1
00:00:06,140 --> 00:00:02,540
I believe that this nation should commit

2
00:00:08,990 --> 00:00:06,150
itself to achieving the goal before this

3
00:00:11,000 --> 00:00:09,000
decade is out of landing a man on the

4
00:00:15,580 --> 00:00:11,010
moon and returning him safely to the

5
00:00:17,990 --> 00:00:15,590
earth from the Sea of Tranquility

6
00:00:20,960 --> 00:00:18,000
President Kennedy's hope was realized

7
00:00:24,560 --> 00:00:20,970
the lunar landing was the climax of the

8
00:00:27,589 --> 00:00:24,570
Apollo years it was an era of excitement

9
00:00:32,690 --> 00:00:27,599
of adventure that sent the American

10
00:00:36,260 --> 00:00:32,700
spirit soaring for the new century back

11
00:00:41,119 --> 00:00:36,270
to the moon back to the future and this

12
00:00:43,790 --> 00:00:41,129
time back to stay and then a journey

13
00:00:48,049 --> 00:00:43,800

into tomorrow a journey to another

14
00:00:49,639 --> 00:00:48,059
planet a manned mission to Mars the

15
00:00:51,680 --> 00:00:49,649
announcement came on the 20th

16
00:00:54,290 --> 00:00:51,690
anniversary of Man's first visit to the

17
00:00:57,139 --> 00:00:54,300
moon President Bush's pledge to take

18
00:00:59,240 --> 00:00:57,149
another giant leap for mankind may very

19
00:01:01,819 --> 00:00:59,250
well rekindle the spirit that stirred

20
00:01:04,549 --> 00:01:01,829
the imagination and sent a generation

21
00:01:10,100 --> 00:01:04,559
gazing skyward to the greatest adventure

22
00:01:11,960 --> 00:01:10,110
of our time space exploration developing

23
00:01:13,850 --> 00:01:11,970
new technology including a new

24
00:01:15,499 --> 00:01:13,860
generation of planetary rover is

25
00:01:18,200 --> 00:01:15,509
critical to the president's space

26
00:01:20,330 --> 00:01:18,210
initiative in the years ahead these

27
00:01:22,760 --> 00:01:20,340
cost-effective vehicles with their

28
00:01:24,890 --> 00:01:22,770
sophisticated technology will perform

29
00:01:27,679 --> 00:01:24,900
the advanced work of sight exploration

30
00:01:30,440 --> 00:01:27,689
and engineering as america prepares to

31
00:01:36,230 --> 00:01:30,450
build a lunar outpost and journeys on to

32
00:01:38,330 --> 00:01:36,240
Mars nASA has begun an important new

33
00:01:40,010 --> 00:01:38,340
technology initiative which will develop

34
00:01:42,440 --> 00:01:40,020
the technologies needed for the

35
00:01:44,719 --> 00:01:42,450
exploration missions one of the

36
00:01:52,780 --> 00:01:44,729
technology program elements is the

37
00:01:58,310 --> 00:01:55,640
at the Jet Propulsion Laboratory in

38
00:02:00,350 --> 00:01:58,320

Pasadena California this new breed of

39
00:02:02,390 --> 00:02:00,360
space hardware has moved beyond the

40
00:02:04,820 --> 00:02:02,400
drawing boards unlike the first

41
00:02:06,920 --> 00:02:04,830
generation of lunar Rovers the new breed

42
00:02:09,590 --> 00:02:06,930
of unmanned Rovers with their stereo

43
00:02:12,260 --> 00:02:09,600
eyes and powerful onboard computers will

44
00:02:15,770 --> 00:02:12,270
drive themselves like no vehicle has in

45
00:02:17,690 --> 00:02:15,780
the past the current rover technology

46
00:02:19,820 --> 00:02:17,700
owes much to another generation of

47
00:02:23,300 --> 00:02:19,830
hardware and to another generation of

48
00:02:24,620 --> 00:02:23,310
engineers it started in the 1960s with

49
00:02:28,850 --> 00:02:24,630
the development of the manned apollo

50
00:02:30,650 --> 00:02:28,860
lunar rover vehicle a prototype unmanned

51
00:02:36,020 --> 00:02:30,660
