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DRONE SAFETY AND RELIABILITY SURVEY RESULTS

A Study to Support Research into Embedded Intelligence

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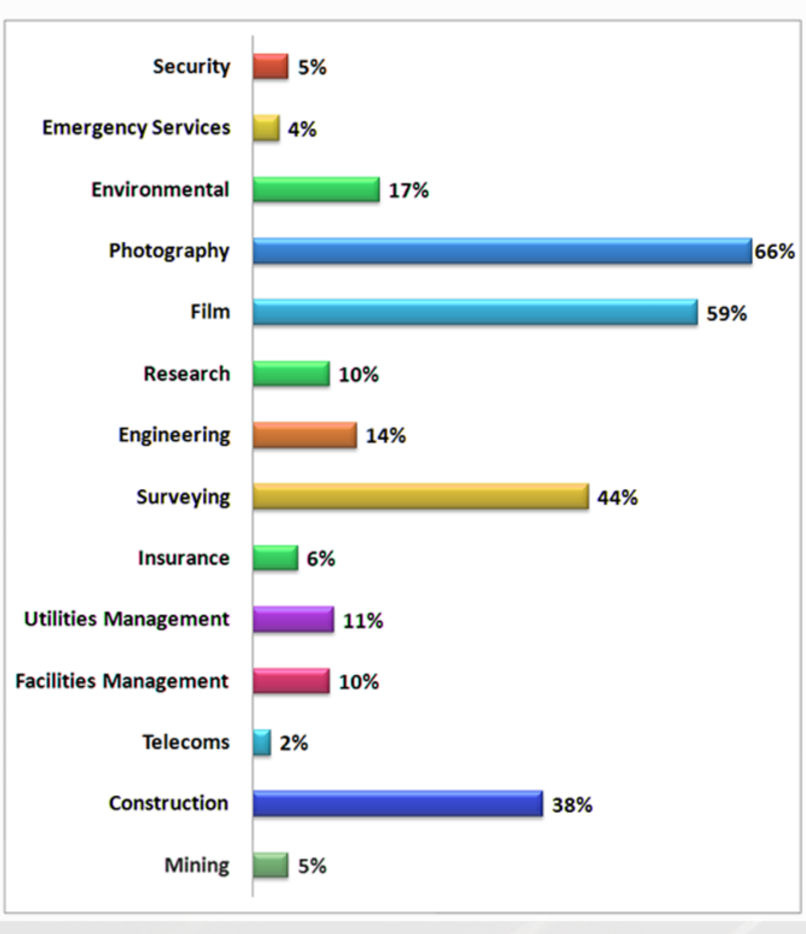
An increase in the commercial use of drones in ever more complex and congested skies means that safety and reliability of operations are paramount to reduce any likelihood of accident or injury.

As part of the CDT for Embedded Intelligence at Heriot Watt University we are interested in the use of on-board intelligence to mitigate the on-set of failure modes to permit the safe operation of robots and autonomous systems. The aim of this survey is to prioritise subsytems and common failure modes currently observed by commercial operators to inform the research and development of intelligent systems.

The survey was issued directly to around 1500 Civil Aviation Authority (CAA) approved drone operating organisations with a response rate of around 10%. Discussed below are the key findings of the survey.

Q2.

Which sector(s) does your company best fit into?(You can select more than one option.)



Over 95% of respondents are CAA Approved Operators.

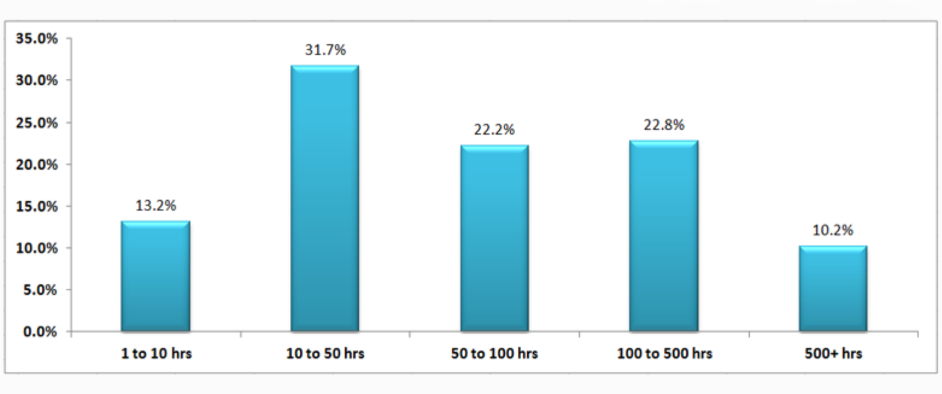
The majority of respondents operate in the Photography and Film sector, followed by Surveying and Construction.

