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Roving Mars

By George Butler

00:
i(narrator) Space exploration/i
ibegan with dreaming,/i
2

00:
ithousands of years/i
iof humans staring into the heavens/i
3

00:
iand wondering,/i
i"How did this begin?"/i
4

00:
i"What else is out there?"/i
5

00:
iThe earliest answers/i
iwere given in myth and poetry./i
6

00:
iNow they are sought by/i
ispace-age technology,/i
7

00:
iand while each mission/i
iincreases our knowledge,/i
8

00:
iit also leads our imagination/i
ifurther and further./i
9

00:
iHow did life begin?/i
10

00:
iDid it happen more than once/i
iin the universe?/i
11

00:
iThe answer may lie on Mars./i
12

00:
iMars today is desolate,/i
idry and barren,/i
13

00:
iand at first glance has little in common/i
iwith our own planet,/i
14

00:
iand yet from orbit we see what look like/i
idried-up lake beds and canyons -/i
15

00:
iclues that,/i
ithree or four billion years ago,/i
16

00:
iMars may once have been/i
iwetter and more Earth-like./i
17

00:
iAnd since life blossomed/i
ihere on Earth, the question is,/i
18

00:
idid it ever take place on Mars?/i
19

00:

iTo answer this question,/i
iNASA's Jet Propulsion Laboratory/i
20

00:
ibrought together/i
ia team of scientists and engineers/i
21

00:
iwhose mission was to discover if Mars/i
iever had what was needed to support life./i
22

00:
iA geologist and astronomer/i
iat Cornell University,/i
23

00:
iSteve Squyres was chosen/i
ito lead the science team./i
24

00:
iAs principal investigator,/i
ihe would direct the team's search/i
25

00:
ifor life's most essential resource -/i
iwater./i
26

00:
i(Squyres)/i I've worked on the question
of water on Mars for 28 years,
27

00:
You can't learn what you need from
a telescope, You must be a geologist,
28

00:
A geologist is sort of like
a detective at the scene of a crime,
29

00:
Something happened here
a long time ago, What happened?
30

00:
Was it warm? Was it wet?
Could life have existed here?
31

00:
The key is in the clues,
and the clues are in the rocks,
32

00:
On Earth, a geologist
can find an interesting rock,
33

00:
crack it open with a hammer
and just look at what's inside,
34

00:
But we're not ready to send
a human geologist to Mars yet,
35

00:
So we had to build a robot geologist,
36

00:
and the only place this could be done
was NASA's Jet Propulsion Laboratory,
37

00:
where some of the most innovative
engineers in the country work,
38

00:
We're talking about a robot,
a rover that can go to Mars,
39

00:
land on the surface, take a look around
and then cut the cord and go -
40

00:
carrying everything it needs with it -
41

00:
cameras, instruments,
communications equipment, everything,
42

00:
Something that can look inside rocks and
can tell us what clues those rocks hold,
43

00:
This place to me is almost sacred,
44

00:
This is the place where our rovers are
assembled before they leave this planet,
45

00:
Everything that we do
in this room must be perfect,
46

00:

Over 4,000 people
have worked on this mission,
47

00:
For every single piece of this spacecraft,
down to the tiniest one,
48

00:
there was a person somewhere
who conceived it, who nurtured it,
49

00:
who took it from a concept
to something real,
50

00:
lt's taken this team three years
to design and build and test these rovers,
51

00:
and we still have work to do,
52

00:
We can only launch when
the two planets are properly aligned,
53

00:
and that's just a month away,
but we still have tests to run,
54

00:
We're working in shifts, almost around the
clock, and we don't know if we'll make it,
55

00:

i(man)/i There's no one person who can get
their arms around this thing and say:
56

00:
''l understand everything
about this vehicle,''
57

00:
lt's now burst the bounds of our brains,
58

00:
This rover is more than
just a roving geologist,
59

00:
This rover also has to be a spacecraft,
60

00:
lt actually has to
fly itself from Earth to Mars,
61

00:
ln addition, it has to do
the very subtle and quick timing control
62

00:
of all the things that happen
as it enters and lands the vehicle,
63

00:
We had to stuff
all that intelligence and capability
64

00:
into that little six-wheel vehicle back there

so that it could get there safely on its own,
65

00:
i(Manning)/i l call our spacecraft
the ''origami spacecraft,''
66

00:
which means it's really
a complicated series of folds,
67

00:
We punched holes in the lander petals
for the wheels to snake through,
68

00:
We've had to fold everything
into these complicated shapes
69

00:
to get this system
to fit inside this tetrahedron,
70

00:
lt's beautiful, but at a price,
and that price, in this case, is complexity,
71

