1) Human perception specificities:

This part of the review is a brief introduction to the large and growing sphere of studies focused on how our brain perceives information. It also will provide the reader with information related to the concepts of textual information encoding, using basic primitives, such as points, lines, areas and volumes [Dhiel, 2005], and their properties, which are colors, shapes, positions etc, as well as, more complex presentational approaches.

There is a large volume of published studies describing the fundamental difference between how our brain perceives, processes, and retrieves visual and textual information. Sperry et al. has suggested that each of the human brain's hemispheres contains a detached processing unit. The fact that each part of the brain responsible for different subtasks, when observing the environment was further studied by [Pai, 90]. The researchers have conducted a number of experiments demonstrating the peculiarities of the verbal and visual memory. The "dual-coding" theory, proposed by the authors, was verified by PET(positron emission tomography) and fMRI(functional MRI) that compared the results of memory experiments between verbal and visual studying approaches. It was found that learning the textual information along with their images has improved participants' memorizing performances.

There are quite a few visual properties that affect cognitive and perception abilities. Some of them, such as Colors, Shapes are presented to the reader in this part of the Review Chapter.

Our eyes see the world in colors, this is the human representation of lightwaves of different lengths. There are some colors that draw our attention more than the others [Maier et. al., 07]. In a recent research Fatma Cubuk et al. conducted a number of Visual-Spatial Aptitude tests, which have proven that cognitive tests were solved generally better when suggested on white background, and have proven quite the opposite with a grey background, by measuring the brain activity zones during the process. The results have also shown that some of the colors produce the brainwaves that are more likely to be found when the brain is more active.

Forms and shapes are also properties that can affect the effectiveness of studying the information. In [HBE96], the author suggests that the features of visual objects are preattentive if they are perceived within 200 ms, i.e. the time interval it takes before the eye reacts and moves. Among the properties that are analyzed preattentively, the author mentions shapes, orientation, sizes, numbers of objects etc.

All the above mentioned properties do not guarantee the proper perception, due to the chance of information overload, and structural complexities of data. According to [S. Risch, 2006] "Image schemas are thus theorized to form a crucial link between perception and cognition, with obvious implications for information visualization. " Metaphor usage is an approach to address such issues. Stephan Dhiel defines a visual metaphor as "analogy which underlies a graphical representation of an abstract entity or concept with the goal of transferring properties from the domain of the graphical representation to that of the abstract

entity or concept". There are some state-of-the-art solutions in the domain of Source Code visualization that we will consider later in the chapter, however none of those solutions adequately address the problem of Source code Evolution visualization.

2) The brief history of VR and AR development.

New technologies often drive the development of the software products. Research into the sphere of Augmented and Virtual realities has a long history. The first recorded AR or VR reference can be found in L.Frank Baums "The Master Key" book, published in 1901. The author mentions a device that is "spectacles" with which "while you wear them every one you meet will be marked upon the forehead with a letter indicating his or her character". More than than six decades later, the first prototype of the VR device has been built by [Sutherland, 63]. The original device

