
Ames Research Center
NASA
SILICON VALLEY
LIVE
SILICON VALLEY
COMMUNICATIONS

1
00:00:00,000 --> 00:00:14,330
(Music)

2
00:00:14,330 --> 00:00:17,380
Matthew Buffington (Host): What's up, everybody?

3
00:00:17,380 --> 00:00:24,050
You are watching the third episode of NASA
in Silicon Valley Live, a conversational show

4
00:00:24,050 --> 00:00:29,600
on Twitch TV with the various scientists,
researchers, engineers and overall cool people

5
00:00:29,600 --> 00:00:37,400
throughout NASA but especially here at NASA's
Ames Research Center in Silicon Valley.

6
00:00:37,400 --> 00:00:41,680
This is a special “Let's Play Space Video
Games” episode.

7
00:00:41,680 --> 00:00:47,140
Obviously on Twitch you're all familiar with
folks playing video games and talking about

8
00:00:47,140 --> 00:00:53,780
them, so we figured let's get some NASA experts
on this Twitch show to basically talk about

9
00:00:53,780 --> 00:00:57,840
the science and engineering that is related
to these video games in space.

10
00:00:57,840 --> 00:01:05,280
So, keep in mind, these are NASA experts,
but we are not professional gamers.

11
00:01:05,280 --> 00:01:10,390

This is not a speed run, this is not a walk through, we don't care about K/D ratios or

12
00:01:10,390 --> 00:01:14,720
even being particularly good at playing any of these games.

13
00:01:14,720 --> 00:01:19,500
This is basically an excuse that we're looking forward to, so we can play these space video

14
00:01:19,500 --> 00:01:23,640
games and talk about NASA science and NASA engineering.

15
00:01:23,640 --> 00:01:28,110
But as a special treat, we're also simultaneously live on NASA TV.

16
00:01:28,110 --> 00:01:34,550
So, if anybody out there who is watching NASA TV wasn't aware, if you want to ask our guests

17
00:01:34,550 --> 00:01:40,390
any questions you can hop on over to Twitch.TV/NASA and join the chat.

18
00:01:40,390 --> 00:01:45,750
I'm your host, Matthew Buffington, and my cohost, Abby Tabor, will be taking those questions

19
00:01:45,750 --> 00:01:48,190
from the chat throughout the episode.

20
00:01:48,190 --> 00:01:49,550
Abby Tabor: Exactly.

21
00:01:49,550 --> 00:01:53,630
Like Matt said, we're especially looking for science and engineering questions because

22
00:01:53,630 --> 00:01:59,670
we have for you here today Chad Frost, Deputy Director of Engineering here at Ames, and

23
00:01:59,670 --> 00:02:08,840
Mary Beth Wilhelm and in the back, if we can get the SkyCam, aerospace engineer Thomas

24
00:02:08,840 --> 00:02:09,840
Lambot.

25
00:02:09,840 --> 00:02:12,670
Matt: Wave, Thomas, you can't just sit there.

26
00:02:12,670 --> 00:02:16,260
And Dave and Bill, got to give them a shout out.

27
00:02:16,260 --> 00:02:23,010
Abby: Our guests are going to take turns playing games and we're going to ask them questions

28
00:02:23,010 --> 00:02:24,010
about what they're seeing.

29
00:02:24,010 --> 00:02:30,620
Matt: One last heads up, if you can't catch us live, you can find us on demand on Twitch

30
00:02:30,620 --> 00:02:36,430
and also on audio podcast services throughout the solar system and beyond.

31
00:02:36,430 --> 00:02:43,250
But before we introduce the first game, we're going to start off with a good old disclaimer.

32
00:02:43,250 --> 00:02:46,530

So, the disclaimer graphic, here we go.

33
00:02:46,530 --> 00:02:51,650
As a U.S. government agency, NASA will not
promote or endorse or appear to promote or

34
00:02:51,650 --> 00:02:55,090
endorse a commercial product, service or activity.

35
00:02:55,090 --> 00:03:00,400
Playing these games is not an endorsement
by NASA or the U.S. Federal Government.

36
00:03:00,400 --> 00:03:03,140
No game developer or publisher requested,
nor did we or will we request to play any

37
00:03:03,140 --> 00:03:04,459
specific game.

38
00:03:04,459 --> 00:03:10,970
The games selected were purely to facilitate
a conversation on space exploration, science,

39
00:03:10,970 --> 00:03:12,590
technology, and engineering.

40
00:03:12,590 --> 00:03:14,410
So, everybody got that?

41
00:03:14,410 --> 00:03:15,410
Abby: Got it.

42
00:03:15,410 --> 00:03:16,410
Matt: We're all good.

43
00:03:16,410 --> 00:03:22,540
With that said let's go a bit old school and
let's play Space Wars and Lunar Lander.

44
00:03:22,540 --> 00:03:29,560
Chad Frost: First off, it's ““Space War!”,
with an exclamation mark.

45
00:03:29,560 --> 00:03:39,020
So, we get really used to seeing all the modern
three-dimensional graphics on PlayStation

46
00:03:39,020 --> 00:03:46,780
or your computer and it's easy to forget where
this all started and, of course, before NASA

47
00:03:46,780 --> 00:03:51,400
flies anything in air or in space we simulate
the heck out of it so we know what it's going

48
00:03:51,400 --> 00:03:52,400
to do.

49
00:03:52,400 --> 00:03:57,440
Somebody has to write the simulation and for
things flying in space what's maybe the most

50
00:03:57,440 --> 00:04:00,500
important thing that you have to simulate
or take into consideration?

51
00:04:00,500 --> 00:04:01,500
Matt: Gravity.

52
00:04:01,500 --> 00:04:02,820
Chad: Gravity, right?

53
00:04:02,820 --> 00:04:05,960
So, this is the theme for today is gravity.

54
00:04:05,960 --> 00:04:10,540
OK, so I want to show you what “Space War!”

looks like.

55
00:04:10,540 --> 00:04:16,070
“Space War!” was literally the first video
game.

56
00:04:16,070 --> 00:04:18,690
Before “Space War!”

57
00:04:18,690 --> 00:04:24,230
We're talking 1960, and this was a game that
was written to run on the digital equipment

58
00:04:24,230 --> 00:04:27,660
corporation PDP1.

59
00:04:27,660 --> 00:04:30,949
This is the first computer to have a graphical
display.

60
00:04:30,949 --> 00:04:35,699
So, before this it was all, you know, typewriters,
electric typewriters is how you interacted

61
00:04:35,699 --> 00:04:36,699
with the computer.

62
00:04:36,699 --> 00:04:39,819
Matt: Do we want to show them the image real
quick?

63
00:04:39,819 --> 00:04:42,360
Before we jump into it and playing it.

64
00:04:42,360 --> 00:04:44,319
Chad: This is what it looked like.

65
00:04:44,319 --> 00:04:51,050
These two guys are playing “Space War!”,

and they have joystick boxes.

66
00:04:51,050 --> 00:04:54,249
Joystick boxes and control boxes, that didn't exist before this either.

67
00:04:54,249 --> 00:04:56,300
So, this was hugely ground breaking.

68
00:04:56,300 --> 00:05:01,050
And you will notice that this display, it's pretty big for the era.

69
00:05:01,050 --> 00:05:04,139
It's like a 19-inch diameter display.

70
00:05:04,139 --> 00:05:11,219
It's a big display for the day and really high-resolution and it turns out these were

71
00:05:11,219 --> 00:05:12,809
radar scopes.

72
00:05:12,809 --> 00:05:17,030
They didn't have a big computer display because no computers had displays.

73
00:05:17,030 --> 00:05:22,389
They used what they had and it was basically a radar tube.

74
00:05:22,389 --> 00:05:26,039
That's how it all started is on the deck PDP1.

75
00:05:26,039 --> 00:05:28,270
Matt: We kept going back and forth.

76
00:05:28,270 --> 00:05:32,120
While we were practising and trying to figure

out who was going to play it, are you guys

77
00:05:32,120 --> 00:05:33,199
going to jump in?

78
00:05:33,199 --> 00:05:36,690
Chad: We're going to play.

79
00:05:36,690 --> 00:05:42,779
This is a simulation of two spaceships flying
around a star.

80
00:05:42,779 --> 00:05:43,909
So, there's gravity.

81
00:05:43,909 --> 00:05:48,690
The star is trying to drag the spaceships
into the middle and on our little spaceships

82
00:05:48,690 --> 00:05:51,960
we have thrusters so we can try to overcome
gravity.

83
00:05:51,960 --> 00:05:56,240
You will see it's kind of dragging us into
orbit and we can try and shoot each other.

84
00:05:56,240 --> 00:05:57,430
Mary Beth Wilhelm: You're going down, Chad.

85
00:05:57,430 --> 00:05:59,569
Chad: Not if I get you first!

86
00:05:59,569 --> 00:06:07,129
Matt: We've learned that Chad is pretty killer
on some of those old school games.

87
00:06:07,129 --> 00:06:09,629
Mary Beth: A fast learner.

88
00:06:09,629 --> 00:06:15,319
Chad: We have hyper space so if it looks like
we're about to die we can warp out of there.

89
00:06:15,319 --> 00:06:16,330
She got me again.

90
00:06:16,330 --> 00:06:17,339
Mary Beth: Pay back.

91
00:06:17,339 --> 00:06:19,569
Abby: How much do you have to fight the gravity?

92
00:06:19,569 --> 00:06:20,569
Chad: Quite a bit.

93
00:06:20,569 --> 00:06:25,020
If you sit there it will drag you into the
middle and eat your ship.

94
00:06:25,020 --> 00:06:32,559
You have to thrust to get around the gravity
well and then maneuver and try and shoot.

95
00:06:32,559 --> 00:06:36,339
Matt: Oh so you're literally doing a gravity
assist.

96
00:06:36,339 --> 00:06:38,319
Chad: Exactly.

97
00:06:38,319 --> 00:06:43,270
Like if we're doing a flyby mission, doing
a planetary space mission and doing a flyby

98
00:06:43,270 --> 00:06:49,509
where we try to use the gravity of a planet
to accelerate the spacecraft, it's the same

99
00:06:49,509 --> 00:06:50,509
thing.

100
00:06:50,509 --> 00:06:54,580
Matt: This is such an old school simulation
but even here at NASA Ames we have super computers

101
00:06:54,580 --> 00:06:59,800
that are doing this but to the thousandth
degree.

102
00:06:59,800 --> 00:07:02,400
Chad: Just like this but only a lot faster.

103
00:07:02,400 --> 00:07:04,000
Abby: Just like this.

104
00:07:04,000 --> 00:07:12,460
Chad: So, this, back in the day, a game like
this took all the resources of that computer.

105
00:07:12,460 --> 00:07:15,979
The code was loaded in on a punched paper
tape.

106
00:07:15,979 --> 00:07:23,990
The max memory on the PDP1 was like 4K of
metal core memory.

107
00:07:23,990 --> 00:07:26,139
Memory was hugely expensive.

108
00:07:26,139 --> 00:07:32,699
But it allowed them to simulate, you know,
what is basically a space mission in its most

109
00:07:32,699 --> 00:07:33,879
elemental form.

110
00:07:33,879 --> 00:07:39,240
Matt: You're getting some advice from SigC,
lead your shots.

