

# Chapter 1.10

## Learning Space in Virtual Environments: Understanding the Factors Influencing Training Time

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### ABSTRACT

Learning the spatial layout of an environment is essential in application domains including military and emergency personnel training. Traditionally, whilst learning space from a Virtual Environment (VE), identical training time was used for all users - a one size fits all approach to exposure / training time. This chapter, however, identifies both environmental and individual user differences that influence the training time required to ensure effective virtual environment spatial knowledge acquisition (SKA). We introduce the

problem of contradicting literature in the area of SKA, and discuss how the amount of exposure time given to a person during VE training is responsible for the feasibility of SKA. We then show how certain individual user differences, as well as environmental factors, impact on the required exposure time that a particular person needs within a specific VE. Individual factors discussed include: the importance of knowledge and experience; the importance of gender; the importance of aptitude and spatial orientation skills; and the importance of cognitive styles. Environmental factors discussed include: Size, Spatial layout complexity and landmark distribution. Since people are different, a one-size fits all

DOI: 10.4018/978-1-60960-587-2.ch110

approach to training time does not seem logical. The impact of this research domain is important to VE training in general, however within service and military domains ensuring appropriate spatial training is critical in order to ensure that disorientation does not occur in a life / death scenario.

## **INTRODUCTION**

The ability to ‘learn’ the environment before engaging in navigation is an area of interest for a variety of application domains (Egsegian et al., 1993, Foreman et al, 2003). Traditionally spatial training is accomplished by providing users with maps and briefings of an environment. These methods, however, only provide topological (survey) knowledge of the environment, which whilst being more flexible, pays little attention to the details of routes and landmarks (Thorndyke, 1980; Golledge, 1991). Procedural learning has a distinct advantage over survey knowledge, as can be seen in an experiments of Thorndyke and Hayes-Roth (1982) where participants with procedural knowledge of an environment, estimated route distances significantly better than participants who had acquired just survey knowledge. Navigation therefore relies heavily on previously acquired visual information, e.g. the process of re-orientation during navigation in a previously visited environments (Montello, 2005), which relies on previously seen “visual references” in order to adjust bearings during navigation. Maps and other traditional navigational equipment cannot provide the same level of supporting information. VE training, therefore, promises to provide procedural knowledge through exploration, and has caught the attention of a variety of researchers all attempting to discuss whether virtual training is more efficient than training through more traditional methods (Witmer et al., 1995; Goerger et al., 1998; Waller et al., 1998; Foreman et al., 2003).

Learning in virtual environments relies on the ability of users to develop an understand-

ing of space by creating a cognitive map of the environment (Asthmeir et al., 1993; Cobb and d’Cruz, 1994; Silverman and Spiker, 1997; Clark and Wong, 2000; Riva and Gamberini, 2000). Cognitive maps are mental representations of space that people develop in order to acquire an understanding of space, both virtual and real, through either procedural knowledge or survey knowledge (Thorndyke, 1980; Golledge, 1991; Witmer et al., 1995; Goerger et al., 1998). When learning in a procedural manner, cognitive maps are created through the act of navigation (Montello, 2005). Navigation itself is made up of two separate and very distinct processes. The first of these processes is locomotion, which is the movement of a person within an environment. The second process is way-finding, which is the planning of routes that a person undergoes when trying to get to a specific destination (Montello, 2005). It is understood that during self-directed locomotion (where the person is actively moving about in the environment solving problems - such as avoiding obstacles), there is a tendency to acquire more spatial knowledge (Feldman & Acredolo, 1979). Virtual environment training, however, provides self-directed locomotion without the possibility of a dangerous life-threatening situation, making it very suitable for emergency training.

Research concerning spatial knowledge acquisition through VEs, have provided a variety of contradicting results. The findings, although conflicting, appear to be subject to a key influencing factor, ‘required exposure time’ (Witmer et al., 1996; Darken & Banker, 1998; Waller et al., 1998; Goerger et al., 1998; and Darken and Peterson, 2001). This factor is the exposure time that a user will spend learning the environment in order to achieve spatial knowledge acquisition.

## **THE IMPACT OF TRAINING TIME**

Witmer et al. (1996), Wilson et al. (1996), Waller et al. (1998), and Foreman et al. (2003) all con-

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