The type of drone platforms typically used within each sector will play a part in the performance with regards to reliability. We found that smaller organisations may spend a few thousand pounds typically on drone platforms, whereas high value operators may spend tens of thousands with a significant increase in software sophistication.

It was our intention to find the common failure modes independant of operating costs.

Q3.

For routine flight operations, please estimate a mean time before a non-critical failure typically occurs?



The respondents indicated that the most likely time for a non-critical* failure is between 10 to 50 hours of operation, although 13% reported non-critial failures occuring within 1 to 10hrs. This highlights the relative complexity and platform dependance on regular health checks to maintain flight readiness.

The responses will depend to some extent on a company's maintenance procedures and the build quality of each drone.

*Non-critical failures are defined as those that do not compromise mission objectives or safety. This was not explicitly defined in the survey.

Over 50% of respondents reported that a critical failure would not occur until after 500 flight hours. It should be pointed out that an option for no failures observed was not provided which may have unfairly biased the results. The commercial aviation failure rate is about 1 in 100,000 flight hours whereas for drones, it has been found to be 1 in 1000 flight hours [1].

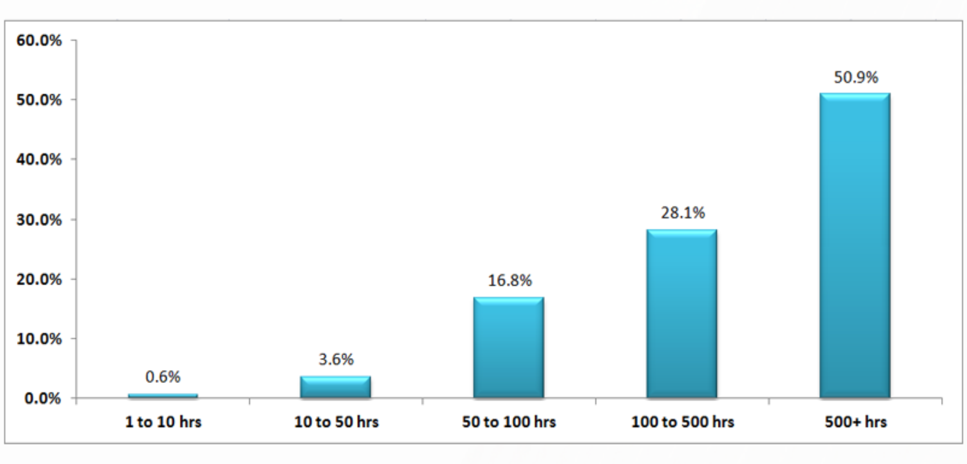
Despite this around 4% of operators reported critical* failures occuring within 50 hours and a further 17% within 100 hours. These types of failures are of particular interest for robust fail-safe systems.

*Critical failures are defined as those that compromise the mission or safety. This was not explicitly defined in the survey.

[1] E. Petritoli, F. Leccese, and L. Ciani, "Reliability and Maintenance Analysis of Unmanned Aerial Vehicles," Sensors, vol. 18, no. 9, p. 3171, Sep. 2018.

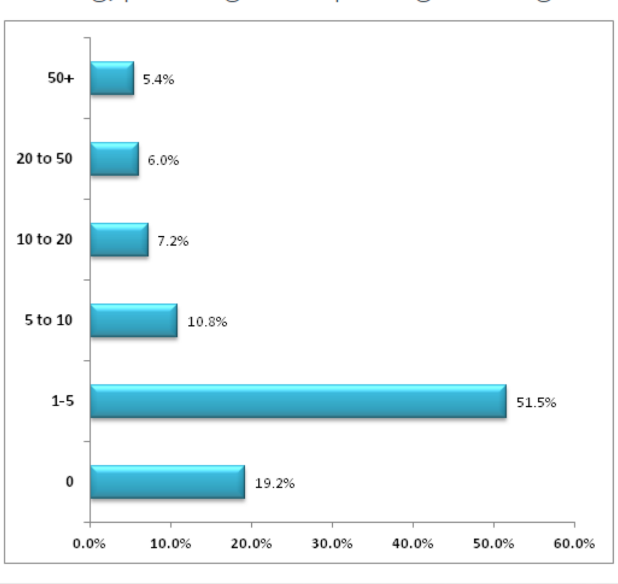
Q4.

