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A Season Marred by Setbacks in Space Missions

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The past few weeks have been a bit rough for spaceflight, with rockets and spacecraft suffering setbacks. The months of June and July 2024 saw some unexpected failures in space activity, including some by established players in this arena, blemishing their record of safety in spaceflight. Over the years, the failures in space systems have been mitigated through automation in procedures and remote monitoring of system health. However, the rapid increase in space activity that has been seen in recent years could have had some effect on the risk-taking ability of space operators. A brief narrative of each incident is given below:

(a) The accidental launch of a Chinese rocket on June 30, 2024, could be termed an accident rather than a failure. The accidental launch happened during a static fire test of a Tianlong-3 first stage from the launch pad. This rocket belonged to a private Chinese company named Space Pioneer, also known as Tianbing Technology, and was scheduled for launch into space in the coming weeks. The probable cause is a structural failure at the connection between the rocket body and the test bench, also called the anchoring point, causing the rocket to take off. The onboard computer automatically shut down, and the rocket fell into a deep mountain very close to the test bench. There were no casualties reported.[12]

(b) Another launch failure from China happened on July 10, 2024. The Chinese company iSpace's seventh launch of its rocket, Hyperbola-1, failed to reach orbit. The first, second and third stages of the rocket performed normally, but the fourth stage worked abnormally, resulting in the failure of the launch mission. With this failure, iSpace's launch success rate has dipped below 50 per cent.

(c) The launch of Ariane-6 on July 09, 2024, proceeded as planned until a minor hitch towards the end of the flight resulted in an incomplete mission. A de-orbit burn was planned to put the rocket onto a trajectory to burn up over the South Pacific. The controlled re-entry for burn-up was to be a demonstration of the European Space Agency's (ESA) commitment towards a ‘zero-debris’ policy. Eventually, the de-orbit burn could not be initiated because an Auxiliary Power Unit (APU) that pressurises the liquid oxygen and hydrogen tanks malfunctioned, preventing re-ignition. Though the mission was successful in placing satellites in orbit, it highlighted a malfunction of the rocket engine.[3] Ariane is amongst the most reliable launch service providers in the global space transportation market.

(d) SpaceX’s most reliable workhorse rocket, the Falcon 9, suffered a catastrophic and unexpected failure after launch on July 11, 2024. Shortly after the launch, the rocket's second stage

failed to ignite, and it could not reach its planned orbit. The 20 Starlink satellites onboard were left in Low Earth Orbit (LEO) below their desired altitudes, which is not a sustainable orbit. The incident has resulted not only in the loss of 20 Starlink satellites but also in the grounding of the Falcon 9 rocket for further investigation. The Falcon rocket was scheduled to carry a Cygnus cargo module to the International Space Station (ISS) and later to carry a replacement crew to the ISS, both of which would get delayed.[4]

(e) The Boeing Starliner carrying two astronauts, including Sunita Williams, in early June this year suffered a malfunction that was detected after the spacecraft docked with the ISS. The two astronauts are stranded on the ISS with no replacement spacecraft readily available, extending their planned duration of stay on-board the ISS indefinitely. It has been reported that five thrusters of the crew capsule failed as it approached the ISS on June 6, 2024, however, the docking was safe.[5]

These events have brought to focus the uncertainties that exist in spaceflight despite advances in technology and refinement in procedures and equipment. The variables are too many, and how equipment behaves in microgravity conditions cannot be predicted with certainty, even though extensive tests and simulations are done before assembly and launch. Malfunctions can happen, and one has to be prepared with the mechanisms and drills to deal with them, whether they result from technical failure or human error. Advanced computer modelling and decades of experience in sending rockets into space have given designers of space systems a much better idea of what to expect. But the unknowns still exist, and how a new system will behave in space remains hypothetical until the first launch.[6]

