



Smithsonian Institution
National Air and Space Museum

1

00:00:07,810 --> 00:00:16,309

Marty, what are you doing?

You can imagine being on the red planet, Roving

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00:00:16,309 --> 00:00:21,640

around, looking around at all the geologic
features and all of the science going on?

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00:00:21,640 --> 00:00:28,520

I can imagine that.

But can you imagine the entry?

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00:00:28,520 --> 00:00:36,530

>> Yeah, that might be a little firey, I guess.

Do you want to help me build this?

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00:00:36,530 --> 00:00:38,600

Sure.

How long is it gonna take?

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00:00:38,600 --> 00:00:48,580

Probably a little longer than 30 minutes.

Maybe you guys, can you help us out here?

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00:00:48,580 --> 00:01:28,229

>>> See, that wasn't too hard.

>> Yeah, I think we've got plenty of time

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00:01:28,229 --> 00:01:35,539

for the show.

>> This is stem in 30.

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00:01:35,539 --> 00:02:11,819

>>> Hi, I'm Marty.

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00:02:11,819 --> 00:02:14,319

>> And I'm Beth.

>> Today we are coming to you live from the

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00:02:14,319 --> 00:02:19,709

national space museum in Washington D.C.

We are inside a gallery called exploring the

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00:02:19,709 --> 00:02:23,950

planets.

>> We want to begin by welcoming our online

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00:02:23,950 --> 00:02:26,890

audience.

We invite to you submit questions.

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00:02:26,890 --> 00:02:32,510

We have an expert who can answer them for

you, and we may even take one on air.

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00:02:32,510 --> 00:02:35,950

>> Now, this gallery is incredible.

There's some great artifacts here.

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00:02:35,950 --> 00:02:39,720

One of my favorites is the blink comparativer

you see behind me.

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00:02:39,720 --> 00:02:46,940

Tide clientabout used this instrument to find

Pluto.

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00:02:46,940 --> 00:02:53,860

He looked through images for months to try

to find Pluto.

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00:02:53,860 --> 00:02:56,150

See how hard that was.

Check out these images.

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00:02:56,150 --> 00:03:01,939

As you see the images, do you see Pluto there?

It's kind of hard to spot.

21

00:03:01,939 --> 00:03:04,840

You see why it might take months?

Look what happens when we add a couple of

22

00:03:04,840 --> 00:03:10,379

arrows.

Do you see it now?

23

00:03:10,379 --> 00:03:15,769

So if we add some arrows here, you're gonna see Pluto drawn out a little bit more.

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00:03:15,769 --> 00:03:27,659

Obviously, you can see why this may have taken months in 1932 to have discovered Pluto.

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00:03:27,659 --> 00:03:33,609

>> Speaking of Pluto, new horizons, the object above me, was launched in 2006.

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00:03:33,609 --> 00:03:38,579

In 2015, it flew by Pluto and took some fabulous photographs.

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00:03:38,579 --> 00:03:45,319

Only 8,000 miles above the surface.

>> All right.

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00:03:45,319 --> 00:03:48,930

One of my favorite stories to tell in this gallery is that of voyager.

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00:03:48,930 --> 00:03:53,330

The full-scale model is up above me.

This spacecraft was launched in 1977.

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00:03:53,330 --> 00:03:58,170

There were actually two of them.

They're still going and sending back signals.

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00:03:58,170 --> 00:04:03,230

On board was a golden record, a record is
a thing that we used to use in the olden days

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00:04:03,230 --> 00:04:07,239

to record sounds.

And on this record, we sent sounds of earth

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00:04:07,239 --> 00:04:17,209

out into space.

Listen to this.

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00:04:17,209 --> 00:04:37,580

\h[trains, dogs barking, thunder\h]

>> Hello, from the children of planet earth.

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00:04:37,580 --> 00:04:45,390

\h[speaking foreign language\h]

>> And now I am joined by Michaela and Caleb

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00:04:45,390 --> 00:04:48,450

Mckentucky\h■■■ McKenzie, I'm sorry, and

Caleb.

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00:04:48,450 --> 00:04:55,270

We're standing here talking about Mars today.

Why do you guys think that we would accepted

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00:04:55,270 --> 00:04:56,757

these recoveries up and not astronauts.

>>> Because they have\h■■■ rovers and not

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00:04:56,757 --> 00:05:02,020

astronaut as soon as.

>> Because they have little cameras and wheels.

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00:05:02,020 --> 00:05:05,780

>> Did you get a chance to look at these things?

>> Aha.

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00:05:05,780 --> 00:05:10,790

>> Did you notice anything that's similar among them?

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00:05:10,790 --> 00:05:16,090

You guys need the mic.

>> They both have little gold pieces, wheels

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00:05:16,090 --> 00:05:19,610

and solar panels.