For routine flight operations, please estimate a mean time before a critical failure typically occurs?



Q5.

Please estimate how many mishaps might be avoided with increased on-board intelligence to aid the pilot per 100 flight hours. ("On-board intelligence" might include algorithms that can detect hazards from camera images, fault tolerant stability and control, increased situational awareness or increased reasoning, planning and reporting from flight data.)



51% of respondents estimated that between 1 to 5 mishaps per 100 hours of operation could be avoided with on-board intelligent systems.

20% of participants also said that there was no need for further on-board intelligent systems to avoid mishaps.

The responses show that there is, at least from 80% of users, a demand for development or the supply of intelligent systems to aid the safe operation of drones.

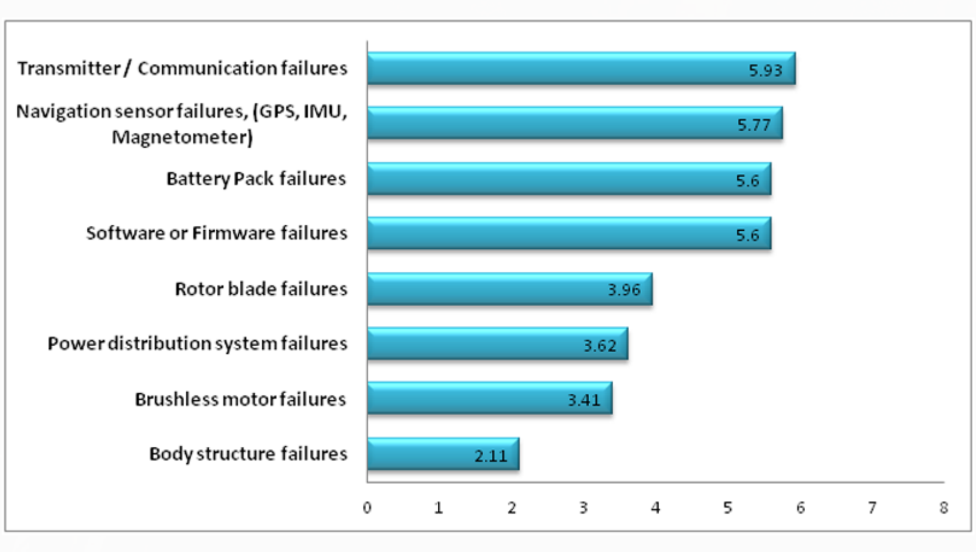
10% of operators suggested that the demand for greater intelligence may mitigate greater than 20 mishaps per 100 flight hours.

The highest ranked subsystems to protect from failure were transmitter and communication systems. These were closely followed by navigation systems and battery pack failures.

Mechanical failures are a lower priority, such as rotor blade damage, brushless motor failures or body structure failures. In terms of the frequency of failure these components are already robustly engineered for higher reliability on current commercial drone platforms.

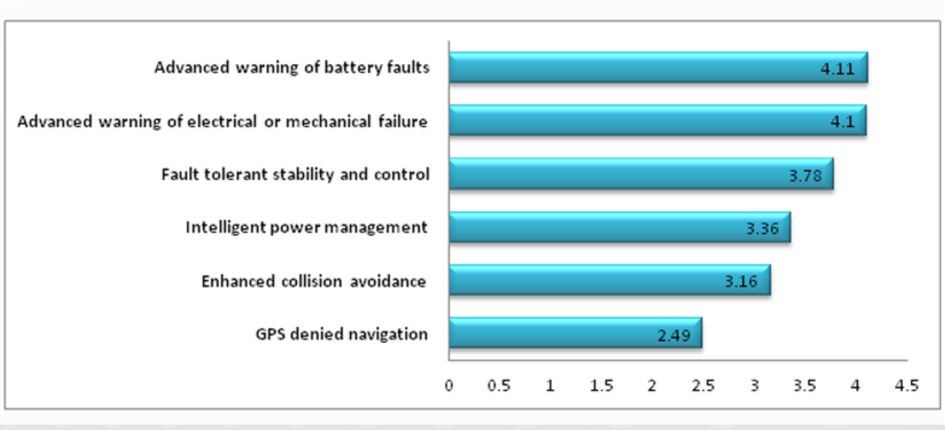
Q6.