00:
i(Squyres)/i There have been
missions to Mars since the '60s,
72

00:
there have been dozens of them,
but two-thirds of those missions failed,
73

00:

Mars is a spacecraft graveyard,
74

00:
A spacecraft has to travel
about 300 million miles to get to Mars
75

00:
at about 60,000 miles an hour,
76

00:
but it still takes seven months to get there,
77

00:
Trying to hit our landing sites
from that distance
78

00:
is like shooting a basketball
from Los Angeles to New York
79

00:
and having it go through the hoop
without touching the rim,
80

00:
The smallest mistake on our part
could put the whole mission in jeopardy,
81

00:
Two of the last three missions to Mars
were failures,
82

00:
One spacecraft burned in the atmosphere,
the other one crashed on the surface,

83

00:
This time, NASA decided to
send two identical spacecraft
84

00:
to double our chances of success,
85

00:
The two rovers are named
''Spirit'' and ''Opportunity,''
86

00:
They have very different personalities,
87

00:
They did when they were babies,
back when we were first building them,
88

00:
''Spirit'' was our troublesome firstborn,
89

00:
Every test we ran,
it seemed we ran on ''Spirit'' first,
90

00:
and the first time you try,
it usually doesn't work,
91

00:
We'd run tests on ''Spirit'' and they'd fail,
92

00:

and we'd try to fix things, run
another test, and that would fail, too,
93

00:
By the time we got to ''Opportunity,''
we'd learned stuff,
94

00:
and things went much more smoothly,
95

00:
The biggest problem was underestimating
the size and weight of the rovers,
96

00:
Once we realized
how big they really had to be,
97

00:
we also realized that
the landing system we planned to use
98

00:
couldn't get them to the ground
in one piece,
99

00:
As the rover got heavier, the lander
got heavier, the aeroshell got heavier,
100

00:
The whole thing got heavier
and heavier and heavier,
101

00:

From the very beginning, on this mission,
it seemed like nothing was going right,
102

00:
i(Squyres)/i The air bags are like the air
bags in your car, but way more expensive,
103

00:
They inflate explosively around the vehicle
and they cushion the landing,
104

00:
The first time we tested them,
they tore open and deflated,
105

00:
Setbacks - we know
they are going to happen,
106

00:
l always tell people,
when you start these projects,
107

00:
the same thing probably happened
to Lewis and Clark
108

00:
and Captain Cook in their exploration -
109

00:
what is guaranteed
is there will be setbacks,
110

00:

i(man over radio) 3, 2, 1.../i
111

00:
i(Squyres)/i These rovers have to land
using a supersonic parachute,
112

00:
The parachute design we thought
would work ripped to shreds,
113

00:
The lander had gotten so heavy
that the chute just couldn't handle it,
114

00:
We were practically out of time,
and all we had was a chute design
115

00:
that would destroy the spacecraft
when we tried to land,
116

00:
i(Manning)/i We had to build
a whole nother set of new designs -
117

00:
no less than three or four designs
we had to test
118

00:
in the three months that followed in
our mad rush to make it to the launch pad,
119

00:

We were running out of money,
we were running out of time,
120

00:
The drop was successful, The fact that
the parachute exploded - not a good thing,
121

00:
- l'd rather have it happen here thani,,,/i
- Mars, That's right,
122

00:
Unfortunately, strictly speaking,
123

00:
that chute that just exploded was the chute
that we were planning on taking to Mars,
124

00:
i(Squyres)/i Mars is a tough place
to send a spacecraft,
125

00:
The average temperature
is 60 degrees below zero,
126

00:
lt goes down to 1 00 below zero at night,
127

00:
There can be dust storms that darken
the skies for months at a time,
128

00:
But if the rovers make it,

they'll give us the experience
129

00:
of what it would be like to be on Mars,
130

00:
We'll be able to look off into the distance
and say, ''Yeah, l'd like to go there,''
131

00:
and then actually go
and see what we find,
132

00:
The rover's arm has the same
dimensions of a human arm -
133

00:
with a shoulder, an elbow and a wrist,
134

00:
The arm tucks up tight under the front
of the vehicle for when we drive around,
135