>> Gold pieces, wheels and solar panels.

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00:05:19,610 --> 00:05:26,590

Now, the rovers are specifically engineered to do certain things while they're on Mars.

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00:05:26,590 --> 00:05:31,120

And is there anything that you notice that's different?

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00:05:31,120 --> 00:05:34,740

>> One's bigger and one's smaller.

>> One's bigger and one's smaller because

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00:05:34,740 --> 00:05:38,620

they do different jobs.

Now, to learn more about the jobs that recoveries

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00:05:38,620 --> 00:05:41,490

do on Mars, let's go to Marty with our first guest.

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00:05:41,490 --> 00:05:45,050

>> Thanks, Beth.

I'm joined today by Kobie boykins, a mechanical

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00:05:45,050 --> 00:05:48,030

engineer at the jet propulsion lab.

Thanks so much for joining us today.

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00:05:48,030 --> 00:05:50,129

>> Thanks for having me.

>> Those guys did a great job.

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00:05:50,129 --> 00:05:55,581

>> They did an awesome job.

>> And when I look at rovers, I notice that

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00:05:55,581 --> 00:05:57,960

the wheels are very, very different.

Why is that?

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00:05:57,960 --> 00:06:00,220

Yeah.

So if you look at the rovers that you guys

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00:06:00,220 --> 00:06:04,670

have here, which is awesome, you start off with the path finder which is a small rover,

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00:06:04,670 --> 00:06:08,210

a technology demonstration.

We wanted to actually see if we could actually

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00:06:08,210 --> 00:06:12,530

drive on the surface of mars.

We didn't know if we could do that or not.

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00:06:12,530 --> 00:06:16,960

So if you look at wheels, specifically you'll see the wheels are very sharp.

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00:06:16,960 --> 00:06:21,550

The texture of the wheels look totally different, and as that we can climb over rocks.

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00:06:21,550 --> 00:06:25,910

As we got Better and understood more about what the surface of Mars was like, we actually

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00:06:25,910 --> 00:06:30,220
went to the Mars science laboratory.
Its wheels are a little bigger and designed

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00:06:30,220 --> 00:06:34,800
more not to climb over rocks but to drive
over loose dust.

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00:06:34,800 --> 00:06:38,389
Think of it as light fluffy snow, if you will,
and that's how they were designed.

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00:06:38,389 --> 00:06:42,310
Then you get to curiosity, the one behind
us, and it's a much larger rover.

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00:06:42,310 --> 00:06:46,699
Its job wasn't worried about rocks.
Because the rocks would be small compared

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00:06:46,699 --> 00:06:50,220
to the size of the rover.
It was to actually climb up Mount Sharp,

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00:06:50,220 --> 00:06:53,440
which is where we landed in the Miguel crater,
to do more investigation.

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00:06:53,440 --> 00:06:58,520
So you can see the history and development
of the wheels and how we've change they would

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00:06:58,520 --> 00:07:01,520
from Rover to rover.
>> Now, there's a feature on the wheels that

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00:07:01,520 --> 00:07:04,430
I think is really interesting.
There's some holes on them.

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00:07:04,430 --> 00:07:12,650

>> Yeah, it's the ODOMETRY feature, just distance.

We can use that feature to actually h■■■

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00:07:12,650 --> 00:07:16,160

after we drive the rover, we know how far we told it to drive.

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00:07:16,160 --> 00:07:21,699

And we'll turn around and take a picture and from the picture we can see how far we drove.

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00:07:21,699 --> 00:07:26,380

The interesting thing about that feature is when we first started off designing the wheels,

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00:07:26,380 --> 00:07:31,830

we actually wrote the words JPL so we could actually stamp JPL on the ground, on the surface

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00:07:31,830 --> 00:07:35,740

so we could see JPL on the surface of Mars, which would be are really cool.

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00:07:35,740 --> 00:07:40,600

But we actually had to hang it. We turned it into Morris code, and if anybody

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00:07:40,600 --> 00:07:44,849

knows Morris code, it actually says JPL in Morris code, so it's really a fun thing about

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00:07:44,849 --> 00:07:49,900

being engineers and designers behind it that you can do things like that.

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00:07:49,900 --> 00:07:54,530

>> But it still serves as very important purpose.
>> Very, very mechanical purpose and something

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00:07:54,530 --> 00:07:57,930

we use for science, as well.

>> Did you learn things when you worked on

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00:07:57,930 --> 00:08:01,449

the first Rover and the second that helped
on the centered.

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00:08:01,449 --> 00:08:04,729

>> Most definitely.

We started the rover program a lot before

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00:08:04,729 --> 00:08:10,160

the first rover, which is what you have here
in the museum.

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00:08:10,160 --> 00:08:16,880

So that was really the start of it.

You can see sort of the evolution of the rover.

