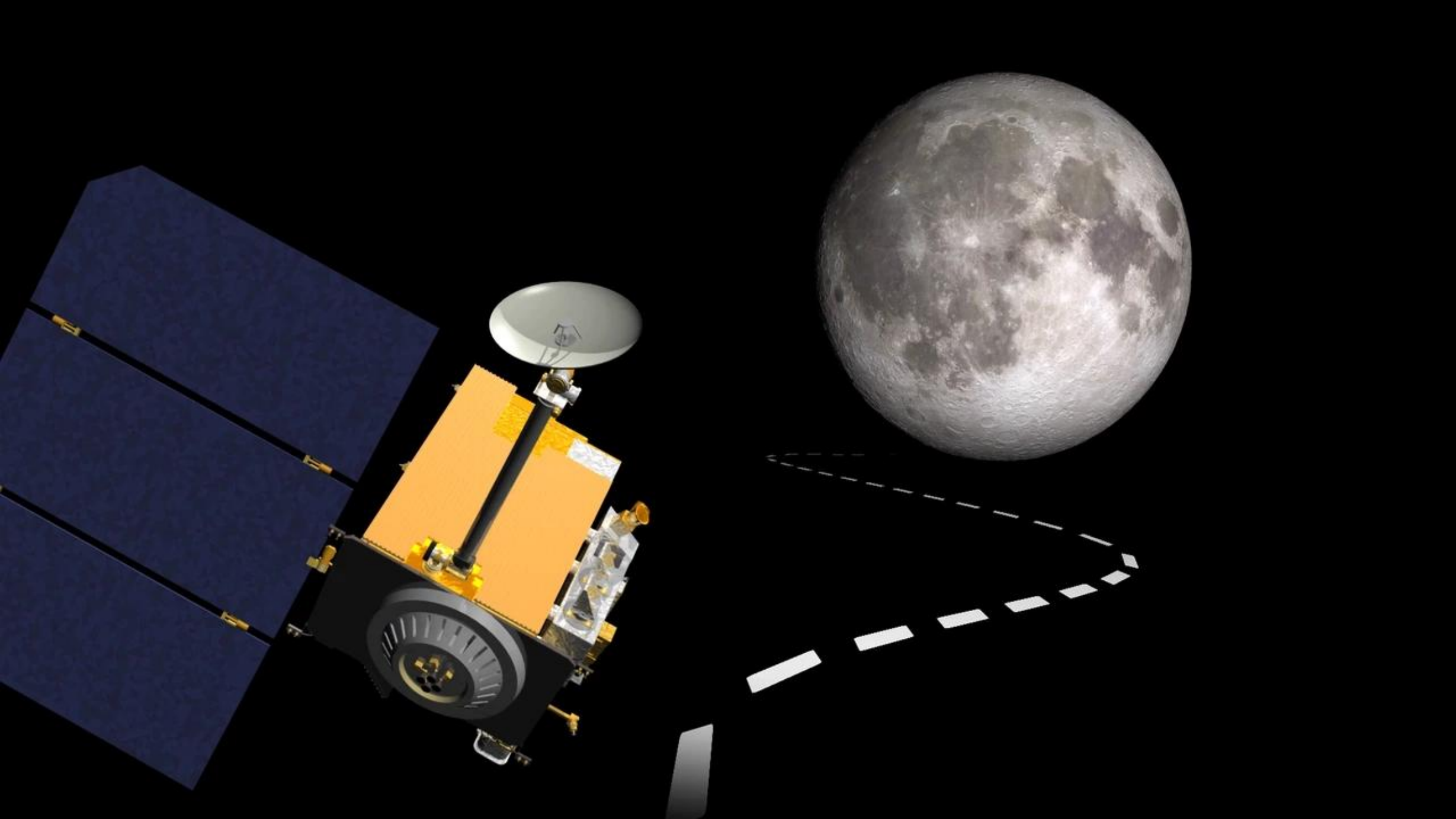

1
00:00:00,250 --> 00:00:10,230
[sound effects]

2
00:00:16,430 --> 00:00:20,590
The Lunar Reconnaissance Orbiter has been orbiting the Moon since 2009,

3
00:00:20,610 --> 00:00:26,770
and during this time, NASA videos have explored numerous aspects of the spacecraft.

4
00:00:26,790 --> 00:00:30,860
But one question keeps popping up . . . How do you drive that thing?

5
00:00:30,880 --> 00:00:35,030
Well, first imagine a souped-up racecar.

6
00:00:35,050 --> 00:00:40,120
Picture revving up that engine, wind flowing over its streamlined body,

7
00:00:40,140 --> 00:00:43,310
turning the wheel around sharp hairpin turns . . .

8
00:00:43,330 --> 00:00:47,310
Got that image? Great! It's nothing like that.

9
00:00:47,330 --> 00:00:50,530
Now picture playing an arcade game,

10
00:00:50,550 --> 00:00:54,720
using your controls to fly a spacecraft around at crazy warp speeds.

