N95-14014

VISUAL INTERFACES: THE HUMAN PERCEIVER

Richard M. Held
Massachusetts Institute of Technology
Cambridge, Massachusetts

P- 2

I was asked to speak about how knowledge of visual perception could be applied to achieve teleoperation and virtual worlds. After a little thought I decided that reversing subject and object makes the question more interesting and provocative. The practice of teleoperation and virtual world technology challenges our understanding of perception, and in the following I try to explain what I mean. But first let me say that vision science incorporates a vast amount of useful knowledge about the capabilities of the visual system. Fortunately, most of it is well-codified in the handbooks, of which the most recent and complete is Boff, Kaufman, and Thomas's Handbook of Visual Perception and Performance (1989). Unfortunately, this codified knowledge does not prepare us for the surprises attendant on the sensory and motor transformations effected by the new technologies. Instead, the surprises refer us to much less well understood areas. Hence the challenge to perceptual science from technology.

World Regularities and the Habitual

New technologies make it easy to transform spatially, temporally, and dynamically the relations among sensory inputs and motor outputs. For example, nothing could be simpler than making your hand appear to reach to the left when you intended it to reach to the right, to make you step up when you should step down, make the usually stable visible world appear to move as you move, and so on. The consequences can be **errors** in performance, **disorientation**, and a form of **malaise** like motion sickness. These examples make us realize to what extent our perceptions are dependent upon the regularities and habitual circumstances of our normal world and the dynamics of our actions in it. We are preadapted to these ordered states in multiple ways that are revealed by the effects of applying the new technologies to the human-machine interface. Compared to our knowledge of basic visual processes, our understanding of these orderings is limited but not insignificant. Some of it has been relegated to the fringes of the field as aberrant and bizarre forms of perception. The following table enumerates several types of transformation and examples.

Type	Examples
Spatial Incongruity	Japanese Illusion Sensory Rearrangement
Temporal Asynchrony	Phase Shift Time Delay
Altered Dynamics	Microgravity Force Amplification
Deprivation	Blank Visual Field High Noise Level

Some of these non-habitual conditions may cause initial errors and disorientations. Some show adaptation during continued exposure in the form of error reduction, better orientation, and reduction of motion sickness. Adaptation requires maintenance of a transformed set of regularities. If the transforms are complex and/or if the coupling is noisy, adaptation may be either very slow or not possible at all. However useful adaptation may be, it does take time and represents an additional load on the processing capacity of the system, sometimes called a cognitive load.

Telepresence and Presence

A particularly intriguing problem, related to the above-mentioned considerations, is the creation of telepresence. It raises the question of what conditions specify the sense of **presence** —a question that seems at first blush so obvious as to require no thought. It is the first axiom of perceiving, namely, that the observer be there to perceive. It implies a here and now spatial juxtaposition (confrontation) of object and observer. We can begin to identify conditions for the sense of presence as:

1. Independent perception of an observer and an object external to the observer.

2. Covariation of sensed observer movement independent of the sensed object yields the sense of an object external to the observer.

3. Observer has access to the sensed object at will.

Achievement of these conditions is, in turn, related to the regularities and habitual circumstances discussed above.