Statistically speaking, the failure rates over the decades have been somewhat consistent. Even though the failure of new systems can be expected to be higher at around 30 per cent, it settles down at around 5-6 per cent after the tenth launch. The historical launch failure rate for manned missions is much lower at around 2 per cent, and only around 1 per cent involve a total failure.[7] There may be environmental similarities leading to a comparison between air accident rates and space failure rates, however, it may not be just to compare the two, as the quantum of flying activity in the air is much higher than the present space activity. The statistical data recorded by a former website www.spacelaunchreport.com gives the following launch failure report:[8]

Statistical Record of Launch Failures in Space Missions

Failures in Unmanned Space Flight	Historical data	8.08%
	Last 20 years	6.68%
Failures in Manned Space Flight	Historical data	1.64%
	Last 20 Years	0.79%

Source: Tabulated by Author

The Gaganyaan mission, a joint project by the Indian Space Research Organisation (ISRO) and the Indian Air Force (IAF), aims to put Indian astronauts in orbit soon. Once humans are involved in a space launch, extra precautions and checks are needed to ensure crew safety. ISRO has carefully curated the sequence of activities to include two unmanned launches before the actual manned space mission. Any defect or error noticed in the unmanned mission will necessitate an additional unmanned mission to ensure that the problem is resolved. With this approach, the chances of failure in the manned mission will be minimised. Despite all precautions, ISRO and IAF must be prepared for contingencies, and all possible situations need to be thoroughly rehearsed.

Military culture demands that everything must go right the first time we try it. However, in space, it may not always be possible to execute a perfect mission despite the advances in technology. Prudence demands that one should expect the best possible outcome but be prepared for the worst-case scenario. Back in the 1960s, both the US space programme and the Soviet Union's space programme went through a process of trial and error as they repeatedly tried to land the first Moon mission but failed. They learnt from each attempt and incorporated the lessons learnt. Space missions should come out stronger when things go wrong.The first Moon missions failed, including India's Chandrayaan landing, but they provided lessons on how to achieve success in subsequent missions. The epic dialogue "Failure is not an option," spoken by actor Ed Harris in his role as NASA's legendary flight-operations director Gene Kranz in the 1995 film 'Apollo 13',[9] sounds compelling only in the movies. In research and development, failure is indeed a possibility that needs to be incorporated into the planning. It should be viewed as a necessary learning objective on the path to success.

Notes:

[1] "China rocket crashes after 'accidental' launch", *BBC*, July 01, 2024, at https://www.bbc.com/news/videos/c897xl1r7v9o. Accessed on July 18, 2024.

[2] Michael Wall, "Not-so-static fire: Private Chinese rocket accidentally launches during test", *Space.com*, July 02, 2024, at https://www.space.com/space-pioneer-tianlong-3-rocket-accidental-launch. Accessed on July 18, 2024

[3] Jeff Foust, "When a workhorse falters", The Space Review, July 15, 2024, at https://www.thespacereview.com/article/4829/1. Accessed on July 18, 2024.

[4] Ibid.

[5] David Propper, "Astronauts stuck in space from Starliner problems confident Boeing will get them home safely", *New York Post*, July 10, 2024, at https://nypost.com/2024/07/10/us-news/astronauts-stuck-in-orbit-from-starliner-problems-confident-boeing-will-get-them-home-safely/. Accessed on July 20, 2024.

[6] Stephen Dowling, "What are the odds of a successful space launch?" *BBC News*, May 19, 2023, at https://www.bbc.com/future/article/20230518-what-are-the-odds-of-a-successful-space-launch. Accessed on July 18, 2023.

[7] Ibid

[8] Radu Weiss, "What is the success/failure ratio of space bound rockets?", Stack Exchange: Space Exploration, at https://space.stackexchange.com/questions/8566/what-is-the-success-failure-ratio-of-space-bound-rockets. Accessed on July 21, 2024.

[9] "In space, failure is an option — often the only one", *Nature*, May 09, 2023, at https://www.nature.com/articles/d41586-023-01547-3. Accessed on July 21, 2024.