PEAK OF FLIGHT NEWSLETTER

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2021 IN SPACEFLIGHT

www.ApogeeRockets.com
4960 Northpark Dr, Colorado Springs CO 80918
Ph# 719-535-9335

APOGEE COMPONENTS

PEAK OF FLIGHT

2021 in SpaceFlight

By Bobby Potter

There's a lot going on in the Space Industry today. More and more private companies are entering the conversation, and new orbital rocket systems are being tested what seems like every day. These are the big events that we might see come to fruition in 2021. For this list, we are looking at entirely new rocket systems or big space exploration milestones. Rockets that have made orbital flights before but are just undergoing upgrades (like the Vega-C) have been left off the list.

New Rockets and Maiden Voyages

Starship Orbital Flight

FIGURE 1: ARTIST RENDERING OF STARSHIP AT BOOSTER SEPARATION

SpaceX has been developing a heavy-lift, fully reusable launch vehicle for many years now. This is the rocket that SpaceX intends to replace their entire fleet with, as a one-size-fits-all solution to space operations. Elon Musk, the founder and CEO of SpaceX, has said that this rocket will be the one to seed a human civilization on Mars.

The SpaceX Starship is touted as being the most powerful rocket system ever built, and will be capable of delivering 220,000 pounds to low-earth orbit. It stands nearly 400ft tall with a diameter of 30ft. This vehicle is intended to be fully reusable, allowing for an extremely low cost-per-flight, which SpaceX believes could get as low as $2 million.

SpaceX Starship (SN8) is just days away from attempting a 50,000ft hop on their latest flight-ready Starship. It has passed several stages of testing, and this is the first Starship to not blow up or be grounded after failures. Should that hop go well, we are very likely to see an orbital flight test in 2021. Should that hop fail, SpaceX will fill the crater and try it again with the next rocket waiting in the wings. This rapid testing and prototyping has been key to SpaceX successes over the years, and makes for one of the most exciting companies to watch.

NASA SLS (Space Launch System)

One of the largest rocket systems ever made is the NASA SLS. Upon completion it will stand 322ft tall and weigh nearly 6 million pounds. The SLS is intended to support lunar exploration missions, and later work toward the goal of establishing a base on Mars.

Nicknamed "America's Rocket" due to the many U.S. based contractors working on the project, the first main objective for this rocket is to deliver payloads to the moon for the establishment of a lunar base.

FIGURE 2: ARTIST RENDERING OF NASA SLS ON THE LAUNCH PAD

This rocket is powered by four RS-25 engines, each generating 512,000 pounds of thrust. In addition to the four RS-25 engines mounted on the core stage, there are 2 solid-rocket boosters. These are in similar design to the solid rocket boosters used on the Space Shuttle, with about 25% more propellant in each booster than what was on the Space Shuttle.

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Newsletter Staff

Writer: Bobby Potter
Layout / Cover Artist: Matthew Martinez
Proofreader: Michelle Mason

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The SLS has been plagued by delays, which has led this already expensive project to become the most expensive rocket ever built. The exorbitant costs of this project have drawn criticism from NASA officials and government regulators for many years. In total, the SLS development has cost NASA $18.5 billion since the program's inception in 2011. Breaking down the cost even further, you can see that each of the 4 non-reusable engines on the SLS cost NASA around $150 million. For the cost of a single engine, NASA could purchase a Falcon Heavy launch that can deliver 2/3rds of the total mass to orbit that the SLS is projected to be capable of. For the cost of just the 4 engines on the SLS, a few Falcon Heavy launches could deliver 2.5x the mass to orbit.

For the $18.5 billion spent in development, NASA could have purchased 205 Falcon heavy launches, and placed 25.5 million pounds into low-earth-orbit, or approximately 1.5x the total amount of mass in orbit today.

Despite the heavy budgetary criticisms, the project has continued on. Although an exact date has yet to be set, we should see the inaugural flight of the SLS sometime in 2021.

New Glenn

The New Glenn rocket is the latest rocket under development from Blue Origin. It is a heavy lift launch vehicle capable of taking nearly 100,000 pounds to low earth orbit.

