1
00:00:00,392 --> 00:00:03,309
(mysterious music)

2
00:00:07,435 --> 00:00:10,691
- Hi, I'm Craig Kundrot, the
director of NASA's Space Life

3
00:00:10,691 --> 00:00:14,547
and Physical Sciences Research
and Applications Division.

4
00:00:14,547 --> 00:00:17,429
Our work in the division
focuses on enabling human space

5
00:00:17,429 --> 00:00:22,128
flight exploration and
pioneering scientific discovery.

6
00:00:22,128 --> 00:00:23,810
What is combustion science and

7
00:00:23,810 --> 00:00:25,909
why do we study it in space flight?

8
00:00:25,909 --> 00:00:28,122
- Well, if you think about
it in application format,

9
00:00:28,122 --> 00:00:30,045
there's really sort of three big classes.

10
00:00:30,045 --> 00:00:31,806
There's fire and its prevention,

11
00:00:31,806 --> 00:00:33,469
and there's power generation

12

00:00:33,469 --> 00:00:35,833
and then there's heat and propulsion.

13
00:00:35,833 --> 00:00:37,241
Why do we want to study these things?

14
00:00:37,241 --> 00:00:41,081
85% of our delivered energy,
even now with all the advances

15
00:00:41,081 --> 00:00:43,315
still comes from burning fuels.

16
00:00:43,315 --> 00:00:45,557
So with planes, trains, automobiles,

17
00:00:45,557 --> 00:00:48,690
ultimately the power
goes back to combustion.

18
00:00:48,690 --> 00:00:51,409
The other side is fire, and
fire is a catastrophic hazard

19
00:00:51,409 --> 00:00:55,087
for space flight, so we need
to improve our understanding

20
00:00:55,087 --> 00:00:57,764
of fire so we can mitigate its risk.

21
00:00:57,764 --> 00:00:59,961
That in particular will
give us information

22
00:00:59,961 --> 00:01:02,221
about the fundamental
processes of flame spread,

23

00:01:02,221 --> 00:01:04,628
from building combustion
of solid materials.

24
00:01:04,628 --> 00:01:06,853
- What materials are we studying in space,

25
00:01:06,853 --> 00:01:08,666
and how do they differ
in their flammability

26
00:01:08,666 --> 00:01:10,734
compared to what we have on Earth?

27
00:01:10,734 --> 00:01:12,934
- The materials do burn
very differently in space.

28
00:01:12,934 --> 00:01:14,572
Some materials melt when they burn,

29
00:01:14,572 --> 00:01:18,214
and the melting materials
in 1G will drip on Earth,

30
00:01:18,214 --> 00:01:20,919
and the dripping takes the
energy away from the fuel,

31
00:01:20,919 --> 00:01:23,134
whereas in space, dripping doesn't occur

32
00:01:23,134 --> 00:01:26,705
and so you get this accumulation
of the molten material,

33
00:01:26,705 --> 00:01:28,698
which increases the fire risk

34

00:01:28,698 --> 00:01:32,729
because you've got all this
hot, flammable fuel ready to go.

35
00:01:32,729 --> 00:01:34,953
Clearly, you can't just set a fire

36
00:01:34,953 --> 00:01:36,525
anywhere on the space station

37
00:01:36,525 --> 00:01:39,021
so it's important to do
in in a safe environment,

38
00:01:39,021 --> 00:01:40,849
so we had a very small flow duct,

39
00:01:40,849 --> 00:01:42,848
probably about the size
of a loaf of bread,

40
00:01:42,848 --> 00:01:46,281
and then we put that
flow duct inside another,

41
00:01:46,281 --> 00:01:48,646
larger experiment rack
which was called the

42
00:01:48,646 --> 00:01:50,282
Microgravity Science Glove Box,

43
00:01:50,282 --> 00:01:53,514
and the crew could only access
that through glove ports.

44
00:01:53,514 --> 00:01:57,281
And so they really weren't
exposed to the flame at all.

45
00:01:57,281 --> 00:02:00,712
- So Gary Ruff, you undertook
a larger enterprise.

46
00:02:00,712 --> 00:02:02,296
Can you tell us about that?

47
00:02:02,296 --> 00:02:04,574
- Sure, the Saffire set of experiments,

48
00:02:04,574 --> 00:02:07,532
or spacecraft fire experiments were,

49
00:02:07,532 --> 00:02:09,337
finally gave us the chance to study some

50
00:02:09,337 --> 00:02:12,945
large scale fires, things
that would have more fuel

51
00:02:12,945 --> 00:02:14,778
and more surface area.

