Big Sky, Many Small UASs[1]

Building a Proactive Risk Management Pathway for the Integration of Commercial Unmanned Aircraft Systems

| THE OPPORTUNITY

A brave new world is upon us. On August 29, 2016 the commercial use of small Unmanned Aircraft Systems (sUAS) began across the United States as a normal, everyday activity. [2] This new frontier debuts the possibilities of technology and unmanned flight to the economy and the American public, providing new services from non-aviation related commercial entities. Already drones have proven their viability to transform industries, improve government safety and infrastructure management, as well as replace humans in dangerous work.

At the Office of Science and Technology (OTSP) Workshop on Drones and the Future of Aviation held on August 2, 2016 both government and industry leaders reinforced the endless potential and innovation of what is possible. [3] It was made clear that the impact that sUAS will have on our future is exponential, ultimately changing our world for the better. This is an exciting time, but as a former military aircrew and aviation mishap survivor, I have some concerns:

> Will technology outpace the safety systems and culture required to proactively manage the risk of sUAS growth? As operational complexity grows will technology such as collision avoidance be enough to keep us safe in a Big Sky with many, small UASs?

| THE CHALLENGE

Though a daunting task, the Federal Aviation Administration (FAA) has worked through the constraints, challenges and requirements of many forces and variables (time, laws, and industry) to produce CFR Part 107, a clear and straightforward set of rules to define the operating parameters of small UAS operations. This provides a good baseline to educate and train remote pilots in command (rPICs) and their optional crew to fly "in the box". This will also set the tone for potential expanded operations in the future to include flight over people and beyond visual line of sight.

However, the main challenge is that rule based risk management (RBRM) exists as the primary safety mechanism. We all start to learn a skill or a profession along with the associated rules, but will RBRM and increased detect and avoid technology be enough of a safety net? Traditionally RBRM is reactive, often lagging behind a real time need and situation. When something bad happens we change the rules...

> Is learning the rules in a live or virtual classroom enough to make one a proficient sUAS operator, capable of safely operating through extremis situations in a dynamic, three-dimensional environment? And, can the rules keep pace with emerging sUAS growth as flying activities increase in volume and complexity?

This challenge increases when introducing a very low threshold to operate a sUAS and an expanding population of rPICs that have little to no experience in airmanship, operational risk management and safety culture, in addition to the invaluable perspective and expertise of situational awareness to "see and avoid" or fly out of the problem. *Commercial growth will bring more industry segments, more companies, more drones and more rPICs. Suddenly the Big Sky with many sUASs will start to get smaller.*

Another factor of this challenge is that up to 80% of both commercial and military aviation mishaps are human factors or "pilot error" related. [4][5] Causal factors such as perception, judgement/decision making and skill errors - factors that go beyond knowing and complying within the rules - are conditions in numerous mishap chains. In an analysis of naval aviation Class A and Class B mishaps from 1999 to 2009 the following results were gathered: of the 487 incidents investigated, errors accounted for 87% of the original unsafe acts committed by the operator, while rule violations was only 13%. [6] A direct comparison between military aviation and the sUAS environment cannot be made as they are different. Yet, many similarities still exist, including the human interface within flight operations and our inherent fallibility. Given the foreseeable future human interface will remain a factor until sUAS operations and oversight are fully autonomous.

| **THE PATHWAY:** How do we safely navigate in this brave new world?