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00:08:16,880 --> 00:08:20,980

So this was really a technology demonstration.

Just drive.

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00:08:20,980 --> 00:08:27,659

Take an image of the land.

And the first time the primary mission

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00:08:27,659 --> 00:08:33,200

was the Rover and there are roving geologists.

Their specific goal was to go look at history

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00:08:33,200 --> 00:08:36,850

of the rocks on Mars and see if Mars was once
a wet place.

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00:08:36,850 --> 00:08:41,510

And then you go to Curiosity.

Not being a roving geologist but a biologist.

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00:08:41,510 --> 00:08:47,700

Her job was to actually see if Mars was once a habitable place and had life the started

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00:08:47,700 --> 00:08:51,000

on Mars, would it be able to be sustained on the surface.

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00:08:51,000 --> 00:08:54,350

>> Also, they've all got very different purposes and you can see that in the models here.

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00:08:54,350 --> 00:08:56,740

>> Most definitely.

>> You ready to take some questions year's,

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00:08:56,740 --> 00:08:59,080

let's do it.

>> Let start with an online question.

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00:08:59,080 --> 00:09:03,940

What was the biggest challenge your team faced when engineering curiosity?

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00:09:03,940 --> 00:09:11,940

>> Well, fantastic question.

I was part of the team that built the actuators

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00:09:11,940 --> 00:09:19,050

for curiosity.

Everything that moves on this vehicle was

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00:09:19,050 --> 00:09:24,100

actually my responsibility at some level, my team's responsibility.

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00:09:24,100 --> 00:09:28,440

We had to make sure we understood how it works and how it was going to give us information,

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00:09:28,440 --> 00:09:31,860

make sure the vehicle was going to perform appropriately on the surface of Mars.

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00:09:31,860 --> 00:09:35,450

And it was a very, very long development. We had some failures and things that didn't

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00:09:35,450 --> 00:09:38,030

work out perfectly. At the end of the day, we got the vehicle

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00:09:38,030 --> 00:09:39,570

on the surface of Mars and it's been working perfectly.

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00:09:39,570 --> 00:09:42,090

Thanks for that question. A really good one.

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00:09:42,090 --> 00:09:49,250

>> All right, Jack, you got a question? Here you go.

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00:09:49,250 --> 00:09:55,530

>> How did the rover take pictures?
>> How does the rover take pictures.

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00:09:55,530 --> 00:09:58,140

Great question. The rover actually has quite a few cameras

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00:09:58,140 --> 00:10:01,880

on it, and a lot of the pictures that you see actually come from what we call the remote

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00:10:01,880 --> 00:10:08,950

sensing mass. And we have some really good cameras.

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00:10:08,950 --> 00:10:12,971

The detector behind the camera.

We take pictures almost exactly the way do

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00:10:12,971 --> 00:10:17,570

you with your cell phone, and that's what

we take that image and then relay it to one

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00:10:17,570 --> 00:10:20,839

of our orbiting spacecraft and then that gets

relayed back to earth.

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00:10:20,839 --> 00:10:23,560

>> Cool, thank you.

>> Thank you.

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00:10:23,560 --> 00:10:26,920

>> Great question.

All right, well, one of the things that we've

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00:10:26,920 --> 00:10:31,350

done by being able to drive around the surface

of Mars is learn some incredible geology.

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00:10:31,350 --> 00:10:36,389

Let's get to Beth with a marks geologist.

\h■■■ a martian geologist.

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00:10:36,389 --> 00:10:41,880

>> Now, I'm joined by Dr.\hJim zimbelman who

is a geologist here.

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00:10:41,880 --> 00:10:47,930

Jim, thank you so much for being here.

We've been roving around on Mars for a long

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00:10:47,930 --> 00:10:49,490

time.

Why?

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00:10:49,490 --> 00:10:54,360

What did we learn?

>> Well, geologists like myself love the pictures,

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00:10:54,360 --> 00:10:58,230

but we always see in a picture, gee, I'd like to get closer to that.

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00:10:58,230 --> 00:11:02,980

That's what rovers have allowed us to do. Beginning with the little one, spirit and

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00:11:02,980 --> 00:11:11,040

opportunity now with curiosity we can go right up to the rocks and examine them in detail.

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00:11:11,040 --> 00:11:16,000

The things that interest me are sand because each little particle is telling us something

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00:11:16,000 --> 00:11:19,310

about the rocks in the the vicinity. So they are giving us different views as we move

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00:11:19,310 --> 00:11:23,360

along the beach\h■■■ giving us different views as we move along the sand dunes or something

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00:11:23,360 --> 00:11:26,200

like that. That's turned out to be true of Mars, and

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00:11:26,200 --> 00:11:31,750

we know that. At the end of January this year, curiosity

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00:11:31,750 --> 00:11:37,600

for the first time investigated an active sand dune on Mars with all of its instruments.

