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Implications Between UAV and ATM Systems In Commercial Airspace Incorporation: Dissertation Defense

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TITLE

IMPLICATIONS BETWEEN UAV AND ATM SYSTEMS IN COMMERCIAL AIRSPACE INCORPORATION

Capitol Technology University

Dissertation Defense

by

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Dissertation Chair: Dr. Ian McAndrew, Ph.D.

Dissertation Committee: Dr. Allen Exner, Ph.D., and Dr. Richard Baker, Ph.D.

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Statement of the Problem

- Human Factors associated with sUAS operations come in an assortment of characteristics, and they are inadequately represented in literature that focuses on the perspective of the air traffic controller as the center of the HITL environment.
- This may impact the safe integration of civilian sUAS as they continue to integrate in the NAS.
- Leads to concern for safety, efficiency, and workload optimization for controllers.
- Shows gaps in related knowledge

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Rationale for the Study

- The research problem is of important social, scientific or theoretical interest because ATC and air traffic management (ATM) are a part of a complex socio-technical system, and better awareness of HF is critical for risk assessment and mitigation protocols that could identify easy-to-use HF tools for ATC and ATM sUAV incorporation. (Teperi, Leppanen, & Norros, 2014).

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Literature Overview

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- Seminal references that are the foundation of the research
  - Cardosi, K., & Lennertz, T. (2017). *Human factors considerations for the integration of unmanned aerial vehicles in the national airspace system: An analysis of reports submitted to the Aviation Safety Reporting System (ASRS).* DOT/FAA/TC-17/25, DOT-VNTSC-FAA-17/25
  - Government Accountability Office. (2018). *Small unmanned aircraft systems: FAA should improve its management of safety risks*. GAO -18-110
  - Federal Aviation Administration. (2021b). *Remote identification of unmanned aircraft*.
- References that addressed methodological issues (ways to combine methods)
  - Miller, M., Holley, S., Mrusek, B., & Weiland, L. (2019). A change in the dark room: The effects of human factors and cognitive loading issues for NextGen TRACON air traffic controllers. *Advances in neuroergonomics and cognitive engineering*
  - Miller, M., Holley, S., Mrusek, B., & Weiland, L. (2020). Assessing cognitive processing and human factors challenges in NextGen air traffic control tower team operations. *Advances in human factors and systems interaction*

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Research Methodology/Design

- Methodology/design-conceptual framework. Quantitative phenomenological research design with statistical analysis of reports involving UAS sightings and incidents. This method was used due to
  - Reliability and validity - it combined models – brings in programs in place
  - HF, safety, and security risks that need to be mitigated for safe and secure incorporation of sUAS in the NAS
  - The HITL between Air Controller and Drone study is new and SHELL and Swiss cheese are proven models in aviation and HF areas
  - Four step model
- Other methodology/design options were not used
  - they lacked the ability to cover complex social-technical systems

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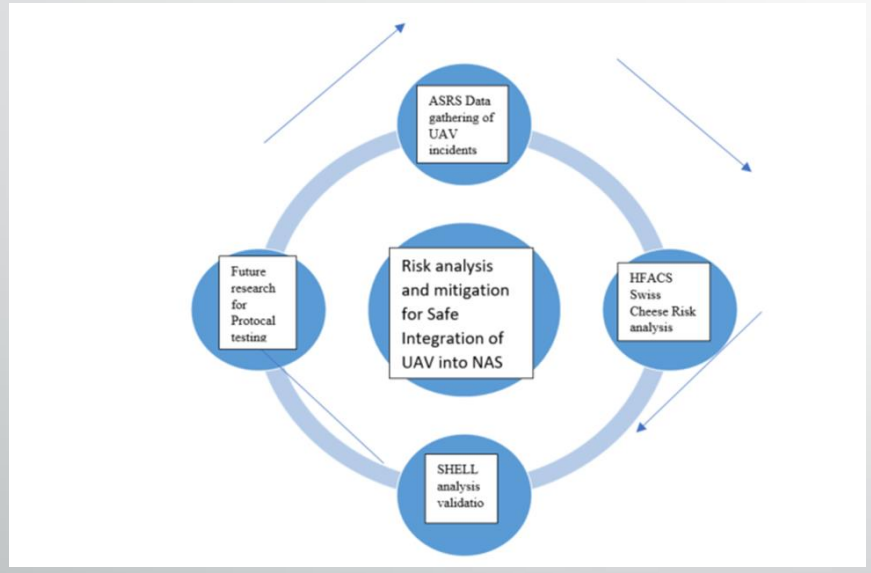
Research Methodology/Design



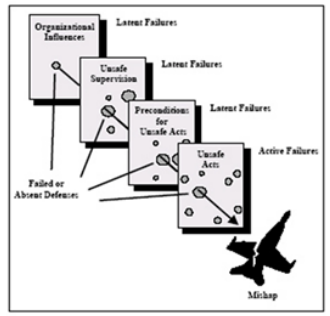


Figure 5. The Swiss cheese model (SCM) of human causation. Adapted from Reason (1987

Figure 6. SHELL model by Hawkins (1987) featuring the liveware-centered interface.