New Glenn was designed for full reusability in mind, with a design engineered for 25 uses. This should dramatically reduce the cost-per-launch of the New Glenn, and with a relatively large payload capacity. It utilizes seven BE-4 engines, and is capable of generating 17,000 Kn of thrust at sea level.

FIGURE 3: BLUE ORIGIN'S NEW GLENN

This rocket is capable of launching during "95% of all weather conditions" according to Blue Origin's website, which for other rockets is a major contributor to scrubbed launches and delays. Should this be true, Blue Origin could secure many contracts that require tight deadlines or very specific launch dates.

To date, the founder of Blue Origin (Jeff Bezos) has primarily funded the development of New Glenn to the tune of about $2.5 billion. However Blue Origin has recently secured a $500 million dollar development contract through NASA which should go to New Glenn. Although no launch date is currently set, New Glenn should make its maiden voyage in 2021.

Boeing Starliner

Following Boeing's failed orbital flight test back in December of 2019, Boeing agreed to perform the test again after the craft had undergone upgrades to ensure the safety of NASA astronauts and the success of NASA mission objectives.

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FIGURE 4: THE BOEING STARLINER

After the first orbital flight test, NASA completed an independent investigation into the technology and hardware that led to the failures. That independent review board found 80 different issues that should be addressed before the next flight test. Boeing then began implementing the requested changes and upgrades, and the second orbital flight test was slated for December of this year.

The substantial software upgrades listed by NASA have led to some delays, but as it stands Boeing is committed to a second orbital flight test in Early 2021. Should that flight test go off without a hitch, Boeing could put a small crew of astronauts onto the International Space Station as early as July of 2021, and be approved for regular crew missions starting in the end of 2021. They would become the second private company in history to do so.

Vulcan Centaur

FIGURE 5: THE VULCAN CENTAUR'S PRIMARY LAUNCH CONFIGURATION

The Vulcan Centaur is the latest rocket under development from the United Launch Alliance (ULA). This rocket is planned to make its maiden voyage in July of 2021. This is the first rocket designed by ULA, however the company has inherited a collection of Delta IV and Atlas V with which they currently provide launch services with. The many technological upgrades they have made to this fleet should lend to higher knowledge than many of their competitors entering this space.

The Vulcan Centaur is a 2-stage, heavy launch vehicle. This vehicle is intended to be able to carry up to 26,000 kg to low earth orbit. The first launch configuration (VC4) will be capable of 25,000 kg to low earth orbit.

Although this rocket is not fully reusable, they do intend to catch a large chunk of this rocket after the booster stage has detached. A module carrying flight avionics, the first stage engine, and other high-value assets will detach from the booster and come down separately. This module will inflate a heat shield and be caught by a helicopter and reused on another Vulcan rocket.

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Although no specific launch date is currently set, the Vulcan Centaur is set to make its debut in the second quarter of 2021.

Terran 1

The Terran 1 is a new launch vehicle under development from Relativity Space. Relativity Space was founded under the impression that the current Spaceflight companies are not using additive manufacturing (namely 3D printing) to its full value, and that entirely 3D printed rockets could drastically reduce the cost to reach orbit. For that reason, this rocket is created using 3D printed components out of their state-of-the-art labs in California. Currently they advertise an expected cost-per-flight of the Terran 1 to be around $12 million. Although a specific launch date has yet to be set, it is intended to make its first flight in 2021.

For this rocket, Relativity Space has developed a 3D printable rocket engine called the Aeon 1. It is 3D printed from a proprietary metal alloy in less than 1,000 pieces, and assembled on site.

The Terran 1 is an expendable launch vehicle capable of taking 1,250 kg into low earth-orbit. 95% of the rocket will be built with 3D printed components in line with Relativity Space's long term goals of being able to 3D print an entire orbit-capable rocket in just 60 days.

Spyder

A company called UP Aerospace based out of Denver, CO is currently developing their first orbital launch vehicle intended to deploy small satellites in support of NASA initiatives. UP Aerospace has a history of successful launches of their sounding rocket (SpaceLoft XL).

