39TH ANNUAL DISTINGUISHED SCHOLAR LECTURE SERIES

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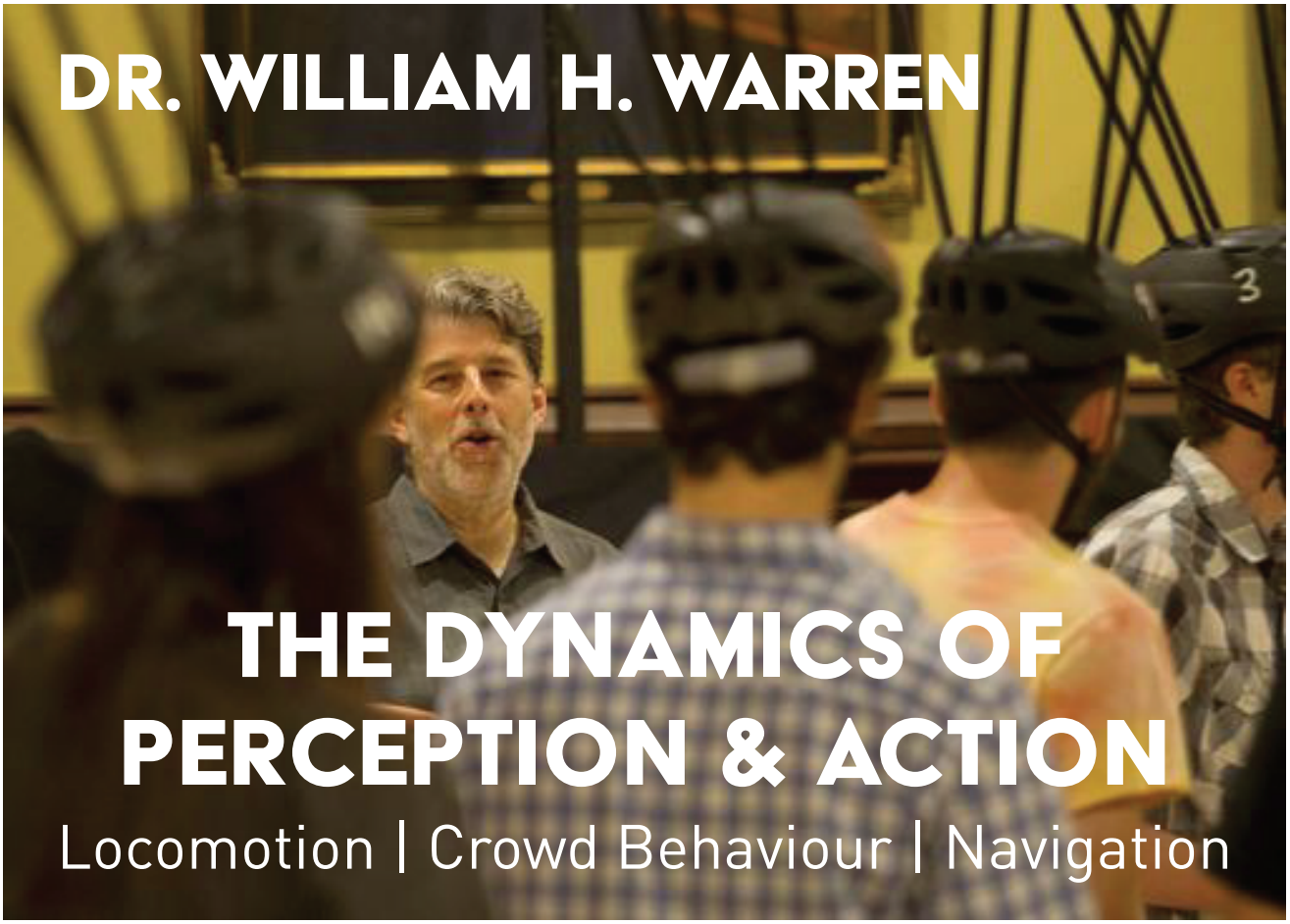

William H. Warren is Chancellor's Professor of Cognitive, Linguistic, and Psychological Science at Brown University and Director of the Virtual Environment Navigation Lab (VENLab). He received his Ph.D. in Experimental Psychology from the University of Connecticut (1982) and did post-doctoral work at the University of Edinburgh (1983). He uses virtual reality techniques to investigate the visual control of human action, including optic flow, locomotion, crowd behavior, spatial navigation, and the dynamics of perceptual-motor coordination.

