Managing Emergencies in Human Commercial Spaceflight with Space Traffic Management.

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Abstract:

Emergencies in space are unavoidable, but with the assistance of some fundamental guidelines in space traffic management, these emergencies can be less severe or mitigated. These guidelines should consider the classification of accidents to find areas that need improvement in space traffic management. Space stations can be utilized to assess damage to a spacecraft in the case of debris hits. They can also be used to dock with a spacecraft, if conditions are met, to resolve any technical or structural problems to ensure successful reentry into the atmosphere. In addition to including universal docking capabilities for spacecraft, it is important to consider creating an addendum which requires all spacecraft to have the capability to land on either water or on land. The Outer Space Treaty has created an international space community and the subsequent Astronaut Return and Rescue Agreement protects the safety of astronauts. However, with the addition of spaceflight participants and tourists, clarification and definition of the word 'astronaut' is crucial. Including spaceflight participants and tourists in the definition of 'astronaut' would ensure the protection of space tourists and in turn, the future of space tourism.

Introduction:

Space traffic management refers to the integration and navigation of space vehicles, objects, and stations through national airspace and on orbit. It plays an important role in managing emergencies that occur during space flight, from the time of launch to landing, just like air traffic management does with commercial airplanes. The intricate system of ground based and satellite tracking, coupled with the addition of air traffic controllers makes it possible to mitigate some of the failures that occur during emergencies on commercial airplanes. The airline industry has taught us that some failures cannot be fully mitigated. However, it is possible to decrease the severity of the accident with the help of air traffic management and in the future, space traffic management. This task is becoming more difficult because of the increase in space objects and launches. Currently, the Joint Space Operations Center of the American Air Force (JSpOC) handles the prevention of space objects from crashing into each other and the assignment of launch windows for objects into space. Other space companies and organizations also track debris and space objects. However, they do not provide conjunction warnings. These warnings are a necessity as there are increases in space launches, especially for space tourism. Failures of manned missions can cause the loss of life or severe injuries. The suggested guidelines below may prove essential to decrease the number and severity of emergencies caused due to accidents in space.

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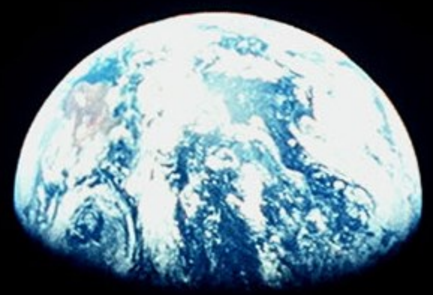
Methods:

For this project, a complete analysis was done on aircraft regulations, air traffic control and the International Civil Aviation Organization to draw parallels to the space industry and regulate Space Traffic Management. These parallels were used to formulate the following guidelines.

Guideline 1:

The first guideline is to require all spacecraft to have the ability to touch down on the ground, to land in water, and to have universal docking capabilities. This concept is already embedded in most designs of spacecraft, but needs to be elaborated on with a possible legal requirement. Having the commandeer and pilot on board the spacecraft know that the spacecraft can land in multiple environments may help make better decisions to save lives in the case of an emergency. Also, by standardizing this component of landing, the mission controller can make sure that the spacecraft has a proper landing site that ensures the safety of bystanders. In addition, if spacecraft meet the orbital requirements to dock with space stations, they should also have the technical requirements of universal docking. Universal docking allows for the utilization of space stations during emergency situations to further protect the passengers on board the spacecraft.



Guideline 2:

The second guideline is to use the same accident classification system as the International Civil Aviation Organization, ICAO for short. This organization has six classifications of airplane accidents that include emergencies such as non- runway landings, loss of control in flight, damages to the aircraft and to ground facilities, and the situation where the cause of the accident cannot be determined (Safety Report - 2016). This classification system and the data obtained from it can be used to assess where improvements are needed in space traffic management. However, in space traffic management, there needs to be a classification system for types of accidents while docking and undocking from space stations as they will become more prevalent.

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Guideline 3:

The third guideline is about redirecting spacecrafts to space stations or satellites with cameras after debris strikes. If a spacecraft gets hit by a piece of debris that is less than five centimeters large, the effects may not be noticeable until that spacecraft reenters the earth's atmosphere, where it has the potential to burn up if that piece of debris had affected the heat shield. In the cases where spacecrafts were hit by pieces of debris, quick checks can be performed on the heat shields to ensure successful reentry into the atmosphere. These checks can be done by having the spacecraft do a rollover maneuver below a space station or a camera enabled satellite. If a breach does occur and the spacecraft has the ability to dock with a space station, they can receive repairs or have the possibility of a replacement spacecraft.

Guideline 4:

The final guideline is in introducing new language to the Outer Space Treaty and the Astronaut Return and Rescue Agreement to clarify and define the term: astronaut. The Outer Space Treaty, article five, and the subsequent Astronaut Return and Rescue Agreement outlines that if an astronaut needs help, states who ratified the treaties are obligated to assist that astronaut in getting back to their launching state. Defining an astronaut as a person who crosses the Karman line (the boundary of space) on a space object includes space tourists. This means that space tourists also have protection under the Outer Space Treaty and the Astronaut Return and Rescue Agreement.

Conclusion:

Many factors play into space traffic management and there is a long way to go in creating a comprehensive space traffic management system. By first focusing on emergency situations in spaceflight, risks to human life are lessened. This is especially true if space companies keep their projected launch dates and a comprehensive space traffic management plan has yet to be implemented. The space industry is fragile right now. If more humans die in the pursuit of space tourism, the support behind the space industry will waiver and this could collapse the tourism sector of spaceflight. A more in depth analysis of implementation, utilization and feasibility of space stations being integrated for emergency responses of spacecraft will be written about in a future research paper.

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