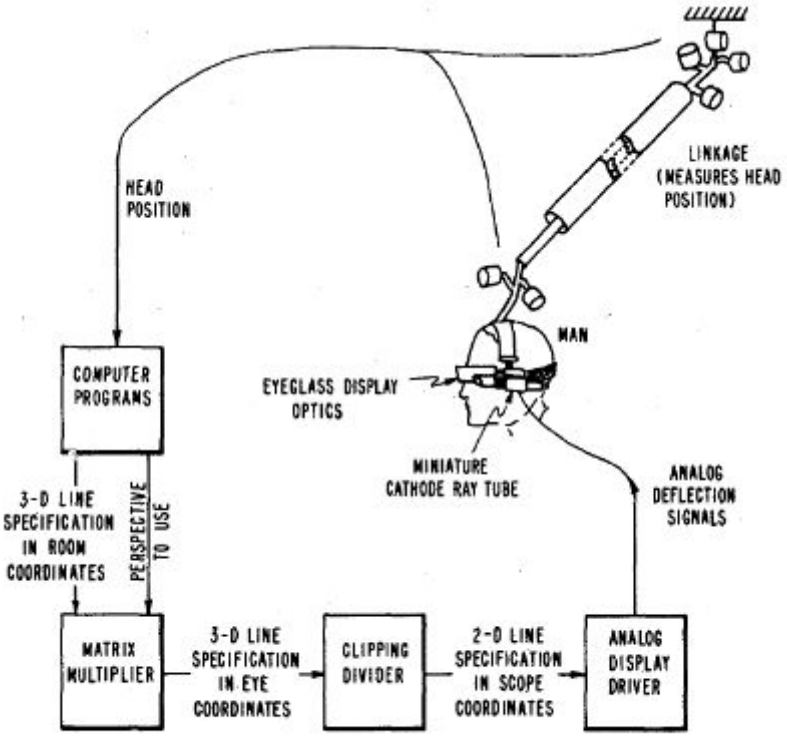

FIGURE 1—The parts of the three-dimensional display system

was extremely heavy, due to such property was given a name "Sword of Damocles". Sutherland et al. have developed a first HMD(Head Mounted Display) that started to keep track of the user's head movement.

Since then, many technological inventions have been produced and introduced to the wide audience, inducing the developers and researchers to come up with more elegant solutions. For the first time the term AR was used in 1992 by Caudell and Mizell. In these three decades the sensors have become smaller and more affordable, handheld devices productions have started to include AR capabilities in their smartphones. Such libraries as Google AR Core and Apple ARKit have become available for a common audience on the compatible devices. Due

to the current gap in the research in this particular direction of AR usage, the topic seems to be indeed interesting.

3) Software visualization

With much research done in the area, the division of the software visualization into three main directions seems to prevail. It is also, according to the S Dhiel, that the visualization can be done using three main approaches.

The first approach is to look at the static parts of code, the relations between the components. Such analysis can be done without running the program and requires a set of metrics to be defined. Software metrics have been researched for decades, some of them have been proven to be effective for particular purposes. Static code metrics have traditionally been used to track the dependency structure, to achieve code optimization, and structural consistency of the project. Chidamber and Kemerer [Chi-Kem, 99] LoC(Lines of Code) metric has been used in the 3 dimensional source code visualization, as an important visualization characteristic for one of the City in [Knig00]. However, the work did not contain other important metrics to visualize. A goal of this research is to prove the effectiveness of using all the 6 metrics for Static Source code visualization.

The second approach that has recently become more and more popular to look at is to measure and visualize the evolution of the software. After two decades of continuous growth, many researchers provide a great body of knowledge in this particular area. Most of the implementations of the 3-dimensional City metaphor does not handle the Evolution of the Software. It is a research gap that this work is also aimed at filling.

Last, but not the least is the Behaviour visualization, or else called Runtime visualization. The execution can be seen as a sequence of program states, where a program state contains both the current code and the data of the program.

To be continued...

1) [1901 - L.Frank Baum - “The Master Key”]
2) [The Sword of Damocles] http://cacs.usc.edu/education/cs653/Sutherland-HeadmountedDisplay-AFIPS68.pdf
3) [44] Caudell, T. P. and Mizell, D. W. (1992). Augmented reality: An application ofheads-up display technology to manual manufacturing processes. InProceedings of theTwenty-Fifth Hawaii International Conference on System Sciences, volume 2 ofICSS’92, pages 659–669. IEEE. (page 1, 15)

4) [Pai90] Allan Paivio. Mental Representations: A Dual Coding Approach. Oxford University Press, New York, 1990.
5) Visualization helps to exploit the mind's capacity by integrating both hemispheres. Using both verbal and nonverbal representations for the same kind of information is often referred to as the dual-coding theory [Pai90].
6) Color and psychological functioning: The effect of red on performance attainment [M.Maier et al.]
7) Chidamber and Kemerer Object-Oriented Measures