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THE NEED FOR HUMAN FACTORS CONSIDERATIONS

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This document outlines the Air Line Pilots Association's (ALPA) aviation automation concerns and expresses the recommendations of both experienced pilots and experts alike. Refer to our statement of position document for additional details at www.ALPA.org under Safety, HFT (Human Factors and Training). Safe and effective aviation automation[*] is only possible when human factors principles are utilized properly. We strongly encourage engineers, regulators, and operators to apply human factors considerations at every stage of aviation automation hardware, software, and procedure design. Occasionally procedures or products are implemented without these considerations. This inattention can make usage problematic and has produced unintended consequences resulting in accidents and incidents. Incorporation of human factors considerations early in product/procedure design will help to avoid repetition of past mistakes and will ensure that automation maintains and increases the level of aviation safety in the future.

Automation is and will continue to play an important role in the evolution of global air transportation. Due to the complexity that arises from decreased traffic separation and increased use of automation, the dangers of coupling - tight integration and interdependence - increase as well. When an automated coupled system fails, the failure can escalate and cause catastrophic breakdown of the entire system. Appropriate human involvement can provide flexibility to counter problems with overly integrated automation.

In order to design against these failures it is essential to follow clear human factors guidelines that allow pilots and air traffic controllers/managers to interact with each other. It is important to design the automation in a way that complements the strengths of the human and automation and protects against their limitations. To paraphrase the director of the NASA

[*] We define automation functionally for commercial flight in terms of how it is used for flight purposes. The three purposes include the following: Control Automation, Information Automation, and Management Automation.

Aviation Program, Amy Pritchett (May 2008, Human Factors in NextGen, Arlington, TX), automation cannot handle the complexities of the Next Generation Air Transportation System without humans at the center as integral components and still maintain our current level of safety.

Automation is evolving into new roles to enable new aviation systems to function with increased utilization and control. This places new demands on a system already under pressure. The new automation components are themselves a potential source of error and risk. This is especially true if automation design and implementation has not adhered to established human factors principles.

Aircraft will still need to be flown by pilots. Piloting tasks will change and evolve, including mastering new types of automation and responsibilities. The ultimate responsibility for flying a safe aircraft will remain with pilots.

Automation Philosophy

A well-trained and well-qualified pilot has been, is, and will be the critical center point of aircraft safety systems and an integral safety component of the entire commercial aviation system (ALPA Unmanned Aircraft System (UAS) Policy, May 2007). This system includes not only the crew and aircraft hardware/software but also the operator, regulator and all policies and procedures employed.

The pilot in command has the final authority and responsibility to assure the safe outcome of the flight. It is imperative that the pilot is able to completely control the aircraft during all phases of flight. A design is unacceptable if the aircraft or the transportation system within which it is intended to operate would prevent the pilot from exercising complete control at all times.

The pilot must continue to be the decision maker at the center of the aircraft operation. This provides needed flexibility in a tightly coupled automated system. This also ensures vested human involvement and responsibility. A pilot is certified by regulating authorities with strict mandates for command and operation of the aircraft. These standards help maintain the high levels of safety required in commercial aviation.

Design and implementation of automated systems must focus on augmenting the benefits and strengths of humans while protecting against natural limitations. In general, automation should solve problems, not create additional problems in new or existing systems.

Design

The most effective automation design places appropriate emphasis on human capabilities and limitations. This type of design focuses on several foundational human factors issues. These include appropriate feedback, meaningful alerts and warnings, proper level of automation, and optimum level of pilot involvement per task. Human factors design requirements and end product goals must be established prior to design conceptualization with input from pilots and other users. This allows necessary modifications prior to actual development.

Automation systems should also be designed for the environment in which they will be operating. This includes the ability to handle short-notice changes necessary to accommodate factors such as varying weather conditions, changes in routing due to the presence of other aircraft, and degraded automation performance or failure. This must be done without placing unmanageable demands on the pilots and air traffic system. Automation systems should also be designed so they are compatible with the original equipment manufacturer (OEM) Flight Deck design philosophy in which they will be used, including those systems added to the flight deck after initial certification.

Pilots must be able to control every level of automation. For this to work correctly, the automation should provide the pilots with clear indication of both its present status and expected future state. The automation must provide adequate time for the pilots to intervene in the operation if necessary. Alerts and warnings must balance too many false alarms with too few critical warnings. Too many false alarms can result in lack of trust; too few actual alarms can result in missing critical failures and false security.

Standardized procedures and Crew Resource Management (CRM) should be considered in conjunction with automation design. The intended procedures must be communicated to the users. Consideration must also be given to the sequence, synchronization of procedures and time criticality of any task. A procedure may be benign when performed in normal sequence, but hazardous if performed slightly out of sequence.

Evaluation and Certification

Every new automation component or tool will require an operational evaluation and should be conducted with the participation of the end user, i.e. line pilots. The operational evaluation should include the accomplishment of a thorough risk analysis that leads to a risk mitigation plan. This must be accomplished before any automation system is introduced into the aviation domain.

Scenarios should be built to evaluate the automation function in the operational context in which it will be utilized. Evaluations should be objective with reproducible metrics. These evaluations must be accomplished prior to certification and accepted for use.

Clear evidence must show that pilots and controllers are able to use the automated system or procedure at acceptable error rates – prior to implementation. This evidence should include empirical tests with sufficient statistical power and external validity to guarantee reliable results. The evidence must demonstrate that typical operators are able to use the equipment to perform both normal and emergency operations. Testing should also show that any actual operational errors or the precursors to those errors are both low risk and only occur at low rates that do not pose risk for actual operations.

Training

The objective of training should be to provide pilots with a complete and accurate model of the automation system. This enables pilots to correctly identify and predict the system's actions and to control them during normal and abnormal situations. Training should not be used as an attempted substitute for poor Human Factors design.

Airline specific automation philosophy should be standardized across fleets to the maximum extent possible as long as it does not conflict with the OEM flight deck design philosophy. This reduces transition errors, increases consistency across fleets, improves transitioning pilot performance, and allows for standardized assessment of potential safety issues.

Any flight automation maneuver or procedure introduced in initial, recurrent, or special training that requires motor skills or complex sequenced actions must be trained in full motion simulator with enough repetition to promote retention and provide the opportunity to demonstrate proficiency.

Specific benefits can be achieved with the consideration and application of human factors to automation in aviation. Current operations will become safer by trapping and eliminating system design flaws. Future operations will be able to meet demands such as increased capacity and efficiency while increasing the existing level of safety.

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