

# Sierra Nevada Corporation: Safely Landing the *Perseverance*

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**Abstract** - This report summarizes the contribution that the Sierra Nevada Corporation (SNC) has given to the NASA Mars 2020 Mission, where the rover *Perseverance* will be sent to Mars to collect rock samples and seek signs of ancient life. The main design given to NASA by the SNC Space Systems division was the Descent Brake Mechanism, crucial to the landing system for past rovers in NASA's Mars Exploration Program.

## I. INTRODUCTION

Space exploration has always been a field of interest for scientists around the world, ever since Gagarin orbited Earth in 1961 and Armstrong and Aldrin went to the Moon in 1969. Though there were additional ventures to the Moon and expeditions sent to the ISS since then, things plateaued when Apollo 17 became the last manned mission to the moon in 1970 due to costs, as well as when NASA ended the Space Shuttle Program in 2011.

That changed over the past few years, as there is a rejuvenated interest in space exploration, both in the public and private sectors. Companies such as Boeing and SpaceX have designed their own spacecrafts to launch into space, with SpaceX launching many of their Falcon rockets and even planning to send people to Mars by 2024. This includes NASA's plan to restart their space exploration program, looking to land another man and the first woman on the Moon by 2024. But a more immediate project is on NASA's mind at the moment - *Perseverance*.

Having a launch window of July-August 2020, NASA is aiming to send the rover *Perseverance* to Mars as part of their Mars 2020 Mission. As it will help understand more of the hardships that will have to be endured on the journey to Mars, as well as more about the conditions on the planet, NASA contracts many external companies to provide hardware and software to work these types of rovers, along with technology which will support the Artemis program. Contracts such as these are essential in the success of these program, as NASA would not be able to design all the necessary assets due to man-time and costs. One company that NASA looks to for help, which will be talked of in great interest throughout the paper, is Sierra Nevada Corporation (SNC).

## II. MARS 2020 MISSION

An continuation of NASA's Mars Exploration Program<sup>5</sup>, a long-term effort of robotic exploration of the Red Planet, the Mars 2020 Missions' main focus is to seek signs of habitable conditions, while also searching for direct signatures of past microbial life. This is the future rover to be sent after a line of other one, including Curiosity, Opportunity, Spirit, and others. While at its' core it has similarities to past rovers, *Perseverance* introduces a slew of new upgrades to analyze the planet in greater detail.

*Perseverance*, the rover which will be sent up in July-

August 2020, will use a drill that can collect core samples of the most promising rocks and soils and set them aside in a "cache" on the surface of Mars. These samples could then be potentially returned to Earth through future missions. This is one of the main innovations being presented in this rover, as instead of relying on the experimental limitations the miniature lab on the rover has, scientists on Earth could study the samples in regular-sized laboratories with state of the art equipment. More thorough analysis of the core and rock samples may then be conducted, and further conclusions may be made of Mars's past.

### A. *Perseverance* Rover

The Mars 2020 Mission rover, named *Perseverance* as a result of a competition among students across the nation, is based off the design of the other rovers in NASA's Mars Exploration Program. Mainly, the design stems from the Curiosity and Opportunity rover, Curiosity being a rover which SNC also provided hardware for, and Opportunity functioning on Mars for a total of 15 years till it died in February 2019.

Though these make up the basis for the design, *Perseverance* improves and changes parts of the past rovers and differs from its' predecessors in many ways. Five main improvements, illustrated through the infographics in Figures 1 and 2, make up the bulk of innovation for this rover - these include improvements on the entry, descent, and landing system (EDLS), caching of samples for further analysis back on Earth, and new wheels to better navigate the terrain of Mars.

