Chapter 3
Simultaneous Perception of Parallel Streams of Visual Data

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ABSTRACT

This chapter presents a study of the perceptual processes that condition the parallel processing of visual data and thus could become a design tool to manage the transfer of information. This allows the designers to analyze and consciously plan this process, taking into account the perceptual mechanisms involved. The chapter combines knowledge from the fields of cognitive science, geometrical optics, graphic design, and—last but not least—it utilizes the author's experience in architecture gained from the study of transparency perception.

1. INTRODUCTION

Learning is a complex process. Various abilities and skills are responsible for success in this field of human's activity. These critical skills include: attention, working memory, processing speed, long-term memory, visual processing, auditory processing, logic and reasoning. As these "skills are interdependent" (Gibson, 2007) the processing of the information could be put to the consideration separately. Following chapter concentrates on the human's ability of visual discrimination (filtration) of images received. It also discusses the exploitation of this mechanism in order to increase the learning performance through proper visualization of knowledge.

Simultaneous perception of parallel streams of information has long been an immanent part of the human mechanism of data reception. It came about as an evolutionary answer to the increase in the complexity of the stimuli received from the environment. This concerns every type of information received at the sensation stage of perception: images (visual), sounds (acoustic), smells (olfactory), as well as tastes (flavor), and tactile stimuli. As humans obtain 90% of their knowledge on their surrounding environment through sight, the processing of visual data seems to be a key source of information, affecting the transfer between the human's surroundings and the brain and thus being vital in the visualization of knowledge.

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2. BACKGROUND

The issues of simultaneous perception of visual data have been long a main theme of consideration in science since the beginning of the psychology in XIX century. This discipline originated from philosophy and gradually progressed towards the understanding of the issues of perception based on the physiology of human's eye and the brain's capacity to process perceived information. Issues of perception are the basis for understanding not only the phenomenon of the information flow, but – what is of the utmost importance in learning – the priority of one information over the other: *the precedence*. The knowledge of the processes facilitates the effective visualization of knowledge, improving the sender's control over the information received by recipient. The understanding of these issues is critical of the use of graphic and visual symbols in cognitive learning.

3. UNITS AND MEASURES

Humans are surrounded by optical energy – light that is faring in every direction through every point in the space, or simply put – a light field. The singular component of the light field is a luminous flux that produces the images humans perceive. Luminous flux was chosen as a photometric measure for all the discussion presented below, because it "takes into consideration the varying sensitivity of the human eye" (Brzezicki, 2013) and had been previously used in literature considering visual reception to describe optical phenomena (Wiggington, 2002). The unit of the luminous flux is the lumen (symbol: lm), defined as 1 candela emitted into the solid angle of 1 steradian (a full sphere has 4π steradians).

In simple means, the luminous flux could be compared to the wind. Humans can not see the wind, humans can only observe the results of the wind's activity: flags flapping, leaves flickering and the gust on the face. Analogously, humans can not see the luminous flux, but only the results of its activity: light reflected off- or transmitted through various objects i.e. the luminance of surfaces.

4. VISUAL INFORMATION PROCESSING

4.1. Data Reception Phase

Visual system relies upon the changes in luminance and its particular configurations, caused by light reflection or absorption by the object. The images of the objects surrounding the observer – the visual data – are projected onto the retina via the optical system of the eye. The photons of light reaching the retina stimulate the retinal receptors, which – through complex electrochemical processes – turn them into electrical signals. Direct contact stimulates the photosensitive retina cells. The light stimulus (optical energy) is thus transformed into a sequence of electrical impulses, which are further processed in the appropriate structures of the brain. Retinal image (real, reduced, inverted) is further processed by the human visual system at three different levels: low-, mid-, and high.

4.2. Levels of Information Processing

The processing of incoming visual signals is divided into three basic stages (Keil & Wilson, 2001), which should be referred to as levels. "The analysis of sensory input occurs in small steps, each of them processing information received from the previous level" (Lindsay & Norman, 1977). The division into levels stems not only from the individual tasks carried out within each stage, but also from the varying anatomical spatial location of the regions processing the stimuli within the brain.

The low-level data reception phase is sensation – the initial stage of perception. In the case of visual stimuli, it consists of transforming light (optical energy) into a sequence of electrical impulses as a result of the transduction phenomenon (Jaskowski,

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