Please rank the following subsystems into the order of those you think most likely to fail. Those most likely at the top.(Click, drag and drop each sentence block, or use the arrows to re-order your answers.)



Q7.

Please place in order of importance, technologies that you think would be most beneficial for commercial drone operations, the most important at the top.(Click, drag and drop each sentence block, or use the arrows to re-order your answers.)



The higherst ranked intelligent technologies are reported as being, advanced warning systems for battery failures, closely followed by advanced warning of electrical or mechanical failures.

Also high on the list is fault tolerant stability and control and intelligent power management.

Collision avoidance and GPS denied navigation was reported as lower down on the list of priorities. This is partly due to technology already being available in this area.

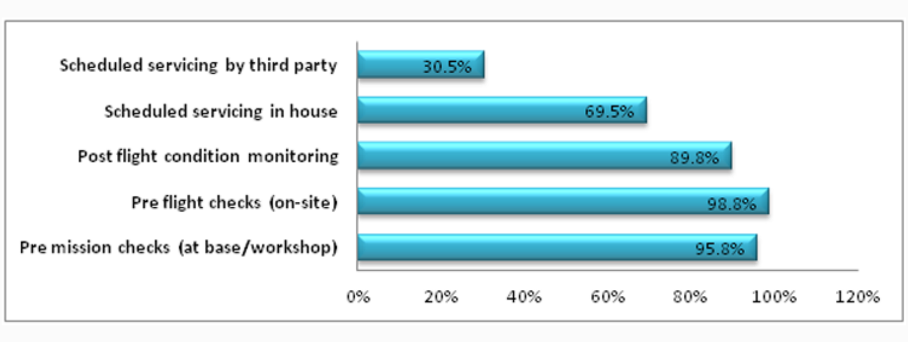
Nearly all operators carry out regular checks in the workshop before operations, immediately before take-off (on site) and carry out post flight checks.

Only around 70% of operators carry out scheduled maintenance and of these 31% use a specialist third party service provider.

The high importance of regular maintenance checks may promote the use of on-board diagnostic and prognostic technology to better provide condition based maintenance data.

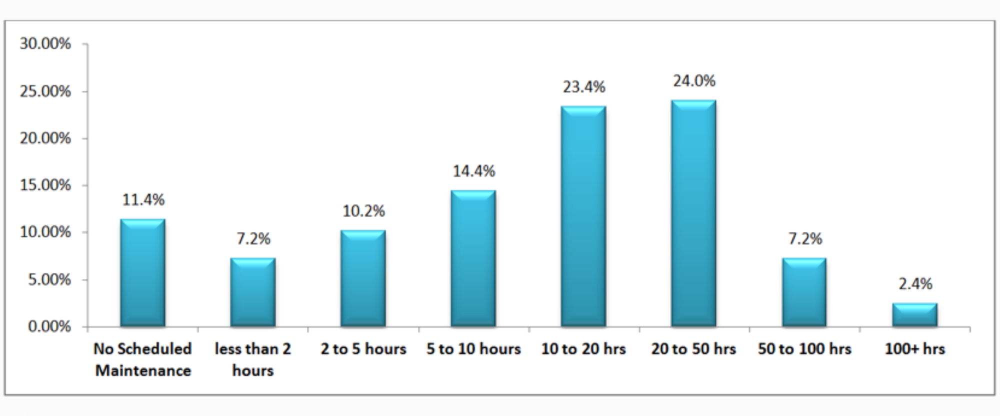
Q8.

Please indicate the type of health checks that you carry out during a drone's lifetime?(Please select all which apply)



Q9.

Please indicate approximately the number of hours flown between any scheduled maintenance.