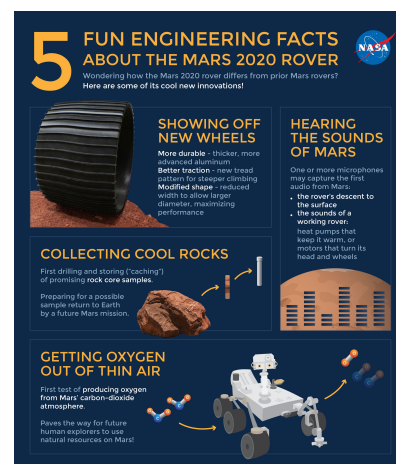
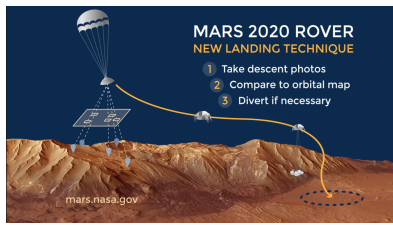


FIG. 1: Upgrades for the *Perseverance* Rover<sup>1</sup>

FIG. 2: New Landing Technique for Mars 2020 Mission<sup>1</sup>

All of these technological improvements couldn't be handled by NASA, due to the highly costly nature of the venture and limited amount of man power, so outside companies had to be contracted. Selections of companies were based on NASA's fourth competitive Tipping Point solicitation, having a combined total award value of about 43.2 million dollars<sup>3</sup>. Of that total award value, part of it went to a company in Nevada to help with the design of spacecraft to be used in the Artemis program, and more importantly with the landing of the 2020 Mars rover - Sierra Nevada Corporation.

### III. SIERRA NEVADA CORPORATION

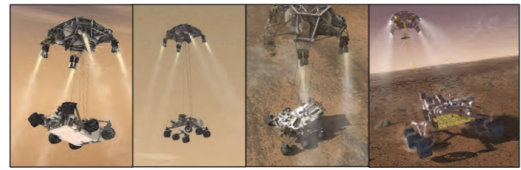
Sierra Nevada Corporation (SNC) is a privately held electronic systems provider and systems integrator stationed in Nevada, specializing in microsattellites, telemedicine, and commercial orbital transportation services. They have contracted with many spaceflight companies and governmentally funded ventures, including the likes of the US Armed Forces and NASA. SNC has worked with NASA in the past many time, with their contract for the 2020 mission marking the 13th time they have provided hardware for a Mars related project.

The exact division of SNC which NASA works with is the Space Systems division, formally known as Space Dev Inc. before being bought by SNC. Space Systems is responsible of the design and manufacturing of spacecraft, satellites, their subsystems, and other components sent to NASA<sup>6</sup>. With more than 25 years of flight heritage, Space Systems has participated in more than 450 successful space missions through the delivery of over 4,000 systems, subsystems and components, reaching seven planets, Pluto and the sun including more than 70 programs for NASA and 50 other clients. Space Systems is also the developer of the Dream Chaser spacecraft, which will provide cargo services to the International Space Station starting in 2020<sup>6</sup>.

### IV. SNC & MARS 2020 MISSION

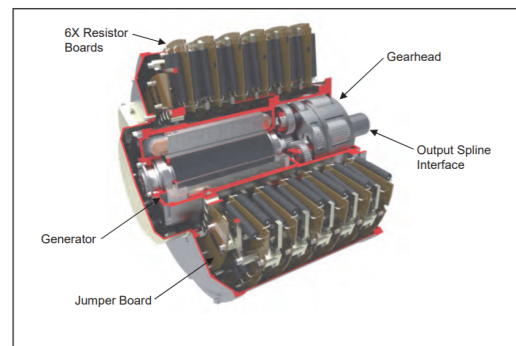
#### A. Descent Brake Mechanism

Though SNC will be providing NASA with other designs for *Perseverance*, such as actuators for robotic arm and sample caching system, the main contribution will be the design for the Descent Brake Mechanism. Not a new design, NASA

FIG. 3: Curiosity Landing Sequence<sup>2</sup>

has contracted SNC in the past for the same design back when the Mars Science Laboratory (MSL) was operational. MSL was the robotic space probe which successfully landed the Curiosity rover in Gale Crater back in 2012, and used the electromechanical dampener assembly designed by SNC Space Systems<sup>2</sup>. This achievement was a major milestone for NASA as it marked the first time a spacecraft of that size and weight was able to successfully land on another planet using a tethered system - thus paving the way for future missions.