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00:11:37,600 --> 00:11:42,610

I've waited over 30 years for this to happen
and it's terribly exciting to finally see

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00:11:42,610 --> 00:11:47,430

some of that new information being revealed.
Not only the pictures that show us some of

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00:11:47,430 --> 00:11:52,370

the detail, but curiosity has instruments
that tell us the chemistry and the mineralogy

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00:11:52,370 --> 00:11:56,779

of the little sand grain exams make other
measurements that we just haven't dreamed

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00:11:56,779 --> 00:12:01,711

you have decades ago when we were wondering
how could we get to an sand do you know on

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00:12:01,711 --> 00:12:04,449

another planet.
So far there's sand dunes on another

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00:12:04,449 --> 00:12:06,550

planet.
So far there's a variety things going

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00:12:06,550 --> 00:12:10,230

on.
It seems to be like a sand dune like those

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00:12:10,230 --> 00:12:15,850

here on earth but the conditions are different
enough that the ripples look a little different.

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00:12:15,850 --> 00:12:20,750

That will need to be explored more.
Again, the advantage of a rover being able

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00:12:20,750 --> 00:12:26,520

to take and use our instruments right up to an area and investigate it in detail, that's

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00:12:26,520 --> 00:12:30,990

terribly exciting.

>> Thank you so much for joins today.

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00:12:30,990 --> 00:12:34,399

>> You're welcome.

>> Now, one of the ways that we learn about

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00:12:34,399 --> 00:12:36,519

the geology is through the cameras.

>> Right.

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00:12:36,519 --> 00:12:41,839

>> And nothing seems like it's by coincidence.

And the height is in the same boat, right?

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00:12:41,839 --> 00:12:43,630

>> Yeah.

Nothing's but coincidence.

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00:12:43,630 --> 00:12:50,529

All it is engineered and designed.

So the cameras are right at 5'2".

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00:12:50,529 --> 00:12:53,410

The reason we did that is that's the average height of a human being.

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00:12:53,410 --> 00:12:57,300

The images we get back from the surface is like somebody is walking along the surface,

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00:12:57,300 --> 00:13:00,089

looking out at Mars.

Like a human beings was really there.

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00:13:00,089 --> 00:13:04,420

Curiosity, a little bit higher than that,
but we still wanted to give that same sense

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00:13:04,420 --> 00:13:09,040

of a human being actually roving the surface
so that they can look around and scientists

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00:13:09,040 --> 00:13:12,680

could actually get a sense of what does this
rock look like or what does that rock look

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00:13:12,680 --> 00:13:17,230

like, that geologic feature and actually helps
with analyzing the data that we get.

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00:13:17,230 --> 00:13:20,830

>> Do you guys have any challenges when you
were designing the cameras and building them?

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00:13:20,830 --> 00:13:24,020

Yeah.

The the cameras are pretty 95 general.

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00:13:24,020 --> 00:13:30,910

The amazing thing is we separate them, just
like your eyes are separated.

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00:13:30,910 --> 00:13:35,449

You can see the depth.

You have to know where those cameras are.

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00:13:35,449 --> 00:13:41,029

And so because Mars is so cold, it can actually
get to minus 128 degrees cent grade on Mars,

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00:13:41,029 --> 00:13:44,150

the temperature in which carbon monoxide freeze
inside the atmosphere, so you can have dry

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00:13:44,150 --> 00:13:50,970

ice on the surface and then it can get warm,
72\hdegrees fahrenheit, or 20\hdegrees cent

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00:13:50,970 --> 00:13:54,300

grade.
So you get metal and metal will move when

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00:13:54,300 --> 00:13:57,450

you have temperature degrees like that.
So you have to be able to understand how do

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00:13:57,450 --> 00:14:05,470

the cameras move and distort and you can take
out and make a 3D image that timely works.

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00:14:05,470 --> 00:14:10,410

>> So you have to know what happens when it's
there.

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00:14:10,410 --> 00:14:13,530

>> And how it points and all the things that
go along with it.

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00:14:13,530 --> 00:14:15,140

>> Wow.
That's cool.

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00:14:15,140 --> 00:14:19,450

The cameras on the Mars rover have taken some
absolutely amazing pictures.

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00:14:19,450 --> 00:14:54,040

Check these out.
>> You were talking about taking pictures

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00:14:54,040 --> 00:14:57,779

on Mars.
Now, when we take pictures here on earth,

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00:14:57,779 --> 00:15:03,010

we have a bluish atmosphere and that influences the colors that we see.

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00:15:03,010 --> 00:15:05,200

>> Most definitely.

How our eyes work.

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00:15:05,200 --> 00:15:08,019

>> But on Mars things are a little different.

