NASA AMES-DRYDEN T-37 DEMONSTRATION COMMENTS

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At NASA Ames Research Center's Dryden Flight Research Facility we had a homemade PVHD in our T-37 for several years. We did not make an evaluation of the instrument or the concept, but used it to demonstrate the idea to anyone interested. This paper is a summary of my observations, based on riding with a large number of pilots using the system and making several flights myself.

The peripheral vision horizon device (PVHD) we used was made from an eight-ball attitude indicator, with a slit cut at the equator of the eight ball, and a light source at its center. The instrument produced a sharp white line about one-fourth of an inch that extended completely across the cockpit from about the left to the right quarterpanels. The line remained parallel to the real horizon during all maneuvers. Its brightness and vertical distance from the horizon were adjustable in flight, as was the lateral center-of-rotation in later flights.

Flight demonstrations were done on visual flight rules (VFR) moonless nights and over terrain with few lights. Pilot responses were mostly favorable to enthusiastic, with no negative reactions. Problem areas noted were the upright-inverted ambiguity; one pilot recovered inverted following an unusual attitude exercise and a general deterioration in the naturalness of cuing at bank angles greater than 60° or pitch attitudes greater than 30°.

During one demonstration we inadvertently flew into a cloud. Surprisingly, the center-of-rotation in bank suddenly was found to be quite unacceptable at its location in the center of the instrument panel between the two pilots. It caused bank changes to be seen as pitch motions. It was very distracting, and the PVHD was immediately turned off. It was apparent that the few ground lights that had been in the visual field during the previous evaluations were indeed significant. We added a provision for adjusting the roll center-of-rotation in flight, and made another flight at low altitude off the coast of San Diego. No surface lights and very few stars were in view. The importance of matching the roll center-of-rotation with the center of the conventional artificial horizon was confirmed on this flight. Any other location was distracting and unpleasant. Even with the roll center-of-rotation correctly positioned, there remained some anxiety and reluctance to abandon the traditional instruments.

Clearly, the flights we had done did not constitute a system evaluation. They did dramatically illustrate how easily that premature and wrong conclusions could be drawn from an inadequate test. In addition to the usual experimental design considerations, the test environment must provide that no external reference is available and, most important, that the subject must have complete responsibility for the safety and control of his airplane.

In the papers I have heard here I have been concerned that no test has been proposed that addresses the main purpose of the PVHD – to reduce the likelihood of disorientation. I can see three possible approaches to such a test.

(1) A direct approach in which one attempts to document a reduction in the incidence of a rare event – disorientation. This seems out of the question because of the length and size of the sample required.

(2) A direct approach in which one examines the state of the mental process of orientation to find out the effect of a PVHD on that process. This may be beyond the art as we presently know it.

(3) An indirect approach in which the effect of a PVHD on various pilot responses is measured to learn if pilot behavior is made more nearly like that in visual flight by the addition of a PVHD. This does seem feasible to me. It would require that differences in pilot response between instrument and visual flight be known. Responses such as control strategies, control aggressiveness, error "signature" for instrument landing system (ILS) task, postural response, eye scan pattern, and response to additional workload would be candidates for measurements.

I think a measuring tool should be developed so that the PVHD can be evaluated and improved in a rational way. The present process of subjective assessments in a poorly controlled or inappropriate environment will not converge on an effective system, or prove that the system is worth its cost.