111
00:07:39,240 --> 00:07:43,509
Chad: It's totally addictive.

112
00:07:43,509 --> 00:07:46,499
You do have to lead the shots.

113
00:07:46,499 --> 00:07:54,949
These are torpedoes, not lasers and the gravity
of the sun-got you, drags the shots into the

114
00:07:54,949 --> 00:07:55,949
middle.

115
00:07:55,949 --> 00:07:57,199
Abby: Really, even your bullets?

116
00:07:57,199 --> 00:08:02,180
Chad: You've got to lead it but you have to
think about where the gravity is taking them.

117
00:08:02,180 --> 00:08:05,969
Matt: Things that you're sending, gravity
is always at play.

118
00:08:05,969 --> 00:08:11,789
Not only when you're orbiting and get someplace
but when you're trying to land so that might

119
00:08:11,789 --> 00:08:15,919
be a good segue on over to good old Lunar
Lander.

120
00:08:15,919 --> 00:08:17,710
Chad: So we're going to switch it over.

121
00:08:17,710 --> 00:08:20,699
Abby: While you do that I have a couple of comments to share.

122
00:08:20,699 --> 00:08:21,789
That's pretty cool.

123
00:08:21,789 --> 00:08:25,659
"I'm glad they're doing something different like this."

124
00:08:25,659 --> 00:08:27,740
And also "Where can I play this?"

125
00:08:27,740 --> 00:08:33,180
Chad: Both of these actually happen to be running off of my web browser.

126
00:08:33,180 --> 00:08:35,539
So, you can find them online.

127
00:08:35,539 --> 00:08:38,979
Matt: Using the Internet search tool of your choice.

128
00:08:38,979 --> 00:08:46,190
Chad: If you Google for deck PDP1 “Space War!” you should be able to find it.

129
00:08:46,190 --> 00:08:51,730
So, onto our next example here is Moon Lander, or Lunar Lander.

130
00:08:51,730 --> 00:08:54,260
This is another pretty old game.

131
00:08:54,260 --> 00:09:04,450
People have seen this in its Atari console,

Atari2600 or before that it was an Atari arcade

132
00:09:04,450 --> 00:09:08,180
game but it actually goes back further than
that.

133
00:09:08,180 --> 00:09:13,190
This was, again, written on a digital equipment
computer, the PDP11.

134
00:09:13,190 --> 00:09:18,870
The PDP11 was the first hacker computer because
it was extensible and people could get on

135
00:09:18,870 --> 00:09:22,070
it and do crazy stuff like games.

136
00:09:22,070 --> 00:09:28,570
So, this was originally called Moon Lander
and it pretty much got picked up by Atari

137
00:09:28,570 --> 00:09:30,900
very much as it originally existed.

138
00:09:30,900 --> 00:09:35,610
Matt: In one of our first episodes that we
did of NASA Silicon Valley Live, we had Jim

139
00:09:35,610 --> 00:09:40,000
Green and Greg Schmidt, they were talking
about landing on the moon.

140
00:09:40,000 --> 00:09:44,390
Mary Beth, as we were talking before hand,
this is Lunar Lander, if you change the color

141
00:09:44,390 --> 00:09:46,620
it could be Mars Lander.

142

00:09:46,620 --> 00:09:50,410
Mary Beth is our residential Mars expert.

143
00:09:50,410 --> 00:09:52,650
Mary Beth: Or Martian.

144
00:09:52,650 --> 00:09:53,770
Matt: Nice.

145
00:09:53,770 --> 00:09:55,530
Let's jump into this.

146
00:09:55,530 --> 00:10:00,500
What goes into this and what's the engineering
that has to happen to land on the moon?

147
00:10:00,500 --> 00:10:02,990
Chad: This is our gravity theme.

148
00:10:02,990 --> 00:10:06,980
Landing on the moon, we don't have an atmosphere
to worry about unlike Mars or Earth but we

149
00:10:06,980 --> 00:10:08,610
still have gravity.

150
00:10:08,610 --> 00:10:13,960
The moon only has one sixth of the Earth's
gravity so it's not as strong but as you will

151
00:10:13,960 --> 00:10:20,600
see, trying to land on the surface you constantly
have to work against this tug of gravity and

152
00:10:20,600 --> 00:10:24,650
it means you constantly have to compensate
for it as you try and land your ship.

153
00:10:24,650 --> 00:10:28,400

You will see up in the top left corner.

154
00:10:28,400 --> 00:10:31,080
Matt: Are you going to give it a go, Mary Beth?

155
00:10:31,080 --> 00:10:32,370
Mary Beth: I can try.

156
00:10:32,370 --> 00:10:37,610
Chad: In the top left corner there is a fuel counter, so you start with a finite amount

157
00:10:37,610 --> 00:10:39,050
of fuel.

158
00:10:39,050 --> 00:10:43,160
There we go.

159
00:10:43,160 --> 00:10:50,160
And so, you've got a finite amount of fuel that reduces as you use the thruster and you're

160
00:10:50,160 --> 00:10:53,930
changing the velocity of the spacecraft.

161
00:10:53,930 --> 00:10:59,240
The only thing you have to work with is the attitude, the orientation of the ship and

162
00:10:59,240 --> 00:11:02,750
how much thrust you're putting out, which is very realistic.

163
00:11:02,750 --> 00:11:06,460
This is just how the actual lunar landers work.

164
00:11:06,460 --> 00:11:10,470

The only difference here is we're working
in two dimensions instead of three.

165
00:11:10,470 --> 00:11:16,090
You will notice in the upper right-hand corner
we have information about the horizontal and

166
00:11:16,090 --> 00:11:20,590
vertical speed and those both need to be zero
when you touch down or you're going to make

167
00:11:20,590 --> 00:11:23,260
a big hole in the ground.

168
00:11:23,260 --> 00:11:28,680
Abby: I like how we zoomed in there.

169
00:11:28,680 --> 00:11:30,170
What year was this game released?

170
00:11:30,170 --> 00:11:36,670
Chad: On the PDP11 this was around the late
'60s, '67 maybe.

171
00:11:36,670 --> 00:11:42,640
And it started coming out on the Atari probably
in the mid-1970s.

172
00:11:42,640 --> 00:11:45,170
Matt: This is amazing.

173
00:11:45,170 --> 00:11:48,050
She is absolutely killing it.

174
00:11:48,050 --> 00:11:50,250
This isn't the first time
you've tried it, is it?

175
00:11:50,250 --> 00:11:52,450

Mary Beth: This is the second.

176
00:11:52,450 --> 00:11:57,510
I heard this was a lot harder than it is.

177
00:11:57,510 --> 00:12:01,790
Chad: You've got fuel left so you can keep
going.

178
00:12:01,790 --> 00:12:04,430
Mary Beth: Topography is an interesting question
too.

179
00:12:04,430 --> 00:12:09,850
Because when it comes to landing on any planetary
surface you have moons and craters and mountains

180
00:12:09,850 --> 00:12:10,850
in the way.

181
00:12:10,850 --> 00:12:16,130
From Mars, there's a lot of conversation into
what is a safe place to land.

182
00:12:16,130 --> 00:12:22,360
When we landed on the moon, it's smooth, it's
the dark patches on the moon when you look

183
00:12:22,360 --> 00:12:25,550
at it in the night sky.

184
00:12:25,550 --> 00:12:30,900
If you search on the Internet pictures of
the North Pole of the moon or the south pole

185
00:12:30,900 --> 00:12:35,250
of the moon, or you look at the far side of
the moon, it looks very different.

186

00:12:35,250 --> 00:12:37,660
It's heavily cratered and -

187
00:12:37,660 --> 00:12:38,660
Chad: Kind of like this.

188
00:12:38,660 --> 00:12:39,660
Mary Beth: Exactly.

189
00:12:39,660 --> 00:12:40,660
It looks very foreign.

190
00:12:40,660 --> 00:12:44,330
Like if you didn't know what you were looking
at, at least for me, I don't think I would

191
00:12:44,330 --> 00:12:45,940
guess immediately it was the moon.

192
00:12:45,940 --> 00:12:50,100
Matt: I'm impressed you can talk about your
work and play this game at the

193
00:12:50,100 --> 00:12:52,850
same time.

194
00:12:52,850 --> 00:12:55,530
I could not do that.

195
00:12:55,530 --> 00:12:56,530
So how are you on questions?

196
00:12:56,530 --> 00:12:58,210
Abby: I have a couple of comments.

197
00:12:58,210 --> 00:13:00,460
Chad, your Lunar Lander is a hit.

198

00:13:00,460 --> 00:13:05,020
They want the link to download this fantastic game.

199
00:13:05,020 --> 00:13:07,590
Chad: Matt, do we have any way to send out links later?

200
00:13:07,590 --> 00:13:13,170
Matt: For people in the chat who are asking questions, as much as the guests can hang

201
00:13:13,170 --> 00:13:18,960
out after the show is over around 3:00 Pacific time, they can stay and answer questions.

202
00:13:18,960 --> 00:13:24,720
Abby: Then, Chad, how many Delta V do we need to leave Earth and can you tell me what we

203
00:13:24,720 --> 00:13:26,520
mean by Delta V?

204
00:13:26,520 --> 00:13:33,570
Chad: Delta V is basically the speed that you need to conduct a maneuver and whether

205
00:13:33,570 --> 00:13:39,880
we're maneuvering from here to the moon or out into deep space or even doing little maneuvers

206
00:13:39,880 --> 00:13:44,830
around something else, you know, engineers put that in the terms of Delta V. It's the

207
00:13:44,830 --> 00:13:49,290
change in velocity, usually expressed in meters per second.

208
00:13:49,290 --> 00:13:52,900

So, leaving Earth, we usually talk about it
as escape velocity.

209
00:13:52,900 --> 00:13:59,720
Abby: I've heard of that, yeah.

210
00:13:59,720 --> 00:14:10,710
Thomas Lambot: Something to note about the
Delta V is that it's not the exact change

211
00:14:10,710 --> 00:14:11,710
of velocity.

212
00:14:11,710 --> 00:14:15,650
Like you start with that velocity, you end
up with that velocity.

213
00:14:15,650 --> 00:14:20,560
As you can see on Lunar Lander, you need to
thrust in some different directions and every

214
00:14:20,560 --> 00:14:23,850
time you do that you're moving the velocity
in some other directions.

215
00:14:23,850 --> 00:14:30,740
So, the Delta V total you need are maneuvers
where you fire in directions to get somewhere.

216
00:14:30,740 --> 00:14:32,260
Delta V.

217
00:14:32,260 --> 00:14:38,460
Chad: So, for example, you don't just need
to leave the Earth, you have to get into typically

218
00:14:38,460 --> 00:14:43,180
Earth orbit and then you have to leave Earth
orbit and if we're going to the moon now you

219
00:14:43,180 --> 00:14:46,730
have to do a braking maneuver to get into
orbit around the moon.

220
00:14:46,730 --> 00:14:48,620
You may need to change that orbit.

221
00:14:48,620 --> 00:14:54,100
Each one of those maneuvers takes some additional
amount of Delta V which translates into how

222
00:14:54,100 --> 00:14:58,410
much propellant do you need, how efficient
is your rocket, all these details.

223
00:14:58,410 --> 00:15:01,050
Mary Beth: I have a question.

