



1
00:00:00,506 --> 00:00:19,666
[Music]

2
00:00:20,166 --> 00:00:23,426
>> The technologies that COBALT
is testing right now will one

3
00:00:23,426 --> 00:00:28,276
day enable NASA to send robotic
or human space flight missions

4
00:00:28,396 --> 00:00:30,196
to land on Mars, the moon,

5
00:00:30,656 --> 00:00:34,546
Europa or other solar system
destinations where we want

6
00:00:34,546 --> 00:00:38,456
to target landing in very
hazardous or precise regions

7
00:00:38,456 --> 00:00:42,246
such as canyons, craters,
on cracked ice fields,

8
00:00:42,506 --> 00:00:45,886
close to geysers
or other geological

9
00:00:45,886 --> 00:00:47,616
or scientifically
interesting locations.

10
00:00:48,516 --> 00:00:54,546
[Music]

11
00:00:55,046 --> 00:00:57,436
So COBALT stands for

Cooperative Blending

12

00:00:57,436 --> 00:00:59,206
of Autonomous Landing
Technologies.

13

00:00:59,766 --> 00:01:02,576
The project is focused
on integrating

14

00:01:02,676 --> 00:01:06,566
and testing two complementary
sensors or instruments;

15

00:01:07,106 --> 00:01:08,926
one the Lander Vision
System, LVS,

16

00:01:08,926 --> 00:01:11,976
and the other the
Navigation Doppler Lidar, NDL.

17

00:01:12,516 --> 00:01:20,556
[Music]

18

00:01:21,056 --> 00:01:23,166
>> And the way it works it
actually uses its camera

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00:01:23,166 --> 00:01:26,056
to take images as
it's coming in to land

20

00:01:26,396 --> 00:01:28,306
and compares them
to its onboard map.

21

00:01:28,946 --> 00:01:30,746
And by doing that you can
actually now determine

22

00:01:30,746 --> 00:01:33,626
where you are on the map of
where you're trying to land.

23

00:01:33,626 --> 00:01:35,416
So that allows you to
do a number of things.

24

00:01:35,446 --> 00:01:38,976
One, it allows you to actually
more precisely determine your

25

00:01:38,976 --> 00:01:41,116
actual position coming
into landing,

26

00:01:41,396 --> 00:01:43,596
and then you can actually
do diverts to actually land

27

00:01:43,596 --> 00:01:44,396
where you want to land.

28

00:01:44,396 --> 00:01:47,376
It also allows you to detect
and notice things like hazards

29

00:01:47,376 --> 00:01:50,606
and actually divert around those
hazards as you come into land.

30

00:01:51,106 --> 00:01:51,916
>> Laser coming on.

31

00:01:52,406 --> 00:01:55,346
>> And give the spacecraft
essentially a set of eyes,

32

00:01:55,346 --> 00:01:58,236
so as it's coming in to land
it's actually enabling its

33

00:01:58,286 --> 00:02:01,036
process in its computer to
see where it's actually going.

34

00:02:01,236 --> 00:02:01,756
>> Lasers on.

35

00:02:02,236 --> 00:02:04,556
>> We'll be conducting two
different flight campaigns

36

00:02:04,736 --> 00:02:05,626
within COBALT.

37

00:02:05,626 --> 00:02:07,776
One is open loop and the
other is closed loop,

38

00:02:08,096 --> 00:02:11,986
the difference being that during
open loop the vehicle is not

39

00:02:11,986 --> 00:02:16,216
utilizing COBALT's navigation
for planning its maneuvers.

40

00:02:16,216 --> 00:02:17,496
It's instead utilizing GPS.

41

00:02:18,426 --> 00:02:20,306
During the closed loop campaign,

42

00:02:20,786 --> 00:02:22,976
the vehicle will actually
rely on COBALT navigation.

43

00:02:26,096 --> 00:02:28,686

>> Ok, team moving
to engine start page.

44

00:02:28,686 --> 00:02:29,276

>> COBALT!

45

00:02:29,276 --> 00:02:29,486

This is LC.

46

00:02:29,486 --> 00:02:30,956

Go/no-go for flight?

47

00:02:30,956 --> 00:02:31,023

>> Go.

48

00:02:31,023 --> 00:02:32,506

>> Pilot prime engine.

49

00:02:32,506 --> 00:02:35,976

>> Priming engine.

50

00:02:36,516 --> 00:02:48,746

[Music]

51

00:02:49,246 --> 00:02:50,506

>> Ok, team, here we go.

