Issues in User Acceptance and Human/Machine Performance: Lessons learned from fielding Intelligent, Adaptive Information Systems

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Applying sophisticated, adaptive and intelligent "information presentation automation" to manage information flow to human consumers in complex systems and domains is not a panacea. Our experience includes the design of adaptive automation and information systems for multiple 'high end' domains including fighter piloting (Pilot's Associate--PA), attack/scout helicopter piloting (Rotorcraft Pilot's Associate--RPA), petrochemical refining and communications resource management for military command and control. Users in such domains are very demanding and critical of automation which does not behave according to their standards and expectations, and it has proven difficult to create systems which are correct enough to achieve user acceptance. Yet, we have found that intelligent interfaces and behaviors can be designed so that perfection is not required, but that value is still provided. Such interfaces require detailed consideration and design of the human-automation relationship. A critical mistake is attempting to make the system too autonomous in its behaviors. Instead, the opportunity for explicit and dynamic collaboration about how the system may best serve the human is critical.

The RPA adaptive information management system provides an example. RPA achieved acceptable levels of usability and statistically significant workload reduction compared to an unaided condition in a series of complex and realistic human-in-the-loop mission simulations (Miller, Hannen and Guerlain, 1999). It is important to note that these results were obtained *in spite of* less than perfect tracking of the pilot's intent and pilots' reports of having to 'Now and Then' override or correct RPA's behaviors. One innovation we employed in the RPA cockpit may have influenced these results: a 'Crew Coordination and Task Awareness' display that, unlike previous some previous systems, gave the two human crew members direct insight into and some control over RPA's notion of the mission context and main tasks of each crewmember. Pilots' acceptance of this display was very high, averaging 4.25 on a scale of 1-5 where 4 corresponded to 'Of Considerable Use' and 5 to 'Extremely Useful.'

The success of this interface innovation has led us to think more seriously about the implications of the associate metaphor for adaptive automation in many domains. Given our experience in working on intelligent information systems, and our familiarity with others in the literature, we have recently drafted a set of 'Etiquette Rules' for adaptive system behavior. The notion of 'etiquette rules' seems to have an appropriate focusing effect—both placing an emphasis on acceptable behavior to a human supervisor, and requiring a degree of anthropomorphic thinking about the system which seems to be productive. These rules will be presented and the general notion of human-machine etiquette will be discussed—along with additional examples from RPA concerning the quantification and tradeoff among rules implemented in that program.

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Miller, C., Hannen, M. and Guerlain, S. (1999). The Rotorcraft Pilot's Associate Cockpit Information Manager: Acceptable Behavior from a New Crew Member. In *Proceedings of the American Helicopter Society's FORUM 55*, Montreal, Quebec, May 25-27.

Biographies:

Dr. Christopher A. Miller, Chief Scientist of SMArt Information Flow Technologies, has over 11 years experience in creating knowledge representations and computational approaches to adaptive user interfaces, automation and decision aids. Until recently a Research Fellow at Honeywell Laboratories, he has led intelligent, adaptive information system design efforts for domains including management of military communication resources, fighter piloting, attack/scout helicopter piloting, oil refinery operations, commercial aviation operations and ground-based dispatch operations. Most recently, Dr. Miller, under NIST and Honeywell's Independent LifeStyle Assistant program, has been adapting this adaptive interface technology to the intelligent and user-centered control of home automation devices to enable elderly clients to remain in their legacy homes longer. Dr. Miller is the author of over 50 articles and papers on computational approaches to interface design, adaptive information and automation, mixed initiative interactions with automation, machine learning and human discourse.

Mr. Harry B. Funk, Vice President of Research and Development for SIFT, has over 10 years experience in design, implementation and evaluation of representations and algorithms for human information management. He has led research, design and system engineering efforts ranging from Small Unit Operations HMI to the Boeing 777 Central Maintenance Computer. This work has been principally focused on optimizing use of human and system information processing and delivery resources. Most recently Mr. Funk, under DARPA's Agile Information Control Environment program, has been investigating human-manipulable formal specification of intent by command personnel for use of communication resources under their purview.