UNIVERSITY OF ALBERTA
DEPARTMENT OF PSYCHOLOGY

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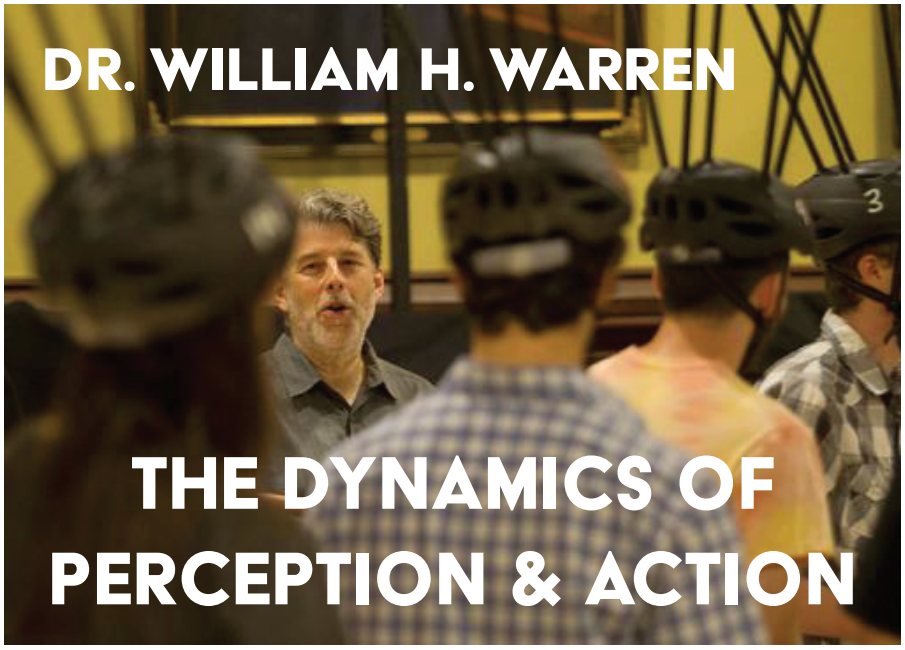

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I. LOCOMOTION

Wed. | CCIS 1-140

How do humans and other animals locomote through a complex, changing environment? I will argue that paths of locomotion emerge in an on-line manner from the interaction between an agent and its local environment. Based on studies of visually-controlled human walking in virtual environments, we create simple dynamical models of steering to a goal, obstacle avoidance, interception, and moving-obstacle avoidance. By combining these elementary behaviors, our 'pedestrian model' can predict locomotor trajectories in more complex environments. Some strategies are strikingly similar to those observed in insect flight control, suggesting very general principles. The results demonstrate that locomotor behavior can emerge on-line as a stable solution of the system's dynamics, without appealing to an internal world model or explicit path planning.

II. CROWD BEHAVIOUR

Thur. | CCIS 1-140

What accounts for patterns of collective motion, such as bird flocks, fish schools, and human crowds? Such collective behavior is thought to emerge from local interactions between individuals. The key to the problem is thus to understand the local 'rules' or visual coupling that govern these interactions. There are many such models of collective motion, but precious little empirical evidence. Based on human experiments with virtual crowds, we model 'following' and characterize the neighborhood of interaction in a crowd. We than use multi-agent simulations of the pedestrian model to predict crowd behavior, and compare the results with motion-capture data on real human crowds. Scenarios like Grand Central Station, Human Swarm, and Counterflow can be successfully simulated with a few components of the pedestrian model. The results support the view that crowd dynamics emerge from local interactions, consistent with principles of self-organization.

III. NAVIGATION

Fri. | CCIS L1-140

How do humans and other animals navigate to places beyond the sensory horizon, which are 'off-line'? It is often assumed that spatial navigation implicates a 'cognitive map,' an internal representation of the environment with a Euclidean geometric structure. Such spatial knowledge could be built up from path integration, as hypothesized for the grid and place cell system. Our experiments on navigation in virtual environments converge with previous research to show that humans (i) have poor and discontinuous path integration, (ii) rely heavily on visual landmarks, and (iii) take highly unreliable shortcuts that (iv) violate the metric postulates. The results imply that humans do not build a geometrically consistent map. I will suggest that spatial knowledge is better characterized as a labeled topological graph that incorporates rough local metric information from the path integration system. Graph knowledge could constrain the pedestrian model by specifying the approximate direction to unseen goals, while the locomotor path emerges on-line. Apparently Euclidean behavior may thus result from minimal spatial knowledge together with on-line control of locomotion.