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3.2.19 Modified Cooper-Harper Rating Scale

General description - Wierwille and Casali (1983) noted that the Cooper-Harper scale represented a combined handling-qualities/workload rating scale. They found that it was sensitive to psychomotor demands on an operator, especially for aircraft handling qualities. They wanted to develop an equally useful scale for the estimation of workload

associated with cognitive functions, such as “perception, monitoring, evaluation, communications, and problem solving.” The Cooper-Harper scale terminology was not suited to this purpose. A modified Cooper-Harper rating scale (see Figure 13) was developed to “increase the range of applicability to situations commonly found in modern systems.” Modifications included: (1) changing the rating-scale end points to very easy and impossible, (2) asking the pilot to rate mental workload level rather than controllability, and (3) emphasizing difficulty rather than deficiencies. In addition, Wierwille and Casali (1983) defined mental effort as “minimal” in rating 1, while mental effort is not defined as minimal until rating 3 in the original Cooper-Harper scale. Further, adequate performance begins at rating 3 in the modified Cooper-Harper but at rating 5 in the original scale.

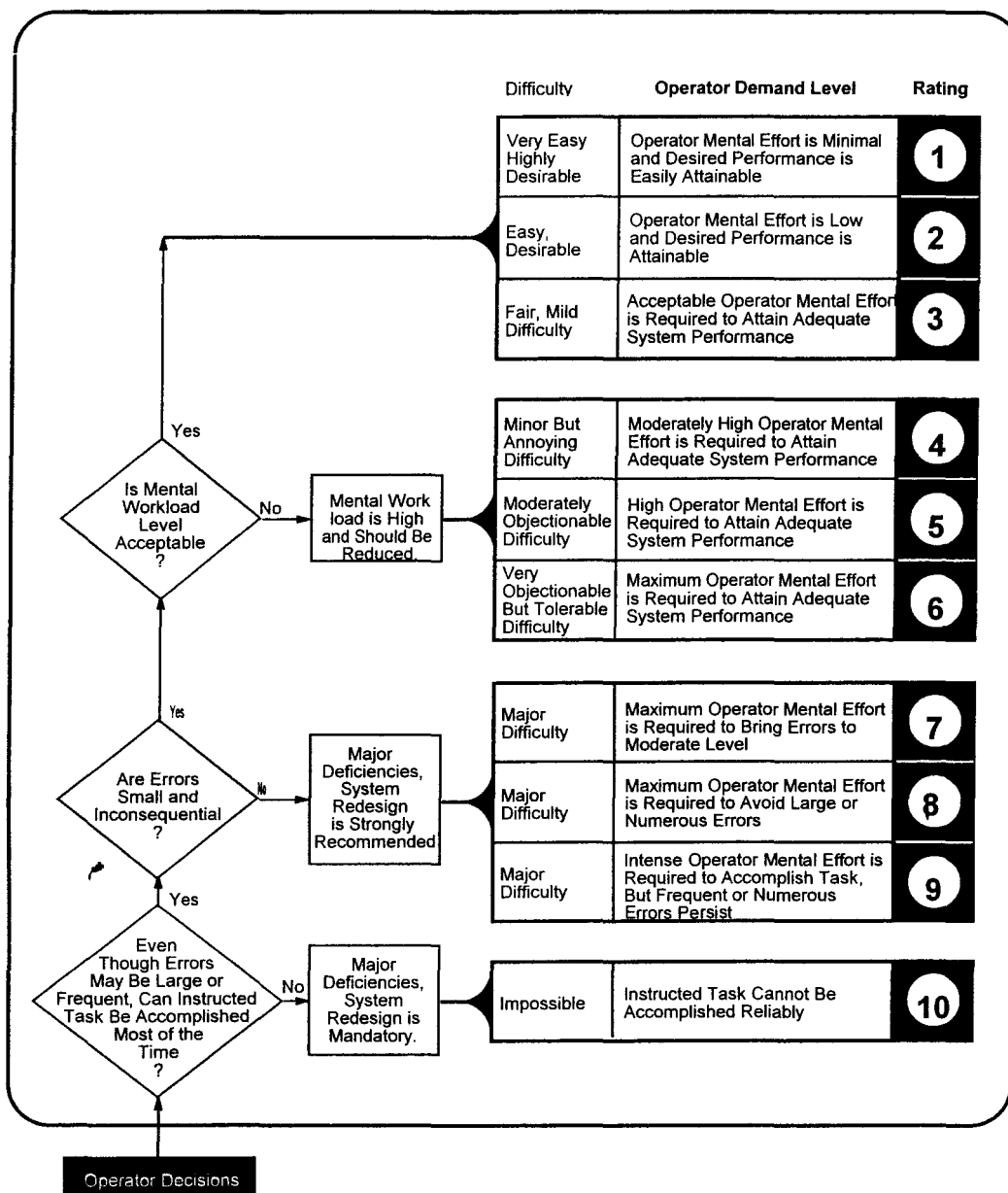


FIG. 13. Modified Cooper-Harper Rating Scale

Strengths and limitations - Investigations were conducted to assess the modified Cooper-Harper scale. They focused on perception (e.g., aircraft engine instruments out of limits during simulated flight), cognition (e.g., arithmetic problem solving during simulated flight), and communications (e.g., detection of, comprehension of, and response to own aircraft call sign during simulated flight).

The modified Cooper-Harper is sensitive to various types of workloads. For example, Casali and Wierwille (1983) reported that modified Cooper-Harper ratings increased as the communication load increased. Wierwille, Rahimi, and Casali (1985) reported significant increase in workload as navigation load increased. Casali and Wierwille (1984) reported significant increases in ratings as the number of danger conditions increased. Skipper, Rieger, and Wierwille (1986) reported significant increases in ratings in both high communication and high navigation loads. Wolf (1978) reported the highest workload ratings in the highest workload flight condition (i.e., high wind gust and poor handling qualities).

