# Physiological indices for the estimation of momentary changes in cognitive workload and mental state

*Piet J. Hoogeboom[1] and L.J.M. (Ben) Mulder[2]*
*National Aerospace Laboratory NLR, Amsterdam*
*University of Groningen, Groningen*
*The Netherlands*

**Summary**

With increasing complexity of working environments, the need for active user assistance has emerged. This need is amplified by the ever-increasing diversity of the potential user groups for specific computer applications and complex work-environments. Therefore future human computer interfaces should adapt dynamically to the actual needs of the user. Adaptive automation adds a new dimension to the standard approach of flexibility provisions, which are inter alia the setting of user preferences (e.g. novice and expert levels, toolbar alterations), online advisory systems (e.g. Microsoft Office Assistant), and full automation (no user actively involved). Adaptive automation allows the user to remain in charge but will assist the user to perform the required tasks in the most effective way taking into consideration the context, environment, user preferences and user experience. As such adaptive automation keeps the user in the control loop, whilst adapting the working environment to the actual user needs. Research in this area has started around 1970 in the military domain (Rouse, 1988). So far practical results have been limited to specific implementations. Continuous improvements in computing power, reduction of power consumption, increase of computer memory, and affordability as described by Moore's Laws[1], have brought cheap and fast computing power for everyone almost everywhere. This and the advent of small, high quality, low-cost sensors have led to the option to increase the complexity of the underlying computing programs to the level required to actively support the user in his tasks and to allow embedded guiding and "learning on-the-job" assistance.

This paper addresses an adaptive automation approach that facilitates more dynamic user assistance in a generic way, solving part of the context and interaction problems. The proposed approach has been called the Operator Status Model (OSM). Some physiological candidate measurements for the real-time classification of the user functional state are assessed in a laboratory experiment, with emphasis on the

[1] Gordon Moore of Intel identified in the early 1970s: 1. The processing power of a microchip doubles every 18 months. 2. The price of a given level of computing halves every 18 months.

In D. de Waard, K.A. Brookhuis, and C.M. Weikert (Eds.) (2004), *Human Factors in Design* (pp. 147 - 160). Maastricht, the Netherlands: Shaker Publishing.