THE FALLACY OF SPACE SAFETY

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During his famous speech before Congress on 25 May 1961, President John F. Kennedy said "*I believe that this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the moon and returning him safely to the earth*." During that speech he put a goal before the space community that was both exciting and nearly impossible. The fact that we were able to send men to the moon and bring them back safely was a combination of hard work and extremely good luck. Just the act of getting men off the Earth and into space is one of the most dangerous undertakings ever attempted and for the foreseeable future will not be "safe".

What is "safe"? The Merriam-Webster dictionary defines the word as free from harm or risk. This means that something cannot or will not happen. Unfortunately, that is a condition that is impossible to attain. Nothing is or can be made safe especially when there is human interaction. This interaction can be from the concept phase through the disposal phase of any item. The ramifications of an unsafe act can be a minor incident up to a fatal accident. When discussing manned spaceflight, unsafe acts or conditions are more difficult to address due to the environment and the distances from support elements. In a 19 April 2007 Wall Street Journal article titled How Safe Is the Race To Send Tourists into Space?, Federal Aviation Administration Associate Administrator Patricia Smith stated "The fact that we are focused on safety and talking about the ramifications of an accident, should demonstrate that safety is the key! At our recent conference in February, on a panel entitled, "*When is a launch vehicle ready to carry passengers*?" industry leaders Alex Tai (Virgin Galactic), Jeff Greason (XCOR), George Whiteside (National Space Society) and John Herrington (Rocketplane Kistler) resoundingly stated that the "*vehicle will fly when its safe to fly*."

So what exactly does "safe" mean when it is used to describe our space programs? The word itself is a misnomer since nothing is or can be made completely safe. The National Aeronautics and Space Administration (NASA) defines safety as freedom from those conditions that can cause death, injury, occupational illness, damage to or loss of equipment or property, or damage to the environment. This concept of safety is inclusive of human safety, which includes workers directly involved in system interactions, workers not directly involved in system interactions, as well as members of the general public.[1] However, in the International Space Station Safety Requirements Document (SSP 50021), "safe" is defined as "a general term denoting an acceptable level of risk, relative freedom from and low probability of: personal injury; fatality; loss or damage to vehicles, equipment or facilities; or loss or excessive degradation of the function of critical equipment."[2] These two NASA documents appear to contradict each other since freedom from those conditions would mean that there is no risk, not simply an acceptable level of risk.

With the end of the United States Space Shuttle Program and the cancellation of the Constellation Program, NASA is under extreme pressure to build a manned spacecraft. While politicians will immediately state that they expect safety to be the number one priority, the political pressure to conduct a successful space mission is enormous. Several Congressmen wrote, "*We have serious concerns about the Administration's course of action with the commercial crew program. It is inexcusable for the Administration to spend hundreds of millions of dollars of taxpayer funds on these nascent systems without the ability to define and impose the necessary requirements to ensure the health and safety of astronaut crews.*"[3] This is an admirable goal but impossible to do since it is impossible to ensure a safe flight due to the inherent risks involved.

Risk is a word that everyone recognizes but not everyone agrees on its meaning. Webster defines risk as the possibility that something bad or unpleasant (such as an injury or a loss) will happen. The problem with trying to ascertain risk is that it is very subjective. What is perceived as risky by one person is simply a form of entertainment to another. Society, politicians and the press, expect engineers to not only understand risk but to design equipment that is risk free. It is society's misunderstanding of risk what is that leads to this mindset. While some level of risk is necessary to achieve an objective, the public and the media do not always agree with NASA on what level of risk is acceptable. "*NASA must be clear and transparent with all of the stakeholders about the*

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level of risk involved in human space flight. The Panel has not seen [underline added] *a significant improvement in this problem over this reporting period*".[4] This disagreement is generally due to the lack of communication between the NASA safety community and the public. Until we in the space safety community are able to convey an understanding of the risks inherent in manned space flight to the public, we will continue to defensively react to an accident instead of concentrating on correcting whatever caused the problem. There are, however, people who can cause damage to a program before it even starts. "*Although it's always going to be fairly risky, the risk will get reduced with experience*" is a quote from Mr. John Logsdon a space policy expert.[5] Statements like this give the impression that simply flying more missions will reduce risk. Experience is a great teacher but rarely do spacecraft designs remain stagnant. Constant upgrades in navigation and life support systems make every spacecraft a different vehicle that needs to be assessed for safety just as if it were a new design.