224
00:15:01,050 --> 00:15:07,220
During the Apollo era, do you know off hand
like how much margin they left for their fuel?

225
00:15:07,220 --> 00:15:09,220
Chad: Yeah, it depends on which mission, right?

226
00:15:09,220 --> 00:15:16,070
So, the first one, Neil Armstrong and Buzz
Aldrin are coming in and they didn't like

227
00:15:16,070 --> 00:15:22,100
what they saw when they were about to touch
down and they went long.

228
00:15:22,100 --> 00:15:27,930
They made the decision on the fly to not touch
down where they had originally planned and

229
00:15:27,930 --> 00:15:33,440
to eat into their fuel margin to try and find

a better spot, with no guarantee that they

230
00:15:33,440 --> 00:15:34,680
would.

231
00:15:34,680 --> 00:15:37,150
And they pretty much used it all up.

232
00:15:37,150 --> 00:15:40,110
They didn't have hardly any left by the time
they actually touched down.

233
00:15:40,110 --> 00:15:41,670
Mary Beth: Just enough to get back?

234
00:15:41,670 --> 00:15:48,230
Chad: It's actually a separate system but
you wouldn't want to run out before having

235
00:15:48,230 --> 00:15:50,630
touched down.

236
00:15:50,630 --> 00:15:56,510
Matt: If you're just joining us, you're watching
NASA in Silicon Valley Live, a new conversational

237
00:15:56,510 --> 00:16:00,400
show that we're trying out on Twitch.TV/NASA.

238
00:16:00,400 --> 00:16:05,280
This is “Let's Play Space Video Games”,
and we're going to switch things up.

239
00:16:05,280 --> 00:16:09,650
Mary Beth is going to switch place with Thomas,
she's going to go to the SkyCam.

240
00:16:09,650 --> 00:16:12,220
Thomas is coming up.

241
00:16:12,220 --> 00:16:18,940
Mary Beth is coming back towards the end.

242
00:16:18,940 --> 00:16:22,640
We're all going to get ready for, “Let's
Play Kerbal Space Program.”

243
00:16:22,640 --> 00:16:30,170
Abby: That's good news for Poppa and Zukus
who are asking if we can talk about the physics.

244
00:16:30,170 --> 00:16:31,340
Let's do that.

245
00:16:31,340 --> 00:16:37,580
Matt: I know Twitch has several highly skilled
Kerbal streamers.

246
00:16:37,580 --> 00:16:41,350
In full disclosure, I'm a complete noob to
Kerbal.

247
00:16:41,350 --> 00:16:50,240
I've been playing this for maybe a week now
and my friend EJ and Scott Manly are extremely

248
00:16:54,890 --> 00:16:51,240
good.

249
00:16:54,890 --> 00:16:56,870
I haven't been able the take him up on that
yet.

250
00:16:56,870 --> 00:17:03,680
This, what we're going to pull up here, is
the console version of Kerbal Space Program.

251
00:17:03,680 --> 00:17:09,030

If we'd had the PC version I'd have Thomas
do this because he's played around with it.

252
00:17:09,030 --> 00:17:14,169
But we're going to at least run a sub-orbital
flight and we're going to try to get in orbit

253
00:17:14,169 --> 00:17:17,650
if we can, depending on how much time we have.

254
00:17:17,650 --> 00:17:20,209
We can hop on over, guys.

255
00:17:20,209 --> 00:17:26,020
So, Thomas, tell us about Kerbal, what exactly
is this for folks who don't know?

256
00:17:26,020 --> 00:17:33,279
Thomas: This is kind of a simulation of what
the Earth will be and you have your little

257
00:17:33,279 --> 00:17:40,720
space assembly, the VAB over there and you
can create your own rockets.

258
00:17:40,720 --> 00:17:44,440
Matt: We're going to jump into the VAB.

259
00:17:44,440 --> 00:17:48,639
As we jump in over here I'm going to load
up one of my saves.

260
00:17:48,639 --> 00:17:53,369
Keep in mind, I just started on the career
mode so I don't really have anything unlocked.

261
00:17:53,369 --> 00:17:56,179
I'm going to open this craft.

262

00:17:56,179 --> 00:17:57,619
Thomas: It's OK, man.

263
00:17:57,619 --> 00:18:00,360
Chad: Which one of those little guys is you,
Matt?

264
00:18:00,360 --> 00:18:02,690
Matt: I'm in there somewhere.

265
00:18:02,690 --> 00:18:04,809
So, what are we looking at?

266
00:18:04,809 --> 00:18:06,659
Thomas: So, it looks like we have…

267
00:18:06,659 --> 00:18:08,759
Thomas: Can you zoom out slightly?

268
00:18:08,759 --> 00:18:14,629
So, we have a rocket liquid engine with some
multiple fuel tanks.

269
00:18:14,629 --> 00:18:15,960
There are different types of rockets.

270
00:18:15,960 --> 00:18:21,649
You can use some liquid engine, a fuel oxidizer,
you put that together, a high pressure in

271
00:18:21,649 --> 00:18:27,909
a chamber, you get a high-pressure gas that
you expel through the back to create some

272
00:18:27,909 --> 00:18:29,769
reaction force to push a rocket.

273
00:18:29,769 --> 00:18:32,980
You can also do that with solid fuel which

is kind of the two mixed.

274
00:18:32,980 --> 00:18:34,570
It's a big firecracker.

275
00:18:34,570 --> 00:18:36,809
You light it, it just goes, you cannot stop
it.

276
00:18:36,809 --> 00:18:39,440
There are pros and cons for using both.

277
00:18:39,440 --> 00:18:44,110
It looks like you've put at the top a capsule
with some ‘goo’ experiment on the side.

278
00:18:44,110 --> 00:18:45,679
Matt: I got a kick out of this.

279
00:18:45,679 --> 00:18:51,169
As you're playing it, you realize the point
of the game is you're flying different experiments,

280
00:18:51,169 --> 00:18:52,169
you're doing stuff.

281
00:18:52,169 --> 00:18:57,610
But I haven't unlocked a whole lot on the
game but over time, as you get more science,

282
00:18:57,610 --> 00:19:01,139
you can unlock more things and more objects
and more stuff.

283
00:19:01,139 --> 00:19:06,630
So yeah, I have the goo up here so we can
figure out how to run these experiments and

284
00:19:06,630 --> 00:19:08,149

the idea is, you know.

285
00:19:08,149 --> 00:19:09,149
Thomas: A pilot.

286
00:19:09,149 --> 00:19:14,350
Chad: If you fly this goo into space, this
is a question for Mary Beth, do we have to

287
00:19:14,350 --> 00:19:16,429
worry about it coming back?

288
00:19:16,429 --> 00:19:20,809
Are there planetary protection considerations
with this space goo?

289
00:19:20,809 --> 00:19:22,179
Mary Beth: No doubt.

290
00:19:22,179 --> 00:19:26,110
Matt: Thomas with your work, you deal with
a lot of experiments and science that goes

291
00:19:26,110 --> 00:19:29,429
up for sub-orbital, not necessarily for the
space station.

292
00:19:29,429 --> 00:19:38,330
Thomas: What we do is we get some of those
science technologies, people have new concepts

293
00:19:38,330 --> 00:19:43,830
of things such as a new sensor or a new goo
system, they want to try out, so we put that

294
00:19:43,830 --> 00:19:48,019
on the rocket and we launch that to 100 plus
kilometers.

295

00:19:48,019 --> 00:19:52,830
Not to the ISS just to space and they can
do their stuff.

296
00:19:52,830 --> 00:19:59,309
We eject the goo, we spin the goo, we do whatever
we want - not whatever we want, what we're

297
00:19:59,309 --> 00:20:02,770
supposed to do, and then we get the data,
bring it back.

298
00:20:02,770 --> 00:20:07,549
So, the people who get the data, they can
figure out how to make it better, how to move

299
00:20:07,549 --> 00:20:09,250
that technology forward.

300
00:20:09,250 --> 00:20:14,259
Matt: Unfortunately, in my situation, I haven't
unlocked the telecommunications yet so we're

301
00:20:14,259 --> 00:20:17,090
going to go up, run the experiment.

302
00:20:17,090 --> 00:20:18,809
We can keep that up on the screen.

303
00:20:18,809 --> 00:20:22,299
Thomas: That's how we do a lot of things too.

304
00:20:22,299 --> 00:20:26,870
Depends, sometimes we communicate some of
the results, sometimes we just go pick it

305
00:20:26,870 --> 00:20:31,220
up, literally, get the canister back with
the payload in it and say how did that go

306
00:20:31,220 --> 00:20:32,220
and get the recording.

307
00:20:32,220 --> 00:20:35,830
Abby: So these could be biology experiments
or what else?

308
00:20:35,830 --> 00:20:37,529
Thomas: Yeah, biology experiments.

309
00:20:37,529 --> 00:20:38,950
We do a lot of technology.

310
00:20:38,950 --> 00:20:46,970
So, for example, a new solar cell, you want
to see if they get irradiated.

311
00:20:46,970 --> 00:20:51,169
What happens to the materials or like the
computer, if you can get irradiated stuff

312
00:20:51,169 --> 00:20:55,340
like that, we send it high and see how it
behaves.

313
00:20:55,340 --> 00:20:56,700
Matt: So I'm going to go ahead.

314
00:20:56,700 --> 00:21:00,059
I bet we have questions, before we jump into
the launch.

315
00:21:00,059 --> 00:21:02,820
Abby: Or launch while I talk.

316
00:21:02,820 --> 00:21:08,610
First of all, "I love space" and the commentary,
“Thanks for doing this, and how is the progress

317
00:21:08,610 --> 00:21:10,669
on finding more Earth-like planets?"

318
00:21:10,669 --> 00:21:14,769
Chad: Progress continues, right?

319
00:21:14,769 --> 00:21:19,999
So, this is an ongoing project.

320
00:21:19,999 --> 00:21:26,090
There's lots and lots of data that came down
from the Kepler and K2 and it's still being

321
00:21:26,090 --> 00:21:27,090
crunched.

322
00:21:27,090 --> 00:21:33,059
I think you guys saw some recent results where
some AI and deep learning algorithms were

323
00:21:33,059 --> 00:21:38,649
being used to go back over the data that's
been collected and find additional exoplanets

324
00:21:38,649 --> 00:21:40,960
and Earth-like planets.

325
00:21:40,960 --> 00:21:46,350
NASA has lots of projects in the works to
continue looking for those kinds of planets.

326
00:21:46,350 --> 00:21:48,760
It's really exciting.

327
00:21:48,760 --> 00:21:54,840
Thomas: All the data they get, they get so
much data, they push it to the crowd and give

328

00:21:54,840 --> 00:21:57,149
it to other scientists around the world.

329
00:21:57,149 --> 00:22:04,629
They crunch data and use the algorithm to
find other planets.

330
00:22:04,629 --> 00:22:07,890
There is a way for people to participate in
NASA ventures.

331
00:22:07,890 --> 00:22:11,950
Abby: Ordinary people go through that data
and find planets, right?

332
00:22:11,950 --> 00:22:13,549
Matt: Let's jump into this launch.

