Military Unmanned Aircraft System Operators: Training and Human Performance Issues

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MILITARY UNMANNED AIRCRAFT SYSTEM OPERATORS: TRAINING AND HUMAN PERFORMANCE ISSUES

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Unmanned Aviation System (UAS) have leveraged considerably from the manned aviation approach. This approach was useful to jumpstart this technology but it is now time to find a more efficient and up-to-date approach, keeping with the capabilities and limitation of the concurrent technology. Three technical areas to mature and address the current limitations are recommended: 1) Selection for UAS Personnel (SUPer), to accurately forecast candidate UAS operator performance across UAS platforms and missions; 2) Distributed, Adaptive & Modular entities for UAS (DyAdeM), to automatically generate realistic & adaptive synthetic environments for simulated UAS training; and, 3) UAS Control Station Human Machine Interface (CaSHMI), to provide validated information display concepts.

Beginning in FY12, the US Navy and Marine Corps began to significantly increase their rate of acquisition of a wide range of Unmanned Aerial System (UAS) platforms. The Army and Air Force have already fielded thousands of these systems in the past decade and plan to continue to do so. These UASs will include significant technological advances, blending automation with dynamic, decentralized control, and will support a wide range of missions. Yet, despite these technological advances and increases in automation, these systems do not lend themselves to easy use by their operators. From a human systems integration perspective, they are not well-supported by control station interfaces, training technologies, or selection tools; as indicated by the fact that as much as 50 percent of all UAS mishaps are attributed to human factors (Williams, 2004; Tvaryanas, 2005, 2006).

Reducing mishaps and unsuccessful UAS operations will require better interface design and a new kind of operator - one who has been specifically selected, trained and equipped to process information safely and effectively. They must interact with cutting-edge technologies, work collaboratively with others, and effectively manage their cognitive workload and attention over long mission durations (McCarely & Wickens, 2005). Since the 1990s, all three services have conducted varying levels of investigation to better understand how to select Air Vehicle Operators (AVOs), how to train them, and how to equip them. These early studies often assumed that selection and training criteria should be similar to those used in manned aviation (Barnes, et al, 2000; Hall & Tirre, 1998) and that manned aviation was the gold standard against which UAS AVO requirements should be considered. Many of these early studies focused on assessing UAS operator requirements for platforms whose control schema and missions mirrored those of manned aviation platforms (Biggerstaff et al, 1998; Kay et al, 1999). The UAS landscape has changed with fiscal realities and evolving mission sets, combined with significant advances in the state of the art of UAS platforms and control schema, which have all evolved the AVO into a mission manager vice a hands-on controller. Today, simply replicating the manned aviation select-train-equip approach is an inefficient solution at best and a potential disaster at worst (McCarley & Wickens, 2005). As stated by a recent US Air Force Scientific Advisory Board: "the considerable base of human factors knowledge derived from cockpit experience may have limited applicability to future systems…" (US Air Force, 2004).

While this sentiment speaks to future aviation systems at large, UASs are a significant departure from traditional roles and responsibilities for its human operator (Figure 1). First, the AVOs, unlike manned aviators, are not co-located with their platform. This decoupling of the human from the system has created unique human system integration issues (Tvaryanas, 2006). Compared to their manned aviation counterparts, AVOs work in sensory-deprived conditions, lacking the visual, auditory, and tactile cues present in manned aviation. Second, as automation becomes more reliable, the role of the AVO will continue to shift towards mission management, likely of multiple and different UAS platforms (Tvaryanas, 2006). Even today, AVOs, especially for larger more capable UASs, interact with their systems more through decision making, course of action planning, collaborative planning, and resource management than through hands-on 'stick and rudder' skills (Kay, et al., 1999). These roles and responsibilities are more reflective of mission management activities, like those of an Air Traffic Controller.