Recently the RMIT University School in Australia reviewed 150 civilian sUAS mishaps that occurred between 2006 and 2016. They reported that 64% of sUAS mishaps were caused by technical problems, which still leaves up to 36% attributable to human error. If we acknowledge this statistic and add to it the fact that over 520,000 drones have been registered in the United States over the last 8 months, a number that continues to grow, our Big Sky gets smaller as the risk of mishaps caused by human error increases. [7] *Although technology will continue to improve sUAS safety and reliability, what more can we do to address and mitigate human error?*

> SYSTEMATIC SAFETY FRAMEWORK

In order to proactively prevent sUAS mishaps and mitigate associated risks we must understand mishap causation: if we know the cause, we can break the chain. Regardless of how rapidly technology improves over the next few years human error will be present and both a causative and contributing factor for sUAS mishaps. This requires a systematic and multi-dimensional framework that can tie together all aspects of sUAS operations and mishap causation. This rationale is clearly highlighted in a United States military UAV mishap assessment completed in 2008:

> "Additionally, there is the trend towards oversimplification when one factor is chosen out of many contributing factors and labeled causal despite all factors involved being equally indispensable to the occurrence of the mishap. Thus, mishaps are often attributed to operator error or equipment failure without recognition of the systemic factors that made such errors or failures inevitable." [8]

It makes sense to start with a model that is proven and can adapt to the sUAS ecosystem. The Department of Defense (DOD) Human Factors Analysis and Classification System (HFACS) is such a model, adopted in 2005 to reduce preventable aviation based mishaps. Derived from noted psychologist and organizational mishap expert James Reason's Swiss Cheese model, HFACS provides the detail and granularity of causation. It also highlights both the active and latent conditions that create a mishap trajectory, most often as a systematic, organizational event. [9]

The HFACS model also helps tie the risk assessment tools (Aeronautical Decision Making (ADM) and Crew Resource Management (CRM)) outlined in Appendix A of the Part 107 Circular Advisory to the operating environment rPICs will encounter. This highlights the impact that factors beyond sUAS flying skills have in managing risk such as environmental, personnel and personal conditions, along with organizational influences and managerial oversight. Equally, an HFACS type model reinforces the responsibility of the operating entity, in many cases a commercial business, to build the right strategy, policies, training and support to effectively and safely operate sUAS resources.

Though some modification is required to depict the unique characteristics of the sUAS environment, a HFACS based model will help define and integrate safety as an important element of the system and more importantly as a culture that enables a comprehensive, multi-dimensional approach to mishap prevention and causation. Such a model helps us understand the coexisting and interconnected impacts of human factors and technology in sUAS safety management.

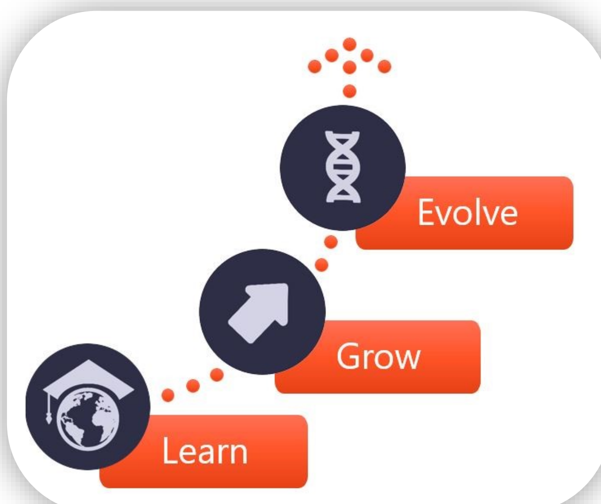
> LEVERAGING TECHNOLOGY TO SUPPORT THE CONTINUOUS LEARNER

Technology will be a main driver of sUAS marketplace growth and success. We must also leverage its power to enable learning, training, and sharing best practices to remain safe. Technology's reach and speed are critical to connect a community of dispersed and growing remote pilots in command and their operational managers, especially for commercial entities new to aviation operations. A truth of the modern world is that "technology typically outstrips policy". [10] It literally moves at the speed of light while governing bodies, regulations and best practices try to keep up. We cannot afford a lag of knowledge, skillsets and best practices for rPICs: too much is at stake. To keep pace with this growing and dynamic environment rPICs must be continuous learners. A pilot's continued interest in building skills is paramount for safe flight and can assist in rising above the challenges which face pilots of all backgrounds. [11] We must adopt this introductory statement from the FAA Risk Management Handbook to the sUAS ecosystem, leveraging the power of technology to develop and evolve safety management systems and cultures.