Bittner, Byers, Hill, Zaklad, and Christ (1989) reported reliable differences between mission segments in a mobile air defense system. Byers, Bittner, Hill, Zaklad, and Christ (1988) reported reliable differences between crew positions in a remotely piloted vehicle system. These results suggested that the modified Cooper-Harper scale is a valid, statistically reliable indicator of overall mental workload. However, it carries with it the underlying assumptions that high workload is the only determinant of the need for changing the control/display configuration. Wierwille, Casali, Connor, and Rahimi (1985) concluded that the modified Cooper-Harper Rating Scale provided consistent and sensitive ratings of workload across a range of tasks. Wierwille, Skipper, and Rieger (1985) reported the best consistency and sensitivity with the modified Cooper-Harper from five alternatives tests. Warr, Colle, and Reid (1986) reported that the modified Cooper-Harper Ratings were as sensitive to task difficulty as SWAT ratings. Kilmer, Knapp, Burdsal, Borresen, Bateman, and Malzahn (1988), however, reported that the modified Cooper-Harper rating scale was less sensitive than SWAT ratings to changes in tracking task difficulties. Hill, Iavecchia, Byers, Bittner, Zaklad, and Christ (1992) reported that the modified Cooper-Harper scale was not as sensitive or as operator accepted as the NASA TLX or the overall workload scale.

Papa and Stoliker (1988) tailored the modified Cooper-Harper rating scale to evaluate the Low Altitude Navigation and Targeting Infrared System for Night (LANTIRN) on an F-16 aircraft.

Data requirements - Wierwille and Casali (1983) recommend the use of the modified Cooper-Harper in experiments where overall mental workload is to be assessed. They emphasize the importance of proper instructions to the subjects. Since the scale was designed for use in experimental situations, it may not be appropriate to situations requiring an absolute diagnosis of a subsystem. Harris, Hill, Lysaght, and Christ (1992) recommend the use of non-parametric analysis techniques since the modified Cooper-Harper rating scale is not an interval scale.