lunar rover that never did make it to

52
00:02:38,210 --> 00:02:36,030
the moon and in the years since the job

53
00:02:40,190 --> 00:02:38,220
of developing a more sophisticated Rover

54
00:02:43,400 --> 00:02:40,200
design has been passed on to another

55
00:02:45,470 --> 00:02:43,410
generation of engineers these two

56
00:02:47,949 --> 00:02:45,480
engineers were in grade school during

57
00:02:50,990 --> 00:02:47,959
the inspiring days of the Apollo program

58
00:02:54,440 --> 00:02:51,000
but there is a surprising continuity in

59
00:02:57,050 --> 00:02:54,450
the evolution of the new Rover Brian

60
00:02:59,030 --> 00:02:57,060
Wilcox was only 12 years old the day

61
00:03:01,960 --> 00:02:59,040
that the early surveyor lunar rover

62
00:03:04,430 --> 00:03:01,970
vehicle prototype rolled out for testing

63
00:03:06,500 --> 00:03:04,440

Brian's father was the director of

64
00:03:08,600 --> 00:03:06,510
research and engineering at General

65
00:03:10,910 --> 00:03:08,610
Motors Defence Research Laboratory where

66
00:03:17,810 --> 00:03:10,920
that vehicle was built under contract to

67
00:03:21,170 --> 00:03:17,820
JPL today brian is the navigation system

68
00:03:23,840 --> 00:03:21,180
manager for the JPL Rover project his

69
00:03:25,580 --> 00:03:23,850
job to take the newest technology and

70
00:03:28,310 --> 00:03:25,590
pick up where past dreamers and

71
00:03:31,069 --> 00:03:28,320
engineers left off and build a vehicle

72
00:03:35,390 --> 00:03:31,079
that can drive itself on another planet

73
00:03:37,670 --> 00:03:35,400
on this vehicle we have computers that

74
00:03:39,949 --> 00:03:37,680
are able to perform several millions of

75
00:03:42,860 --> 00:03:39,959
operations per second compared to

76
00:03:43,340 --> 00:03:42,870
perhaps a few hundred operations per

77
00:03:46,800 --> 00:03:43,350
second

78
00:03:49,980 --> 00:03:46,810
the vehicles designed in the 60s and so

79
00:03:53,580 --> 00:03:49,990
we're able to autonomously move six to

80
00:03:56,340 --> 00:03:53,590
ten miles a day and to do that without

81
00:03:58,740 --> 00:03:56,350
human intervention although planetary

82
00:04:01,140 --> 00:03:58,750
surface exploration stalled in the years

83
00:04:03,690 --> 00:04:01,150
following Apollo lunar rover and Viking

84
00:04:08,310 --> 00:04:03,700
Mars Lander successes research and

85
00:04:10,920 --> 00:04:08,320
development at JPL has continued one

86
00:04:13,200 --> 00:04:10,930
example is military robotic vehicle

87
00:04:16,949 --> 00:04:13,210
technology programs with synergistic

88
00:04:19,890 --> 00:04:16,959

autonomous navigation technology the new

89
00:04:22,350 --> 00:04:19,900
space initiative has happened and JPL is

90
00:04:25,470 --> 00:04:22,360
ready with early versions of the next

91
00:04:29,130 --> 00:04:25,480
generation of Rovers today marks the

92
00:04:33,420 --> 00:04:29,140
debut of Robbie the new Rover navigation

93
00:04:35,610 --> 00:04:33,430
testbed vehicle today's test is the

94
00:04:39,240 --> 00:04:35,620
culmination of many years of work for

95
00:04:41,250 --> 00:04:39,250
just one of JPL's dedicated teams but it

96
00:04:44,580 --> 00:04:41,260
is also the continuation of the dream of

97
00:04:46,260 --> 00:04:44,590
early NASA visionaries the test today is

98
00:04:48,930 --> 00:04:46,270
to demonstrate semi autonomous

99
00:04:50,550 --> 00:04:48,940
navigation what we will do is several

100
00:04:54,330 --> 00:04:50,560
cycles of semi autonomous navigation

101
00:04:57,030 --> 00:04:54,340
