo: iZun.eu,
Source: Author's design)**

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[11] Hroch is student information system on CULS

5.4.5. EYE LEVEL BULLETIN BOARD

Eye level bulletin board is special technical feature that could be applied in place of typical magnetic or cork bulletin board. Television screen is installed in eye level and proportion of articles is different. Idea is the same like in regular bulletin board, but instead of printing tons of paper, announcement is just displayed on screen.

For bulletin board are valid same rules as for output screen recommendation (described in chapter 5.4.1.1. Elements description of Multimedia Information System) with this differences:

- Font size could be significantly smaller, because it is expecting different position of screen
- There should be more articles on one screen
- Bulletin board can contain features like, *today special events* or *calendar* with most important upcoming events
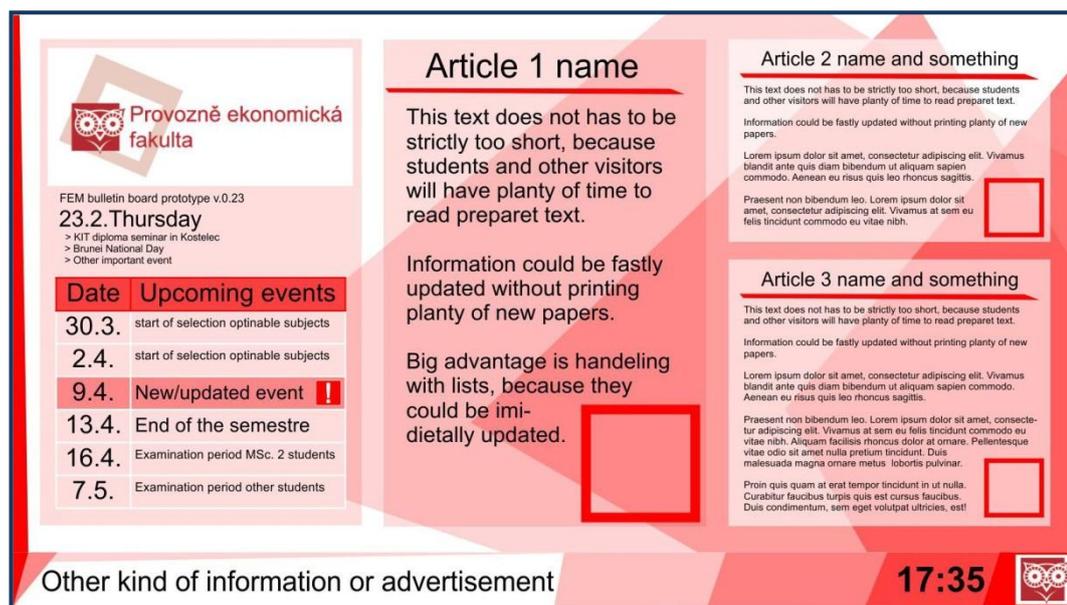
Figure 14 Design of eye level bulletin board (Source: Author's design)

Bulletin board is only concept that need significant changes in technological background. This idea is fully functional in Sportgastain, area for Skiing, where are on screens provided information about current snow situation.

Screen system has plenty of advantages. It could be semi automatic, e.g. list of students with any rest is actualized immediately without new printing or hand writing. Other example is that outdated information simply do not appear on the screens.

Ecological aspects (saved paper) should be question for different study, but Economical aspects are not hard to calculate.

Main disadvantage is new screens that needs to be bought and create new environment for displaying announcements. Also provide staff training for filling the system.

5.5. USED SOFTWARE AND TECHNOLOGY

This is a last subchapter and describes software used for creation concept and design of multimedia information system. All software used is licensed due to a policy of software corporations and their Student editions that are much cheaper than commercial versions. These lower budget versions allow to non commercial subjects - students to work with legal and fully supported software.

Graphical software

CorelDRAW X5 - Software for vector graphics, creating concepts and final graphical design of output screen and bulletin board.