333
00:22:13,549 --> 00:22:17,200
Thomas, I'm going to have you talk us through
and Mary Beth, if you have anything on the

334
00:22:17,200 --> 00:22:22,019
science goo side that we need to know as the
NASA scientist, we expect you to do this.

335
00:22:22,019 --> 00:22:25,659
Abby: I'll have a physics question but I'll
let you launch.

336
00:22:25,659 --> 00:22:29,509
Thomas: Don't check the range or anything,
just launch like that.

337
00:22:29,509 --> 00:22:30,509
Come
on.

338
00:22:30,509 --> 00:22:34,440
Matt: I did not check the range.

339
00:22:34,440 --> 00:22:37,090
I did not go through my checklist either.

340
00:22:37,090 --> 00:22:39,169
Thomas: That's a heavy turn right there.

341
00:22:39,169 --> 00:22:42,499
Good thing you have some fins on it.

342
00:22:42,499 --> 00:22:45,130
Abby: What are the fins doing for him?

343
00:22:45,130 --> 00:22:49,309
Thomas: As you build up speed, those fins
will act to counteract the drag.

344
00:22:49,309 --> 00:22:53,809
So, you see this rocket right now is like
tilted and you have some balance with the

345
00:22:53,809 --> 00:23:00,929
center of pressure, center of thrust and without
getting details it's easy to tip over and

346
00:23:00,929 --> 00:23:01,929
crash and burn.

347
00:23:01,929 --> 00:23:06,460
That's why rocket science, or rocket engineering,
is really what it is.

348
00:23:06,460 --> 00:23:07,460
Pretty complex.

349
00:23:07,460 --> 00:23:09,989
One mistake and everything can literally go
in flames.

350
00:23:09,989 --> 00:23:12,940
Abby: So this question from Block Watcher
is good.

351
00:23:12,940 --> 00:23:17,730
"Do you have to consider relativity when going
to the moon or Mars or is Newtonian mechanics

352
00:23:17,730 --> 00:23:18,730
enough?"

353
00:23:18,730 --> 00:23:22,309
Chad: It's a good question.

354
00:23:22,309 --> 00:23:26,649
Moon and Mars for the most part Newtonian
suffices.

355
00:23:26,649 --> 00:23:33,029
If you're going off into the deeper space,
further out missions, it starts to come into

356
00:23:33,029 --> 00:23:39,249
effect but for moon and Mars, for the most
part, we don't have to take it into account.

357
00:23:39,249 --> 00:23:41,129
It depends on the mission, though, right?

358
00:23:41,129 --> 00:23:43,899
There's some missions where you're actually
trying to…

359
00:23:43,899 --> 00:23:50,679
Your science is all about looking at gravity
effects, trying to prove out some of the fundamental

360
00:23:50,679 --> 00:23:54,019
laws of physics and in those cases you do.

361
00:23:54,019 --> 00:23:58,990
The mission's sensitive to those parameters
but if you're just trying to get there, not

362
00:23:58,990 --> 00:23:59,990
so much.

363
00:23:59,990 --> 00:24:00,990
Abby: OK.

364
00:24:00,990 --> 00:24:01,990
Interesting.

365
00:24:01,990 --> 00:24:10,530
Thomas: So looks like we ran out of fuel.

366
00:24:10,530 --> 00:24:15,200
The goo seems to be getting cold now.

367
00:24:15,200 --> 00:24:16,289
That's good data.

368
00:24:16,289 --> 00:24:17,289
It's valuable.

369
00:24:17,289 --> 00:24:19,659
Matt: Trying to get people a good view of
the goo.

370
00:24:19,659 --> 00:24:24,539
Thomas: So usually when you have rockets like
that, when you run out of fuel, you just,

371
00:24:24,539 --> 00:24:27,561
you know, you jettison the rest of the rocket
that you don't need, the part of the rocket

372

00:24:27,561 --> 00:24:31,869
you don't need because especially when you
have multiple stage like on rocket on top

373
00:24:31,869 --> 00:24:37,159
of a rocket, when you're like halfway through,
when you use the bottom part of the rocket

374
00:24:37,159 --> 00:24:40,950
you can - it's like dead mass and you need
to carry that dead mass.

375
00:24:40,950 --> 00:24:48,039
The best we do when we go to space, you stage,
meaning you remove some part of it.

376
00:24:48,039 --> 00:24:53,600
Matt: I should have jettisoned my stuff a
while back after I ran out of fuel?

377
00:24:53,600 --> 00:24:54,600
Yeah.

378
00:24:54,600 --> 00:24:56,950
I'm going to go ahead and pop off after that.

379
00:24:56,950 --> 00:25:02,539
Thomas: It's a crewed flight, we have a pilot
in there.

380
00:25:02,539 --> 00:25:07,519
Matt: On the bottom right, if we start spinning
around too much he's going to have a bad time.

381
00:25:07,519 --> 00:25:09,789
Thomas: He looks very happy when you spin
it, actually.

382
00:25:09,789 --> 00:25:11,289
Matt: His face.

383
00:25:11,289 --> 00:25:13,289
Chad: He's enjoying that.

384
00:25:13,289 --> 00:25:17,179
Abby: I have a couple of related questions.

385
00:25:17,179 --> 00:25:21,200
How many years before we see engines that
will enable deep space travel?

386
00:25:21,200 --> 00:25:23,749
And then "It's only rocket science.

387
00:25:23,749 --> 00:25:25,669
When is the debut of SLS"?

388
00:25:25,669 --> 00:25:27,830
As in what year, the space launch system?

389
00:25:27,830 --> 00:25:29,190
Chad: Those are good questions.

390
00:25:29,190 --> 00:25:34,019
The first question is when will we have rockets
that will let us explore deep space.

391
00:25:34,019 --> 00:25:35,580
We're already doing that.

392
00:25:35,580 --> 00:25:37,409
We're just not doing it with crew.

393
00:25:37,409 --> 00:25:41,270
So, we're sending missions into deep space.

394
00:25:41,270 --> 00:25:47,200
We've got the early probes have left the solar

system, right?

395
00:25:47,200 --> 00:25:50,429
So, I would say this is really a two-parter.

396
00:25:50,429 --> 00:25:55,769
One is when are we going to have engines that
will let us take crews into deep space and,

397
00:25:55,769 --> 00:26:00,119
again, I would say well you could do it today,
it's just a very long mission.

398
00:26:00,119 --> 00:26:05,399
So, if you're prepared to send crews out there
for years at a time, right, you could do that.

399
00:26:05,399 --> 00:26:09,309
Abby: With the engines we have, the whole
package of everything else we need.

400
00:26:09,309 --> 00:26:14,690
Chad: So electric propulsion gives you higher
efficiency, we're doing that with smaller

401
00:26:14,690 --> 00:26:17,360
spacecraft today.

402
00:26:17,360 --> 00:26:20,169
There's no reason you can't scale that up.

403
00:26:20,169 --> 00:26:25,309
But even with those engines, you're talking,
you know, missions that last many, many years

404
00:26:25,309 --> 00:26:28,730
to get crew out into the outer part of the
solar system.

405

00:26:28,730 --> 00:26:31,220
Matt: There's a parachute.

406
00:26:31,220 --> 00:26:33,899
He's going to make it.

407
00:26:33,899 --> 00:26:38,659
Thomas: Something to note is going to lower
Earth orbit requires so much fuel.

408
00:26:38,659 --> 00:26:42,249
Like a rocket is like more than 85% fuel.

409
00:26:42,249 --> 00:26:46,703
Just to get to lower orbit you use most of
that and once you're in space you have a lot

410
00:26:46,703 --> 00:26:49,279
of maneuvers to do and things like that.

411
00:26:49,279 --> 00:26:53,700
So, the rest of that mass that is left over,
you need to pack in there all the stuff you

412
00:26:53,700 --> 00:26:57,200
want, including a very good propulsion system
to do things.

413
00:26:57,200 --> 00:27:03,330
So, NASA looks into some of those new types
of engine, also even things like a nuclear

414
00:27:03,330 --> 00:27:10,029
thermal rocket that might be something that
could bring us closer time travel to Mars

415
00:27:10,029 --> 00:27:11,279
and other places.

416

00:27:11,279 --> 00:27:12,809
Abby: OK, so we're on it?

417
00:27:12,809 --> 00:27:13,809
Thomas: We are.

418
00:27:13,809 --> 00:27:15,659
It's a tough problem but it's moving.

419
00:27:15,659 --> 00:27:16,679
Abby: What is SLS?

420
00:27:16,679 --> 00:27:19,619
Chad: It's the space launch system.

421
00:27:19,619 --> 00:27:26,529
It's the next big giant rocket that NASA's
building to take crew out to the vicinity

422
00:27:26,529 --> 00:27:34,100
of the moon and beyond and I think the next
SLS launch is the EM1 mission or Earth Moon

423
00:27:34,100 --> 00:27:35,100
1 mission.

424
00:27:35,100 --> 00:27:39,499
It won't have a crew onboard but it will test
all the systems to go out around the moon

425
00:27:39,499 --> 00:27:40,499
and back.

426
00:27:40,499 --> 00:27:45,980
I think it's currently late 2019, don't quote
me on that, but I think that's the current

427
00:27:45,980 --> 00:27:46,980
launch date.

428
00:27:46,980 --> 00:27:48,179
Abby: Not too far-off.

429
00:27:48,179 --> 00:27:51,590
Chad: The next flight after that will be the
first one that will have crew on it.

430
00:27:51,590 --> 00:27:57,609
You're looking at probably 2020, '22 or that
time frame.

431
00:27:57,609 --> 00:27:59,600
Thomas: It's a pretty big rocket.

432
00:27:59,600 --> 00:28:04,190
The last rocket we had like that was Saturn
5, which we had to launch all the Apollo missions

433
00:28:04,190 --> 00:28:06,619
to go to the moon.

434
00:28:06,619 --> 00:28:09,200
It's 10% more thrust in it.

435
00:28:09,200 --> 00:28:12,750
If you have a chance to see the SLS launch,
go see it.

436
00:28:12,750 --> 00:28:15,289
It will be quite something.

437
00:28:15,289 --> 00:28:17,279
Abby: Cool.

438
00:28:17,279 --> 00:28:22,220
Matt: How are we doing on the chat Abby?

439

00:28:22,220 --> 00:28:23,309
Chad: Splash down there.

440
00:28:23,309 --> 00:28:27,789
Matt: I'm almost at splash down.

441
00:28:27,789 --> 00:28:30,580
The parachute is good, I should be fine.

442
00:28:30,580 --> 00:28:33,320
Thomas: Did you bring the goo back?

443
00:28:33,320 --> 00:28:35,390
Matt: The goo is on board.

444
00:28:35,390 --> 00:28:39,429
I haven't unlocked the communications yet
to send the data back so I have to bring it

445
00:28:39,429 --> 00:28:40,429
back.

446
00:28:40,429 --> 00:28:41,429
Chad: Clearly you need to play this more.

447
00:28:41,429 --> 00:28:45,270
Matt: Yes, I definitely need to unlock better
things.

448
00:28:45,270 --> 00:28:48,119
Abby: Over here I have a bunch of questions
about Mars but I'm waiting

449
00:28:48,119 --> 00:28:52,039
for Mary Beth to come back so let's take more
of the rocket launch questions.