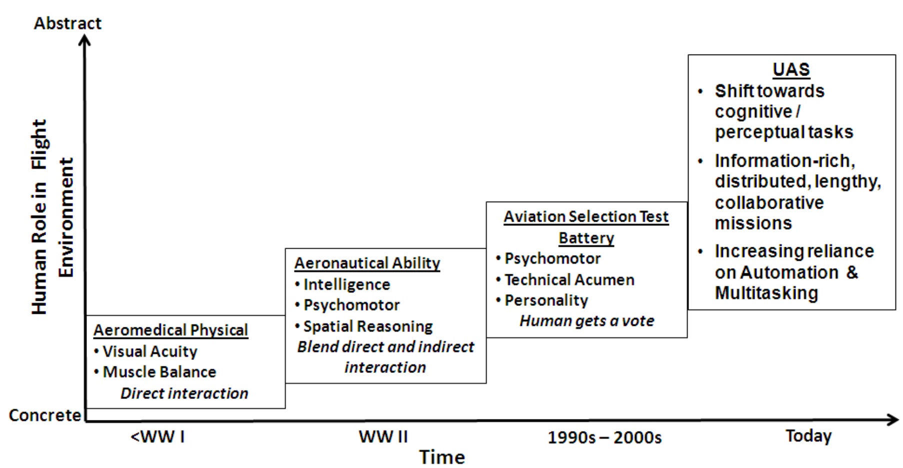

Figure 1: The Evolving Role of Human in Aviation Systems. In the early days of aviation, aviators had a very direct connection with their platform – basically a one-to-one mapping between the control inputs they provided and the subsequent behaviors the aircraft responded with. As aircraft became more complex, this mapping changed. With these changes came a shift in the role of the aviator, with a corresponding shift in the KSAOs they need in order to succeed. Today, UAS represent the most radical shift yet in this role, with the operators being 'dis' located from their platform; their inputs have very limited direct impact on their

aircraft's moment-by-moment action and mission success depends more on individual operators' ability to process and act on information and coordinate with other team members.

These, and other, differences between manned and unmanned aerial systems require new technologies and methodologies to ensure effective UAS operations. One approach is to address the selection, training, and interface design gaps as equal parts of a common approach for optimizing Human System Integration. This will require a detailed examination of: the types of Knowledge Skills and Abilities (KSAs) necessary to succeed in UAS operations; the best approaches for utilizing simulation-based training; and design approaches that will provide UAS operators with an effective way of interacting with their systems. The remainder of this paper discusses how the different Services may address these three areas.

Selection

Effective selection procedures identify individuals who possess a minimum level of qualifications and aptitude in the relevant knowledge, skills, and abilities to perform specific tasks and missions. Done properly, selection and classification procedures match overall training and interface design requirements. For manned aviation, the Department of the Navy uses a secure, web-based test delivery platform called the Automated Pilot Exam (APEX) to deliver the manned Aviation Selection Test Battery (ASTB) worldwide. APEX is government-owned and is capable of delivering psychomotor evaluations, tests of divided attention, and reaction-time evaluations using stick-and-throttle inputs or keyboard and mouse. It is also capable of administering computer-adaptive multiple-choice tests, which tailor test content to the examinee's ability level; this reduces test length, increases score accuracy, and greatly improves test security.

UAS platforms represent a unique domain from the perspective of the KSAs needed for successful operations. This is partly due to the wide range of platforms and missions that UAS support and partly due to the unique role that UAS operators are asked to assume. UAS operators must excel at integrating information from partial, incomplete, and abstracted data, attained from multiple sources, in collaboration with other UAS operators who may be located across vast geographical and temporal ranges. In the near future, they may also be required to concurrently operate more than one platform and perform more than one mission goal. As the technical capabilities of these platforms continue to grow, along with the mission sets, these cognitive and social competencies will have a far greater influence on mission success than the traditional ones currently selected for in manned aviation.

There are currently no tools in place to select and classify candidate UAS operators based on these competencies. Preliminary research suggests that such tools should include an emphasis on assessing: spatial capabilities (McKinley et al, 2011); social and interpersonal abilities and personality traits (Kay et al 1999; Carretta & Ree, 2003); executive processes, like attention management, information processing, multitasking, and decision making (Squire & Parasuraman, 2010; McKinley et al 2011); and human-autonomy interactions (McCarley & Wickens, 2005; Squire & Parasuraman, 2010). Similarly, there are no standards, policies, and guidelines for developing UAS operator career fields based on these competencies. Manpower and personnel decisions regarding the candidate pool from which AVOs are chosen have historically been based on manned aviation requirements rather than on UAS operational requirements. Recent studies conducted by the Air Force suggest that non-aviators may be as competent as aviators in terms of many of the KSAs associated with UAS operations (McKinley, et al., 2011).