Only weeks before he died, Gus Grissom wrote the following: "*There will be risks, as there are in any experimental program, and sooner or later, we're going to run head-on into the law of averages and lose somebody. I hope this never happens, and... perhaps it never will, but if it does, I hope the American people won't think it's too high a price to pay for our space program*."[6] The difficulty that we face is relaying to the general public and politicians how we assess risk, work to eliminate those risks that we can, and accept those risks that are inherent in spaceflight. People take risks every day by simply getting into a car. They do not think about the risks because driving is a daily event; therefore, they have become acclimated to that risk. Spaceflight, especially manned flight, is not an everyday event and should not be treated as such. Unfortunately, it is still being perceived by the public as though it is a daily activity. When the inevitable accident occurs, it is a shock to people who should know better. During an interview about the Space Shuttle Columbia accident for the Public Broadcasting Station, NASA engineer Don Nelson stated that the "*launch schedule was a prime consideration. We kept saying that safety is the number one consideration, but launch schedule was right up there with it. We were showing the congress and the American public that, "We've got a space truck here that's ready to go, let's go start doing other things in space." So we're* [SIC] *extremely important that we meet those schedules and keep the operating cost of the vehicle down"*.[7] Spaceflight is not something that affects most people on a daily basis; therefore, those not directly involved in the manned programs are not actively learning about and understanding the risks that come with spaceflight. Due to this lack of understanding safety suffers from a pendulum effect. The greater the time between accidents, the less people actually understand the real risks that are involved. Because of this belief that spaceflight is safe, the public expects every flight to proceed flawlessly. Accordingly, when an accident happens, the pendulum swings the other way, and everyone wants to know why the risks inherent in every flight were considered acceptable.

During a speech at the Jet Propulsion Laboratory in Pasadena, California, JPL in 1992, NASA Administrator Daniel S. Goldin remarked, "*We need to stretch ourselves, Be bold -- take risks. [A] project that's 20 for 20 is not successful. It's proof that we're playing it too safe. If the gain is great, risk is warranted. Failure is OK.*"[8] What Mr. Goldin did not state was how to handle the inevitable backlash that always occurs following a mishap. A seeming contradiction to the above statement is this excerpt from a 2012 letter from Congressman Pete Olson to the White House Office of Science and Technology Director John Holdren stating "*Safety is the most critical component of human space exploration. This is a no brainer for NASA*."[9] It is not the failures that are jeopardizing our space programs; it is the perception that space travel can be made completely safe that is our biggest threat.

NASA is not the only federal agency that appears to have issues with space safety. The Federal Aviation Administration (FAA) is restricted from promulgating regulations pertaining to the safety of spaceflight participants and the crews of commercial spacecraft. The Commercial Space Launch Amendments Act (CSLAA) of 2004 states, "The Secretary may issue regulations governing the design or operation of a launch vehicle to protect the health and safety of crew and space flight participants." The Act further states, ''*Regulations issued under this subsection shall (C) be limited to restricting or prohibiting design features or operating practices that have resulted in a serious or fatal injury (as defined in 49 CFR 830, as in effect on November 10, 2004) to crew or space flight participants during a licensed or permitted commercial human space flight; or contributed to an unplanned event or series of events during a licensed or permitted commercial human space flight that posed a high risk of causing a serious or fatal injury (as defined in 49 CFR 830, as in effect on November 10, 2004) to crew or space flight participants; and (D) be issued with a description of the instance or instances when the*

design feature or operating practice being restricted or prohibited contributed to a result or event described in subparagraph (C).”[10] There was a restriction on enacting new regulations for eight years after the signing of the Act into law. This can appear to indicate a desire to wait for a severe accident before the FAA can act. The author of the Bill, Representative Dana Rohrabacher (R-CA) said “*Regulating in the absence of flight data is the worst choice we can make*”.[11] While having actual flight data is the best way to learn if a vehicle is safe, trained safety professionals can utilize safety analysis such as fault-trees, Failure Modes and Effects Analysis, etc., to identify safety issues long before a first flight.

If the administration running America’s space program cannot seem to agree on what the meaning of safety is, how can we expect the public to believe we are doing our best to produce as safe a vehicle as possible for astronauts during a flight to the moon, Mars, or beyond? It will be our ability to educate the public on the hazards of spaceflight, and our efforts to reduce those risks, that will determine if manned spaceflight continues.

