
STEVE LEE
EDL ENGINEER

1
00:00:05,120 --> 00:00:08,310
when people look at it

2
00:00:14,150 --> 00:00:11,350
uh it looks crazy

3
00:00:16,230 --> 00:00:14,160
that's a very natural thing

4
00:00:18,230 --> 00:00:16,240
sometimes when we look at it it looks

5
00:00:22,550 --> 00:00:18,240
crazy

6
00:00:24,790 --> 00:00:22,560
it is the result of reasoned engineering

7
00:00:27,990 --> 00:00:24,800
thought

8
00:00:32,549 --> 00:00:30,790
the top of the atmosphere down to the

9
00:00:34,790 --> 00:00:32,559
surface

10
00:00:38,069 --> 00:00:34,800
it takes a seven minutes

11
00:00:39,190 --> 00:00:38,079
it takes 14 minutes or so

12
00:00:41,270 --> 00:00:39,200
for the

13
00:00:43,590 --> 00:00:41,280

signal from the spacecraft

14
00:00:45,830 --> 00:00:43,600
to make it to earth that's how far mars

15
00:00:46,869 --> 00:00:45,840
is away from us

16
00:00:49,350 --> 00:00:46,879
so

17
00:00:52,790 --> 00:00:49,360
when we first get word that we've

18
00:00:55,510 --> 00:00:52,800
touched the top of the atmosphere

19
00:00:56,869 --> 00:00:55,520
the vehicle has been alive

20
00:00:59,270 --> 00:00:56,879
we're dead

21
00:01:07,270 --> 00:00:59,280
on the surface

22
00:01:11,190 --> 00:01:09,030
entry descent landing

23
00:01:13,190 --> 00:01:11,200
also known as edl is referred to as a

24
00:01:16,149 --> 00:01:13,200
seven minutes of terror because we've

25
00:01:18,070 --> 00:01:16,159
got literally seven minutes to get from

26
00:01:19,190 --> 00:01:18,080
the top of the atmosphere to the surface

27
00:01:20,789 --> 00:01:19,200
of mars

28
00:01:24,070 --> 00:01:20,799
going from thirteen thousand miles an

29
00:01:26,390 --> 00:01:24,080
hour to zero in perfect sequence perfect

30
00:01:27,990 --> 00:01:26,400
choreography perfect timing

31
00:01:31,030 --> 00:01:28,000
and the computer has to do it all by

32
00:01:34,310 --> 00:01:31,040
itself with no help from the ground

33
00:01:36,789 --> 00:01:34,320
if any one thing doesn't work just right

34
00:01:38,950 --> 00:01:36,799
it's game over

35
00:01:42,230 --> 00:01:38,960
we slam into the atmosphere and develop

36
00:01:44,069 --> 00:01:42,240
so much aerodynamic drag our heat shield

37
00:01:45,590 --> 00:01:44,079
it heats up and it glows like the

38
00:01:48,789 --> 00:01:45,600

surface of the sun

39
00:01:50,789 --> 00:01:48,799
1600 degrees

40
00:01:52,149 --> 00:01:50,799
during entry the vehicle is not only

41
00:01:53,590 --> 00:01:52,159
slowing down

42
00:01:55,510 --> 00:01:53,600
violently

43
00:01:56,630 --> 00:01:55,520
through the atmosphere but also we are

44
00:01:59,510 --> 00:01:56,640
guiding it

45
00:02:02,069 --> 00:01:59,520
like an airplane to be able to land in a

46
00:02:04,310 --> 00:02:02,079
very narrow constrained space

47
00:02:05,830 --> 00:02:04,320
this is one of the biggest challenges

48
00:02:07,749 --> 00:02:05,840
that we are facing

49
00:02:10,309 --> 00:02:07,759
and one that we have never attempted on

50
00:02:12,550 --> 00:02:10,319
mars mars is actually really hard to

51
00:02:14,869 --> 00:02:12,560
slow down because it has just enough

52
00:02:16,150 --> 00:02:14,879
atmosphere that you have to deal with it

53
00:02:17,350 --> 00:02:16,160
otherwise it will destroy your

54
00:02:19,110 --> 00:02:17,360
spacecraft

55
00:02:20,390 --> 00:02:19,120
on the other hand it doesn't have enough

56
00:02:22,949 --> 00:02:20,400
atmosphere

57
00:02:24,550 --> 00:02:22,959
to finish the job

58
00:02:25,670 --> 00:02:24,560
we're still going about a thousand miles

59
00:02:28,390 --> 00:02:25,680
an hour

60
00:02:30,390 --> 00:02:28,400