450
00:28:52,039 --> 00:28:54,159
Chad: We have a big focus on Mars coming up

here.

451
00:28:54,159 --> 00:28:56,309
Abby: We do.

452
00:28:56,309 --> 00:29:04,769
And then another kind of question, "I have
a big question about college.

453
00:29:04,769 --> 00:29:08,259
Is it worth it to go to the naval academy
because they have the largest number of NASA

454
00:29:08,259 --> 00:29:11,440
astronauts rather than going with something
more preferable?"

455
00:29:11,440 --> 00:29:18,139
Chad: Heck, yeah, if you want to be an astronaut
that's a great path.

456
00:29:18,139 --> 00:29:21,399
Even if you don't want to be an astronaut
that's a great path.

457
00:29:21,399 --> 00:29:27,330
The military academies are a fantastic education
for engineering in particular, lots of other

458
00:29:27,330 --> 00:29:29,360
things too.

459
00:29:29,360 --> 00:29:36,659
I mean if you're focused on a career to be
an astronaut or anything in the related field,

460
00:29:36,659 --> 00:29:40,429
you can't really go far wrong with the naval
academy, first-class education.

461
00:29:40,429 --> 00:29:42,479
Abby: I guess there are other ways in.

462
00:29:42,479 --> 00:29:43,869
Chad: There certainly are.

463
00:29:43,869 --> 00:29:48,240
If you look at our current class of astronauts,
they come from a really diverse set of backgrounds.

464
00:29:48,240 --> 00:29:49,570
Abby: Which is nice.

465
00:29:49,570 --> 00:29:56,120
Matt: So we collected some more science so
hopefully I'll be able to unlock more rockets

466
00:29:56,120 --> 00:29:59,789
and cool things to build bigger and better
rockets.

467
00:29:59,789 --> 00:30:05,720
But I think the next step, what we're going
to do, we have some time but I have a quick

468
00:30:05,720 --> 00:30:10,220
reminder to anybody, if you're just joining
us now you're watching NASA in Silicon Valley

469
00:30:10,220 --> 00:30:11,220
Live.

470
00:30:11,220 --> 00:30:16,559
A new conversational show we're trying out
here on Twitch.TV/NASA.

471
00:30:16,559 --> 00:30:20,729
We're playing Kerbal Space Program.

472
00:30:20,729 --> 00:30:28,929
I find the irony of all of our heavily accomplished
NASA experts of engineering and scientists,

473
00:30:28,929 --> 00:30:30,970
even Abby, you have a degree in neuroscience?

474
00:30:30,970 --> 00:30:31,970
Abby: Yep.

475
00:30:31,970 --> 00:30:36,850
Matt: The person with the communications and
public relations degree is the one who is

476
00:30:36,850 --> 00:30:38,230
launching these rockets over here.

477
00:30:38,230 --> 00:30:40,610
Chad: You're making it look so easy, Matt.

478
00:30:40,610 --> 00:30:45,350
Matt: I'll play a lot and let you guys talk
about the cool stuff.

479
00:30:45,350 --> 00:30:48,509
Chad: I think you need to get us into orbit
here.

480
00:30:48,509 --> 00:30:51,429
Matt: I think we're going to do it.

481
00:30:51,429 --> 00:30:56,749
So, folks, before we were even trying this
out, I tried several times and it didn't quite

482
00:30:56,749 --> 00:30:58,460
work so why not?

483

00:30:58,460 --> 00:31:03,720
We're just going to give it a try and just
to let you know how much of a noob I am to

484
00:31:03,720 --> 00:31:06,019
this, this is even on the training module
one.

485
00:31:06,019 --> 00:31:09,960
So, I'm going to jump into a training module
and try to get into orbit.

486
00:31:09,960 --> 00:31:12,649
That will be a fun one.

487
00:31:12,649 --> 00:31:13,870
Abby: Let's do it.

488
00:31:13,870 --> 00:31:17,749
Matt: We'll give that a kick and then we'll
switch things up and switch on over to the

489
00:31:17,749 --> 00:31:18,749
next game.

490
00:31:18,749 --> 00:31:21,109
Chad: Come on, how hard can it be?

491
00:31:21,109 --> 00:31:22,440
It's only rocket science.

492
00:31:22,440 --> 00:31:23,759
Matt: I know, right.

493
00:31:23,759 --> 00:31:28,380
And keep in mind, I had a hard time like getting
this one.

494
00:31:28,380 --> 00:31:31,639

I like having this one work and it's on the
training mode.

495
00:31:31,639 --> 00:31:36,100
So, they're even like have Gene Kerman is
guiding me through.

496
00:31:36,100 --> 00:31:41,019
Thomas: You spent a good amount of the morning
trying and you said the next one is going

497
00:31:41,019 --> 00:31:42,229
to be the good one.

498
00:31:42,229 --> 00:31:43,590
So, this is the next one, right?

499
00:31:43,590 --> 00:31:45,749
Matt: This is the one.

500
00:31:45,749 --> 00:31:50,150
Part of it is just not following directions
of what my friend Gene Kerman is going to

501
00:31:50,150 --> 00:31:51,150
show.

502
00:31:51,150 --> 00:31:54,679
We're going to flip on over, my throttle is
up.

503
00:31:54,679 --> 00:31:56,389
Thomas: The weather is looking good.

504
00:31:56,389 --> 00:31:57,830
Matt: We've got all the approved forms.

505
00:31:57,830 --> 00:32:00,059
Thomas: Are we good for science?

506
00:32:00,059 --> 00:32:01,169
Mary Beth: Go.

507
00:32:01,169 --> 00:32:03,460
Chad: Have you had your flight readiness review,
Matt?

508
00:32:03,460 --> 00:32:06,190
Matt: I was going to say, let's talk about
that.

509
00:32:06,190 --> 00:32:09,590
How realistic is this or what are they missing
in Kerbal?

510
00:32:09,590 --> 00:32:11,299
Thomas, you're familiar with Kerbal.

511
00:32:11,299 --> 00:32:16,200
What are the things that are not being simulated
in here like paperwork?

512
00:32:16,200 --> 00:32:18,899
Thomas: Paperwork, filings and review.

513
00:32:18,899 --> 00:32:25,129
All those things, it's literally taking part
of the rocket, putting them together and then

514
00:32:25,129 --> 00:32:28,010
push the big red button.

515
00:32:28,010 --> 00:32:31,500
There is no big red button.

516
00:32:31,500 --> 00:32:34,099
You know, you don't look at the range, you
don't look at the weather, you don't look

517
00:32:34,099 --> 00:32:40,529
at really, all sorts of things that you're
supposed to look at and to make a rocket fly

518
00:32:40,529 --> 00:32:43,759
there is so much stuff behind it, to check
so many things.

519
00:32:43,759 --> 00:32:50,049
I think, Chad can talk about going through
all the FDR’s, stuff like that.

520
00:32:50,049 --> 00:32:55,210
Chad: There's quite the process, right, and
of course, at NASA there's even that much

521
00:32:55,210 --> 00:32:59,159
more process because typically we're dealing
with humans on board.

522
00:32:59,159 --> 00:33:03,759
So, there's a lot of reviews, let's make sure
all the engineering is done right, let's make

523
00:33:03,759 --> 00:33:07,850
sure everything was made correctly, have we
taken everything into account?

524
00:33:07,850 --> 00:33:08,850
It's a long process.

525
00:33:08,850 --> 00:33:13,620
And, of course, in Kerbal, we're seeing the
very end where the thing's on the pad, we've

526
00:33:13,620 --> 00:33:15,639
built it, press the button, let's go.

527

00:33:15,639 --> 00:33:17,019
So that's the fun part.

528
00:33:17,019 --> 00:33:22,619
Matt: Comparing what that little sub-orbital
hop was, got some cool science, brought it

529
00:33:22,619 --> 00:33:24,720
back, definitely useful.

530
00:33:24,720 --> 00:33:26,479
What's the difference between this one?

531
00:33:26,479 --> 00:33:29,379
Different stages going on here for people
who have no clue what they're looking at.

532
00:33:29,379 --> 00:33:37,409
Thomas: On the side I believe is two solid
stage, it's a heavy kick, a lot of boost,

533
00:33:37,409 --> 00:33:41,820
not that efficient but the thing you want
to do when you launch a rocket, especially

534
00:33:41,820 --> 00:33:46,039
when you want to get orbital, the first thing
is get out of the atmosphere.

535
00:33:46,039 --> 00:33:50,970
Go out of the atmosphere and you have - you
try to turn because going to space straight

536
00:33:50,970 --> 00:33:59,529
up is "easy", it's getting to orbital speed,
that's the tough part there.

537
00:33:59,529 --> 00:34:05,860
Going up, you have all the part, the turn,
very complex to do as Matt is going to demonstrate.

538
00:34:05,860 --> 00:34:09,159
Matt: My friend Gene Kerman is going to walk through this.

539
00:34:09,159 --> 00:34:12,950
I tried four times and I kept bailing every single time.

540
00:34:12,950 --> 00:34:15,090
Chad: You were getting close.

541
00:34:15,090 --> 00:34:16,540
Matt: Let's give this a go.

542
00:34:16,540 --> 00:34:19,780
Let's get the throttle up.

543
00:34:19,780 --> 00:34:23,620
Matt: Let's try this out.

544
00:34:23,620 --> 00:34:27,600
Look at that.

545
00:34:27,600 --> 00:34:31,150
Thomas: Let's do it.

546
00:34:31,150 --> 00:34:35,840
The big winglet in the back, I wouldn't put that in something that goes that fast – might

547
00:34:35,840 --> 00:34:37,730
have
some aerodynamic issues there.

548
00:34:37,730 --> 00:34:42,250
Matt: The thing that has been getting me is the SAS not being turned on.

549
00:34:42,250 --> 00:34:43,610
Abby: What's that?

550
00:34:43,610 --> 00:34:45,640
Chad: Stability augmentation system.

551
00:34:45,640 --> 00:34:47,390
Matt: What exactly is that?

552
00:34:47,390 --> 00:34:48,920
Abby: Stops it shaking so much?

553
00:34:48,920 --> 00:34:51,730
Chad: It makes it that much more stable, right?

554
00:34:51,730 --> 00:34:56,730
Matt: All I know is that as I've not had that
on I have not been very successful.

555
00:34:56,730 --> 00:35:01,660
Chad: You can see the end of the fin wiggling
back and forth a little bit and that's the

556
00:35:01,660 --> 00:35:07,460
stability augmentation system at work and
it's basically using a computer to sense what

557
00:35:07,460 --> 00:35:14,020
the thing, what the rocket is doing and augment
the control to help it be more stable than

558
00:35:14,020 --> 00:35:15,020
it otherwise would be.

559
00:35:15,020 --> 00:35:16,930
Abby: Did you say you can see that right now?

560
00:35:16,930 --> 00:35:18,970

Chad: You can see the fin wiggling a bit.

561
00:35:18,970 --> 00:35:20,690
Abby: This is that realistic?

562
00:35:20,690 --> 00:35:21,690
Wow.

563
00:35:21,690 --> 00:35:27,550
Thomas: In orbital rocket you don't use the
fin - Well, you can.

564
00:35:27,550 --> 00:35:33,000
On high-speed rocket you do use the fins to
change trajectories, more missile type of

565
00:35:33,000 --> 00:35:34,000
things.