11
00:00:54,740 --> 00:00:56,910
Yeah, it's nothing like that either.

12
00:00:56,930 --> 00:01:04,100
Flying LRO involves computer science, satellite technology, and a great deal of teamwork.

13
00:01:04,120 --> 00:01:07,300

Not as cool as what you might have imagined,

14
00:01:07,320 --> 00:01:12,500
but it's still an impressive and sophisticated technological operation.

15
00:01:12,520 --> 00:01:17,700
For starters, LRO is controlled by a group of engineers - the Mission Operations Team.

16
00:01:17,720 --> 00:01:21,230
They work out of a control room, called the Mission Operations Center.

17
00:01:21,250 --> 00:01:23,750
All commands to the spacecraft originate from this control room

18
00:01:23,770 --> 00:01:30,810
and are sent through antennas around the globe.

19
00:01:30,830 --> 00:01:33,030
And here's where we reveal the big secret.

20
00:01:33,050 --> 00:01:38,210
Most spacecraft operations are actually handled using preprogrammed commands.

21
00:01:38,230 --> 00:01:43,300
Every day a team member builds a "command load" using specialized computer software.

22
00:01:43,320 --> 00:01:48,480
This is essentially a time-sensitive schedule of commands, such as thruster maneuvers,

23
00:01:48,500 --> 00:01:53,670
starting and stopping its cameras, and pointing the spacecraft to a selected target.

24
00:01:53,690 --> 00:01:57,860
These command loads are then activated on board by the "Single Board Computer,"

25
00:01:57,880 --> 00:02:03,060
which talks to the electronics and microprocessors in LRO's instruments.

26
00:02:03,080 --> 00:02:07,240
Many operations require real-time monitoring.

27
00:02:07,260 --> 00:02:12,270
In some cases, team members simply observe as the preprogrammed commands execute.

28
00:02:12,290 --> 00:02:18,380
At other times, the team must initiate a specific command for an action to occur on board.

29
00:02:18,400 --> 00:02:22,590
One event requiring real-time monitoring is a lunar eclipse.

30
00:02:22,610 --> 00:02:27,800
A lunar eclipse could mean trouble for LRO since it's solar-powered.

31
00:02:27,820 --> 00:02:30,930
To prevent damage from the frigid temperatures, prior to the eclipse,

32
00:02:30,950 --> 00:02:35,100
the spacecraft will spend about fourteen hours heating up.

33
00:02:35,120 --> 00:02:39,210
Nearly all instruments will be turned off as well to preserve battery power.

34
00:02:39,230 --> 00:02:45,270
Once out of the darkness, commands are given to reconfigure the spacecraft.

35
00:02:45,290 --> 00:02:48,300
If an emergency occurs during spaceflight,

36
00:02:48,320 --> 00:02:51,490
the Single Board Computer can put LRO into a "safe mode."

37
00:02:51,510 --> 00:02:54,680
This maintains safe temperatures and electricity

38
00:02:54,700 --> 00:02:58,780

until the team can contact the satellite and determine the problem.

39
00:02:58,800 --> 00:03:03,910
One final aspect to operating this spacecraft involves its reaction wheels.

40
00:03:03,930 --> 00:03:07,990
And no, these don't have spinners or flashy rims.

41
00:03:08,010 --> 00:03:12,420
Reaction wheels help orient a spacecraft through managing angular momentum.

42
00:03:12,440 --> 00:03:14,620
An easy way to think about this concept

43
00:03:14,640 --> 00:03:18,720
is how it's easier for a bicycle to stay upright when the wheels are turning.

44
00:03:18,740 --> 00:03:22,910
On LRO there are four reaction wheels constantly spinning.

45
00:03:22,930 --> 00:03:28,080
By making very small changes in their speeds, the satellite is kept pointed toward the moon.

46
00:03:28,100 --> 00:03:32,150
Larger changes in the wheel speeds can get the spacecraft to point in different directions -

47
00:03:32,170 --> 00:03:37,360
perhaps toward Earth to take a picture or the stars for instrument calibration.

48
00:03:37,380 --> 00:03:40,600
Over time, the reaction wheels spin faster and faster

49
00:03:40,620 --> 00:03:42,780
as they keep the instruments pointing at the moon,

50
00:03:42,800 --> 00:03:45,810
causing the angular momentum to steadily increase.

51
00:03:45,830 --> 00:03:51,000
As a result, every few weeks, a decrease in the angular momentum is needed.

52
00:03:51,020 --> 00:03:54,030
This is done by firing thrusters,

53
00:03:54,050 --> 00:03:58,210
as that gets the reaction wheels to compensate and spin more slowly.

54
00:03:58,230 --> 00:04:03,580
This process is called a momentum unload maneuver.

55
00:04:03,600 --> 00:04:09,650
So as you can see, operating a lunar spacecraft is a different sort of driving experience.