HUMAN FACTORS

Organized by John Flach and Yves Guiard

Dynamic Interactive Computer Tests of Driving Performance

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We examine a human factors problem in the spirit of the Ecological Approach to perceiving, utilizing 'flow models' of perception. To develop better predictors of automobile driving performance, and diagnostic and training tools for driving, we have conducted research utilizing digitized interactive video scenarios of automobile driving, displayed via Macintosh computer. We use digitized real-world video running on the computer, recording RT and other responses on the same system. Our aim is to develop low-cost interactive performance-related measures of auto operation using drivers' views of traffic situations. Factors related to visual impairment, e.g., scenario illumination level, can be manipulated from the computer interface. Skill and load-related variables, such as driving speed can be selected by the testee via joystick, or by the tester via interface controls.

Our work examines variations in traffic and road conditions, egomotion velocity, illumination (including night-driving and glare), Tc/Ta, and other variables potentially related to road accidents. Speed and accuracy of responses to traffic signs, signals, and events are recorded. We present results obtained with elderly and younger drivers on these scenarios, contrasting these performances with more traditional psychological measures used to predict driving performance. While responses to higher-order variables (e.g., Ta) are not independent of classical measures of lower-order variables (e.g., magnitude estimates of distance/velocity), they are at best modestly correlated. Implications for theory and applications are discussed.

Everyday Listening, Auditory Icons, and Technology Affordances

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Two of the fundamental concepts of Gibson's ecological psychology—direct perception and affordances—have served as guides in my work on human-computer interaction. The concept of direct perception has influenced my approach to audition and its application in the design of informative sounds for computer interfaces. The concept of affordances has guided my understanding of the opportunities for action offered by systems and the perceptual information that makes these opportunities apparent. The results of this work, *auditory icons* and *technology affordances*, are examples of taking an ecological approach to interface design.

An ecological approach to audition emphasizes our tendency to listen to events in the world rather than sounds per se. This experience, called *everyday listening*, offers a foundation for understanding sound and hearing in a way that complements more traditional accounts. Where standard psychoacoustics focuses on sensations such as pitch, loudness, and timbre, and their acoustic correlates of frequency, amplitude, and spectra, everyday listening is concerned with perceptions of source attributes such as size, force, and material, and their (often complex) acoustic correlates. Studies of everyday listening offer a new framework for understanding and manipulating sound, one based on our perceptions of the world rather than sound itself.

Although we are only beginning to understand everyday listening, the perspective it implies can be used in the design of meaningful auditory cues for computer systems. *Auditory icons* are everyday sounds which represent events by analogy with everyday sound-producing events. Dimensions and features of sources are mapped to those of system events, thus allowing easily learned and recognized representations. Several examples of systems which use auditory icons demonstrate the sorts of functions they can perform. They can indicate ongoing processes and modes, aid navigation, help in coordinating collaborative work, and provide information about the affordances of systems.

Recently I have been exploring the concept of *technology affordances* as a way of understanding how perceptual information can make evident the possibilities offered by systems. The concept provides a concise and useful way to link system attributes to people's behaviors. For instance, the physical attributes of video can be related to its strengths and weaknesses as a medium for communication, leading to new designs. The concept of affordances is also useful in understanding the role of perceptual information in guiding users' interactions with systems. For example, the attributes of events that are communicated by everyday sound shape the affordances they make evident. In sum, work on both auditory icons and technology affordances indicates the utility of an ecological approach to human-computer interaction.

Why Does the Skilled Actor Make It Look Easy? Because It Is !

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Fluent, skilled performance invites a simple, lawful explanation. In all but the simplest of tasks, the environment and goals underconstrain skilled behavior and the emergence of various strategies is observed. Here, behavior is fluent and stereotyped, but the stream of behavior is only one of many capable of meeting task goals. Since such behavior appears to be environmentally underconstrained, it is tempting to locate additional sources of constraint to mechanisms internal to the actor, typically through postulating rules which serve as an internal representation of the actor's strategy. We argue that this theoretical approach has the potential to severely overestimate the degree of constraint internally generated, as it fails to consider that strategic behavior, to the extent it is stereotyped, supplies its own set of environmental constraints on possible action above and beyond those existing in non-routinized human-environment interaction. We therefore consider skilled strategic behavior the product of a bootstrapping process in which a strategy at any point during skill acquisition generates an additional set of environmental constraints; these constraints are subsequently exploited through modifications to the strategy, new constraints are introduced, and so on. While it is still the case that the uncontrolled or unskillfully controlled environment underconstrains behavior, the *skillfully controlled* environment is much more constraining, and therefore much simpler to skillfully control. This theory provides an explanation of the difficulty of learning skills through instruction, as the environmental information upon which the skilled actor selects actions may not come into existence until the environment is *skillfully controlled*, and alternatively, the efficacy of the 'training wheels' approach to learning, in which the actor is exposed to the information available at skilled levels of performance prior to the actor's ability to self-produce that information. The theory is articulated through discussions of laboratory research on skilled behavior in a Tetris video game and naturalistic observation of the skilled behavior of short-order cooks.

Ecological Interface Design: An Initial Empirical Evaluation

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The objective of this research is to develop interfaces for complex human-machine systems which will support operators, not only in routine events, but during unfamiliar and unanticipated events as well. A prescriptive design framework, called ecological interface design (EID), was developed to address this important research problem. According to EID, an interface should represent the work domain in the form of an abstraction hierarchy if it is to properly support operators during unanticipated events (i.e., knowledge-based behavior). To evaluate this hypothesis, an experiment conducted within the context of a thermal-hydraulic process control system was undertaken. The performance of a traditional interface based on a physical representation was compared with that of an EID interface based on a physical/functional representation. Subjects were presented with a dynamic scenario of the process' behavior and were asked to diagnose the event and to recall the final state of the system. There were three types of events: normal, fault, and random. Two groups of subjects were used: theoretical experts in thermal-hydraulics and novices. The experimental findings allow one to derive the following defensible conclusion: An interface based on an abstraction hierarchy representation of the work domain can provide more support for knowledge-based behavior than an interface based on physical variables alone, because it results in a better match to the theoretical expert's mental model.

Natural Intelligence and Artificial Realities

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The use of the term 'artifical realities' to describe information structured as movement-slaved visual flow fields has become so widespread, that it may already be too late to clarify its contradiction in terms. From an ecological point of view (Gibson, 1979) realities consist of substances, media, and surfaces, and they simply cannot be artifical. What can be artificial though, are computer generated *representations* that reproduce the array of light reflected from *natural* realities. A principal, ecological approach to computer representations is presented on the basis of Gibson's (1979, 1977/1982) ideas on displays and degrees of indirectness. The new display technologies are a conglomorate of different categories of perceptual and manipulation tools. As such, they challenge the old distinctions. A new taxonomy for interactions with electronic mediators of information is suggested. Then theories of ecological interface design will be introduced. They have been developed within an area, where artificial (i.e., abstract or invisible) information has been a recognized problem for decades, namely remote control of complex systems. Examples of process control displays will be analyzed in order to outline some ecological principles for displays within artificial environments and to point to areas of potential problems.

References

Gibson, J. J. (1979). *The ecological approach to visual perception.* Boston: Houghton Mifflin Company.

Gibson, J. J. (1982). Notes on direct perception and indirect apprehension. In E. Reed & R. Jones, R. (Eds.), *Reasons for realism.* Hillsdale, NJ: Lawrence Erlbaum Associates.