>> That's correct.

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00:15:08,019 --> 00:15:11,639

And you have something that looks like Mars actually when you look through it, right?

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00:15:11,639 --> 00:15:13,720

Yes.

What is different about taking pictures on

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00:15:13,720 --> 00:15:17,639

Mars\h■■■

>> Mars tends to be a little bit more red,

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00:15:17,639 --> 00:15:21,110

in the spectrum of light that we see here on earth.

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00:15:21,110 --> 00:15:24,499

Mostly because of the atmosphere and dust that's captured in the atmosphere.

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00:15:24,499 --> 00:15:26,620

>> Okay.

So we're gonna take a look at these rocks.

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00:15:26,620 --> 00:15:28,520

>> Yeah.

So everybody look at the rocks.

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00:15:28,520 --> 00:15:33,190

>> We're looking at the rocks.

And now, this is the way we would see them

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00:15:33,190 --> 00:15:34,410

on earth.

>> Right.

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00:15:34,410 --> 00:15:38,920

>> And this is similar to the way we would see it on Mars.

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00:15:38,920 --> 00:15:42,110

>> That's exactly right.

So what you can see is when you look at that

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00:15:42,110 --> 00:15:46,569

through that filter, through that sort of roseish colored filter, you actually start

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00:15:46,569 --> 00:15:52,389

to lose some of the definition in the rocks.

Our eyes are built to see a lot of different

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00:15:52,389 --> 00:15:56,480

depths of field and different things, and you can actually look at rocks and see different

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00:15:56,480 --> 00:16:06,160

pieces, but with the filter, it actually h

>> Now, how do we look at images from Mars

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00:16:06,160 --> 00:16:10,389

in a way that we can understand and see things that we want to see?

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00:16:10,389 --> 00:16:16,050

We use different filters and put those in front of our camera and take images that have

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00:16:16,050 --> 00:16:20,480
different wavelengths of light.
So you you can think in the color spectrum

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00:16:20,480 --> 00:16:24,670
that what we see is actually a very, very
small bit of the whole spectrum of light.

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00:16:24,670 --> 00:16:28,839
We can use blue, we can use red.
We don't use red like we see, but red a little

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00:16:28,839 --> 00:16:32,519
bit outside of our eyes because that actually
helps the scientists actually look at rocks

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00:16:32,519 --> 00:16:37,890
and see different characteristics of the rock,
like do they have coarse veins in there, is

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00:16:37,890 --> 00:16:42,589
there gold in the rock?
We're looking for different structure within

197
00:16:42,589 --> 00:16:46,949
the rock and that tells us a lot about what's
going on geologic factors that are on the

198
00:16:46,949 --> 00:16:51,959
surface of Mars.
>> And how do you calibrate these so that h■■■

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00:16:51,959 --> 00:16:54,680
>> Great question.
>> So that you can see these colors?

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00:16:54,680 --> 00:16:57,769
>> Right.
So on the rover, we actually have what we

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00:16:57,769 --> 00:17:02,529

like to call sun dial, and that sundial has some collaboration pieces and so we'll turn

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00:17:02,529 --> 00:17:08,970

our cameras are toward the sundial. So we know it's red, green, yellow, blue.

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00:17:08,970 --> 00:17:13,940

We can look at the sundial and actually collaborate to the colors and make a false color image

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00:17:13,940 --> 00:17:17,770

that we can present back to earth and say here's what it would look like if you were

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00:17:17,770 --> 00:17:19,720

looking at it on earth, even though it's on Mars.

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00:17:19,720 --> 00:17:23,160

>> And that allows scientists to look for minerals that they're looking for.

207

00:17:23,160 --> 00:17:26,370

>> Right, look for different things, different structures in the rock, yes.

208

00:17:26,370 --> 00:17:27,370

>> Okay.
Great.

209

00:17:27,370 --> 00:17:32,530

Now, in order to get these rovers to Mars, they had to be pretty light weight.

210

00:17:32,530 --> 00:17:34,222

>> Yes.
>> And they are built with metal.

211

00:17:34,222 --> 00:17:40,220

And earlier, I talked to Stan seagle who told us all about the metals that are on the Mars

212

00:17:40,220 --> 00:17:44,420

rovers.

>> I am joined now by Stan seagle, are you

213

00:17:44,420 --> 00:17:47,590

a titanium expert.

>> Wellh■■■ you are a titanium expert.

214

00:17:47,590 --> 00:17:53,660

>> Sometimes they call me that, yes.

>> Why is titanium a good the metal for aerospace

215

00:17:53,660 --> 00:17:57,780

industry and spacecraft?

>> Well, it's very important when you go into

216

00:17:57,780 --> 00:18:03,080

space weight.

Titanium has high strength and a low density.