Adobe Photoshop - Colour corrections, adjusting photos, work with bitmap files.

Microsoft Office 2007 - MS PowerPoint for diagrams and final presentation, MS Word for thesis itself.

Multimedia platform

Adobe Air® runtime - Environment for displaying output screens

HTML 5 - Creating the website, mobile phone interface

Cloud solution

Dropbox.com - Archiving and backup, exchanging sources

Technological devices

Canon 550D - most of the photo documentation.

PC/Notebook - both with Windows 7 - hardware necessary for creating thesis and running all of above software.

Scanner Cannon - Scanning pictures from book sources

6. CONCLUSION

The thesis describes all current elements of the multimedia, using scientific and technical literature. Based on the knowledge from the literature overview, the author has reflected the current situation in the historical context, describing and commenting on several multimedia theories.

The next task was to find a concrete task with the possibility of improvement by the multimedia. For this purpose, multimedia information systems (MIS) were selected. These systems were studied and reflected upon for two years, and some of the author's research and the most relevant samples could be found in the attachments of the thesis.[12]

The main practical goal was to improve the university television screen system. This task consisted of reflecting the current system, designing new concept and new elements. Thesis offers several very relevant features that were added or mentioned for a future implementation.

The design of the new concept made use of UML methodology for diagrams, graphic design and web development approach, database knowledge, other skills and technical knowledge based on informatics studies.

The newly created concept of the multimedia information system improves the existing system and enriches it with new features. Almost every designed function, feature or template does not need buying any new technical devices or licensed software, it only needs changes in databases and the displaying platform.

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[12] Attachments page 76

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ATTACHMENTS

Figure 15 Metro station in Oslo (Source: Author's archive)

Figure 16 Metro station in Oslo, detail on screen (Source: Author's archive)

Figure 17 Small buffet in København (Source: Author's archive)

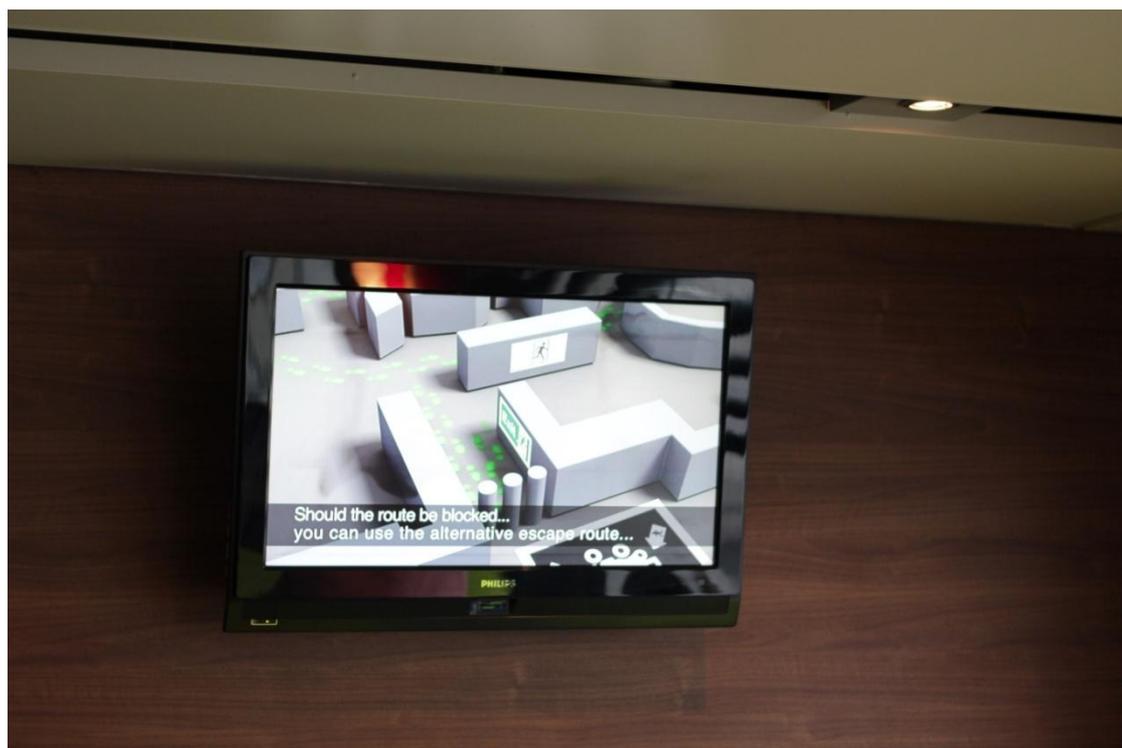**Figure 18 Small buffet in København, detail on menu (Source: Author's archive)**

