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FUTURE SHOCK: SPACE X AND ITS REUSABLE ROCKET

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Background:

Going by Alvin Toffler, a future shock is "*too much change in too short a period of time*". On 08 April 2016, Elon Musk and his privately owned Space Exploration Technologies demonstrated precisely what that entails in space by launching a Dragon cargo capsule with an expandable module for the International Space Station orbiting at around 440 kilometres and then successfully landing the first stage of its Falcon 9 rocket on an oceangoing platform. That single launch has changed the manner in which space activities would be conducted in the future. More significantly, this single event impacts across the spectrum of space and impacts all space players across the globe like no other event.

Conventional Satellite Launches

Launching a satellite is a complex task involving a variety of sophisticated technologies and operations. Notwithstanding the technological complexities the basic principles are fairly standard, simple and largely involve the following process.

The first stage of the launch vehicle contains the rockets and fuel that are needed to lift the satellite and launch vehicle off the ground and into the sky. The rockets have to be very powerful because a launch vehicle at lift off weighs hundreds of tons. After all the fuel has been used up, the first stage is no longer needed and breaks off and falls back to Earth, in most cases it splashes back into the adjoining seas where the risk to people and property is minimum. The second stage contains smaller rockets that ignite after the first stage is finished. The rockets of the second stage have their own fuel tanks. The second stage is used to send the satellite into space. Like the first stage, it breaks off after all the fuel has been used up and burns up in the Earth's atmosphere. The upper stage of the launch vehicle is connected to the satellite itself, which is enclosed in a metal shield, called a "*fairing*." The fairing protects the satellite while it

is being launched and makes it easier for the launch vehicle to travel through the resistance of the Earth's atmosphere. The fairing splits apart once the satellite is above the Earth's atmosphere and burns up in the Earth's atmosphere. The rockets of the upper stage fire after the satellite is in space and inject the satellite into its precise orbit. Once the satellite reaches its desired orbital height, it unfurls its solar panels and communication antennas, which had been stored away during the flight. The satellite then takes its place in orbit with other satellites and is ready to provide services to the public. On the other hand, the rocket that enabled the launch in the first place crashes back into the sea and is lost forever. Launching another satellite would involve undertaking the entire launch exercise afresh from start to finish.

Billionaire entrepreneur Elon Musk and his privately owned Space Exploration Technologies changed all of that on 08 April 2016 by launching a Dragon cargo capsule with an expandable module for the International Space Station orbiting at around 440 kilometres, and then successfully landing the first stage of its Falcon 9 rocket on an oceangoing platform[1]. After at least four unsuccessful attempts to land an unmanned rocket on a football field-sized floating platform in the Atlantic Ocean, Elon Musk's SpaceX finally pulled off the dramatic feat on 08 April in its first launch to resupply the International Space Station since its rocket exploded last year.

The Achievement of Space X

Satellite lunches are expensive and most rockets cost tens or hundreds of millions of dollars, yet are rendered as junk the moment they launch. Instead of being recycled, they crash into the ocean and sink to the bottom after lofting a payload into orbit. By delivering its cargo to the ISS and at the same time not dispensing with its rocket but instead landing it on a drone ship in the Atlantic Ocean, Space-X demonstrated its competency in reusable launch technology. SpaceX attempted this feat in earnest on four separate occasions in the past year or so, but all of those rockets either crashed into a drone ship or toppled over and exploded. In its previous attempts to land on what SpaceX calls an "autonomous spaceport drone ship," the rockets came close each time and hit the platforms. But each time they either crashed hard, or fell over and exploded. Two other SpaceX rocket boosters were also equipped to land but never got the chance, since one mission blew up shortly after launch and high seas prevented another landing attempt.

After several unsuccessful attempts to land an unmanned rocket on a football field-sized floating platform in the Atlantic Ocean, Elon Musk's SpaceX finally pulled off the dramatic feat on 08 April. The episode is most vividly described by Christian Davenport of the Washington Times and is reproduced as below[2]; "*The first stage was hurtling toward space when it*

started a bit of aerial acrobatics, turning itself around and heading back toward Earth. As it approached the platform, the booster was tilted into the wind but was able to right itself just before touching down, about nine minutes after lift-off. Crews were expected to board the ship and secure the rocket to the platform. It's quite a tiny target. It's like trying to land on a postage stamp there, Musk said. It's like a carrier landing versus a land landing."

What the Feat Entails

This single feat opens up a vast vista of opportunities in outer space making the environment more usable and less challenging both technologically and economically. The above is a very significant milestone in the Company's as also humanity's quest to develop cheap, reusable rockets that make the entire panoply of space capabilities from application satellites to scientific investigations probes to interplanetary exploration much more affordable and accessible. For the company, it expands its edge in the burgeoning commercial space launch industry. Consequently, Musk's exultation is understandable when he states that a 100-fold cost reduction of access to space is possible, should his rocket-recycling scheme prove as repeatable and reliable as flying an airplane. However, the company still has a long way to go before it qualifies Musk's statements. First, they'll have to gain customer confidence by many more demonstrations of reusability, viability and cost effectiveness. Many more such landing feats will have to be accomplished before rockets become as reusable as aircrafts or anywhere close to that analogy.