00:
but when we get to a rock
that we want to examine,
136

00:
the arm unstows and reaches out,
using all of its joints
137

00:
to place the instruments on a rock
and to begin to study them,

138

00:
The hand has four fingers,
One is a microscope,
139

00:
two are spectrometers to tell us
in detail what the rocks are made of,
140

00:
and the fourth one is called the RAT -
the Rock Abrasion Tool,
141

00:
To examine the rocks, we've got to
get to them, and Mars is very bumpy,
142

00:
So to deal with bumps, engineers came up
with a ''rocker-bogie'' suspension system,
143

00:
lt's a very clever design
that allows each of the six wheels
144

00:
to go up and over a rock independently
while the rover itself hardly tilts at all,
145

00:
OK, come on in, guys,
Now, stay clear, Watch it, watch it,
146

00:
Stay clear of this, 'cause it's gonna move,

Watch the wheelsi,,,/i
147

00:
i(Squyres)/i lt goes way beyond
this single mission,
148

00:
The eventual goal
is to send humans to Mars,
149

00:
but the first person to walk on Mars
is not an astronaut today,
150

00:
lt's someone in high school
or in elementary school,
151

00:
i(man)/i So it's turning in place,
then, when it gets lined up just right,
152

00:
we're gonna drive it backwards,
153

00:
i(Squyres)/i We've invested so much work,
so many years,
154

00:
so much of our hopes
and our dreams into these rovers,
155

00:
And then when you think

about where they're going,
156

00:
the ride they're gonna get on that rocket,
the transit through space,
157

00:
what it's like when that parachute
goes out at mach 2,
158

00:
going through the Martian atmosphere,
159

00:
You're standing next to this little robot
160

00:
and you realize it's gonna spend eternity
on the surface of another world,
161

00:
lt's going to another planet, for real,
162

00:
And once they're gone, that's it,
163

00:
After the rovers launch, we're never gonna
see them again with our own eyes,
164

00:
We've done everything we can to prepare
them for the dangers they'll have to face,
165

00:
but it's gonna be very hard
to say goodbye,
166

00:
i(wind machine)/i
167

00:
''Spirit'' will be launched first,
then ''Opportunity'' three weeks later,
168

00:
Mars and Earth are both orbiting the sun,
169

00:
so they're always moving
relative to each other,
170

00:
Every 26 months,
there's a brief interval
171

00:
when the planets are lined up just right,
172

00:
At that time, and only at that time,
we have enough rocket fuel to make it,
173

00:
So this is our one shot,
174

00:
i(launch alarm blaring)/i
175

00:
i(man over PA) 5, 4, 3, 2, 1.../i
176

00:
i(Squyres)/i We don't fire a rocket motor
all the way to Mars, We don't need to,
177

00:
We just place the spacecraft
on a trajectory to Mars,
178

00:
and let it coast for 7 months
and 300 million miles
179

00:
until it reaches the planet,
180

00:
Once it's been pushed on its way to Mars
by the launch vehicle,
181

00:
it has to maintain
its orientation toward the sun
182

00:
and it needs to be able to
correct its orientation and direction
183

00:
so that it would hit Mars and get to this
very tiny spot on Mars we're aiming for,
184

00:
So all that has to take place over
the course of the seven-month journey,
185

00:
i(Manning)/i Landing is when
the real challenge begins,
186

00:
Mars is so far away,
it takes about ten minutes
187

00:
for a radio signal to travel
one way between Mars and Earth,
188

00:
but it's only six minutes from when we
first hit the top of the Martian atmosphere
189

00:
to when we're bouncing on the surface,
190

00:
There's nothing we can do to help when it's
time to land, The rovers are on their own,
191

00:
and we're just passive,
passionately interested observers
192

00:
waiting for a radio signal that shows
whether or not they've survived,
193

00:
Not going to be an issue,
The current reported temperature
194

00:
is about zero degrees Celsius,
which is close to the limit,
195

00:
the flight-allowable limit, howeveri,,,/i
196

00:
i(man)/i Landing on Mars
is so complicated,
197

00:
There are so many things
that can go wrong,
198

00:
The flight computer has to know precisely
the right time to deploy the parachute,
199