Thresholds - Not stated.

Sources -

Bittner, A.C., Byers, J.C., Hill, S.G., Zaklad, A.L., and Christ, R.E. Generic workload ratings of a mobile air defense system (LOS-F-H). Proceedings of the 33rd Annual

- Meeting of the Human Factors Society (pp. 1476-1480). Santa Monica, CA: Human Factors Society; 1989.
- Byers, J.C., Bittner, A.C., Hill, S.G., Zaklad, A.L., and Christ, R.E. Workload assessment of a remotely piloted vehicle (RPV) system. Proceedings of the 32nd Annual Meeting of the Human Factors Society (pp. 1145-1149). Santa Monica, CA: Human Factors Society; 1988.
- Casali, J.G. and Wierwille, W.W. A comparison of rating scale, secondary task, physiological, and primary-task workload estimation techniques in a simulated flight task emphasizing communications load. *Human Factors*. 25, 623-642; 1983.
- Casali, J.G. and Wierwille, W.W. On the comparison of pilot perceptual workload: A comparison of assessment techniques addressing sensitivity and intrusion issues. *Ergonomics*. 27, 1033-1050; 1984.
- Harris, R.M., Hill, S.G., Lysaght, R.J., and Christ, R.E. Handbook for operating the OWLKNEST technology (ARI Research Note 92-49). Alexandria, VA: United States Army Research Institute for the Behavioral and Social Sciences; 1992.
- Hill, S.G., Iavecchia, H.P., Byers, J.C., Bittner, A.C., Zaklad, A.L., and Christ, R.E. comparison of four subjective workload rating scales. *Human Factors*. 34, 429-439; 1992.
- Kilmer, K.J., Knapp, R., Burdsal, C., Borresen, R., Bateman, R., and Malzahn, D. Techniques of subjective assessment: A comparison of the SWAT and modified Cooper-Harper scale. Proceedings of the Human Factors Society 32nd Annual Meeting. 155-159; 1988.
- Papa, R.M. and Stoliker, J.R. Pilot workload assessment: a flight test approach. Washington, DC: American Institute of Aeronautics and Astronautics, 88-2105, 1988.
- Skipper, J.H., Rieger, C.A., and Wierwille, W.W. Evaluation of decision-tree rating scales for mental workload estimation. *Ergonomics*. 29, 585-599; 1986.
- Warr, D., Colle, H. and Reid, G. A comparative evaluation of two subjective workload measures: The subjective workload assessment technique and the modified Cooper-Harper scale. Paper presented at the Symposium on Psychology in Department of Defense. Colorado Springs, CO: US Air Force Academy; 1986.
- Wierwille, W.W. and Casali, J.G. A validated rating scale for global mental workload measurement applications. Proceedings of the 27th Annual Meeting of the Human Factors Society. 129-133. Santa Monica, CA: Human Factors Society; 1983.
- Wierwille, W.W., Casali, J.G., Connor, S.A., and Rahimi, M. Evaluation of the sensitivity and intrusion of mental workload estimation techniques. In W. Romer (Ed.) *Advances in man-machine systems research*. Volume 2 (pp. 51-127). Greenwich, CT: J.A.I. Press; 1985.
- Wierwille, W.W., Rahimi, M., and Casali, J.G. Evaluation of 16 measures of mental workload using a simulated flight task emphasizing mediational activity. *Human Factors*. 27(5), 489-502; 1985.
- Wierwille, W.W., Skipper, J. and Reiger, C. Decision tree rating scales for workload estimation: theme and variations (N85-11544), Blacksburg, VA: Vehicle Simulation Laboratory; 1985.
- Wolf, J.D. Crew workload assessment: Development of a measure of operator workload (AFFDL-TR-78-165). Wright-Patterson AFB, OH: Air Force Flight Dynamics Laboratory; December 1978.