Although not much has been published regarding this rocket, we do know they intend to use 4 stages, all solid rocket motors, to reach orbital velocity. The primary purpose of this rocket is to deploy small satellites, like cubesats, into orbit. This rocket will be capable of deploying up to six cubesats per launch.

Nuri

FIGURE 6: ARTIST RENDERING OF NURI ON THE LAUNCH PAD (RENDERING BY THE KOREA AEROSPACE RESEARCH INSTITUTE)

Nuri (KSLV-II) is a rocket under development from South Korea, and the second attempt at an orbital launch vehicle for that nation. The first orbital rocket, Naro, did achieve an orbital flight in 2013 after 3 attempts, but was not used after that third launch. The Nuri rocket is intended to be a low-cost launch option for orbital payloads, with the goal of being competitive in the commercial market.

All the motors and technology in Nuri are being developed in South Korea by companies within its borders. The nation of South Korea is requiring that all these technologies be developed internally, as to not rely on other nations for orbital launch capabilities.

Nuri is a 3-stage rocket, utilizing Jet A-1 rocket fuel and liquid oxygen for propellant. The first stage uses 4 KRE-75

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engines, the second uses one modified KRE-75 for efficiency in a vacuum, and the third stage uses a smaller, KRE-07 engine. The current goal for Nuri is to deliver 2,600kg to Low Earth Orbit. Even if there are some delays, we are likely to see Nuri fly in 2021.

Blue Whale 1

Also out of South Korea, the Blue Whale 1 is expected to make its maiden voyage in early 2021, being tentatively scheduled for the first half of the year. Originally this rocket was intended to launch in July of 2020, but has not yet flown to date. With heavy delays like that, and not much information being publicly communicated, only time will tell if they are able to make orbit in 2021, regardless of schedule.

Blue Whale 1 is a project under development from Perigee Aerospace, a company with only 30 employees, and is intended to become the smallest orbital launch vehicle in history.

These rockets come at a very low price point, with Perigee Aerospace intending to keep the cost-per-flight at or below $2 million. Perigee Aerospace also intends to develop the capabilities to be able to launch up to 40 Blue Whale 1's per year. They are capable of 50kg to sun-synchronous orbit, or 63kg to low-Earth orbit.

RS1

RS1 (Or Rocket System 1) is an orbit capable rocket under development from ABL Space Systems. It is intended to deliver 1,350kg to low-Earth orbit, and launch from anywhere using the container deployment launch site. This rocket is intended to launch with a minimal flight control team, and the launch pad equipment can be transported using regular shipping methods, as they are contained in shipping containers. This means a launch site could be quickly established anywhere by transporting these technologies on freight ships or through cargo planes. All that is required to be installed at the launch site is a small concrete pad, with everything else remaining portable.

FIGURE 7: THE RS1 FROM ABL SPACE SYSTEMS. (IMAGE BY ABL SPACE SYSTEMS)

Even the rocket itself can be stored and shipped in regular shipping containers, allowing for the US military to transport and deploy these at high speed.

Although there is not a tremendous amount of more information currently available regarding this rocket, we are expected to see a launch sometime in the first quarter of 2021.

Gaganyaan 1

FIGURE 8: GAGANYAAN DURING RECOVERY AFTER A PAD ABORT TEST. (IMAGE BY THE INDIAN COAST GUARD)

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The Gaganyaan 1 is the first manned orbital rocket under development from the Indian Human Spaceflight Program. It is technically slated for December of 2020 for an orbital flight test, but we could see it actually carry astronauts to space in the second half of 2021. This would mark impressive advancements from a country that just recently entered into spaceflight operations.

This capsule is intended to be fully autonomous, performing all launch and guidance requirements without human input. It is designed to carry 3 crew members for up to seven days at low-Earth orbit.