00:
lf it deploys it too high,
when the parachute opens,
200

00:
the wind forces
will just rip it to shreds,
201

00:
lf we deploy the parachute
too low of an altitude,
202

00:
it won't open in time,
and it will just crash right into the ground,
203

00:
i(Squyres)/i The trick is every time
there's some critical event -
204

00:
the parachute deploys,
the heat shield falls away -
205

00:
we change the frequency
of the radio signal,
206

01:
And so Polly's sitting at her console,
207

01:
and she's looking for
these changing frequencies,
208

01:
And when the number changes,
she knows that this event has happened,
209

01:
that event has happened,
210

01:
i(Lee on radio) Flight Director Willis reports/i
iall systems go for Entry Descent Landing./i
211

01:

iWe are roughly 1 1 minutes,/i
i48 seconds from landing/i
212

01:
iat the Gusev Crater/i
iin the southern hemisphere of Mars./i
213

01:
iAtmospheric entry in 3, 2, 1./i
214

01:
We have just passed
one minute to atmospheric entry,
215

01:
Current altitude 1 21 miles,
current velocity 1 2,084 miles per hour,
216

01:
iWe are now at an altitude of 7 3 miles,/i
217

01:
imoving at a speed of/i
i1 2, 1 92 miles per hour./i
218

01:
iExpected parachute deploy/i
iin five seconds./i
219

01:
i4, 3, 2, 1, mark./i
220

01:
iWe are awaiting confirmation/i
ithat parachute has deployed./i

221

01:
i(man) Parachute's been detected./i
222

01:
iHeat shield deployed event./i
223

01:
iSpacecraft reporting that heat shield/i
ihas jettisoned./i
224

01:
i- Separation detected./i
i- Spacecraft reporting lander separated,/i
225

01:
imoving at a speed of 1 7 3 miles per hour./i
iWe are near our terminal velocity./i
226

01:
iExpected retro-rocket ignition/i
ion my mark. Mark./i
227

01:
iAt this point in time/i
iwe should be on the ground./i
228

01:
iAny signal that we receive from now/i
iindicates the vehicle would be alive,/i
229

01:
ion the ground and bouncing./i
230

01:
iThe spacecraft has to survive all/i
ithe bounces for landing to be a success./i
231

01:
iNo signal at the moment./i
232

01:
i(man) Stand by./i
233

01:
iSignal strength is currently intermittent./i
234

01:
i- We don't see a signal at the moment./i
i- Right./i
235

01:
iWe saw an intermittent signal/i
ithat indicated we were bouncing./i
236

01:
iHowever, we currently do not/i
ihave signal from the spacecraft./i
237

01:
iPlease stand by./i
238

01:
This time, we're approximately
ten minutes after landing,
239

01:
The vehicle should have
rolled to a stop by now,

240

01:
The deep-space stations in Goldstone
and Canberra are searching for the signal,
241

01:
i(woman)/i We see it!
242

01:
i-(man)/i What do we see?
i-(man #2)/i We've got the signal!
243

01:
i(Squyres)/i The first thing to do
is open our solar panels to the sun
244

01:
so we'll have some power,
This charges up the batteries,
245

01:
After that, we can deploy the camera mast
so the rover can see,
246

01:
and deploy the antenna
so the rover can talk to us,
247

01:
i(cheers and applause)/i
248

01:
i(man)/i Our first pictures from Mars!
249

01:
- What is that?
- That's looking down on our vehicle,
250

01:
i(woman)/i Oh!
251

01:
We could not have imagined
returns as early as this,
252

01:
as clear as this,
as successful as this,
253

01:
and in the volume that it has been,
254

01:
Ladies and gentlemen, Mars,
255

01:
i(Squyres)/i We sent ''Spirit''
to Gusev Crater,
256

01:
a crater in
the southern highlands of Mars,
257

01:
lt's 1 00 miles in diameter,
258

01:
What makes it special is that emptying
into it is a giant water-carved channel,

259

01:
Gusev is a hole in the ground
with a dry river flowing into it,
260

01:
There has to have been a lake
in this crater once upon a time,
261

01:
We sent ''Spirit'' there to seek out
sediments, to look for sedimentary rocks
262

01:
that were laid down long ago in that lake,
263

01:
Once we landed,
the scariest part of the mission
264

01:
was the initial unfolding of the rover,
265

01:
There are so many gears and springs
and motors and hinges and latches
266

01:
that have to work just right,
or you're done,
267

01:
Once everything's deployed,
we're ready to start looking around,
268

01:
We can look off into the distance with
our cameras and our infrared spectrometer,
269