where the vehicle will take images it

102
00:04:58,920 --> 00:04:57,040
will correlate those images to find the

103
00:05:03,090 --> 00:04:58,930
distance to each point in the in the

104
00:05:05,580 --> 00:05:03,100
scene it will match that information

105
00:05:08,280 --> 00:05:05,590
with a global terrain database and then

106
00:05:10,590 --> 00:05:08,290
it will plan a path based on that best

107
00:05:13,020 --> 00:05:10,600
estimated knowledge of the terrain

108
00:05:17,610 --> 00:05:13,030
surface the semi autonomous navigation

109
00:05:20,520 --> 00:05:17,620
system will now be put to the test Andy

110
00:05:23,700 --> 00:05:20,530
Michigan what we've gotten to today is

111
00:05:27,240 --> 00:05:23,710
basically the result of integrating many

112
00:05:30,600 --> 00:05:27,250
different subsystems that involve many

113
00:05:34,740 --> 00:05:30,610

different elements the hardware the

114
00:05:37,070 --> 00:05:34,750
software sensing by the vehicle the

115
00:05:39,210 --> 00:05:37,080
perception and the determination what

116
00:05:42,720 --> 00:05:39,220
what is the terrain in front of the

117
00:05:44,890 --> 00:05:42,730
vehicle the conversion of that to an

118
00:05:47,230 --> 00:05:44,900
appropriate map

119
00:05:51,070 --> 00:05:47,240
and integrating that with a path planner

120
00:05:53,560 --> 00:05:51,080
which takes that data and and plans a

121
00:05:56,110 --> 00:05:53,570
safe path all of those pieces had to

122
00:05:58,480 --> 00:05:56,120
come together and work together to allow

123
00:06:01,719 --> 00:05:58,490
us to get to today the cameras should

124
00:06:03,879 --> 00:06:01,729
scan and do local terrain maps of this

125
00:06:07,409 --> 00:06:03,889
area here and it should find the a

126
00:06:10,570 --> 00:06:07,419
traversable path around Roger Bedard the

127
00:06:11,920 --> 00:06:10,580
unmanned rover navigation work that

128
00:06:14,710 --> 00:06:11,930
you're seeing in terms of the test work

129
00:06:17,290 --> 00:06:14,720
going on down here is but one part of

130
00:06:19,420 --> 00:06:17,300
the NASA rover program there's other

131
00:06:21,670 --> 00:06:19,430
technology work going on at JPL in the

132
00:06:23,350 --> 00:06:21,680
power area and the mobility area in the

133
00:06:25,360 --> 00:06:23,360
mission operations area there's also

134
00:06:27,400 --> 00:06:25,370
work at other centers at Ames Research

135
00:06:29,770 --> 00:06:27,410
Center at Marshall Space Flight Center

136
00:06:32,650 --> 00:06:29,780
and work at universities mainly at

137
00:06:35,529 --> 00:06:32,660
carnegie mellon university the rover

138
00:06:37,689 --> 00:06:35,539

must drive itself around a rock mound to

139
00:06:40,719 --> 00:06:37,699
a destination behind the mound which is

140
00:06:42,550 --> 00:06:40,729
not visible from its starting point the

141
00:06:45,370 --> 00:06:42,560
trail is apparent to the human eye and

142
00:06:48,070 --> 00:06:45,380
mind but will Robbie with its machine

143
00:06:50,529 --> 00:06:48,080
intelligence find the way there will be

144
00:06:53,080 --> 00:06:50,539
no communication with the rover it will

145
00:06:55,510 --> 00:06:53,090
have to navigate on its own for the team

146
00:06:59,500 --> 00:06:55,520
and Robbie the test site is as remote as

147
00:07:02,589 --> 00:06:59,510
Mars 35 million miles away a likely

148
00:07:05,920 --> 00:07:02,599
place for it to be used would be on Mars

149
00:07:08,500 --> 00:07:05,930
either doing a sample return and

150
00:07:11,379 --> 00:07:08,510
exploration or survey of sites for

