Spacecraft Simulation: Tendency towards Automation

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Introduction

The researcher proposes to identify inherent advantages or disadvantages associated with automation to perform the tasks required for space operations, including control of the spacecraft. This analysis will put forth the contrast of gradually relinquishing human pilots from the aforementioned control capabilities, via thorough simulation training, that in turn might consequently increase the probabilities of over complacency.

These will be identified by describing current and future state of the art spacecraft simulation technology available for the industry, while also presenting the inherent problems identified hereunder.

Problem

At the start of the space program, before the first manned orbital flight, there was much less confidence in the ability of a human pilot to perform the tasks required for space operations. Many engineers expressed the view that it would be better to design spacecraft with completely automatic control (Phillips, 2002, p.35). Test pilots, on the other hand, who had at least approached orbital flight conditions in tests of very high-altitude airplanes, usually felt confident that they could control the entire flight of a spacecraft just as they had controlled high-altitude airplanes (Phillips, 2002, p.35). As follows, a laconic snapshot of the two main problems derived thereof:

The Subproblems:

1. The first subproblem. This first subproblem pertaining to pilots in full control is human error. This has always been a predominant factor when humans are involved in

flight control, and according to the FAA (2010), it's the most common factor of aviation crashes.

2. The second subproblem. This subproblem pertains how establishing full automated control leads to overdependence or complacency. This could lead to the negligence of the necessity of their participation during crucial periods of a flight, such as the landing, takeoff and docking phases. The extensive use of advanced automated systems has also raised a new concern for pilots with extensive use for automation induced complacency which is the inability to detect an automation malfunction.

Purpose & Rationale

Since humans began to venture into space in the 1960's, all selected astronauts were given mission specific training, including spacecraft simulation to better prepare the crew for a test bed of scenarios they would later encounter; including dynamics, propulsion, control systems, guidance and displays (Anderson, 2008).

For instance, according to Phillips, W.H. (2002), at the time the space program started, a three-axis rotational simulator was under construction in which a cockpit was mounted to provide angular motion in pitch, roll, and yaw. This simulator was intended to study combined rolling and yawing oscillations of an airplane. Now a days, modern simulators use electronic displays and general-purpose motion bases, as oppose to the first spacecraft simulators that used mechanical systems to simulate accurately the motion of the vehicle.

Given our advancement in technology, the rationale to analyze now is not if all spacecraft flight operation can be delegated towards an evermore automated simulation environment, but whether such approach, through the gradual elimination of human pilot intervention, would be wise.

Interest

For humans to explore and subsequently keep expanding throughout the cosmos, our technology will have to go on par with our desires for successful space flight and habitation. This objective would therefore entail significant achievements in the research and development of new technologies for the benefit of mankind.

Spacecraft simulation is one of these important variables involved in our quest for space exploration, since it directly pertains to the manner in which future missions will be carried out. In this sense, spacecraft simulation is considered an indispensable or integral addition to this highly complex and dynamic field. So much so, that its main objective is improving and controlling flight management efficiency.

Furthermore, important studies on the field must also be fully considered. For instance, according to a study conducted by Singh, Molloy and Parasuraman (1993) on the psychological dimension of automation-induced complacency, they suggested that: Complacent behavior might be occurring only when complacency potential coexisted with other conditions, such as:

- Pilot inexperience with the equipment
- High workload brought about by poor weather heavy traffic, or equipment trouble
- Fatigue due to poor sleep or long flights; and
- Poor communication between ground and crew or among crew members.

Importance to Aviation Simulation

Nowadays, with the widespread use and increasing level of automation, it is also crucial to analyze the issues that give rise and concerns pertaining to human intervention, accidents and incidents; and issues on human factors, specifically complacency.

Attending the over complacency concerns exposed in the problem section of this survey; cconsequently, vigilance is a critical component of human performance not only for the subject of spacecraft simulation, but also in a diverse array of work environments including commercial aviation, military surveillance, air traffic control, transportation security.

The research topic at hand, along with others contributed throughout the years, are valuable stepping stones that ignites curiosity and interest in future generations to develop the necessary technology for spacecraft simulation, whilst, crucially keeping in mind the human factor side of over dependency in simulation.

This undoubtedly is an extremely important topic to aviation and the space industry since respective space programs currently prefer to use automation without completely withdrawing the human operator from such systems due to the common belief that human beings are more flexible, adaptable and creative than is automation and thus, they are better equipped to respond to hanging or unpredictable conditions.

Furthermore, if the goal of every space program is to have a well defined safety culture, then pilots must always be alert and well trained, not only to manually perform the tasks currently performed by computers, but also to acquire such vigilance that in the event a computer malfunction is eminent, the pilot can identify the error, assess the situation and act accordingly. The latter statement is where it is evident that the pilot presence and control will always be necessary to contribute that creative and adaptive factor to any scenario.

Review of Relevant Literature

For the topic at hand the researcher has read a body of available publications and reports on similar topics.

The criteria of selection of relevant literature was not only looked upon for the subjects it contributed to, but also the respective organization of each research sources, so that it reflects a certain pattern, such as an organization that proceeds in chronological order or an organization that groups similar perspectives together. Once these variables were taken into consideration, and the various publications read and exhausted, hereunder a snapshot of some of the literature reviewed on topics that best suited the one selected by the researcher:

- Human Factors in Aviation by Salas & Maurino (2008), to analyze the inherent variables involved in pilot errors during flight control.
- Introduction to Flight by Anderson (2008), analyzing the chapter of Space Flight and the processes involved during manned missions, so the researcher could better ascertain all elements that automation help to solve during flight, and that otherwise would be a considerable load on any human pilot.
- Another important relevant literature closely reviewed was the Monograph in Aerospace History by Phillips (2002), so that a clear understanding of the first spacecraft simulation and pilot training experience could be better analyzed from the perspective of an aeronautical engineer present during the early stages of the space program.

References

Anderson, J. (2008), *Space Flight*, Introduction to Flight, p. 589

NASA, (2008), *February Tech Briefs*, retrieved from: http//:www.techbriefs.com

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Phillips, W.H. (2002), *Journey Into Space Research*, Monographs in Aerospace History, p. 35-36.

Salas & Maurino (2008), *Flight Simulation as Safety Generators*, Human Factors in Aviation, p. 293, 300

Singh, I., Molloy, R., and Parasuraman, R. (1993), *Results*, Effects of Adaptive Task Allocation on Monitoring of Automated Systems, p. 671.