01:
and we can learn a lot from a distance
of i5/i0 yards, 1 00 yards,
270

01:
about what the rocks look like
and what they're made of,
271

01:
Then, if we see a rock
that has a texture or a composition
272

01:
that looks interesting to us, we can drive
over to it and check it out in detail,
273

01:
For driving, the rover has
these kind of googly-eyed cameras
274

01:
that it uses to take images
of the terrain in front of it,
275

01:
They've got wide-angle lenses,
and they provide sort of a fisheye view,
276

01:
''Spirit'' uses these pictures to make
its own decisions about how to drive,

277

01:
lt'll drive forward, look at a rock and say,
''That's too big, l have to go around that,''
278

01:
Or maybe it'll see smooth sailing
and just move on,
279

01:
We can actually program different levels
of courage or cowardice into the rover,
280

01:
telling it how aggressive to be, depending
on how dangerous we think the terrain is,
281

01:
These rovers are so complicated that it
takes hours to get a set of commands right,
282

01:
so when we operate them, we'll normally
send commands to them just once a day,
283

01:
The first rock that we looked at
was this one,
284

01:
We named it Adirondack,
285

01:
When a rock sits
on the surface of a planet,

286

01:
it can undergo
what's called ''weathering,''
287

01:
When it's exposed to
sunlight or humidity or wind,
288

01:
the surface of the rock can be modified,
289

01:
and the evidence of how it formed
can be destroyed,
290

01:
So, to get to the clues you need,
291

01:
you have to get inside the rock,
below the weathered surface,
292

01:
The key to understanding Adirondack
was the Rock Abrasion Tool,
293

01:
The RAT gives us the ability
to grind into a rock,
294

01:
exposing the unaltered evidence inside,
295

01:
So we put a RAT hole into Adirondack
and then we hit it with everything we had,
296

01:
We looked at it with our cameras,
our spectrometers, and our microscope,
297

01:
Adirondack is a piece of lava,
lt's not a sedimentary rock,
298

01:
And every other rock around it
is a piece of lava, too,
299

01:
This was a huge disappointment,
300

01:
We came to Gusev Crater
looking for sediments
301

01:
that were laid down long ago
in a lake,
302

01:
but what we found was lava -
volcanic rock,
303

01:
The sedimentary rock must be there,
but it's been buried under the lava,
304

01:
and we couldn't get to it,
305

01:
When we realized that we hadn't landed
on the stuff we came for,
306

01:
we decided
we had to go someplace else,
307

01:
A mile and a half away,
there's this spectacular range of hills
308

01:
called the Columbia Hills,
309

01:
You gotta remember ''Spirit'' was designed
to go only 600 yards over its lifetime,
310

01:
so we set out for those hills
not knowing if we'd ever make it,
311

01:
Meanwhile, on the other side of Mars,
''Opportunity'' was about to land,
312

01:
When ''Opportunity'' landed
at Eagle Crater,
313

01:

it was a 300 million-mile
interplanetary hole in one,
314

01:
We rolled to a stop
right in front of layered bedrock,
315

01:
Bedrock is geologic truth,
316

01:
''Opportunity'' landed
in front of a Martian history book,
317

01:
When we drove off the lander
and looked at the soil in front of us,
318

01:
we saw that it was littered with
what looked like little round beads,
319

01:
an uncountable number
of little round things,
320

01:
We took out our microscope, we reached
out and looked at the soil in detail,
321

01:
and the picture that came down
was astounding,
322

01:

They were perfect spheres,
323

01:
l will remember for the rest of my life
324

01:
how l felt when l saw that first picture,
325

01:
When we got to the outcrop
and looked at it up close,
326

01:
we realized that the spheres
are embedded in the rock
327

01:
like blueberries in a muffin,
328

01:
The rock erodes away and the blueberries
fall out and roll down into the soil,
329

01:
The blueberries are made of hematite,
330

01:
a mineral that on Earth
is often formed in liquid water,
331

01:
Next we found jarosite, which is a mineral
that couldn't have formed
332

01:
unless there'd been water in the rocks,
so there was water underground here,
333

01:
Our most extraordinary discovery came
when we found ripples in the rocks,
334

01:
ancient ripples formed when water flowed
over sand on Mars billions of years ago,
335

