Virtual Environments in Design and Evaluation: 
An Aid for Accessible Design of Home and Work Settings for 
People with Physical Disabilities

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Abstract: One of the major challenges facing the professionals involved in the home modification 
process is to succeed in adapting the environments in a way that enables an optimal fit 
between the individual and the setting in which he or she operates. The challenge 
originates primarily from the fundamental characteristic of design – one can see and test 
the final result of home modifications only after they have been completed. The goal of 
this study was to address this problem by developing and evaluating an interactive living 
environments model, HabiTest, which will facilitate the planning, design and assessment 
of optimal home and work settings for people with physical disabilities. This paper 
describes the HabiTest tool, an interactive model that has been implemented via an 
immersive virtual reality system which displays three-dimensional renderings of specific 
environments, and which responds to user-driven manipulations such as navigation 
within the environment and alteration of its design. Initial results of a usability 
evaluation of this interactive environment by users are described.

1 INTRODUCTION

Analyzing and evaluating the suitability of built environments to human activities is 
typically performed only after the construction phase has been completed. The major 
challenges facing professionals originate from the fundamental characteristic of 
design – one can test the suitability of a designed environment only after it has been 
completed. The study described in this paper presents a different approach wherein a 
virtual reality (VR) environment serves as an alternative environment to carry out 
analysis and evaluation before the final realization of the construction phase. Our 
study related to the research framework of VR and environmental modification.
Virtual Environments in Design and Evaluation

1.1 Home Modification Process

People with disabilities are often severely limited in their ability to function independently in their homes or at work as a result of physical, cognitive or sensory environmental barriers (Iwarsson, Isacsson and Lanke 1998). Successful environmental modifications to an existing structure can eliminate these barriers by accommodating age and health related disability thereby turning an environment from one that is disabling into one that is enabling. Such modifications aim to achieve an accessible environment that can be fully utilized by the user for its intended purposes (Nielsen and Ambrose 1999); the goal is to achieve an environment that facilitates the individual's ability to perform every day activities and occupations by providing a compensation for their functional loss. Environmental modifications are an inseparable part of the rehabilitation process in the western world (Gitlin 1998).

Yet, despite 30 years of experience and research, the gap between client needs and successful environmental modification remains large since adaptations to home or public settings present a number of major challenges, starting from the need of achieving an optimal fit between the individual and the setting in which he or she operates (Gitlin 1998). Other challenges relate to the modifications of a private home that require having sufficient knowledge and funds or, in contrast, to modifications of public areas where successful adaptations have to meet the needs of a broad range of disabilities (Palmon et al. 2004). Limited success of environmental modifications are also related to the lack of reliable and valid assessment tools and the lack of common conceptual definitions between the professional parties involved in the modification process (Gitlin 1998).

1.2 Virtual Reality and Environmental Modification

Only recently, virtual reality has begun to be applied to environmental modification and to designing and testing the accessibility of an environment for people with disability (Eriksson, Ek and Johansson 2000, Maver, Harrison and Grant 2001). Eriksson, Ek and Johansson (2000) have developed an immersive, desktop simulation program for the design of barrier free home and work environments. Users view a typical living environment and are able to manipulate objects (e.g., furniture) within the environment. It was found to be a useful planning tool in encouraging communication and participation of all the people involved in the design process. The users of the system enjoyed the opportunity to make modifications and to implement their own ideas for barrier-free design, but participants with physical disabilities had difficulty in adopting a user-centered viewpoint while using it. Maver, Harrison and Grant (2001) developed a wheelchair motion platform that was designed to allow wheelchair users to navigate and explore a virtual representation of buildings. Their aim was to develop a tool that would enable the evaluation of wheelchair accessibility of a building in the early stages of building design or redevelopment of old buildings.