THE DESIGNERWORKBENCH PROJECT
SEMI-IMMERSIVE INTERACTIVE MODELING

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ABSTRACT

The DesignerWorkbench project aims at transforming the classical industrial modeling and design paradigm into its
virtual analog using state-of-the-art three dimensional l display technology, data gloves and spatial tracking. This paper
outlines the fundamental tools and design paradigms required for the implementation of this modeling environment and
demonstrates the usability of virtual environments (VEs) for the simulation of two-handed clay modeling and design
tasks on the basis of non uniform rational B-splines (NURBS).

Keywords: Computer Graphics, Computer Aided Design, Virtual Reality, Virtual and Immersive Environments,
Interactive Modeling

1 INTRODUCTION

As companies focus on streamlining productivity in the pursuit of global competitiveness, the migration to computer-
aided design (CAD), computer-aided manufacturing (CAM), and computer-aided engineering (CAE) systems has
established a new backbone of modern industrial product development. While most of these technological advances are
of high benefit to the engineering and design community, they still lack some of the important visual and haptic features
crucial to product development. A car design, for example, traditionally originates from a clay model, that after
digitization, forms the basis for a numerical CAD description in Bezier, B-spline, or NURBS format. Consequently,
physical models, so called mock-ups, still play a key role in the otherwise CAD-centered development cycles. The
DesignerWorkbench aims at closing this technology gap experienced by design and CAD engineers by transforming the
classical design paradigm into its fully integrated digital and virtual analog (Figure1). Previously complex tasks such as
the creation or modification of objects in 3D space can now be achieved with intuitive hand gestures while working in a
semi-immersive environment. This approach allows the preservation of the hands-on experience from the physical world
while overcoming the well known classical 2D constraints introduced through the keyboard. A powerful feature of this
implementation is its ability to provide an unprecedented amount of real estate for the user in the form of a 3D desktop.
Anyone with experience in working with multiple open and overlapping windows or virtual 2D desktops on a regular
display will appreciate that objects, tools, and other components can now be placed and arranged in an almost unlimited
3D domain.

2 HARDWARE SETUP

The DesignerWorkbench was specifically designed to work with a new generation of stereo projection systems
currently marketed under names like ImmersiveWorkbench, ResponsiveWorkbench and ImmersaDesk. We use the
ImmersiveWorkbench from Fakespace which allows stereo projection of 3D computer-generated images onto an
approximately 2*1.5m projection area. A 4-processors SGI Onyx2 InfiniteReality (225MHz, R10000 processor) system
was used as the rendering engine. The basic hardware setup is illustrated in Figure 2. The user is wearing shutter glasses
with integrated head tracking for stereoscopic viewing and uses a set of pinch gloves for interaction with the VE. The
input devices are described next:

* Stylus: Using a fixed transmitter as reference, this pencil-like system accurately tracks position (x, y and z
coordinates) and orientation (yaw, pitch and roll) of a receiver contained in the stylus. In addition, it provides an
integrated button that can be associated with particular actions.

  Gloves: The Pinch System uses cloth gloves with electrical sensors in each fingertip. Contact between any two or
more digits completes a conductive path, providing a variety of possible "pinch" gestures that can be associated
with distinct actions. Additionally, an attached electromagnetic tracker captures the position of each glove.

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3 IMPLEMENTATION

The core component of this modeling environment is the virtual toolbox. The virtual toolbox merges the advantages of conventional physical tools with the high-precision components of today's CAD systems. Cumbersome operations suddenly become possible by exploiting the strength of the hands-on approach and the possible elimination of physical constraint in the VE. Instead of actually defining tools, the user defines actions and functionality, which can be applied to arbitrary objects in the VE. This approach provides the designer with unlimited space for creativity and the means for the creation of new tools and design concepts. The fact that tools can be used to shape models which then can be turned into tools on their own is one of the crucial features of this environment.

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