01:
So there wasn't just
water underground here,
336

01:
there was water at the surface,
337

01:
''Opportunity'' discovered that
at this place billions of years ago,
338

01:
Mars was most likely a habitable world,
339

01:
A place that, for some interval of time,
was suitable for some forms of life,
340

01:
Decades of work paid off
with this discovery,
341

01:

Billions of years ago, there were
shallow occasional pools of water,
342

01:
Don't think an ocean,
Think of salt flats,
343

01:
And the water may not have been
a pretty blue,
344

01:
ln fact, it may have been so acid,
it dissolved iron out of the rocks
345

01:
and made wine-red pools
under a pink Martian sky,
346

01:
All the discoveries that ''Opportunity''
made about water
347

01:
happened in the first six weeks
of the mission,
348

01:
Everything went right for that rover,
349

01:
l call ''Opportunity''
''Little Miss Perfect,''
350

01:

''Opportunity'' lands
where the evidence is right there,
351

01:
The driving is like a parking lot,
Everything is perfect,
352

01:
''Spirit,'' our kind of tough,
hard-working, blue-collar rover,
353

01:
lands in this awful, rocky,
rugged place on a lava plain
354

01:
a mile and a half from
the nearest interesting rocks
355

01:
and has to struggle for five months
just to begin her mission,
356

01:
''Spirit'' had to work for everything,
literally had to climb a mountain on Mars,
357

01:
We use the power
that comes from the sun
358

01:
to operate the vehicle
and to charge the batteries,
359

01:
so the solar arrays are essential,
360

01:
On the way to the Columbia Hills,
''Spirit's'' solar arrays got coated with dust,
361

01:
We were getting to the point
where ''Spirit'' was simply gonna die,
362

01:
Then, one wonderful day, we climbed up
onto the crest of a ridge,
363

01:
where we were hit by not one
but several gusts of wind
364

01:
that just cleaned the solar arrays off,
365

01:
lt was like having a brand-new rover,
366

01:
''Spirit'' got high up in the Columbia Hills
367

01:
and started to find stuff that was different
from anything we'd seen,
368

01:
There were salt deposits in the hills
and rocks that had been altered by water,

369

01:
lt took months of work and struggle,
but ''Spirit'' finally showed us
370

01:
there had been water
on both sides of the planet,
371

01:
She gave us exactly what we needed,
372

01:
These rovers were designed
to last only 90 Mars days,
373

01:
and they've already
done many times that,
374

01:
They've developed personalities,
They're workhorses, They say:
375

01:
''Push us, Ask us to do more,
We can go further, We can go faster,''
376

01:
So we ask so much more
than they were ever intended to,
377

01:
and to our amazement, they do it,
378

01:
We don't know what will kill these rovers,
They do get old, Motors break,
379

01:
Lubrication goes away in the motors,
the wheels may stop turning,
380

01:
We have no idea what will happen,
381

01:
But they're not gonna last forever,
and as the dust keeps falling,
382

01:
the solar arrays keep getting dirty,
383

01:
What could happen with time is someday
we won't be able to charge the batteries
384

01:
to keep the rover warm at night,
and if that happens, it'll get too cold,
385

01:
and one morning, it just won't wake up,
386

01:
''Spirit'' and ''Opportunity''
have shown us that once,
387

01:

three to four billion years ago,
Mars had the essential ingredients for life,
388

01:
so the next step is to seek out
evidence of life itself,
389

01:
Right now we have
one example of life - us,
390

01:
We may be all there is,
We simply don't know,
391

01:
But if you can show that life developed
twice in one solar system,
392

01:
and then you consider the multitude
of solar systems out there,
393

01:
it takes no great leap of imagination
to believe that life might be
394

01:
a common phenomenon
throughout the universe,
395

01:
Our rovers have gone farther,
harder and longer
396

01:
than even we, their creators,
believed possible,
397

01:
They've done heroic work,
398

01:
But someday we won't need robots,
399

01:
Someday there'll be humans
on the surface of Mars,
400

01:
and boot prints in our wheel tracks,
401

01:
This mission has put us
on a great trajectory
402

01:
to learn more about Mars
and about ourselves,
403

01:
But right now ''Spirit'' and ''Opportunity''
are still roving Mars,
404

01:
lt's not just that they've
exceeded our wildest dreams -
405

01:
in many ways

they iare/i our wildest dreams,