Servicing is generally carried out after 20 to 50 hours of flight time for most companies. Around 10% of companies reported that servicing was carried out within 5 hours of flight time and 10% in the 50 to 100 hours of flight time range.

A fairly large proportion of companies, 15%, did not have any scheculed maintenance. This could also be better supported with on-board diagnostic and prognostic technology.

The individual responses provided a valuable insight into the commercial experience of drone safety and reliability.

The bar graph categorises the types of improvements recommended.

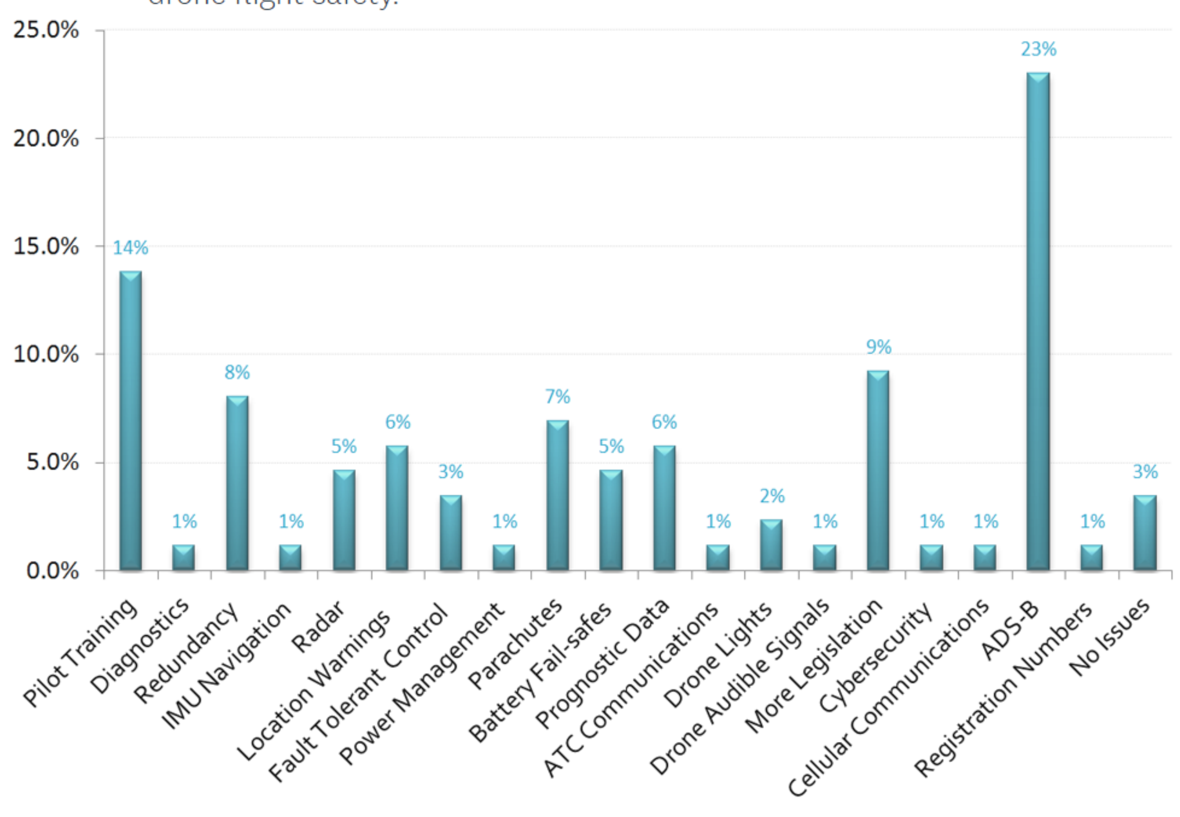
There is clearly a high demand for ADS-B transponders and for rigorous pilot training currently.

A few companies said that they had experienced no failures during operation over many years of commerical operation.

However over 50% of responses related to some form of on-board intelligent augmentation of the current platforms.

Q10

Finally, please comment on any other technology you believe might improve drone flight safety.



The results from the survey will inform research carried out on intelligent subsystems for commercial UAVs to increase safety and reliability. The results are made public and distributed to leading research institutions to better inform the research community of the current concerns over UAV operations.

For more information or queries about the survey please contact: mho1@hw.ac.uk

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