DESTINATION MARS: THE NEW FRONTIER

Produced by the staff of the Charles Hayden Planetarium, Museum of Science, Boston

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ASTRONAUT

I see a world.

A world in many ways like Earth. A world on which we may someday live, even thrive. It's within reach now. The next great adventure, the next giant leap for humankind.

Mars.

(MUSIC)

NARRATOR

We call it the Red Planet. It's fueled our imagination for centuries, inspiring music, stories, and the dream of exploring other worlds.

In our solar system, Mars is our neighbor. Its red sands are alien to our eyes, but its huge canyons and mountains remind us of home.

Mars is much smaller than Earth, but unlike the other planets, it offers many essentials for survival. Temperatures are cold but manageable, there's adequate surface gravity, and a thin atmosphere. A day on Mars even lasts about 24 hours, just like Earth.

But getting to Mars is not easy. The fastest journey takes many months, years with a return trip. For decades, we've sent rovers and orbiters in our stead. Many failed in their missions. Some never arrived at all.

Even so, we've studied Mars more than any world beyond our own. Years of robotic exploration have revealed clues to the planet's distant past - clues that now compel us to learn more.

Imagine turning back the clock four billion years. All the planets, including Earth, were very different then.

Through our missions, we've learned that Mars was once a warmer, more temperate world. Rivers coursed through its canyons. Enormous lakes and seas of water flooded its surface.

Ancient Mars may have been much more like Earth – a world capable of supporting life.

Over time, the thick protective atmosphere that kept the planet warm dwindled away, causing nighttime temperatures to plummet far below zero, and exposing the surface to the dangerous radiation of space. Nearly all the liquid water evaporated. The rest was locked up as ice, and buried beneath the soil.

As hospitable as ancient Mars may have seemed, today it is a cold, dry, hostile wasteland.

Any remaining traces of water near the surface contain chemicals that are toxic to life as we know it. In fact, we've never found evidence of any kind of life - past or present - existing here at all.

Still we wonder: What can Mars tell us about the potential for life on other worlds? Can it help us understand how life developed on Earth? Or how our planet itself could change over time?

To discover the answers, we need to search beyond Earth. Our robotic explorers are already paving the way, but it has taken them years to achieve what a person could do in mere hours. They can't maneuver quickly or change course easily. *We* can.

So today's missions are laying the groundwork for future *human* missions to Mars.

As we learn more about the Martian environment and discover icy troves within its soil, these missions will teach us how to use the planet's resources to help us survive on a cold and empty world.

And one day, we'll get there.

(MUSIC CHANGE)

To send humans to Mars, we first need to learn how to live away from Earth.

That starts here, where countries, companies, and countless people from around the world are joining together to take on the many challenges of living in space.

We've already seen the fruits of this global cooperation. Zipping around Earth once every ninety minutes, the International Space Station represents one of humanity's greatest feats of engineering, and - thus far - our crowning achievement in human spaceflight.

Building the Space Station united more than a dozen nations from around the globe, each developing different components, all assembled piece by piece in space like a giant puzzle.

More than twenty years later, we're still working together to build upon and improve it.

Today, the Space Station is a state-of-the-art research laboratory, a continuously inhabited outpost where an international crew of men and women live and work in Earth orbit for months at a time.

(MUSIC CHANGE)

Astronauts here work in microgravity, in perpetual freefall around Earth, with few of the comforts of home. They are today's pioneers – setting us up for future missions by testing the limits of our bodies and minds in ways we can't easily replicate on the ground.

Astronauts have performed thousands of experiments inside the Space Station. This research not only helps us plan longer missions, but it also often leads to unexpected solutions for challenges back on Earth, improving the quality of life for people across the world.

Using the Space Station, we've developed affordable methods to purify and recycle water. We've advanced the use of robots in surgery, and extended the shelf life of the food we eat. And these are just a few of the innovations that the Space Station has given back to humanity.

As we learn to live in space for longer, more distant journeys, we'll continue to break new ground in biotechnology and medicine by discovering new ways of keeping ourselves healthy – of healing our bodies and improving our resilience to illness.

(MUSIC)

We already have a constant presence in space. It's astounding. But it's only our first baby step in spaceflight. At just 250 miles above the surface, astronauts are well within Earth's magnetic field, which protects them from most of the harmful radiation of space.

The crew cannot survive without Earth. They rely on people on the ground who manage the Space Station's operations, and they count on resupply missions to bring necessities from home. And an emergency return vehicle on standby makes Earth a quick escape, just a few hours away.

To go deeper into space, astronauts must be able to operate – and survive – on their own, without depending on Earth. And we'll need new technologies that make travel to space not just possible, but *routine*.

Private companies, like SpaceX and Boeing, are joining this effort by flying spacecraft that can bring supplies - and soon, humans - to the Space Station.

NASA and its partners are coming up with new ways to revolutionize space travel. And now, we're seeing them get creative.

(MUSIC CHANGE)

At Kennedy Space Center near Orlando, Florida, SpaceX has been making history with their rockets.

These rockets land safely back on Earth, and can be re-used, a necessary practice for making spaceflight affordable and sustainable.

And more aerospace engineering firms like Blue Origin, Northrop Grumman, Sierra Nevada, and Lockheed Martin, are building reusable spacecraft technology as well.

NASA connects them all by providing resources and guidance along the way. And today, NASA is transforming its historic and celebrated space center into a flexible, multi-user spaceport that will usher in a new era of deep space exploration, and serve as the foundation for a modern, thriving space program.

The next generation of rockets and spacecraft is emerging – building upon ideas and technologies that have already proven successful.

The vehicles that once got humans to the Moon are being reimagined, rebuilt, and tested, to be bigger, more powerful, and safer than ever before.

