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AIAA Shaping the Future of Aerospace

Setting the pace to Mars

With so much being said about exploring the Red Planet, Aerospace America invited Boeing executive John Elbon to help us make sense of it all. His company is one of six funded by NASA in August to develop prototype equipment for the journey to Mars.

▲ **In this Boeing concept**, astronauts would live and work inside conjoined habitats in cislunar orbit near the moon. A power and propulsion module would provide electricity and motion control for their spacecraft. The crew would conduct operations, scientific studies and test hardware needed to reach Mars.

Mars is at the center of a global conversation about space exploration.

Everyone seems to have a theory on the best way to get humans beyond low-Earth orbit to live and work on the Red Planet. We're seeing the invention of new options, a retreading of old ideas, and sometimes a combination of both. Thinking big is a good thing, and then we must get to work on a plan that's practical and possible. Apollo-era visionaries did the same thing and then executed a plan within the parameters of what was possible given current technologies and enduring laws of physics.

Enthusiasm and excitement generated by ideas for advancing human space exploration, like those of Boeing, SpaceX, Blue Origin and Lockheed Martin, are key to generating widespread support. Ideas are meant to motivate people, to drive exploration fueled by curiosity.

It's an exciting time in the space industry as we build rockets for launch, test new spaceships, and develop innovative technologies for keeping humans alive on orbit in deep space.

Boeing's approach for human missions to Mars, embodied in our "Path to Mars" campaign, could be viewed as more pragmatic because we believe a more gradual approach is required. The vision challenges us to leverage our human spaceflight experience to achieve a permanent — and steadily expanding — human presence in deep space.

There will always be risk in human space flight and it's important that we don't allow ourselves to be stymied by risk aversion. At the same time, approaches for making stepwise progress, building on lessons learned as we go, are critical to long-term success.

Space flight is challenging — one miscalculation could cost years in research, millions of dollars in production or the loss of life. It's critical to set realistic expectations and align those with an achievable timeline. Getting to Mars and back safely is going to be a marathon, not a sprint. The first step is the research and technology developments on the International Space Station.

ISS is the cornerstone of current space operations and supports the development of a broad array of exploration capabilities.

Science research and technology demonstrations on the space station — such as autonomous rendezvous

and docking trials and ongoing human health and behavioral research — bring us closer to new destinations.

The station's One Year Crew mission, in which astronaut Scott Kelly and cosmonaut Mikhail Kornienko spent 340 days on the outpost, is a prime example of researchers using the ISS as a platform for preparing humanity for exploration into deeper space. During this and earlier missions on ISS, scientists and researchers gained valuable and often revealing data on the effects of microgravity on bone density, muscle mass, strength, vision and other aspects of human physiology.

Today, astronauts grow food on the space station. The ability to produce high-energy, low-mass food during spaceflight maintains crew health during long-duration missions while reducing the resources that must be carried for long-distance travel.

Crews on ISS are also using 3-D printing to manufacture tools and spare parts. This is the first step toward establishing an on-demand machine shop in space.

And on ISS, the Environmental Control and Life Support System recovers and recycles water from everywhere: urine, hand washing and oral hygiene. Through the Water Recovery System, almost 99 percent of the water is reclaimed, filtered, and ready for consumption.

Commercial Crew is the first NASA human spaceflight program that will utilize a commercial-government partnership to provide crewed transportation to the ISS. Boeing will manufacture, own and operate one of those vehicles, the CST-100 Starliner. There will be a fleet of reusable Boeing Starliners.

NASA will essentially purchase a seat for their astronauts. This model of contracts in the long run will free up funds for NASA to focus on future deep space exploration missions like going to Mars.

When Bill Boeing started this company in 1916, his relatively modest goal of helping to deliver mail for the U.S. Postal Service grew into an international commercial transportation market. Today, we're extending that market to space travel.

Over the next decade, the space station might be joined in low-Earth orbit by other orbiting research facilities. Space tourism is a potential growth area but only if low-Earth orbit can sustain a viable market and we can lower costs to a more consumer-friendly ticket price. Those of us in industry, partnered with NASA, have focused primarily on developing the capabilities to live and work in low-Earth orbit. Crew and cargo transportation and LEO destinations represent the "supply side" of the economic model. Developing robust commercial markets in LEO now requires focus and investment on the "demand side."

Boeing is also a part of NASA's journey to Mars as a prime contractor building the Space Launch System or SLS, the largest, most powerful rocket ever built. This is the rocket that will get humans to Mars.

SLS represents the cornerstone of the nation's push beyond low-Earth orbit into deep space in the 2020s. The program is on track to meet its cost and schedule commitments. Flight hardware is being built. And it continues to make sustained progress toward the first deep-space test flight in 2018 and first crewed mission in 2021. These early missions to the proving ground will provide the basis for the private sector to build upon.

SLS is capable of carrying more than twice the payload to deep space of any other launch vehicle today. It is uniquely designed to safely and effectively enable early exploration proving ground missions near the moon to validate our systems and operations. Those missions will create the confidence necessary to embark on human missions to Mars in the early 2030s and provide systems, standards and technology for the private sector to use.

With this capability, humans will be capable of a variety of missions, whether it's building an outpost near the moon; placing in orbit bigger, better telescopes that can look more deeply into the universe; or landing on the Red Planet.

The "Path to Mars" is a reference scenario that reflects a step-wise evolution of critical capabilities from ISS to missions in the lunar vicinity in preparation for the human journey to Mars. The architecture behind this scenario involves assembling and operating an outpost near Earth's moon between 2021 and 2025. The five components of the outpost include two habitat modules, an airlock, a logistics module, and a power bus and augmentation module.

Boeing is already working on a full-scale ground prototype cislunar habitat demonstrator as part of NASA's Next Space Technologies for Exploration Partnerships 2 or NextSTEP-2 program. Building an outpost in cislunar space will also offer international partnerships and commercial opportunities for lunar exploration and collaborative research. The outpost could also serve as a staging ground for governments and private companies that are interested in activities around or on the moon.

Crews would spend the rest of the 2020s evaluating deep space habitability, logistics, operational procedures and vehicle systems in an environment similar to what will be experienced on the journey to Mars.

Under the Boeing plan, a landing on the surface would follow in the mid- to late 2030s.

A century of innovation changed the way we work, live and play around the globe and in space. Developing new technologies for Mars could feed economic growth on Earth. Methods for conducting agriculture under extreme conditions and generating power, including improved solar cells, could benefit our planet.

Mars is our ultimate goal because it holds the promise of a better tomorrow for generations to come. It's a big part of why we're here. ★

John Elbon is Boeing's vice president and general manager for space exploration. He was Boeing's program manager for construction and assembly of the International Space Station from 2003 to 2006. Elbon has a bachelor's degree in engineering from Georgia Institute of Technology.