Interestingly, India has announced a companion for the astronauts aboard Gaganyaan in the form of Vyommitra. Vyommitra is a humanoid robot designed to assist astronauts with climate control, life support systems, and some other mundane tasks aboard the capsule. It can accept tasks and direction with voice-input, and even change its posture for launch and landing operations. It is a humanoid so that it can record data from its sensors as it is also intended to get a better understanding of the impact of launch operations and weightlessness on a human body.

Space Exploration Milestones

Not only are there a ton of new rockets hitting the scene in 2021, but there are also many big milestones in the exploration of space. 2021 should bring us new lunar missions, orbital refueling attempts, and a variety of other mission objectives.

Tianhe

Although Tianhe is not a rocket in itself but instead being launched atop a Long March rocket, it does signify a rather significant moment in space exploration. Tianhe is the first and foundational component for the development of a Chinese Space Station. Tianhe will supply crew quarters for up to three astronauts, life support systems, as well as guidance, navigation and orientation control.

Several other missions are scheduled in 2021 for the development and creation of this Space Station, including a second mission to install a lab module, as well as the first crew visits to the space station after those modules are completed.

The foundation modules for Tianhe are currently scheduled for launch in Q1 of 2021. The Lab and crewed missions will follow in the summer.

Lunar Missions

The United States, India and Russia intend to complete lunar missions in 2021. All three countries seek to place lunar landers on the surface, with India achieving this goal for the first time. Although lunar landers are not necessarily new, it does signify a heavily renewed interest in lunar exploration ahead of the planned manned operations.

NASA still intends to complete manned operations on the moon in 2024.

The James Webb Space Telescope

The largest and most capable Space Telescope ever is scheduled to finally go up into space next year, being sent atop an Ariane 5 rocket, and currently scheduled for October. It is touted by NASA as being 100x more powerful than the legendary Hubble Telescope.

With infrared optics, it will catch the faintest bits of light from the furthest reaches of our galaxy. This light will have traveled up to 13.5 billion years, allowing us to see some of the earliest galaxy formations after the big bang. The infra-

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red sensors on board are so sensitive that it could detect the heat signature of a bumble bee 240,000 miles away (or roughly the distance to the moon).

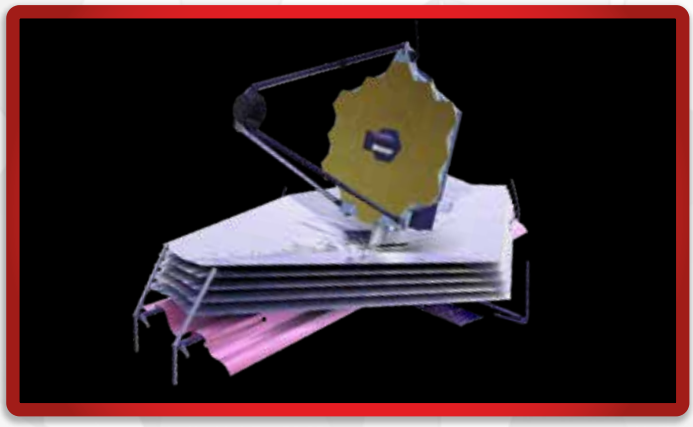

FIGURE 9: RENDERING OF THE COMPLETED JAMES WEBB TELESCOPE AND HEAT SHIELD

The James Webb Telescope will also be able to tell us much more about the content of atmospheres found in exoplanets orbiting the stars of other solar systems. This is an important component in the search for life outside of Earth, as byproducts of biological life can be found in the chemical makeup of an atmosphere.

Mars Exploration

Three nations, the United States, China, and the United Arab Emirates all currently have missions enroute to Mars as we speak. All of them are expected to arrive at Mars for orbital insertion in February of 2021. The United States intends to land their Mars Lander on February 18th, while China intends to land theirs in April. The UAE is just putting a satellite into Mars orbit, alongside the orbiters from the US and China

Conclusion

We are in for a big year in 2021. Though Covid-19 has been responsible for countless setbacks in the space industry, the renewed vigor of these operations seems to just be spurring far more space activity than we have ever seen before. 2021 will be a record year for a number of new orbit-capable launch systems, and likely check off important milestones in the goals of lunar and Mars exploration.

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