Regardless of the analogy, the customer base is inherently wide in that reusable rockets are of great use across the entire spectrum of space users ranging from civil, military, to commercial users. Rapid response and launch-on-demand space capabilities are coveted by all modern militaries across the world and revolutionise war fighting capabilities. As a matter of fact, the military potential far outweighs the civil or commercial uses. Capability gap-filling in times of crises and wars is far more critical to militaries rather than commercial players and the potential is indisputably vast. It becomes manifold in conjunction with reusable and highly manoeuvrable aerospace vehicles like the X-37 B that are already operational[3]. A combination of reusable rockets and common aerospace vehicles heralds the beginning of a new space age. However, the obvious disconnect is that Space X is a commercial company and hence the endeavour is anything but commercial and assuming state or military participation or utility is far-fetched. The above may be so in the Indian context, but is not so in the American scheme wherein industry participation is inherent and forms part and parcel of the entire state endeavour. The case herein is no different; Space X or Space Exploration Technologies Corporation is an American aerospace manufacturer and

space transport services company with its headquarters in Hawthorne, California, USA. It was founded in 2002 by former PayPal entrepreneur and Tesla Motors CEO Elon Musk with the goal of creating the technologies to reduce space transportation costs and enable the colonization of Mars.

Space X and State Support

The state plays a significant part in its funding and support, which, by itself is not unusual in that across the world a mutually symbiotic relationship exists amongst states and the industry. States are not averse to supporting the industry and amongst the many pay-offs is a certain level of state control over the space industry. Put simply, space products made by the industry support the overall state effort and Space X can be expected to be no different. Apart from commercial gains to the company, it also enables strategic military gains to the state. The immediate gain for the state is that Space X enables a cheaper way of lofting cargo to the International Space Station that was created by NASA in the first place and hence it makes sense for NASA to support the endeavour. But, the ISS is on life extension and is set to retire within the next few years. So what can justify cash flows into the endeavour can only be a much larger agenda that encompasses a variety of civil, military and commercial uses in addition to supplying the ISS . As a matter of fact, more and more satellites and space capabilities are inherently dual –use and hence the distinction of military and civil satellites is artificial at best. Either way, as mentioned earlier, reusable launch has enormous potential for use across the spectrum of civil, military and commercial capabilities and perhaps that explains the consistent cash flows from NASA to Space X. For instance, from 2006 to 2008, SpaceX endured three failed launches of the Falcon 1 rocket. The fourth, in September 2008, finally succeeded. Still, the company appeared poised to go bankrupt as it struggled to meet payroll in late 2008. Even as its cash ran out, SpaceX was in the midst of capital-intensive transition from the single-engine Falcon 1 rocket to the much more complex Falcon 9 rocket. What enabled the transition was NASA's award of commercial cargo contracts worth over $ 1.6 Billion to Space X. That contract allowed SpaceX to finish the Falcon 9 rocket and build the Dragon spacecraft. The Falcon 9 has become the company's workhorse rocket, which offers launches at a steep discount to competitors. With the cargo contract, SpaceX also positioned itself to win a lucrative $2.6 billion contract from NASA to deliver crews to the ISS. Meanwhile NASA also continues spending Billions to develop its own heavy lift rocket when Space X already has one. The only explanation could be a state vision that is well beyond the immediate future and has clear cogent plans for maintaining its lead in space for times to come. It augurs us well to

discard our horse braces and draw the right lessons from the above achievement.

(Disclaimer: The views and opinions expressed in this article are those of the author and do not necessarily reflect the position of the Centre for Air Power Studies [CAPS])

Notes

[1] Ref Phil Plait, "Space X stitches the landing" *Slate.Com* 08 April 2016 at http://www.slate.com/blogs/bad_astronomy/2016/04/08/spacex_successfully_lands_its_falcon_9_booster_on_a_barge_at_sea.html accessed on 15 April 2016.

[2] Christian Davenport, " Elon Musk's Space X nails landing at sea" , Washington Post, 08 April 2016 available at https://www.washingtonpost.com/news/the-switch/wp/2016/04/08/elon-musks-spacex-nails-landing-at-sea/ accessed on 14 April 2016.

[3] For operational details on X-37B, see Kiran Krishnan Nair, " X-37 B Space Plane: Space Militarisation, Weaponisation or plain Experimentation" *CAPS In Focus* , 17 Oct 2014 at http://www.academia.edu/8831580/X-37B_Space_Plane_Space_Militarization_Weaponization_or_Plain_Experimentation