Current efforts focus on developing a series of assessments to identify individuals with appropriate UAS AVO-relevant aptitudes and KSAs from populations including both military (Enlisted and Officer) and civilian personnel, as well as individuals with or without previous manned flight experience. The expected results from these efforts include the identification of KSAs and behaviorally anchored proficiency requirements for UAS AVO operators; the degree to which each KSA can be satisfied using civilian, Enlisted, or Officer candidates, and whether those candidates should have prior manned flight experience; and an identification of KSAs best attained through a training curriculum, along with guidelines for how to structure such a curriculum.

Training

Typical simulation-based training for aviation requires the integration of hundreds, if not thousands, of simulated entities into the overall training scenario. Developing these entities requires significant time and effort and results in entities whose behaviors are strictly guided, scripted, and limited based on pre-determined rules that define the entities' behaviors over the course of the training scenario. The net result is entities whose behaviors are not realistic, leading to reduced training effectiveness; yet this training requires significant effort to create, thus having prohibitively high authoring costs.

An alternative approach is to replace hand-coded rule sets with a capability to automatically generate new and appropriate Computer Generated Forces (CGF) behaviors from one or more data sources including: data captured during live UAS exercises or data captured as experts operate their systems within a simulated environment. On the basis of one or more of these initial data sets, it should then be possible to model those behaviors and provide new behaviors that will drive CGF entities in a training environment. This approach will require integrating cognitive modeling approaches with machine learning techniques to generate tactically authentic behaviors. Recent advances in the development of knowledge structures (Bermejo, 2006; Koeing, 2009) provide a formal approach for representing and characterizing underlying behaviors from large data sets (Boyce & Pahl, 2007), making it possible to capture structured data from multiple sources. Cognitive models provide a means of formally representing these underlying behaviors of interest. Machine learning techniques provide a wide range of inductive approaches to generalize these behaviors to new missions and contexts. Training objectives, doctrine and tactics, techniques and procedures (TTPs) bound the initial cognitive models and subsequent machine learning generalization to ensure that new behaviors are tactically authentic. The resultant behaviors can then be integrated into new training scenarios.

Current efforts focus on providing the underlying behaviors that drive CGFs. Of particular interest are behaviors driving large numbers of entities that provide the ecological background against which the “Patterns of Life” play out in the scenario. These include seemingly random actions of groups of individuals, ground vehicles, or surface ships as they affect and are affected by the trainee's actions. The manner in which these behaviors drive CGF, as well as the manner in which these forces are represented to the trainee, should be part of the design developed.

Interface Design

Critical challenges with using a single system to display information relating to operating multiple and different types of UAS platforms include: characterizing the necessary information that operators must interpret to make effective decisions; providing information in a way that allows for task switching and multi-tasking without reducing operator performance; enabling AVOs to manage the flow of information from UASs with varying levels of autonomy; supporting collaboration with other UAS teams and support personnel; and designing flexibility into the system to account for new platforms, missions and advances in information display technologies - such as those that adapt information based on context, mission, and user performance. At the core of this challenge lies the need to find platform-common information and platform-specific information requirements. These requirements should consider the mission characteristics required to perform in a "Patterns of Life" scenario. Once identified, follow the manned aviation lead in developing a "common" approach to representing basic aviation information (Wiener & Nagel, 1988; Mejdal, McCauley & Beringer, 2001). Approaches for representing information which will optimize AVO performance should be developed and design guidelines and solutions should be implemented similarly to other mission management-like domains, such as Air Traffic Control (Friedman-Berg, Yuditsky, & Smith, 2004). Traditional human factors techniques, (e.g., Wickens & Hollands, 2000) as well as more recently developed neuroergonomic assessment methodologies (e.g., Parasuraman & Rizzo, 2007), are expected to form the basis for much of this technical area.

Current efforts focus on documenting human factors-driven design guidance developed, in coordination with the appropriate Navy leads, for the Common Control System; CGF improvements to AVO training; and inputs and recommendations for KSAs to be part of AVO candidate selection and classification. For test and evaluation purposes, the Navy will make use of simulated Common Control stations, populated with CGFs and appropriate mission scenarios.

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