52
00:02:15,717 --> 00:02:18,645
We really didn't know how
large the flame would grow.

53
00:02:18,645 --> 00:02:20,897
One of the findings was that it

54
00:02:20,897 --> 00:02:23,318
very quickly reached a steady state.

55
00:02:23,318 --> 00:02:25,817
The spread rate was quite a bit slower,

56
00:02:25,817 --> 00:02:27,973
really the flame length

was a little bit smaller

57
00:02:27,973 --> 00:02:30,569
than what I certainly anticipated.

58
00:02:30,569 --> 00:02:33,581
Saffire was about 40 centimeters wide,

59
00:02:33,581 --> 00:02:35,780
by almost a meter long.

60
00:02:35,780 --> 00:02:39,210
And so we would burn that
whole sample in one experiment.

61
00:02:39,210 --> 00:02:41,997
Saffire provides the large scale.

62
00:02:41,997 --> 00:02:44,894
- So they're gonna need
really unexpected results?

63
00:02:44,894 --> 00:02:47,685
- On a ritzy experiment
we did back in the '90s,

64
00:02:47,685 --> 00:02:51,709
we were planning to study a
smoldering piece of fabric,

65
00:02:51,709 --> 00:02:53,777
and we were igniting it in a spot

66
00:02:53,777 --> 00:02:56,887
and we were expecting to
see this circular growth

67
00:02:56,887 --> 00:02:59,653
out from that, but what

happened was instead of having

68
00:02:59,653 --> 00:03:03,270
a nice, uniform ring, the
flame broke up into tiny

69
00:03:03,270 --> 00:03:05,524
little spots like smolder spots,

70
00:03:05,524 --> 00:03:08,016
and then they started propagating outward

71
00:03:08,016 --> 00:03:10,917
like little bugs crawling everywhere.

72
00:03:10,917 --> 00:03:12,254
It was just so freaky looking,

73
00:03:12,254 --> 00:03:13,777
and we had totally not expected that

74
00:03:13,777 --> 00:03:17,140
and later we were able to
make lots of measurements

75
00:03:17,140 --> 00:03:19,101
from that and come up with
some really good theories

76
00:03:19,101 --> 00:03:20,893
to explain that, but it certainly

77
00:03:20,893 --> 00:03:23,254
was not an expected finding.

78
00:03:23,254 --> 00:03:25,982
- What are future directions
for combustion research,

79
00:03:25,982 --> 00:03:27,522
based on what we've seen so far?

80
00:03:27,522 --> 00:03:29,793
- Well we're continuing
pursuing the surprises,

81
00:03:29,793 --> 00:03:32,178
the area we had a low
temperature chemistry.

82
00:03:32,178 --> 00:03:34,853
And then we're following
on a CIR, we're gonna be

83
00:03:34,853 --> 00:03:36,877
doing gaseous flames,
and then following that,

84
00:03:36,877 --> 00:03:38,669
we're gonna be doing
solid fuel experiments

85
00:03:38,669 --> 00:03:40,429
in the same facility.

86
00:03:40,429 --> 00:03:42,826
We're doing more testing
in the Saffire lab.

87
00:03:42,826 --> 00:03:45,665
- We've got five principal
investigators lined up

88
00:03:45,665 --> 00:03:47,520
to use the solid fuel insert,

89
00:03:47,520 --> 00:03:50,316
and each investigator

is studying some aspect

90
00:03:50,316 --> 00:03:54,483
of flame spread, flammability,
or ignition processes.

91
00:03:55,861 --> 00:03:58,710
- For Saffire, our future
and what we're looking for

92
00:03:58,710 --> 00:04:00,612
is just to make bigger fires.

93
00:04:00,612 --> 00:04:01,957
(they laugh)

94
00:04:01,957 --> 00:04:04,905
And we want to see how
those types of bigger fires

95
00:04:04,905 --> 00:04:06,829
then interact with the vehicle,

96
00:04:06,829 --> 00:04:08,765
and what effects it has there

97
00:04:08,765 --> 00:04:12,648
so we can provide the right
equipment to protect the crew.

98
00:04:12,648 --> 00:04:15,617
- Thank you, David Urban,
Sandra Olson, Gary Ruff,

99
00:04:15,617 --> 00:04:17,389
for this briefing on combustion science,

100
00:04:17,389 --> 00:04:18,818
and a look ahead to the future.

101
00:04:18,818 --> 00:04:21,173
For more information on
the future of combustion