566
00:35:34,000 --> 00:35:35,100
Chad: It's more a missile thing.

567
00:35:35,100 --> 00:35:38,720
Abby: I have a couple of more questions.

568
00:35:38,720 --> 00:35:42,940
Chad: Just imagine running this on the PDP1.

569
00:35:42,940 --> 00:35:45,560
Look how far we've come.

570
00:35:45,560 --> 00:35:51,870
Abby: Back to our deep space topic, SG Stream
is asking do you think Star Trek space journeys

571
00:35:51,870 --> 00:35:54,400
will one day be possible?

572

00:35:54,400 --> 00:35:57,630
That kind of deep space travel.

573
00:35:57,630 --> 00:36:01,330
Chad: I think we need the warp drive first.

574
00:36:01,330 --> 00:36:02,900
I think that's the hard part.

575
00:36:02,900 --> 00:36:08,810
Certainly, you know, humanity has the will,
we don't yet have the way.

576
00:36:08,810 --> 00:36:09,810
Abby: OK.

577
00:36:09,810 --> 00:36:10,810
Working on it?

578
00:36:10,810 --> 00:36:11,810
Chad: Yeah.

579
00:36:11,810 --> 00:36:12,810
Thomas: Working on it.

580
00:36:12,810 --> 00:36:16,650
Abby: I have a few questions on specific targets
and missions so you guys let us know if you

581
00:36:16,650 --> 00:36:19,210
can comment on that or if you just don't know.

582
00:36:19,210 --> 00:36:26,640
So, have there been any more planned missions
to Ceres, that's the asteroid?

583
00:36:26,640 --> 00:36:30,080
Chad: I don't think we have anything planned
right now.

584
00:36:30,080 --> 00:36:32,770
Mary Beth: I think right now they're planning
the plan.

585
00:36:32,770 --> 00:36:33,830
Chad: Planning the plan.

586
00:36:33,830 --> 00:36:39,600
Mary Beth: Every 10 years the planetary science
community comes together and discusses what

587
00:36:39,600 --> 00:36:44,740
the top priorities are and determines where
they want to go next and Ceres is a really

588
00:36:44,740 --> 00:36:49,720
cool target right now because they found clays
which are indicative of water and they also

589
00:36:49,720 --> 00:36:51,130
found carbon.

590
00:36:51,130 --> 00:36:56,500
So, there's a lot of models for how this might
be happening but one of the models I heard

591
00:36:56,500 --> 00:37:01,330
about, which I think is pretty neat, is that
Ceres, the surface you're looking at, which

592
00:37:01,330 --> 00:37:07,950
is a large dwarf planet, is actually at the
bottom of an old ocean, which is wild.

593
00:37:07,950 --> 00:37:12,090
As a planetary scientist I'm really excited
about Ceres and learning more about it.

594

00:37:12,090 --> 00:37:17,270
I hope the community decides in a few years
that we should go back and explore more.

595
00:37:17,270 --> 00:37:18,980
Chad: So hopefully soon.

596
00:37:18,980 --> 00:37:20,060
Abby: Hopefully soon.

597
00:37:20,060 --> 00:37:27,210
Now what about the IMAGE satellite, what can
you tell us about IMAGE satellite and it being

598
00:37:27,210 --> 00:37:28,210
found again?

599
00:37:28,210 --> 00:37:30,720
Chad: I don't know anything about IMAGE.

600
00:37:30,720 --> 00:37:34,310
Abby: Can't speak to that one.

601
00:37:34,310 --> 00:37:39,320
This question, I wonder if this was inspired
by the goo.

602
00:37:39,320 --> 00:37:42,980
What role does a biochemist have in space,
such as Commander Peggy Whitson?

603
00:37:42,980 --> 00:37:46,330
Mary Beth: Biochemistry, that's what I do.

604
00:37:46,330 --> 00:37:49,290
Chad: What a great question.

605
00:37:49,290 --> 00:37:52,250
Abby: What role is there for you in space,

Mary Beth?

606
00:37:52,250 --> 00:37:56,910
Mary Beth: There's many parts of NASA where
biochemistry is important.

607
00:37:56,910 --> 00:38:04,950
The people who make sure the astronauts are
safe and how they adapt in the environment,

608
00:38:04,950 --> 00:38:09,410
biology and how that operates in space by
sending cultures or other living organisms

609
00:38:09,410 --> 00:38:15,290
up to the space station.

610
00:38:15,290 --> 00:38:20,090
Organic chemistry, so chemistry with carbon
molecules happens everywhere in our solar

611
00:38:20,090 --> 00:38:26,780
system, from dust to the surface of other
planetary bodies and actually, the molecules

612
00:38:26,780 --> 00:38:33,020
that we're made out of were deposited by comets
and other meteorites that rained down on Earth

613
00:38:33,020 --> 00:38:37,360
when it was still very young and so there's
a lot of interesting chemistry that goes on

614
00:38:37,360 --> 00:38:41,700
here at Ames in the astrobiology chemistry
department where they try to demonstrate some

615
00:38:41,700 --> 00:38:46,661
of those reactions that occurred that led
to the beginnings of life.

616
00:38:46,661 --> 00:38:50,810
Abby: So cool, I love that stuff.

617
00:38:50,810 --> 00:38:56,560
It's space science because it's relevant to
everything we're studying out there but it's

618
00:38:56,560 --> 00:38:59,290
expected because it's biology and chemistry
and lab science.

619
00:38:59,290 --> 00:39:03,680
Matt: Where are we at now, Thomas and Chad?

620
00:39:03,680 --> 00:39:12,410
Thomas: 72 kilometers up your engine is off
and oh, OK.

621
00:39:12,410 --> 00:39:21,050
Matt: The blue arch is what my arc would be
but you see, my friend Gene Kerman has plotted

622
00:39:21,050 --> 00:39:22,810
for me the orange line.

623
00:39:22,810 --> 00:39:29,750
If I hit the gas at the right spot I'm going
up and going down and at a certain point you

624
00:39:29,750 --> 00:39:30,750
keep falling, I guess?

625
00:39:30,750 --> 00:39:33,910
Chad: You have to be pointed in the right
direction if you're going to fire up your

626
00:39:33,910 --> 00:39:34,910
engines, again.

627
00:39:34,910 --> 00:39:38,910
Matt: Unfortunately that's where the blue
thing is at the bottom.

628
00:39:38,910 --> 00:39:41,570
We might make this happen.

629
00:39:41,570 --> 00:39:44,330
Thomas: You still have some fuel so you might
actually do it.

630
00:39:44,330 --> 00:39:46,290
Abby: Matt, how reactive is it?

631
00:39:46,290 --> 00:39:49,620
If you move a little do you go winging off
in the wrong direction?

632
00:39:49,620 --> 00:39:53,710
Matt: Yeah, unfortunately, the SAS, the stability
mode helps a ton.

633
00:39:53,710 --> 00:39:55,820
I've tried doing it and accidentally turns
it off.

634
00:39:55,820 --> 00:40:01,330
9 times out of 10 if something goes wrong
it's because I turn off the stability system.

635
00:40:01,330 --> 00:40:05,850
Which makes me wonder why the stability system
is an option to have off.

636
00:40:05,850 --> 00:40:18,220
Thomas: I know here on Kerbal, sometimes if
you have ways to do more real gravity turn,

637

00:40:18,220 --> 00:40:23,160
you turn it off because otherwise the SAS
tries to fight your gravity transferring in

638
00:40:23,160 --> 00:40:24,160
the beginning.

639
00:40:24,160 --> 00:40:29,220
So, it's kind of fine tuning but, yeah, it's
what you wanted most of the time.

640
00:40:29,220 --> 00:40:32,670
You did a nice backflip earlier on the rocket.

641
00:40:32,670 --> 00:40:38,360
Matt: I half blame that on Thomas because
he's yelling "Do a barrel roll" and I was

642
00:40:38,360 --> 00:40:42,070
like, I can do a roll, and that didn't work
out well.

643
00:40:42,070 --> 00:40:53,310
Chad: You have a stability augmentation system
on most high-speed aircraft as well and there's

644
00:40:53,310 --> 00:40:57,260
usually an off switch, right?

645
00:40:57,260 --> 00:40:58,930
Why on earth would you have an off switch?

646
00:40:58,930 --> 00:41:03,750
One of the main reasons is you can practice
flying without the stability augmentation

647
00:41:03,750 --> 00:41:07,920
system in case it ever stops working unexpectedly.

648

00:41:07,920 --> 00:41:11,460
You still want to be able to fly.

649
00:41:11,460 --> 00:41:13,470
Matt: I'm in orbit.

650
00:41:13,470 --> 00:41:15,470
Thomas: You're in orbit.

651
00:41:15,470 --> 00:41:16,470
Whoa.

652
00:41:16,470 --> 00:41:18,530
The pin worked.

653
00:41:18,530 --> 00:41:20,130
That's all you needed Matt.

654
00:41:20,130 --> 00:41:25,700
Matt: Can you guys see that on camera?

655
00:41:25,700 --> 00:41:28,480
So, look at that.

656
00:41:28,480 --> 00:41:30,870
Thomas: Good job.

657
00:41:30,870 --> 00:41:37,150
Matt: You have this peak thing up at the top
over here - wait, not there.

658
00:41:37,150 --> 00:41:40,070
What is the difference between these points
and why are they important?

659
00:41:40,070 --> 00:41:47,620
Thomas: So on your orbit you have the point
that's the closest to the body you are orbiting

660
00:41:47,620 --> 00:41:59,130
around, and the furthest one, and it's important
to know when to inject more thrust to do some

661
00:41:59,130 --> 00:42:05,970
orbit things like that, meaning you go at
high-speed, when you go at high-speed you

662
00:42:05,970 --> 00:42:10,280
do some cool, orbital stuff to save your fuel.

663
00:42:10,280 --> 00:42:15,280
Getting from one orbit to another is really
a whole game of how to properly manage your

664
00:42:15,280 --> 00:42:18,430
fuel because fuel is your life in space.

665
00:42:18,430 --> 00:42:24,650
So, a lot of smart people are needed to figure
out all the things behind this.

666
00:42:24,650 --> 00:42:25,890
It's a lot of work.

667
00:42:25,890 --> 00:42:30,660
Matt: We'll do another question and then we'll
get ready to pivot.

668
00:42:30,660 --> 00:42:32,770
Abby: How to choose, there are lots.

669
00:42:32,770 --> 00:42:36,140
I would like to get through some of these.

670
00:42:36,140 --> 00:42:43,020
When we go to Mars will we use centrifugal
or linear gravity?

671
00:42:43,020 --> 00:42:57,520
Chad: I
never heard it used in those terms so I'm

672
00:42:57,520 --> 00:43:00,770
not exactly sure what they're asking.

673
00:43:00,770 --> 00:43:07,470
If you're trying to get to Mars, you know,
there's no such thing as a straight-line trajectory

674
00:43:07,470 --> 00:43:09,710
in curved space.

675
00:43:09,710 --> 00:43:16,120
So, gravity is effectively curving space time
so you're flying a big curve.

676
00:43:16,120 --> 00:43:22,250
I'm not sure if that's what they're getting
at or not.