eLearning and Learning Management Systems (LMSs) must be integral components of the sUAS continuous learner solution. These applications will not replace live instruction or experiential learning, but will enhance it. Content beyond basic rule knowledge and operating skills will require a frequency of reinforcement, especially if it involves risk management, hazard identification and decision making skills. While live training is essential, how much knowledge can a fledgling rPIC retain and adopt over the course of a week, especially with a population of learners that may have little, if any, exposure to aviation? eLearning provides mobile reinforcement that is available twenty-four seven.

More so than manned aircraft operations, sUAS procedures are primarily visual. Operators have a reduced physiological connection to the drone they are controlling: no sensation of G force, thud of the landing gear, or stall buffet. Visual based learning is therefore key. Modern learning that focuses on visual based content supports this reality. With the use of eLearning authoring tools video content from the drone or instructor can be quickly turned into targeted training on hazard identification or aeronautical decision making based on relevant, real world situations.

The wide and diverse sUAS applications will create a broad community of operators and learners. Training, best practices and safety management may be driven by a variety of factors such as drone type, operating entity, task and flying environment. Content and knowledge will need to be contextualized by industry, geographic regions and organizational culture. One size may not fit all and content may change quickly. A LMS connects those communities in real-time and can help users quickly create and scale customized training to meet specific needs.



Finally, feedback loops are critical in aviation. Debriefing and extracting lessons is essential for proactive risk management. The speed and accuracy with which that occurs significantly fosters sUAS growth. This is where a LMS can really compress the feedback cycle, leveraging the speed of technology to accelerate the learning loop. Through analytics and collaborative classrooms sUAS trainers can stay connected to their learners, track their progress, and contextualize learning at the individual and team levels. Knowledge and best practices can be transferred horizontally from one rPIC to the next within the context of the course material. In some instances the learner may become the teacher, having discovered a better operating process or identified an unknown hazard that quickly gets incorporated in the training. These are just a few examples of how the power of technology can serve to develop and sustain continuous learning in the sUAS community.

| CONCLUSION

Similar to the human genome, the Pandora's Box of sUAS has been opened. It brings endless possibilities and opportunities to improve and reshape our economy and how we live. We must ensure that safety management is proactive to keep pace with sUAS growth today and in the future. To achieve this we need to:

> Develop systematic risk management frameworks that integrate technology and human factors. We must also leverage the speed and reach of technology to share knowledge and train rPICS to effectively and efficiently operate safely, incorporating the required decision making and risk mitigating processes.

The Challenger and Columbia space shuttle mishap investigations brought to light an important point that is worth applying to sUAS growth. In one of the most advanced and technologically centered fields - spaceflight - it was organizational culture, a human factor, which was a major contributing influence to both incidents. Sadly, the lessons learned from Challenger were never really incorporated, citing failure as a learning organization and setting up many of the latent conditions for Columbia. [12]

We need Section 9 of any sUAS Accident Report to be comprehensive and address true causation, which is commonly a blend of technology and human error. [13] The mishap data then needs to be thoroughly analyzed, individually and collectively, to quickly disseminate lessons learned throughout the sUAS community of operators. A human factors based safety model and learning technology such as a LMS can significantly help in this process, making the Big Sky a safer place as an ever increasing number of small UASs inhabit our airspace.

| ABOUT THE AUTHOR

Joe Schweitzer is the Chief Learning Officer for ELEARNINGFORCE Americas, an IT services company that implements a SharePoint based LMS. He believes in the power of technology to enable organizational learning to learn, grow and ultimately evolve. In a previous life he served in the United Stated Marine Corps as a naval flight officer, squadron training officer and forward air controller. As an aviation mishap survivor, Joe has a passion for aviation safety, and the discovery and transfer of lessons learned to prevent and mitigate future catastrophes.

APPENDICES & REFERENCES

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