217

00:18:03,080 --> 00:18:08,200

And the combination of those two properties make it one of the most efficient metals in

218

00:18:08,200 --> 00:18:10,760

flight.

>> When you're working with titanium, it's

219

00:18:10,760 --> 00:18:15,300

more difficult than other metals, how do you make the parts for the spacecraft?

220

00:18:15,300 --> 00:18:22,450

>> Well, basically, titanium is produced by all the same processes that ill aluminum

221

00:18:22,450 --> 00:18:31,350
and steel and stainless in forging, rolling
and excluding and things of that nature, there's

222

00:18:31,350 --> 00:18:33,740

no difference.

Titanium is a little bit more difficult to

223

00:18:33,740 --> 00:18:37,780

work and sometimes you have to use special
care and handling.

224

00:18:37,780 --> 00:18:42,840

>>> How do you find the best quality and how
do you test for that?

225

00:18:42,840 --> 00:18:45,740

>> Well, there's three areas we like to test
in.

226

00:18:45,740 --> 00:18:51,390

Once when we melt the titanium, we want to
make sure the composition is perfect.

227

00:18:51,390 --> 00:18:59,330

So we take chemical analysis at various points
in that INGUS and then process it to bar product

228

00:18:59,330 --> 00:19:07,880

or plate and then we take coupons and measure
the strength and sometimes we will look into

229

00:19:07,880 --> 00:19:12,360

the part like ultrasound in the medical field
and look for defects inside.

230

00:19:12,360 --> 00:19:17,840

>> Oh, okay.

>> Now, is the titanium used to build and

231

00:19:17,840 --> 00:19:22,710

spacecraft\h■■■ is that pure titanium?

Pure titanium has the strength of around 40,000.

232

00:19:22,710 --> 00:19:30,940

The most popular is titanium.

That has four types the strength.

233

00:19:30,940 --> 00:19:36,350

That's what's used on most aircraft and space.

Small amount of pure titanium is used but

234

00:19:36,350 --> 00:19:39,450

not very much.

>> So you have to combine it with some other

235

00:19:39,450 --> 00:19:42,090

things to make it useful for the aerospace
museum.

236

00:19:42,090 --> 00:19:44,590

>> That's right.

And we call that a oing.

237

00:19:44,590 --> 00:19:48,310

>> Stan, thank you so much for answering our
questions today.

238

00:19:48,310 --> 00:19:53,480

>> My pleasure, thank you.

>> It is time for my favorite part of the

239

00:19:53,480 --> 00:20:01,520

show, stem it to win it.

>> Hi.

240

00:20:01,520 --> 00:20:07,120

I am jointed by patients and Lucus and they
are going to play our game.

241

00:20:07,120 --> 00:20:10,570

Here's what we're going to do.

We're going to show you guys an image.

242

00:20:10,570 --> 00:20:16,990

Either an image from earth or from Mars.

When you think you know it, hit your button.

243

00:20:16,990 --> 00:20:17,990

Okay.

Ready?

244

00:20:17,990 --> 00:20:22,950

Let's take a look at first image.

Okay.

245

00:20:22,950 --> 00:20:32,190

Lucus, earth or Mars?

I think it's earth because the rock doesn't

246

00:20:32,190 --> 00:20:35,700

look like it could have came from Mars.

>> Okay.

247

00:20:35,700 --> 00:20:41,140

So Lucus thinks it's earth.

Our online audience says earth.

248

00:20:41,140 --> 00:20:44,420

Let's see what our specialist Jim zimbelman says.

249

00:20:44,420 --> 00:20:49,200

>> Well, you've been looking at a view of earth, looking at something called an alluvial

250

00:20:49,200 --> 00:20:52,580

fan.

This is a process that's very common in deserts.

251

00:20:52,580 --> 00:20:58,550

It turns out there are alluvial fans on Mars
and the importance of that is it involves

252

00:20:58,550 --> 00:21:02,300

water, carrying the rocks and debris to make
the fan.

253

00:21:02,300 --> 00:21:05,660

>> Okay, are you guys ready for your next
image?

254

00:21:05,660 --> 00:21:08,180

Are ready?
Here it is.

255

00:21:08,180 --> 00:21:11,980

Earth or Mars?

Okay, patience, what do you think it is?

256

00:21:11,980 --> 00:21:14,200

>> Mars.

>> Patience thinks it's Mars.

257

00:21:14,200 --> 00:21:20,830

Our online audience thinks it's Mars.

Let's see what Jim zimbelman had to say.

258

00:21:20,830 --> 00:21:25,800

>> So now you've been looking at an image
of gullies on Mars.

259

00:21:25,800 --> 00:21:29,980

Why is that important?

This is another form of water flow that is

260

00:21:29,980 --> 00:21:32,071

eroding these things.