The Curiosity rover utilized a landing system by the name of "Skycrane", a free-flying rocket-decelerated descent stage which set the rover down, which hung on a 7.5m long bridle cord, without the engines fully powering down or the descent stage eve touching the surface. Using this method, the Curiosity rover could safely land on the surface of the planet, without sustaining any damage. This landing process is depicted in Figure 3, showing the descent stage lowering while the cords extend to their full length and safely deploy the rover on the planet's surface.

FIG. 4: Descent Brake Assembly designed for the Curiosity Rover<sup>2</sup>

A key component of the Skycrane landing system is the device which allows the rover to be lowered by a distance of 7.0 m to fully extend its bridle, as the cord couldn't be extended during entry through the planets' atmosphere. This device - the Descent Brake Mechanism - allows this deployment to happen quickly and with controlled speed that decreases toward the end of deployment for a controlled landing at the full bridle length. Composed of a main generator, resistor board, and additional parts illustrated in Figure 4, this design lets the mechanism work in a way that doesn't provide friction against the bridle as it deploys at a constant rate to its' max length. A lack of friction and a high degree of control over the deployment lets the minimum amount of energy be released,

which came out to around 24 kJ. This design has the advantage of being completely passive, and unlike previous friction technologies, also offers highly consistent performance over a wide temperature range.

These types of innovations in the design and functionality make it unrivaled in the safe deployment of a rover, and will be just as necessary to the *Perseverance* as it was to the *Curiosity*. For if the rover was not controlled correctly and left to its own devices, it could deviate from its chartered path in the EDLS, or plummet to the planets' surface and crash on impact. So the control on descent and deployment of that bridle cord ensures the safe landing and functioning of the rover.

## V. CONCLUSION

Continuing the exploration of the Red Planet, the Mars 2020 Mission will help understand more of the planets' past and possibility of microbial life, while also paving the way for manned missions in the future. For this NASA must deploy another rover, this time coming in the form of *Perseverance*.

The design and manufacturing of *Perseverance* would never be possible without the contracting of external companies, such as the Sierra Nevada Corporation. While not as prominent as other companies such as Boeing and SpaceX and given the same level of publicity, SNC has given NASA the means to deploy and land their rovers in a safe and efficient manner.

Their long standing relationship with NASA, reaching back all the way to 1992 and spanning 13 collaborations over sev-

eral projects, proves how crucial they are to NASA and their missions. This includes the *Curiosity* rover, in which their Descent Brake Mechanism was first contracted by NASA and will now be used again to safely land the new rover. This collaboration does not stop with this 2020 mission, as they are also geared to help NASA with designing components for the Artemis program and safely get another pair of people to the moon again by 2024. These types of collaborations with NASA and the US government, along with SNC's own project of the Dream Chaser spacecraft, hints at a bright future for the company's ventures into space explorations. The next step for them is this Mars 2020 Mission, which would not be successful without their involvement.

## REFERENCES

- <sup>1</sup>*Mars 2020 Mission*, NASA Science, 2016, <https://mars.nasa.gov/mars2020/>
- <sup>2</sup>Down, D., Moser, J., Mobley, J., 2013, *Development of the Descent Brake Mechanism for the Mars Science Laboratory*, 2013 IEEE Aerospace Conference
- <sup>3</sup>*NASA Announces US Industry Partnerships to Advance Moon, Mars Technology*, NASA, July 30th 2019, <https://www.nasa.gov/press-release/nasa-announces-us-industry-partnerships-to-advance-moon-mars-technology>
- <sup>4</sup>*Sierra Nevada Corporation Headed to Mars For 13th time*, Sierra Nevada Corporation, May 2nd 2016, <https://www.sncorp.com/press-releases/snc-mars-2020-mission/>
- <sup>5</sup>*NASA's Mars Exploration Program*, NASA, 1994, <https://mars.nasa.gov/>
- <sup>6</sup>*SNC: What We Do*, Sierra Nevada Corporation, <https://www.sncorp.com/what-we-do/>