And this is where they come together.

The iconic Vehicle Assembly Building is one of the largest buildings in the world. Here, engineers stack the rocket segments and prepare them for launch.

(MUSIC CHANGE)

The rocket that will give us our biggest push yet is NASA's massive *Space Launch System*, or SLS.

SLS is the world's most powerful, most versatile rocket. Longer than a football field, most of its enormous body holds the fuel needed to get a human-ready spacecraft moving faster than 17,000 miles per hour, enough to launch it from Earth towards the Moon, Mars, or anywhere in the solar system.

At the top of the rocket sits the crew vehicle, called *Orion*, built to carry four people into space, and back.

About the size of a minivan, Orion is designed to take us farther than humans have ever been before. The capsule can support the astronauts living inside for a few weeks at a time.

The first test flight of SLS and Orion together is the Exploration Mission, EM-1, which has no astronauts onboard. The mission is a practice run intended to stretch the system to its limits in preparation for future human flights.

Minutes after launch, most of the fuel has been consumed, and the rocket jettisons its spent components.

As Orion leaves Earth, its solar arrays deploy - the spacecraft can now power itself.

Two hours after launch, SLS has done its job – Orion is on a path towards the Moon.

Engineers at mission control track the spacecraft carefully through its three-week journey.

This far from Earth, radiation is a serious hazard to astronauts. To help us prepare, Orion's sensors measure radiation levels inside the craft. And tiny satellites called CubeSats are deployed from the rocket to collect more data about the space environment, and to scout the Moon for resources that could prove useful for future missions.

EM-1 ends with Orion's safe return to Earth. The next Exploration Mission, EM-2, follows a similar path, but this time with a crew of brave astronauts on board.

Our return to the Moon is the next step on the path to Mars.

This realm is a *thousand* times farther than the Space Station. A rescue here could take days, or weeks.

While learning to become less reliant on Earth, we'll establish a permanent human presence in orbit around the Moon. Like the International Space Station, this proposed outpost will be a global partnership, bringing together the strengths of nations and industry to give us unprecedented access to the Moon for science, and to let us prove our technology in deep space.

And when we're ready, it will become a gateway for the journey to Mars, and beyond.

We can't know all the details of a human mission to Mars. Not yet, anyway. But we can imagine what it might be like.

(MUSIC CHANGE)

ASTRONAUT

The moment has come.

Behind us, now out of sight, is the blue marble that nourished me my whole life, that's been home to everything I've ever known and everyone I've ever loved.

I am thrilled. Apprehensive. And more alive than ever.

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Yesterday. I glanced out the window and there it was. A speck of red dust in a sea of stars. Mars.

I'll be honest, there've been times when I thought this day would never come. The initial rush of adrenaline from the rocket launch and the Moon flyby has — over days, weeks, months — given way to routine and the commonplace. We exercise, we do spacecraft maintenance. We check in with Earth, but the ever-growing communication delay between us and mission control is a constant reminder that we're truly on our own out here.

But still, problems can come up at any time, and we did have a few close calls. About a month after we sped past the Moon, one of the external panels which reflect the Sun's damaging radiation back into space — well, it was struck by a tiny meteoroid and was seriously damaged. We huddled to discuss our options. Ultimately, we were able to print new parts and the flight engineer installed the spare within a day. Crisis averted.

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My shipmates have been incredible. We've had our moments, but if I had to be cooped up with anyone for 200 million miles, I'd choose these three over almost anybody else.

*Well, almost anybody, because it's been *so* much harder being this far from my family than I expected. And I knew it would be tough. A few weeks ago, my little girl sent me a video that just about did me in. She opened the giant notebook I gave her before I left to a page where she wrote in bold colors, "I love you to Mars and back." She spelled Mars with a "z."*

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I look out the window again and again. Mars is getting bigger all the time. Landing on the surface will be our most dangerous task so far, but we've trained in the simulators for everything we could anticipate going wrong. Once we touch down, we will look forward to seeing the astronauts already there. They'll have made us a meal, with fresh vegetables grown in the greenhouse. My mouth is watering already.

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It's almost time. I can't wait to put on my spacesuit and finally set foot on Mars. I'm going to sift the Martian soil through my gloved hands. I've only ever seen it through the video and data streams of the rovers. But to actually hold it myself. It will be like walking into the world of my imagination.

(MUSIC)

NARRATOR

Humankind's journey to Mars represents decades of preparation, but getting there is only the beginning. Mars is a new frontier, with new dangers and discoveries, and as in past generations we'll once again learn to live off the land and rely on human ingenuity to survive.

We'll need energy from solar panels or the planet's own heat, to provide sustainable power to our systems.

We'll need water, whether drawn from ice buried under the Martian soil, or by purifying it from another source.

We'll develop protective gear that can shield us from radiation and the extreme temperatures on Mars.

We'll learn how to grow food in the cold, parched soil.

We'll use the planet's atmosphere or take chemicals from the Martian rocks to engineer breathable air.

And we'll need shelter, either on the surface or underground.

On Mars, every basic need is a monumental challenge in itself, and it's going to take *all* of our skill, creativity, and spirit to get us there, and home again.

ASTRONAUT

When the hatch on the lander finally opens, and we walk outside, Mars is stunning.

Sand and dunes, wind and boulders, ground and sky. The same words I've used my entire life, applied to a completely different world.

The feeling is extraordinary. To touch land again. To stand in such alien beauty. To be among the first humans this far from Earth, paving the way towards becoming a truly interplanetary species.

The farther we travel, the more deeply we come to know ourselves, what we can do, and just how much we're capable of achieving.

For now, though, I'll be calling this red marble something other than Mars.

I'll call it… home.

(END OF SHOW – CREDITS AND MUSIC)