The new commercial space companies have the opportunity to open the space safety conversation with the public, but according to Mr.Tommaso Sgobba, "I believe that they are shrouding this into a level of secrecy that is not good for the industry itself." They should be more open and communicate what they do."[12] Starting with the initial manned flights, the public received all of its information either through the print media or one of the three network news organizations. ABC News took the lead in reporting by hiring a dedicated science editor, Mr. Jules Bergman. Mr. Bergman was unique in being the first network correspondent assigned to report on science and space. After NASA had chosen the first seven astronauts, he covered the subject with such passion that he spent almost as much time with the astronauts at Cape Canaveral, FL., as he did at home in New York. He said he wanted to give his audiences *"not an ivory-tower discussion of science, but an on-the-spot report of discoveries, which are changing the lives of human beings daily*." Starting in 1961, until his untimely death in 1987, Jules Bergman covered every manned American space flight, from Alan Shepard’s Mercury 3 flight in 1961, to the Challenger disaster in 1986, for ABC News. Mr. Bergman’s reporting allowed the American public to understand not only the excitement of spaceflight but the dangers associated with this new frontier. By having a single, dedicated reporter for all spaceflight activities, ABC News was able to capture and hold America’s fascination with all aspects of spaceflight.[13] Unlike the informed analysis that Mr. Bergman brought to reporting on spaceflight accidents, today’s broadcasters appear to report first, then fact check if necessary. This appears to be a conditioned response to the desire for instantaneous reports that characterize 24-hour news. Every accident that involves the loss of a crewmember is immediately designated as a disaster. This is not to disparage the loss of any crewmember, but due to the type of reporting and the desire to immediately affix blame, spaceflight accidents put programs at a greater risk of cancellation due to politicians trying to show that they are doing something.

In the past, people learned about spaceflight and space programs through the news. Most people under the age of 40 now get their impression of space flight from science fiction programs and movies like *Star Wars* and *Star Trek*. This can lead to the perception that the only dangers faced during spaceflight are the Klingons, The Borg and the Empire. The major difference between generations is that the younger generation does not receive the majority of its information through the traditional media of television and print but through Hollywood, the internet and social media. Print newspapers are losing circulation every year and television news generally report only delays and failures. The internet is filling the void but is far too often wildly inaccurate making it difficult and time consuming for people to differentiate between a bloggers opinion and the facts. In order to get a basic understanding of what is currently happening in the spaceflight industry, an individual needs to purposely search the internet which requires enough knowledge to know what to search for. There are a number of space related websites, but unless a person is actively looking for specific information, he will not see anything on space safety. Due to the complicated nature of both spaceflight and spacecraft, how does a person who does not have an engineering degree understand what is being developed or what is happening during a flight? To the public’s detriment, television news has not had a dedicated space analyst since ABC news lost Mr. Jules Bergman in 1987.

Without dedicated science analysts at the major news organizations, how does the safety community get the public to understand the efforts being made to keep spaceflight as safe as possible? Social media is rapidly becoming the best way to disseminate timely information to a very large audience. Twitter®, a social networking and microblogging service, connects an average of 241 million users a month[14]

(as of 31 Dec 2013) and the internet social media website Facebook® averaged 829 million users as of June 2014.[15] Approximately 51% of people aged 25–34 used social networking in the office.[16] While nearly everyone has the ability to use social media, governments and the private sector space companies view the use of these media to discuss safety issues as a large problem and not a solution. Some may see informing the public of our safety efforts as a bad thing because those who do not understand what a safety program is or what its goals are can easily misinterpret our efforts. The safety community needs to push for a dedicated public affairs office (PAO) representative that can accurately convey the efforts that are being made to make manned spaceflight as safe as possible. With the ability of users to interact through social media, it is the best way for our safety community to connect with, inform and educate the public on how we are working for a safer manned flight program.

There are, however, several problems with trying to use these avenues for information dissemination. The first issue is to clarify what really constitutes a safety issue. It is not a question of if an accident during a manned mission will happen but when. The response to that event may very well determine if we continue manned exploration of space. The public has been led to believe that spaceflight is a safe endeavor. If they have already been informed about a safety issue and the reason the risks were accepted, than the discussion will be about fixing the problem instead of affixing blame. We should be focusing on using safety issues discovered during planned reviews as an opportunity to show the vigilance of the safety community at work.

In order to find an actual safety issue, a person has to have had some training in safety. Every engineer working in the space program wants to design and produce equipment that is as safe as possible but they are often focused on making a system work. Without specific safety training engineers may not understand how to assess the risks associated with the equipment they are designing. Few systems on a spacecraft work independently. The interactions of each system must be understood during the development phase to assess the risks involved. The problem is that very few of these engineers have any formal safety training. The undergraduate engineering degree programs for six major universities in the United States (University of Texas in Austin, Texas A&M College Station, Notre Dame, California Institute of Technology, Georgia Institute of Technology, and Embry-Riddle Aeronautical University) were reviewed; none had a requirement for safety courses. Most of the universities have safety training courses, but these are mainly in the manufacturing area. Without having engineers that have been specifically trained in safety intimately involved in the design process, important safety analysis may be missed that can have severe implications later in a program. Due to the complex nature of spaceflight hardware (and software) and the consequences of a failure very often being catastrophic, having engineers without proper safety training is unacceptable.