151
00:07:13,899 --> 00:07:11,389
eventual human outpost they could do

152
00:07:16,540 --> 00:07:13,909
that on the moon as well with all

153
00:07:20,820 --> 00:07:16,550
systems go Robbie begins to make his way

154
00:07:26,710 --> 00:07:23,890
by far it's the most sophisticated of

155
00:07:28,960 --> 00:07:26,720
all rover designs its distinction goes

156
00:07:33,790 --> 00:07:28,970
beyond the stereo cameras that double

157
00:07:38,800 --> 00:07:33,800
for eyes and the flexible backbone of

158
00:07:41,020 --> 00:07:38,810
its three parts chassis and the high

159
00:07:46,540 --> 00:07:41,030
gear ratios that provide the muscle to

160
00:07:49,090 --> 00:07:46,550
climb over boulders what makes this

161
00:07:52,270 --> 00:07:49,100
Rover unique is its computer software

162
00:07:56,710 --> 00:07:52,280
the semi autonomous navigation or San

163
00:07:59,620 --> 00:07:56,720

technology simply put Sam is the onboard

164
00:08:01,630 --> 00:07:59,630
intelligence in a PC sized computer that

165
00:08:04,720 --> 00:08:01,640
provides the brains to navigate and

166
00:08:07,060 --> 00:08:04,730
drive the vehicle to understand how

167
00:08:10,960 --> 00:08:07,070
Robbie finds his way around a rock mount

168
00:08:13,270 --> 00:08:10,970
for example let's look inside first the

169
00:08:14,830 --> 00:08:13,280
electronic eyes view the mound and the

170
00:08:18,460 --> 00:08:14,840
computer understands it to be an

171
00:08:21,640 --> 00:08:18,470
obstacle this is the combined panoramic

172
00:08:24,160 --> 00:08:21,650
data from those three scans you see the

173
00:08:26,710 --> 00:08:24,170
vehicle has its six wheels turned into a

174
00:08:29,520 --> 00:08:26,720
hard left turn and then when we go to

175
00:08:32,620 --> 00:08:29,530
combine that with the global data and

176
00:08:37,180 --> 00:08:32,630
the original data from the first path

177
00:08:39,250 --> 00:08:37,190
this is what results considering the

178
00:08:41,620 --> 00:08:39,260
programmed restrictions the computerized

179
00:08:43,930 --> 00:08:41,630
semi autonomous navigation system like a

180
00:08:47,770 --> 00:08:43,940
human navigator begins to make decisions

181
00:08:50,500 --> 00:08:47,780
to follow a path of least resistance the

182
00:08:53,710 --> 00:08:50,510
process occurs over and over as Robbie

183
00:08:56,320 --> 00:08:53,720
cautiously moves forward as Robbie is

184
00:08:58,390 --> 00:08:56,330
moving the onboard computers continually

185
00:09:00,670 --> 00:08:58,400
monitor the movement and trigger reflex

186
00:09:05,020 --> 00:09:00,680
actions if the path execution is not as

187
00:09:07,060 --> 00:09:05,030
predicted as Robbie progresses towards

188
00:09:09,100 --> 00:09:07,070

its final destination the look of

189
00:09:12,070 --> 00:09:09,110
success sweeps across the faces of those

190
00:09:15,010 --> 00:09:12,080
who have worked so long and so hard for

191
00:09:17,260 --> 00:09:15,020
this moment the semi autonomous

192
00:09:19,870 --> 00:09:17,270
navigation experiment may have been only

193
00:09:22,150 --> 00:09:19,880
a first step a first step in developing

194
00:09:23,920 --> 00:09:22,160
a kind of machine intelligence that

195
00:09:26,410 --> 00:09:23,930
someday will affect not only how we

196
00:09:28,300 --> 00:09:26,420
explore the universe but how we live out

197
00:09:30,600 --> 00:09:28,310
our lives on earth

198
00:09:33,910 --> 00:09:30,610
the NASA Exploration Technologies

199
00:09:35,980 --> 00:09:33,920
program will lead the way as America