52

00:02:50,506 --> 00:02:53,426

Masten ops to all,
six-second countdown.

53

00:02:53,616 --> 00:02:58,396

Five, four, three, two, one.

54

00:02:58,396 --> 00:02:58,756

Ignition.

55

00:02:59,516 --> 00:03:08,826

[Music]

56

00:03:09,326 --> 00:03:13,386

>> During our flight testing,
we take off at one location

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00:03:14,136 --> 00:03:16,906

and then we target a landing
site that's 300 meters away.

58

00:03:17,406 --> 00:03:21,146

On takeoff, we ascend up
to a 500-meter altitude.

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00:03:21,736 --> 00:03:25,236

During that time, our Navigation
Doppler Lidar begins sensing

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00:03:25,236 --> 00:03:29,496

velocity and range within the
first five meters of altitude.

61

00:03:30,126 --> 00:03:33,356

The Lander Vision System
begins performing train row

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00:03:33,426 --> 00:03:36,426

to navigation at about 50
to 100 meters altitude.

63

00:03:36,986 --> 00:03:40,806

So during the ascent, we're
getting initial measurements

64

00:03:40,956 --> 00:03:44,316

and starting to generate the
COBALT navigation solution.

65

00:03:44,316 --> 00:03:47,986

After we reach the
500-meter altitude,

66

00:03:48,156 --> 00:03:52,096

the vehicle reduces the engine
throttle, the engine thrust,

67

00:03:52,426 --> 00:03:56,726

and starts falling back towards
the Earth to build up velocity.

68

00:03:56,726 --> 00:04:01,906

Once we hit a 25 meter per
second downward velocity,

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00:04:02,826 --> 00:04:05,766

the executed divert maneuver

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00:04:05,766 --> 00:04:09,416

that targets specified landing
location 300 meters down range.

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00:04:09,416 --> 00:04:14,396

The vehicle then navigates
until about a 20-meter altitude

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00:04:14,396 --> 00:04:15,656

above that landing site,

73

00:04:16,176 --> 00:04:19,616

and then executes a vertical
descent to touchdown.

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00:04:19,616 --> 00:04:25,796

This is all autonomous on
Masten's GPS-based navigation

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00:04:26,406 --> 00:04:29,786

for open loop and then

during closed loop

76

00:04:29,786 --> 00:04:30,866
on COBALT's navigation.

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00:04:31,516 --> 00:04:42,746
[Music]

78

00:04:43,246 --> 00:04:43,576
>> Booyah!

79

00:04:44,146 --> 00:04:44,456
>> Alright!

80

00:04:44,836 --> 00:04:44,956
>> Yeah!

81

00:04:45,516 --> 00:04:48,516
[Talking at once]

82

00:04:49,016 --> 00:04:51,000
[Applause]

83

00:04:53,126 --> 00:04:54,016
>> Well done, sir.

84

00:04:54,016 --> 00:04:54,446
Well done.

85

00:04:54,696 --> 00:04:56,826
>> So Masten is out here
at the Mojave Space Port.

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00:04:56,826 --> 00:04:58,846
We're supporting NASA's
[inaudible] opportunities

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00:04:58,846 --> 00:05:01,506

by testing different
technologies here in the desert

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00:05:01,506 --> 00:05:03,336

that are hopefully land
on another planet one day.

89

00:05:03,606 --> 00:05:05,516

So when you have your payload
and it's going to go land

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00:05:05,516 --> 00:05:09,026

on Mars, it's really nice to
know how it's going to function

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00:05:09,216 --> 00:05:10,566

in that landing environment.

92

00:05:10,566 --> 00:05:13,346

Propulsive landing specifically
was something we have not done

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00:05:13,346 --> 00:05:14,536

on another planet yet.

94

00:05:14,726 --> 00:05:16,996

So instead of taking the risk
of sending something all the way

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00:05:16,996 --> 00:05:19,996

to Mars and not knowing how well
it works, we can come out here

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00:05:19,996 --> 00:05:21,446

in the desert, plot
opportunities,

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00:05:21,446 --> 00:05:24,656

provides the payload with the
ability to come onto our rockets

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00:05:24,656 --> 00:05:27,026

and do a similar type profile

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00:05:27,026 --> 00:05:30,196

to what they will see

when they go to land.

100

00:05:30,196 --> 00:05:30,576

>> Alright, guys!

101

00:05:30,576 --> 00:05:31,666

Great job today!

102

00:05:32,516 --> 00:05:35,626

[Applause]