The second issue is the view of social media more as a problem than a solution. Governments tend to approach these types of communication with distrust or open hostility without first trying to understand the nature of their power. Due to the embarrassment caused by the Eric Snowden leaks, governments are tightening controls of employees' use of social media to discuss anything relating to their jobs. Information that deals with government contracts and/or equipment can be classified, and information dealing with the designs of commercial equipment may be proprietary therefore, not legal for unauthorized dissemination over social media.

The major governmental space agencies and commercial space companies all have Facebook® pages but none of them have a dedicated section on safety. The advantage of Facebook® is that there is not a restriction on the amount of information that can be posted, (Twitter® is restricted to 140 characters). Most of the space agencies have Twitter® accounts. The greatest advantage of Twitter® is that it is mainly used on cell phones so this would avail our efforts to millions of people not only spaceflight engineers. One of the Twitter® features is called "trending". Twitter® uses an algorithm to identify popular topics through the use of common words, phrases or buzzwords known as "hashtags". The top ten trending topics are posted on the Twitter® homepage, so anyone clicking on one of these topics can view discussions on that topic. By using this method of information dissemination, the public can learn not only how the safety community works but what issues are being addressed. If the safety issue related to that event had been openly discussed, it would cause fewer problems with the media and politicians when an incident/accident happens.

The final issue is determining who will be responsible for the postings and what safety information to publish on these sites. The "who" may already be available.

In the Aerospace Safety Advisory Panel – Annual Report for 2013 the statement "*NASA must be clear and transparent with all of the stakeholders about the level of risk involved in human space flight. The Panel has not seen a significant improvement in this problem over this reporting period*" highlights the inability to adequately disseminate safety information.[17] With open discussions on safety comes the responsibility to protect sensitive design information. This is the most difficult balance to attain and where a dedicated flight safety Public Affairs Office (PAO) representative is needed. Engineers have always believed that the best way to solve a problem is to openly discuss an issue thereby allowing everyone involved to express ideas. Unfortunately rocket technology can be used for the peaceful exploration of space or the design of weapons. Keeping the public informed of new developments in hardware and software can help in the understanding of the dangers involved in exploration, but social media is not the place for the open discussions of the design details that can be misused. It would be the PAO representative's responsibility to convey the safety issues and the work being done to resolve them without revealing any specific design information. While some in the public and the media will always want to have all the information made available, sufficient safety related details can be made available to explain what safety issue is being worked without breaking export restrictions. What the space agencies need to do is remove the perception that we are trying to keep the public "in the dark" and work to get people excited once again about spaceflight. The best way is not to flood the public with so much data that they lose interest but to present enough facts to stimulate curiosity. As the public awareness of the risks of spaceflight, and the work that the safety community is doing to address them increases, if any accident does occur, the negative responses will be reduced.

The success of science fiction related to space exploration such as (Star Trek, Star Wars, etc…) shows that the public is very interested in learning about what is beyond our own planet. Getting people interested and excited in manned flight is essential to the continuance of our space programs. Unless we find a way to connect with the younger "wired" generation, the only spaceflight will be robotic. That would be a great loss to mankind.

What is the fallacy of our safety programs? It is the presumption that space flight can be made safe. With the end of the United States Space Shuttle program and the cancellation of the Constellation program, NASA is under extreme pressure to build a manned spacecraft. Many politicians state that they expect safety to be the "number one priority" however the political pressure to conduct a successful space mission is enormous. That pressure cannot override the necessity for safety but without a public that understands the risks of spaceflight and the work being done to mitigate the hazards, the biggest risk we face is the loss of a future in space due to ignorance.

In spaceflight we ride the ragged edge of failure during every mission. With every flight a million things have to go right but only one has to go wrong. It is the safety community's job to not only identify what could go wrong but work to eliminate design flaws and keep the decision makers, both public and within the space agencies, aware of any residual risks. We never want to underestimate the risks involved in space exploration, but we also do not want to let undue caution destroy the will to move forward.

Safety for most people is the perception that there will be no chance of injuries. That fallacy is projected into our space programs by not only well known engineers and politicians talking about safe space flight but also our record of success. The reality that the best designed equipment and meticulous training are no guarantee of a successful flight are far too often lost on the public. Unless we find a way to educate the public on our efforts to remove as much risk as possible, space exploration will continue to be one accident away from becoming nothing more than a history lesson.

"Life is inherently risky, there is only one big risk you should avoid at all costs, and that is the risk of doing nothing." (Denis Waitley – 1933)

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