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Data Analysis - ASRS

Figure 17. Most often reported HF involved ASRS

Row Labels	Count of Human factors involved
Situational Awareness	19
situational awareness Distraction	3
NA	3
Situational Awareness communication breakdown flt crew	2
situational awareness procedures	2
HF environment	2
environment Situational awareness	1
distraction for manned acft	1
Situational awareness distraction communications breakdown flight crew and ATC	1
Situational Awareness	1
SA cognitive load* four acft comm breakdown workload	1
communication breakdown with ATC workload	1
distraction	1
situational awareness	1
human machine interface	1
communications breakdown	1
Human machine interface situational awareness training Qualifications Distration	1
Situational Awareness environment	1
training situational awareness	1
confusion	1
communication breakdown	1
SA cognitive load* four acft comm breakdown	1
(blank)	
Grand Total	47

Figure 18 All the HF cited in ASRS

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Data Analysis –FAA Sighting

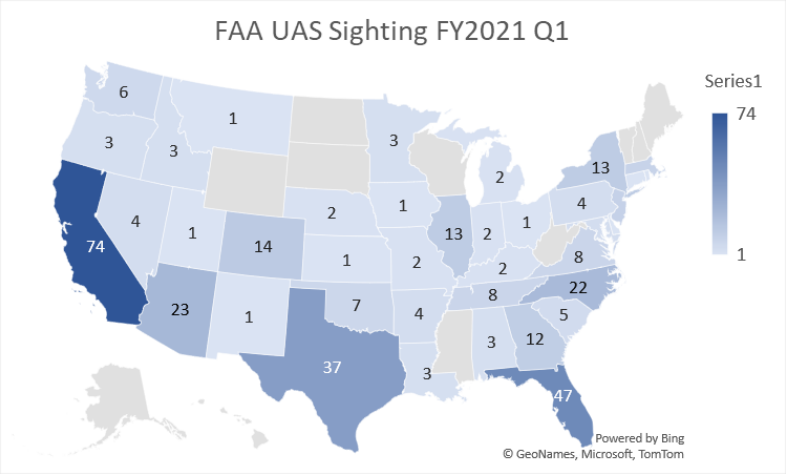

Figure 20 FAA UAS sighting FY2021Q1

Most sighting reports go through ATC to FSDO –
-Cognitive workload change
-Situational Awareness diverted
-Communication is increased and mistake or misunderstandings can increase
-95% did not require evasive action

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Findings/Outcome

- The significant outcome/finding of the research is that NAS continues to be safe with few accident reports that resulted in a large loss due to the proactive collaboration of all stakeholders in the integration of sUAS in the NAS. This built the foundation for Remote ID adaptation that is imperative to safe integration and continued safe and secure operations. Additional findings include
  - Analysis of the reports indicate that through training in HITL, and HF, that ATC and sUAS human errors are mitigated
  - There is a gap in the literature and understanding in HITL, HF ATC and drone relationship
  - Most reports show that there is a possibility of HITL HF incident that involves ATC and the drone
  - Through education and training human error can be mitigated (SHELL, SCM, SMS, and PDCA
  - Strong foundation for solution has been laid through ASRS and FAA sighting reports- data analysis can continue to prevent HITL errors

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Implications of Findings

- Implications of findings:
  - Research needs to continue –cusp of major changes
  - Currently it is difficult to validate sighting as most drones do not have a 'digital license plate' –regulation changed in 2021 Remote ID use will need time to implement – (positive implication)
  - Most current available data is voluntary –Remote ID will change that scenario and will provide data the is more reliable and valid

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Recommendations/Solutions/Next Steps

- Collaboration of all stakeholders
- Development of risk management with SMS
- Enhancement of education and public perception
- Exploration of new technology (Remote ID and others) and development of Concept of Operations
- Maintain sustainable research and recurring assessment analysis of available data
- Ensure recurrent training for controllers and pilots

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Recommendations for Research

- Continued research in this complex system of systems that places the primary focus on the air traffic controller as the controller is the primary HITL. This will ensure there are multi faceted solutions that enable the NAS to reach its full potential.
- Continued research has many opportunities for all stakeholders that will ensure a continued safe and orderly NAS and for additional contribution of knowledge in the area of this dissertation (SMS, PDCA)

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Contribution to Knowledge

- The investigation of human error possibilities in sUAS integration in the NAS from the Air traffic controller perspective has not been done. By investigating through qualitative research of a social technical complex systems of systems, this study attempted to rectify the scarcity of research from the ATC perspective as the center component in the HITL to ensure safe incorporation of sUAS in the NAS. This was done by combing HF analysis models that had not been combined before in its conceptual framework.

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- Thank you.
- Questions?