so at that point we use a parachute

61
00:02:31,990 --> 00:02:30,400
the parachute is the largest and

62
00:02:33,990 --> 00:02:32,000
strongest supersonic parachute that

63
00:02:36,949 --> 00:02:34,000

we've ever built to date it has to be

64
00:02:38,470 --> 00:02:36,959
able to withstand 65 000 pounds of force

65
00:02:43,830 --> 00:02:38,480
even though the parachute itself only

66
00:02:48,470 --> 00:02:46,150
when it opens up that fast it's a neck

67
00:02:50,390 --> 00:02:48,480
snapping nine g's

68
00:02:52,309 --> 00:02:50,400
at that point we have to get that heat

69
00:02:54,150 --> 00:02:52,319
shield off it's like a big lens cap

70
00:02:56,390 --> 00:02:54,160
blocking our view of the ground to the

71
00:02:58,229 --> 00:02:56,400
radar the radar has to take just the

72
00:03:00,630 --> 00:02:58,239
right altitude and velocity measurements

73
00:03:05,670 --> 00:03:00,640
at just the right time or the rest of

74
00:03:09,910 --> 00:03:07,589
this big huge parachute that we've got

75
00:03:11,430 --> 00:03:09,920
it'll only slow us down to about 200

76
00:03:13,830 --> 00:03:11,440
miles an hour

77
00:03:15,990 --> 00:03:13,840
and that's not slow enough to land

78
00:03:17,990 --> 00:03:16,000
so we have no choice but we've got to

79
00:03:20,470 --> 00:03:18,000
cut it off

80
00:03:22,229 --> 00:03:20,480
and then come down in rockets

81
00:03:23,670 --> 00:03:22,239
once we turn those rocket motors on if

82
00:03:25,670 --> 00:03:23,680
we don't do something we're just going

83
00:03:27,509 --> 00:03:25,680
to smack right back into the parachute

84
00:03:30,550 --> 00:03:27,519
so the first thing we do is make this

85
00:03:33,430 --> 00:03:30,560
really radical diverting movement we fly

86
00:03:35,350 --> 00:03:33,440
off to the side diverting away from the

87
00:03:37,670 --> 00:03:35,360
parachute killing our horizontal

88
00:03:39,910 --> 00:03:37,680

velocity and our vertical velocity

89
00:03:42,229 --> 00:03:39,920
getting the rover moving straight up and

90
00:03:44,070 --> 00:03:42,239
down so it can look at the surface with

91
00:03:46,869 --> 00:03:44,080
its radar and see where we're going to

92
00:03:48,869 --> 00:03:46,879
land and we head straight down

93
00:03:50,229 --> 00:03:48,879
to the bottom of a crater

94
00:03:54,869 --> 00:03:50,239
right beside

95
00:03:58,630 --> 00:03:57,030
we can't get those rocket engines too

96
00:04:01,110 --> 00:03:58,640
close to the ground because if we were

97
00:04:02,390 --> 00:04:01,120
to descend propulsively with our engines

98
00:04:04,070 --> 00:04:02,400
all the way to the ground we would

99
00:04:05,910 --> 00:04:04,080
essentially create this massive dust

100
00:04:07,670 --> 00:04:05,920
cloud that dust cloud could then go and

101
00:04:08,869 --> 00:04:07,680
land on the rover it could damage

102
00:04:10,710 --> 00:04:08,879
mechanisms and it could damage

103
00:04:14,149 --> 00:04:10,720
instruments so the way we solve that

104
00:04:16,069 --> 00:04:14,159
problem is by using the sky crane 20

105
00:04:19,189 --> 00:04:16,079
meters above the surface you have to

106
00:04:21,909 --> 00:04:19,199
lower the rover below us on a tether

107
00:04:23,510 --> 00:04:21,919
that's 21 feet long and then gently

108
00:04:24,950 --> 00:04:23,520
deposit

109
00:04:28,310 --> 00:04:24,960
on its wheels

110
00:04:32,629 --> 00:04:30,390
as the rover touches down and is now on

111
00:04:34,629 --> 00:04:32,639
the ground the descent stage

112
00:04:36,950 --> 00:04:34,639
is in a collision force with a roller

113
00:04:39,189 --> 00:04:36,960

and must cut the bridle immediately and