677
00:43:22,250 --> 00:43:27,890
To get to Mars we're not using any gravity
assist maneuvers so we're not flying in close

678
00:43:27,890 --> 00:43:33,420
to the sun, like you saw in “Space War!”,
and using that to slingshot us around or anything.

679
00:43:33,420 --> 00:43:38,440
We're flying a more traditional trajectory
to get out there.

680
00:43:38,440 --> 00:43:39,710
Abby: OK, cool.

681
00:43:39,710 --> 00:43:41,870
Chad: So hopefully that answered their question.

682
00:43:41,870 --> 00:43:43,990
Abby: You can come back with clarification.

683
00:43:43,990 --> 00:43:51,210
Chad: If not they can submit us another question
and we'll try to figure it out.

684
00:43:51,210 --> 00:43:56,580
Matt: Let me go, just as a shout out to everybody,
if you're joining us you're watching NASA

685
00:43:56,580 --> 00:44:02,400
in Silicon Valley Live.

686
00:44:02,400 --> 00:44:05,390
This episode is “Let's Play Space Video
Games”.

687
00:44:05,390 --> 00:44:12,490
Let's have Mary Beth, our resident Mars expert,
she's going to come on up and replace Chad.

688
00:44:12,490 --> 00:44:17,860
I think we're due for the disclaimer as I
try to get things up and ready.

689
00:44:17,860 --> 00:44:25,030
Let's throw up our fun disclaimer which is:
As a U.S. government agency, NASA will not

690
00:44:25,030 --> 00:44:32,100
promote or endorse or appear to promote or
endorse a commercial product, service or activity.

691
00:44:32,100 --> 00:44:38,040
Playing these games is not an endorsement
by NASA or the U.S. Federal Government.

692

00:44:38,040 --> 00:44:40,790
No game developer or publisher requested,
nor did we or will we request to play any

693
00:44:40,790 --> 00:44:42,030
specific game.

694
00:44:42,030 --> 00:44:46,150
The games selected were purely to facilitate
a conversation on space exploration, science,

695
00:44:46,150 --> 00:44:47,960
technology, and engineering.

696
00:44:47,960 --> 00:44:53,830
With all of that out of the way, eyes up,
guardians, let's go visit Mars.

697
00:44:53,830 --> 00:44:57,490
Abby: Finally, because I have so many questions.

698
00:44:57,490 --> 00:45:04,780
Matt: Ready to go to Mars in the early 3200s
to play Destiny 1.

699
00:45:04,780 --> 00:45:09,210
I think we troubleshooted for a ridiculous
amount of time yesterday to try to get this

700
00:45:09,210 --> 00:45:10,460
up and running.

701
00:45:10,460 --> 00:45:13,060
Evidently my home console doesn't play very
well.

702
00:45:13,060 --> 00:45:17,830
Any non-NASA home console doesn't play well
with the NASA Internet connection, and you

703
00:45:17,830 --> 00:45:20,800
need an Internet connection to play Destiny.

704
00:45:20,800 --> 00:45:29,530
In full disclosure these are recordings I've
made.

705
00:45:29,530 --> 00:45:34,650
As I'm on Mars and playing it, all I could
think of was I need to talk to Mary Beth.

706
00:45:34,650 --> 00:45:36,170
Is this accurate?

707
00:45:36,170 --> 00:45:37,170
Is this real?

708
00:45:37,170 --> 00:45:41,880
Is this really what Mars looks like or could
even look like?

709
00:45:41,880 --> 00:45:44,270
So, as you see now, as we're making our approach.

710
00:45:44,270 --> 00:45:46,240
Mary Beth: Did we just go through a wormhole?

711
00:45:46,240 --> 00:45:49,490
Matt: Basically, that's what we do.

712
00:45:49,490 --> 00:45:56,630
Abby: Before we begin, people are asking for
a ballpark of when we will land humans on

713
00:45:56,630 --> 00:45:57,630
Mars?

714
00:45:57,630 --> 00:46:00,150

Mary Beth: That's a good question.

715
00:46:00,150 --> 00:46:05,450
I think the date keeps getting pushed back
because getting to Mars with humans is extremely

716
00:46:05,450 --> 00:46:10,300
expensive so I don't actually know what the
current estimate is off the top of my head

717
00:46:10,300 --> 00:46:17,430
but presumably, you know, if SLS starts to
show progress.

718
00:46:17,430 --> 00:46:18,430
Abby: The next big rocket.

719
00:46:18,430 --> 00:46:21,760
Mary Beth: Yeah, I think we'll get there hopefully
when I'm an old lady.

720
00:46:21,760 --> 00:46:27,410
Matt: Is tell us about it, Mary Beth, is this
what Mars looks like or could look like?

721
00:46:27,410 --> 00:46:30,630
We're seeing rocks, we're seeing dust and
even like trees?

722
00:46:30,630 --> 00:46:33,800
So, what would it take for trees, what do
you think?

723
00:46:33,800 --> 00:46:37,030
Mary Beth: So, Mars is extremely dry.

724
00:46:37,030 --> 00:46:40,460
It's so dry it's like hard to explain how
dry it is.

725
00:46:40,460 --> 00:46:47,010
For example, if you've heard of deserts in
the US like the Mojave, that's like maybe

726
00:46:47,010 --> 00:46:51,060
10 to 100,000 times wetter than the surface
of Mars today.

727
00:46:51,060 --> 00:46:57,650
So, this kind of vegetation level reminds
me of the Mojave Desert, or the Atacama Desert

728
00:46:57,650 --> 00:47:01,430
in Chile.

729
00:47:01,430 --> 00:47:10,080
So, unless we figure out a way to maybe grow
plants on the Martian surface, I think the

730
00:47:10,080 --> 00:47:14,040
one big hurdle to doing that would be the
irradiated environment.

731
00:47:14,040 --> 00:47:23,160
Mars doesn't have a protective layer like
Earth does and radiation is damaging to organic

732
00:47:23,160 --> 00:47:24,360
compounds.

733
00:47:24,360 --> 00:47:29,730
I don't know if that would be too great for
life.

734
00:47:29,730 --> 00:47:34,940
Matt: Tell people a little bit - before we
jump into the questions, the first time I

735
00:47:34,940 --> 00:47:39,660

met Mary Beth was, you coauthored a paper
about liquid water on Mars.

736
00:47:39,660 --> 00:47:41,110
Do you want to talk a bit about that?

737
00:47:41,110 --> 00:47:47,220
Mary Beth: Sure, one of the big questions
that drives my research is did Mars ever host

738
00:47:47,220 --> 00:47:48,220
life?

739
00:47:48,220 --> 00:47:50,200
Did life ever begin on Mars?

740
00:47:50,200 --> 00:47:55,570
Sort of the first question you have to ask
in order to answer that question is was Mars

741
00:47:55,570 --> 00:47:58,420
a nice place to live for a microorganism?

742
00:47:58,420 --> 00:48:02,310
And the number one ingredient for life on
Earth is water.

743
00:48:02,310 --> 00:48:07,400
I worked on a team that was studying this
feature called recurring slope linear which

744
00:48:07,400 --> 00:48:09,100
is hotly debated.

745
00:48:09,100 --> 00:48:11,990
Matt: Like on these slopes over here?

746
00:48:11,990 --> 00:48:12,990
Mary Beth: Exactly.

747
00:48:12,990 --> 00:48:18,280
They are these weird features that show up
in the springtime and summertime and we identified

748
00:48:18,280 --> 00:48:26,530
hydration bands within a salt structure using
satellites and remote sensing data.

749
00:48:26,530 --> 00:48:28,320
That was a pretty exciting project to work
on.

750
00:48:28,320 --> 00:48:34,170
Matt: I was going to say, for people who are
watching I'm purposely avoiding the Fallen

751
00:48:34,170 --> 00:48:41,890
and Cabal and the Vex, they're alien species
that came to Mars.

752
00:48:41,890 --> 00:48:45,230
What is the research you're doing of possibility
of life on Mars?

753
00:48:45,230 --> 00:48:47,590
Mary Beth: We look for real aliens.

754
00:48:47,590 --> 00:48:51,780
So, one of the big questions that NASA is
trying to answer.

755
00:48:51,780 --> 00:48:55,120
Is there life anywhere else in the universe?

756
00:48:55,120 --> 00:49:02,950
So there's a group of people who do life detection
and we're looking for the signs - we're starting

757

00:49:02,950 --> 00:49:09,120
to design the instrumentation and starting
to come up with the concepts to guide our

758
00:49:09,120 --> 00:49:16,060
future missions to look for life on Mars or
in the plume of a moon or on the surface of

759
00:49:16,060 --> 00:49:17,230
Europa.

760
00:49:17,230 --> 00:49:25,150
Where we know liquid water currently exists
or once existed a long time ago.

761
00:49:25,150 --> 00:49:31,030
So, a few billion years ago, Mars had shallow
seas and a thick atmosphere and was a lot

762
00:49:31,030 --> 00:49:34,270
more Earth-like than the dry, dusty desert
we see today.

763
00:49:34,270 --> 00:49:37,300
Matt: Go ahead, Abby, let's get some chat.

764
00:49:37,300 --> 00:49:42,390
Abby: You mentioned the possibilities for
growing anything on Mars and so how long until

765
00:49:42,390 --> 00:49:46,250
we can terraform Mars like it used to be.

766
00:49:46,250 --> 00:49:50,090
That's transforming the environment so we
can grow things.

767
00:49:50,090 --> 00:49:54,730
Mary Beth: One guy I work with at Ames has
written some papers on that and it would take

768
00:49:54,730 --> 00:49:56,580
a long time.

769
00:49:56,580 --> 00:50:01,030
Even if you liberated all the water in the
poles, I don't know if it's like over the

770
00:50:01,030 --> 00:50:03,530
course of a lifetime of a human that that
would be possible.

771
00:50:03,530 --> 00:50:04,560
Abby: What's the idea?

772
00:50:04,560 --> 00:50:06,240
You get water out of the ice?

773
00:50:06,240 --> 00:50:07,630
Mary Beth: You get water out of the icecaps.

774
00:50:07,630 --> 00:50:09,470
Abby: And irrigate the ground.

775
00:50:09,470 --> 00:50:14,900
Mary Beth: Increase the pressure in the atmosphere.

776
00:50:14,900 --> 00:50:21,210
But I think kind of a more realistic picture
of colonization of Mars is underground or

777
00:50:21,210 --> 00:50:25,590
covered by dirt or having protective - I think
this notion of like astronaut just roaming

778
00:50:25,590 --> 00:50:30,780
around on the surface is, like for me, would
be a scary thing because of the radiation

779
00:50:30,780 --> 00:50:31,780
environment.

780
00:50:31,780 --> 00:50:37,070
So, I don't know, I think there's different
people that have different concepts of what

781
00:50:37,070 --> 00:50:41,190
Martian colonization would look like but I
don't know if it would be dudes driving around.

782
00:50:41,190 --> 00:50:43,180
Matt: On sparrows.

783
00:50:43,180 --> 00:50:45,170
Chad: Cave dwellers.

784
00:50:45,170 --> 00:50:49,150
Mary Beth: Cave dwellers, exactly, yeah.

785
00:50:49,150 --> 00:50:54,250
That's what in my mind, at least, that's how
I imagine it, but who knows?