Figure 19 Escape instructions on ferryboat (Source: Author's archive)
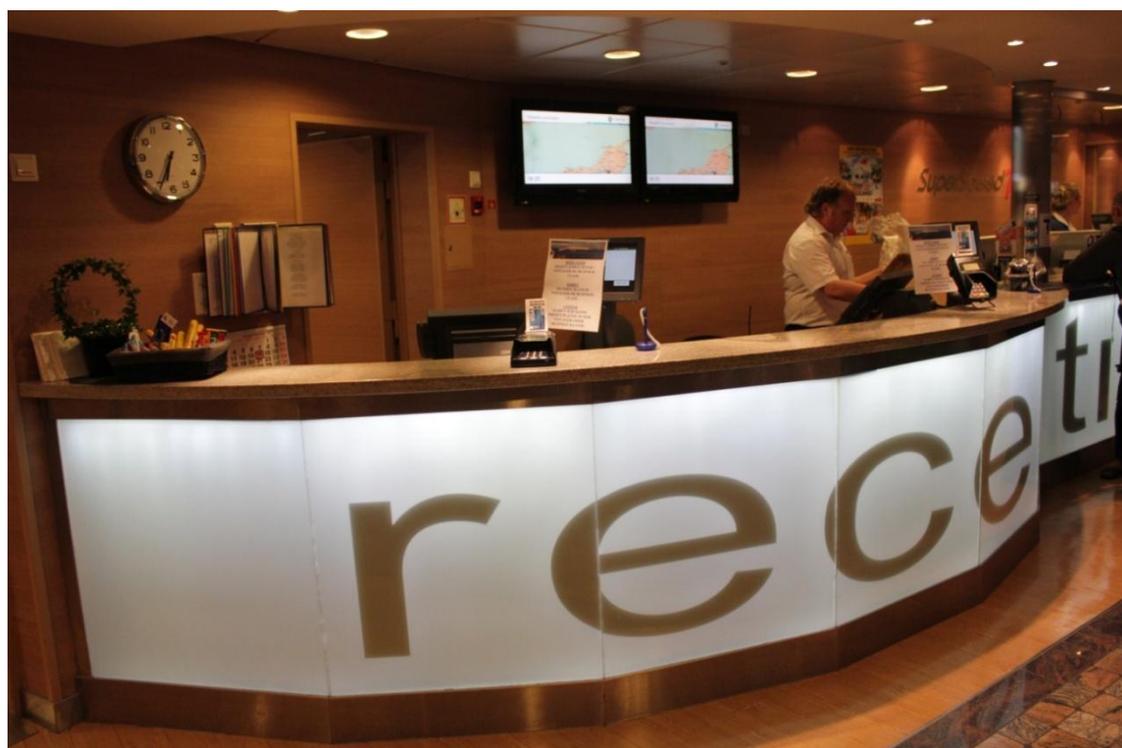

Figure 20 Map behind reception on ferry boat (Source: Author's archive)

Figure 21 Advertisement in shopping centre on ferry boat (Source: Author's archive)

Figure 22 Train station in Bergen (Source: Author's archive)

Figure 23 CULS information system before mess hall (Source: Author's archive)