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Practical Examples of How Universities Can Contribute to Accident Investigation

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After an accident occurs, an investigation is conducted using the investigative processes respective to an organisation. We argue that a critical next step for safety is to continue to conduct post-report research. At the conclusion of many of these investigations, reports (e.g., Australian Transport Safety Bureau, 2008; Australian Transport Safety Bureau, 2019) often state that further research into certain areas is required or would be useful. Sometimes the organisation has capacity to conduct additional research or safety studies internally but often resources limit the amount of research projects that can be done. This is where a university collaboration can offer assistance to examine research areas in greater detail. Furthermore, university partners can be involved in the training of investigators and the investigation itself. They are therefore integral to the lifecycle of an investigation.

HIGHER DEGREE RESEARCH PROJECTS

University partners provide a range of safety-related research opportunities that can assist investigators. RMIT University for example, has produced recent research projects into safety and investigation-related aviation issues. This paper details six practical examples of how a university has provided or is providing additional research support into areas of interest following an investigation.

Engine failure after takeoff

This research project aims to compare pilot recovery performance after engine failure at four different heights. Motivation into this research project was driven from the outcomes of AO-2017-057 - Loss of control and collision with terrain involving Cessna 441, VH-XMJ, 4km west of Renmark Airport, South Australia on 30 May 2017 and AO-2019-072 - Loss of control and collision with terrain involving Angel Aircraft Corporation 44, VH-IAZ, near Mareeba Airport, Queensland, on 14 December 2019. There was no clear consensus regarding the ideal training height for student pilots to use to practise recovery after engine failure. When conducted at take-off, low heights (below 400 feet) have been used previously and this has occasionally led to a fatal accident due to a loss of control.

This project will use instructor/student pairings to work through engine failure recovery at the manual height, stall recovery height, 1500 feet (taken from occurrence data) and the 400 feet Civil Aviation Safety Authority (CASA) minimum. Twin-engine simulators based at RMIT's Point Cook flight school will be used. Pilots will be required to continue to complete the exercises until they successfully recover the aircraft without instructor intervention. Dependent variables will include pilot performance (reaction time, comments, instructor metric ratings, checklist application and CASA competency items), workload and situation awareness ratings, eye-tracking and voice communications. Follow-up cognitive probe questions will be used after the exercises to discuss each scenario's challenges.

This methodology is representative of how the exercise is actually conducted with real aircraft by including the same kind of tasks a pilot would be expected to complete. Using a flight simulator however, is a much lower risk exercise compared to an actual aircraft and simulator studies has shown that they evoke similar physiological responses in participants (Borgvall, Castor, Svensson & Nahlinder, 2007).

Improved risk management in unmanned aircraft systems

The Unmanned Aircraft Sector (UAS) is a relatively new industry that has a considerable amount of uncertainty associated with it. This research (Washington, 2019) targeted the risks associated with the operation of UAS over populous areas. Owing both to the recency and the unique characteristics of this sector, there is a great level of uncertainty which has the potential to affect the accuracy of existing risk management models. For example, the fact UAS do not have a human pilot on board, they come in a broad range of sizes and configurations (fixed wing, multirotor, helicopter and hybrid) and are used in many types of operational scenarios. This has created challenges to the existing risk management frameworks, which often lead to inaccurate assessments.

This research examined how to incorporate uncertainty in the risk management process by applying Bayesian methods and normative decision theory to enable a more robust ground risk model, which contributes to a more rational, objective, and transparent compliance decision making in the presence of uncertainty. It provided a

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comprehensive treatment of uncertainty to support the development of UAS regulations.

Aircraft safety and passenger anthropometry

This research (Melis, Silva & Yeun, 2019) project examined the safety aspects around the impact of the anthropometric characteristics of airline passengers and aircraft emergency evacuation. The design of commercial passenger aircraft must take into consideration the certification requirement that all occupants should be able to evacuate from the cabin within 90 seconds in an emergency. Manufacturers are required to demonstrate compliance with this regulatory requirement before an aircraft can be issued a certificate from the aviation authorities saying it is fit to fly. However, people are getting heavier at a global scale and most aviation authorities have failed to incorporate this trend into the regulations and design standards.

This research looked at the mismatch between actual people's weight and size and if the one in the Australian regulations would pose any risks in terms of both the emergency egress and the operation of the aircraft. Findings showed that egress time significantly increased when greater percentages of obese passengers were considered, highlighting the importance for the aviation authorities and other key aviation stakeholders to consider a more accurate representation of passengers' anthropometric parameters in the design and operation of aircraft.

Improving the effectiveness of safety reporting systems

An important aspect of aviation safety is a safety reporting system. Safety reporting systems are key for the establishment of a good safety culture, as they facilitate the collection of minor safety occurrences, which are the precursors for accidents.

This research (Jausan, Silva & Sabatini, 2017) examined why a reporting system was not performing as expected and the key barriers that influence the effectiveness of reporting systems in aviation organisations. A survey was conducted amongst personnel at various levels/ranks and with different roles and the resulting data provided an accurate assessment of these barriers (e.g., lack of professional development, lack of funding, lack of supervision).

A unified airspace risk management framework for UAS operations

This research (Bijjahalli, Gardi, Pongsakornsathien, Sabatini and Kistan, 2022) produced an example of enhancing risk management processes for UAS operations. It provided national aviation authorities and operators with a risk-based approach supported by a ground risk model incorporating risks across all facets of the system. This conceptual safety risk management plan is adaptable to both 'as low is reasonably practicable' and 'so far as is reasonably practicable' principles.