786
00:50:54,250 --> 00:50:57,530
Matt: Let's do more chat.

787
00:50:57,530 --> 00:51:03,640
Abby: Was there enough standing water on Mars
for long enough for the biology of life to

788
00:51:03,640 --> 00:51:04,640
take hold?

789
00:51:04,640 --> 00:51:07,430
Mary Beth: We think so and maybe it wasn't
standing water.

790

00:51:07,430 --> 00:51:09,550
Like early Mars could have been cold and wet.

791
00:51:09,550 --> 00:51:14,580
So, it might have been more like Antarctica
than like the Amazon.

792
00:51:14,580 --> 00:51:19,900
Abby: 'Bacon 1989' asks, "Didn't the
Curiosity rover come across running water

793
00:51:19,900 --> 00:51:22,360
but avoided it due to the possibility of contamination?"

794
00:51:22,360 --> 00:51:24,080
Mary Beth: I don't think so.

795
00:51:24,080 --> 00:51:30,260
There was a paper that determined that it
was possible to have liquid water at or near

796
00:51:30,260 --> 00:51:36,680
the surface but there's a group at NASA called
Pan-Planetary Protection that are careful

797
00:51:36,680 --> 00:51:42,760
about the places we explore so we don't contaminate
those places or they don't contaminate us.

798
00:51:42,760 --> 00:51:49,670
Curiosity was sterilized but not well enough
to explore those places.

799
00:51:49,670 --> 00:51:51,930
If that's true they would have avoided them
maybe.

800
00:51:51,930 --> 00:51:53,780
Abby: That does make sense.

801
00:51:53,780 --> 00:51:58,920
“ASDF512X” - Do microbes count as alien
life on planets?

802
00:51:58,920 --> 00:52:00,210
Mary Beth: Totally, yeah.

803
00:52:00,210 --> 00:52:01,210
We're looking for microbes.

804
00:52:01,210 --> 00:52:06,320
We're looking for microscopic organisms, cellular
life as we know it.

805
00:52:06,320 --> 00:52:10,120
We're not looking for little green men.

806
00:52:10,120 --> 00:52:16,380
And it makes sense, right, the ingredients
for life were ubiquitous in the early solar

807
00:52:16,380 --> 00:52:17,380
system.

808
00:52:17,380 --> 00:52:23,840
They rained down everywhere and so we're looking
for life that maybe resembles terrestrial

809
00:52:23,840 --> 00:52:26,910
life or life as we know it but maybe is a
little bit different.

810
00:52:26,910 --> 00:52:30,180
So that's how we're coming up with the framework
to search for life elsewhere.

811
00:52:30,180 --> 00:52:36,460
We're coming up with a reasonable set of molecules
to search for that are similar to what we

812
00:52:36,460 --> 00:52:37,480
have on Earth.

813
00:52:37,480 --> 00:52:39,250
Abby: Cool.

814
00:52:39,250 --> 00:52:41,650
Here is an unusual but interesting question.

815
00:52:41,650 --> 00:52:46,460
“Chris 84567” asks, “To terraform Mars,
why don't we fly a rocket with whole lot of

816
00:52:46,460 --> 00:52:48,630
poop on it for a basis for life to start.

817
00:52:48,630 --> 00:52:50,490
I'm serious, like fertilizer?”

818
00:52:50,490 --> 00:52:54,140
Mary Beth: It's too dry.

819
00:52:54,140 --> 00:52:59,190
Abby: Does the lack of magnetic field on Mars
add great difficulty to the difficult task

820
00:52:59,190 --> 00:53:00,190
of terraforming?

821
00:53:00,190 --> 00:53:05,140
Mary Beth: Absolutely, radiation is a problem.

822
00:53:05,140 --> 00:53:13,260
Some of the oldest rocks on Mars are magnetized.

823
00:53:13,260 --> 00:53:18,120
Because Mars is so small it doesn't have the

same internal structure that Earth does so

824
00:53:18,120 --> 00:53:22,280
it lost its magnetic field and then got
bombarded with radiation.

825
00:53:22,280 --> 00:53:27,740
Matt: We're going to switch over to more game
play, introducing everybody to Phobos and

826
00:53:27,740 --> 00:53:30,360
Deimos, but we can keep taking some of the
chat.

827
00:53:30,360 --> 00:53:32,930
I did want to show off, but what is Phobos?

828
00:53:32,930 --> 00:53:39,320
Mary Beth: Phobos is a moon of Mars, there's
two moons that orbit Mars, Phobos and Deimos,

829
00:53:39,320 --> 00:53:45,580
and they're different than our moon because
our moon is actually was created by a big

830
00:53:45,580 --> 00:53:47,290
impact that happened on Earth.

831
00:53:47,290 --> 00:53:51,410
So, something very large smashed into Earth
and then formed our moon.

832
00:53:51,410 --> 00:53:56,360
But people believe that - scientists believe
Phobos and Deimos are actually captured objects.

833
00:53:56,360 --> 00:54:03,330
Phobos in particular is a rubble pile that
has a thin crust on top of it.

834
00:54:03,330 --> 00:54:05,540
Definitely wouldn't be walking around with
like gravity.

835
00:54:05,540 --> 00:54:10,130
Matt: That is one of the first reactions because
we were hopping around on Mars, jumping and

836
00:54:10,130 --> 00:54:15,160
flying into the air, considering that gravity
base that we've established on Mars.

837
00:54:15,160 --> 00:54:18,050
What would happen if we jumped like that for
real on Phobos?

838
00:54:18,050 --> 00:54:19,990
Mary Beth: I think you'd go flying.

839
00:54:19,990 --> 00:54:26,370
Thomas: The smoke in the back there, probably
not smoke rising like that, no gravity, no

840
00:54:26,370 --> 00:54:27,370
convection.

841
00:54:27,370 --> 00:54:28,370
Mary Beth: No atmosphere.

842
00:54:28,370 --> 00:54:33,910
Matt: So when we hop on our little bike and
had the end trail things, it probably wouldn't

843
00:54:33,910 --> 00:54:34,910
exist on Phobos?

844
00:54:34,910 --> 00:54:35,910
Thomas: Need an atmosphere for that.

845
00:54:35,910 --> 00:54:40,460
Matt: No, not much of an atmosphere.

846
00:54:40,460 --> 00:54:41,900
Mary Beth: It's also the right color.

847
00:54:41,900 --> 00:54:48,160
So Phobos is one of the least reflective objects
in the solar system and its dark color comes

848
00:54:48,160 --> 00:54:50,310
from the minerals that it's made out of.

849
00:54:50,310 --> 00:54:56,710
Matt: And as it flipped over we saw Mars,
is that about how close it is?

850
00:54:56,710 --> 00:55:03,030
Seeing those pictures of Earth from the moon,
I'm guessing if you're on Phobos, Mars would

851
00:55:03,030 --> 00:55:06,560
be huge or are you further away?

852
00:55:06,560 --> 00:55:12,630
Mary Beth: You'd have to go and see how far
away it is from the Martian surface.

853
00:55:12,630 --> 00:55:20,080
There's a cool picture I wanted to mention
that just came out, I think it made the news

854
00:55:20,080 --> 00:55:24,510
a couple of weeks ago or maybe a few months
ago, from the OSIRIS-Rex mission, where they

855
00:55:24,510 --> 00:55:29,000
actually took a picture of Earth and the moon
in the same frame and it's so cool, you can

856
00:55:29,000 --> 00:55:30,650
actually see the distance between them.

857
00:55:30,650 --> 00:55:32,770
So, I encourage folks to go out and search
for that.

858
00:55:32,770 --> 00:55:40,740
Matt: Let's hit up as much in the chat because
we're going to have to wrap up in 3 minutes.

859
00:55:40,740 --> 00:55:41,830
We're going to have to wrap up.

860
00:55:41,830 --> 00:55:45,430
Let's get as many on the chat as we can before
we get counted out.

861
00:55:45,430 --> 00:55:48,960
Abby: Is the icecap on the pole of Mars methane
or would that be some

862
00:55:48,960 --> 00:55:49,960
sort of water?

863
00:55:49,960 --> 00:55:54,080
Mary Beth: It's mostly carbon dioxide ice
because the pressure is so low so carbon dioxide

864
00:55:54,080 --> 00:55:55,630
can act as ice.

865
00:55:55,630 --> 00:55:59,780
But there is a small percentage of it that
is water and some new work that's been coming

866
00:55:59,780 --> 00:56:04,540
out shows that there is some other ice deposits

in the northern regions on Mars.

867
00:56:04,540 --> 00:56:06,620
Sorry, water ice.

868
00:56:06,620 --> 00:56:10,340
Abby: 'Frosty' asks, "When was the moon created?"

869
00:56:10,340 --> 00:56:15,030
Mary Beth: Early on in the solar system, so I think it happened, you know, within the

870
00:56:15,030 --> 00:56:18,130
first few hundred million years of the formation of Earth.

871
00:56:18,130 --> 00:56:20,690
So, the early solar system was a really violent place.

872
00:56:20,690 --> 00:56:25,090
There were lots of things hitting each other and then it sort of calmed down over time.

873
00:56:25,090 --> 00:56:28,980
So that's when the moon was formed out of the Earth's material.

874
00:56:28,980 --> 00:56:35,380
Matt: Looks like we are getting the "wrap it up" sign.

875
00:56:35,380 --> 00:56:36,480
This has been amazing.

876
00:56:36,480 --> 00:56:42,860
So, for folks who have been watching, this has been NASA in Silicon Valley Live.

877
00:56:42,860 --> 00:56:48,250
Huge thanks to our guests, we have over on
the SkyCam we have Chad Frost, sitting over

878
00:56:48,250 --> 00:56:49,250
there.

879
00:56:49,250 --> 00:56:51,470
We're going to switch to the SkyCam, there
we go.

880
00:56:51,470 --> 00:56:53,860
Of course, with Dave and Bill sitting over
there.

881
00:56:53,860 --> 00:56:55,150
Huge thanks to Chad.

882
00:56:55,150 --> 00:56:58,680
Up top over here we have Thomas Lambot and
Mary Beth Wilhelm.

883
00:56:58,680 --> 00:57:02,230
A huge thanks to everybody who watched and
asked questions.

884
00:57:02,230 --> 00:57:06,740
A few guests are going to hang out in the
chat and keep answering those questions.

885
00:57:06,740 --> 00:57:09,750
We are all on major social media platforms under "NASA Ames."

886
00:57:09,750 --> 00:57:13,340
If you enjoyed the stream please comment and
let us know.

887
00:57:13,340 --> 00:57:15,010
We're testing this out.

888
00:57:15,010 --> 00:57:16,770
This is new territory for us.

889
00:57:16,770 --> 00:57:21,620
If you haven't already, go ahead and click
like, share, subscribe, whatever button you

890
00:57:21,620 --> 00:57:24,550
see on the screen or podcast app.

891
00:57:24,550 --> 00:57:27,910
Having that stuff really helps other people
find the content.

892
00:57:27,910 --> 00:57:30,360
We will be back for one more Twitch episode.

893
00:57:30,360 --> 00:57:35,180
We're aiming for Monday, February 12th, but
keep an eye out on social media and we'll

894
00:57:35,180 --> 00:57:39,880
send out more information as that date gets
closer.