But gullies are not just martian\h■■■ martian

261

00:21:32,071 --> 00:21:37,460

features but also occur on the earth where the same process is going on.

262

00:21:37,460 --> 00:21:48,220

Martians...

>> Okay, Lucas, what do you think it is?

263

00:21:48,220 --> 00:21:52,450

>> I think it's earth again because it looks more like earth.

264

00:21:52,450 --> 00:22:01,540

>> Or online audience thinks it's Mars. Here's Jim.

265

00:22:01,540 --> 00:22:08,390

>> You've been looking at highs that have been caused by forces in the planet.

266

00:22:08,390 --> 00:22:13,010

First you're looking at earth and there are also ridges like this on Mars because the

267

00:22:13,010 --> 00:22:19,280

same internal forces are there.
>> You guys did a great job.

268

00:22:19,280 --> 00:22:23,190

Let's go back to Kobie and Marty.
>> Thanks, Beth.

269

00:22:23,190 --> 00:22:27,130

Great job, guys.
Kobie, how do we keep these rovers going so

270

00:22:27,130 --> 00:22:29,170

long?
Because they've all outlived their lifetime.

271

00:22:29,170 --> 00:22:35,110

>> Yeah, it's a really good question.

I wish I could tell you exactly.

272

00:22:35,110 --> 00:22:39,630

Spirit and opportunity, those were designed to last for 90 days.

273

00:22:39,630 --> 00:22:43,921

We've been on the surface of Mars exploring for 12 years with opportunity, which is an

274

00:22:43,921 --> 00:22:47,750

amazing feat.

There's a lot of testing that goes into the

275

00:22:47,750 --> 00:22:52,530

engineering, and I mean, on all the sites, throughout the development, the design of

276

00:22:52,530 --> 00:22:55,711

the building, the testing, we've actually tried to make sure that we've understand what

277

00:22:55,711 --> 00:23:01,180

was going to happen with rover and make sure that we built something that was robust.

278

00:23:01,180 --> 00:23:03,710

But we never would have guessed that it would have lasted this long.

279

00:23:03,710 --> 00:23:08,930

And even with curiosity, we made it our primary mission to last one marks year and two earth

280

00:23:08,930 --> 00:23:12,350

years.

And we've got a lot of great science and have

281

00:23:12,350 --> 00:23:17,180

all this information.

But a lot of how we make it last is to get

282

00:23:17,180 --> 00:23:19,910

good engineering design.

You start with the fundamentals and you test

283

00:23:19,910 --> 00:23:26,280

it and you fix the things that break and then

send it to mars.

284

00:23:26,280 --> 00:23:30,120

>> What's next?

We're sending a lot more stuff to mars, which

285

00:23:30,120 --> 00:23:35,340

is quite entertaining and interesting.

In 2018 we're going to send a message called

286

00:23:35,340 --> 00:23:38,250

insight.

It actually puts a seismometer on the surface

287

00:23:38,250 --> 00:23:44,030

of Mars and that will tell us the tidal effects

IE what happens here on earth with the oceans

288

00:23:44,030 --> 00:23:50,850

and how we move, and you'll see it will on

Mars and we'll actually be able to maybe tell

289

00:23:50,850 --> 00:23:54,600

if the subsurface of Mars is liquid or not,

so does it still have a liquid core.

290

00:23:54,600 --> 00:23:59,000

And then the next one is another mission just

like curiosity with the same type of rover,

291

00:23:59,000 --> 00:24:03,050
same size rover with a whole different science
fleet.

292
00:24:03,050 --> 00:24:07,360
Hopefully it will get a name soon.
It has one of my favorite instruments, one

293
00:24:07,360 --> 00:24:11,870
of myh■■ it's a new science experiment,
I'll call it a technology demonstration called

294
00:24:11,870 --> 00:24:15,800
moxy.
We're going to take the carbon dioxide in

295
00:24:15,800 --> 00:24:18,810
the atmosphere of Mars and convert that into
oxygen.

296
00:24:18,810 --> 00:24:21,450
>> Wow.
And that's a first step towards actually sending

297
00:24:21,450 --> 00:24:24,380
humans towards Mars.
>> You can start to lead in that if you'd

298
00:24:24,380 --> 00:24:26,480
like that.
Yeah, I think it's very cool that we would

299
00:24:26,480 --> 00:24:28,590
be able to do that.
>> Incredibly cool.

300
00:24:28,590 --> 00:24:32,810
All right, ready for questions?
Let's start with an online question.

301

00:24:32,810 --> 00:24:36,520

How long is curiosity's mission and how long will its power source last?

302

00:24:36,520 --> 00:24:40,290

>> Awe, a very good question.

The first part is the primary mission for

303

00:24:40,290 --> 00:24:47,180

curiosity was supposed to be one marTIAN year and will drive up to 20■kilometers.