A post-accident analysis of civil remotely-piloted Aircraft System (RPAS) accidents and incidents

This research examined RPAS accidents and incidents. A sample of 152 accidents and incidents involving RPAS were analysed (Wild, Gavin, Murry & Silva, 2017). These data were collected over a 10-year period, 2006 to 2015. Results indicated that safety occurrences involving RPAS have a significantly different distribution of contributing factors when sorted into distinct categories.

This research provided a thorough and up-to-date characterisation of the safety deficiencies specific to RPAS, which contributed to the development of adequate safety management systems. The majority of RPAS occurrences involved system component failures, which were the result of equipment problems. 'Human factors' and 'loss of control in-flight' were found to be the second most common contributing factor and occurrence category, respectively.

The most significant conclusion was that reporting systems must be implemented to address RPAS accidents and incidents specifically. More useful data will assist further analysis and facilitate an improved understanding and greater awareness.

The role of augmented reality in air accident investigation and practitioner training

This research (Anniballe, Silva, Marzocca & Ceruti, 2020) looked at the application of digital visualisation tools to assist air accident investigators, including both their investigation activities and as a training resource. Augmented Reality technology was used to re-create a real aircraft crash scene, both in terms of wreckage distribution and features of the surroundings, in a full-scale representation.

Overall, it was concluded that Augmented Reality has achieved a maturity stage sufficient to consider it as an effective tool for training of air accident investigators and, to some extent, to support the investigation process itself.

These research projects illustrate how University projects can assist investigations and that safety-related research activities can be put into the public domain.

OTHER RESEARCH PROJECTS AND SUPPORT

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In addition to research projects relevant to accident investigation, a university partner also offers additional capability to busy investigators, an extensive network of contacts, international safety projects, other resources and cross disciplinary expertise.

Additional capability to busy investigators

Universities can offer capability in the form of many researchers. RMIT for example, has 62 academics and 105 higher degree research students in the PhD and Master programs for aerospace engineering and aviation. There are also cross over partnerships with other disciplines. This can provide broad academic capability to conduct research projects related to accident investigation.

International safety projects

Universities can also provide the contacts to conduct large-scale international projects. One RMIT example is current research looking into the crew supply chain (all activities which relate to resource planning and tracking of flight crew, cockpit and cabin) with The Airline Group of the International Federation of Operational Research Societies (AGIFORS).

This research is examining the challenges with crew scheduling operations and identifying a gap in formal training requirements that exists for this group. An industry questionnaire about crew scheduling challenges will be developed and administered to various international operators and a newly developed training program will/is being proposed. The safety implication for investigators is to standardise training for this operational group, leading to better roster pairings and a reduction in crew fatigue events due to these more effective pairings.

Extensive network of contacts

A university can offer a wide network of contacts to support accident investigation research. For example, at RMIT existing agreements and Memorandums of Understanding are established with various Government and private aviation and aerospace entities. These facilitate and expedite collaborative research projects.

Resources and facilities

A university partner offers various resources for research projects including online library databases, higher degree by research students, flight school facilities and simulators, laboratories and potential accident site locations for training. RMIT offers the Point Cook training facility, various flight simulators, the Qantas future pilot program, air traffic control and management simulation and a virtual crash lab to simulate practical investigative techniques and facilitate online learning.

Research facilities and internal cross disciplinary expertise

A wide range of cross-disciplinary research facilities can be offered by universities to assist with investigation-related research projects. For example, RMIT offers the Intelligent Transport and Mission Systems (ITMS) group, which performs high-impact research on advanced vehicular and infrastructure technologies with the objective of improving safety, efficiency and sustainability of single and multi-modal transport systems. This group is multi-disciplinary and collaborative in nature with research activities focusing on air transport systems; land transport systems; maritime transport systems; transport safety and safety management systems, human factors and ergonomics; trusted autonomous systems and operations; defence, security and humanitarian mission systems; and system cyber-physical security.

These research programs, and related research activities, closely follow the RMIT University's research concentrations in Traffic and Transport Modelling, Advanced Aerospace/Aviation Technologies, Rail Transport Systems, Sustainable Automotive Technologies, Advanced Manufacturing and Logistics Engineering.

Furthermore, there are research capabilities for cognitive human-machine interaction, intelligent automation, navigation and guidance systems, multi-domain traffic management, a data-driven approach for airspace management, integrity automation, digital twin capabilities and damage tolerance optimisation of structures.

INVESTIGATOR QUALIFICATIONS

The other important role a university can play in the improvement of accident investigation is the training of investigators. Tertiary institutions can offer formal qualifications in investigation, which can equip staff with skills to work across multi-modal investigations.

RMIT for example, works with the Australian Transport Safety Bureau (ATSB) to develop these programs, program structure and course material, which ensures the learning experience of students is industry-relevant and work-integrated. This high-level strategic partnership with the ATSB delivers postgraduate transport investigator training covering aviation, marine and rail transport.

ATSB subject matter experts with considerable industry experience also deliver a range of specialised topics in the program.

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The programs include the graduate certificate in transport safety investigation, the graduate diploma in transport safety investigation and a master of transport safety investigation.

CONCLUSION

This paper highlights how a university partner can assist investigators throughout the investigation lifecycle. By accessing the resources of a university partner, they can assist with training investigators, participating in investigations and conducting research projects relevant to investigation safety.

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