304

00:24:47,180 --> 00:24:50,840

So we've done the primary mission in terms of time, not in terms of distance.

305

00:24:50,840 --> 00:24:53,840

We haven't driven that far mostly because there's been really exciting science that's

306

00:24:53,840 --> 00:24:57,640

really close to where we've landed.

How long is the source?

307

00:24:57,640 --> 00:25:03,840

We have what we call a multi■mission radio thermal isotope, our nuclear source on the

308

00:25:03,840 --> 00:25:07,430

vehicle.

It's half life is I think something like 37

309

00:25:07,430 --> 00:25:10,350

years.

We're not gonna have a power problem per\hse

310

00:25:10,350 --> 00:25:13,920

with that vehicle, but I don't actually know how long that power source will last.

311

00:25:13,920 --> 00:25:17,530

I can sort of say about the half life.
So it has power for quite a long time.

312

00:25:17,530 --> 00:25:22,390

But like the solar rays in spirit and opportunity,
as long as the sun is still giving it energy,

313

00:25:22,390 --> 00:25:32,300

we still make enough energy for the rover
to work.

314

00:25:32,300 --> 00:25:34,990

>> How quickly can a rover move?
>> How quickly can a rover move?

315

00:25:34,990 --> 00:25:41,540

That's a fantastic question.
Do you know how big a football field is?

316

00:25:41,540 --> 00:25:46,000

Our rover can, curiosity, do a football field
in 45 minutes.

317

00:25:46,000 --> 00:25:50,330

So very slow.
5 millimeters a second, it takes about 45

318

00:25:50,330 --> 00:25:53,650

minutes to go the length of a football field.
Really, really slow.

319

00:25:53,650 --> 00:25:58,050

You wouldn't want to watch it drive, it's
sort of like, is it gonna make it, is it gonna

320

00:25:58,050 --> 00:26:00,470

make?
So it's not very fast.

321

00:26:00,470 --> 00:26:03,920

It's 300\million\miles away depending on how you look at it from earth.

322

00:26:03,920 --> 00:26:07,630

There's no gas station no\h■■ somebody to fix it, so we have to go slow to process

323

00:26:07,630 --> 00:26:11,760

all the information.

>> All right, an online question next.

324

00:26:11,760 --> 00:26:13,930

>> Okay.

Another online 1.

325

00:26:13,930 --> 00:26:16,150

>> What made you want to design robots on Mars?

326

00:26:16,150 --> 00:26:20,450

>> What made me want to design robots on Mars?

For me, it was actually Fort fifth grade.

327

00:26:20,450 --> 00:26:24,840

My fifth grade teacher really challenged me and asked me a question about what is it that

328

00:26:24,840 --> 00:26:29,460

I wanted to do.

I really at that time was into star trek and

329

00:26:29,460 --> 00:26:34,990

wanted to be the engineer on the starship enterprise and thought it would be so cool

330

00:26:34,990 --> 00:26:38,270

to be the person that people go, wait, this is broken, can you fix it.

331

00:26:38,270 --> 00:26:44,120

So that sort of started me on the career of
doing engineering in aerospace engineering,

332

00:26:44,120 --> 00:26:47,820

building vehicles that go to space.
That's really where I got my start.

333

00:26:47,820 --> 00:26:51,140

I think it actually started before that.
I like working with my hands and see things

334

00:26:51,140 --> 00:26:55,600

and how they get put together.
>> Thank you so much for talking with us today.

335

00:26:55,600 --> 00:27:00,500

We'd like to thank the international titanium
association for sponsoring the show today

336

00:27:00,500 --> 00:27:05,130

and encourage everyone to tune in next month
as we take to the skies for one of my favorite

337

00:27:05,130 --> 00:27:12,900

topics, kites.
>> Hi, I'm Beth Wilson, I'm one of the host

338

00:27:12,900 --> 00:27:14,280

at them?
30.

339

00:27:14,280 --> 00:27:19,740

Did you know that every year the national
air and space museum host a kite family day?

340

00:27:19,740 --> 00:27:24,600

And during this day, we bring in flyers who
can fly kites indoors.

341

00:27:24,600 --> 00:27:31,740

>> You can't fly a kite inside.

>> Actually, you can.

342

00:27:31,740 --> 00:27:37,740

In fact the flyers refer to it not so much as flying a kite, but dancing with it.

343

00:27:37,740 --> 00:27:41,740

But no one steps on your toes.

>> I can dance.

344

00:27:41,740 --> 00:27:46,620

>> You can barely NAY■NAY.

If you think kites are interesting, be sure

345

00:27:46,620 --> 00:27:50,981

to join us for our next stem in 30.

>> Could you even fly a kite?

346

00:27:50,981 --> 00:27:54,799

>> I've had trouble with that in the past, but we're going to call this show redemption.