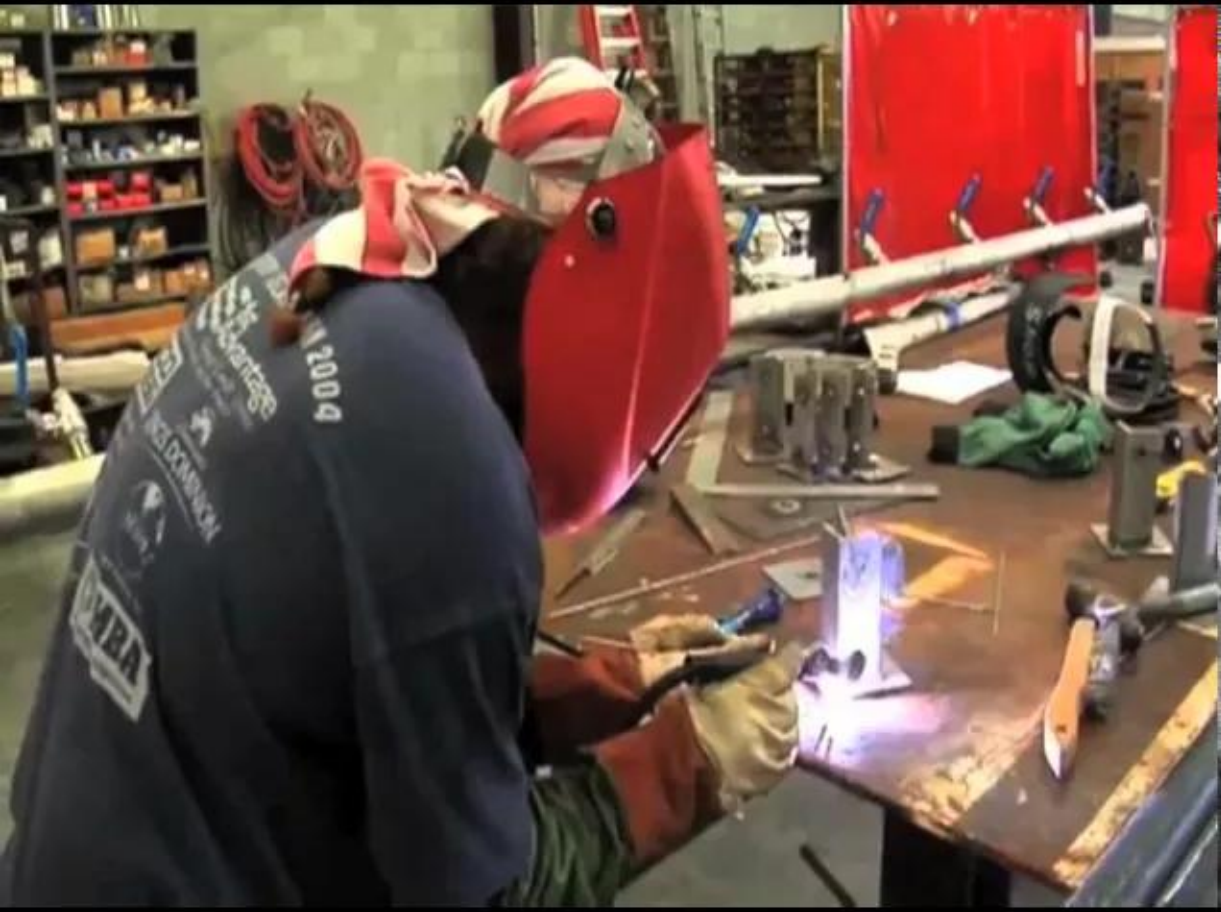

1
00:00:00,006 --> 00:00:01,106
[Sound Effects]

2
00:00:01,106 --> 00:00:02,446
Hi my name is Elizabeth Thiel.

3
00:00:02,446 --> 00:00:04,966
I'm from Komachin Middle
School in Washington state

4
00:00:04,966 --> 00:00:05,966
and you're watching NASA Now.

5
00:00:06,516 --> 00:00:29,856
[Sound Effects]

6
00:00:30,356 --> 00:00:33,836
Hi, I'm Matt and
this is NASA Now.

7
00:00:34,536 --> 00:00:36,736
At NASA, every part
of the manufacturing

8
00:00:36,736 --> 00:00:39,516
and assembly process of
a spacecraft is critical

9
00:00:39,606 --> 00:00:41,106
to ensuring mission success.

10
00:00:41,686 --> 00:00:43,136
Today, we'll meet an expert

11
00:00:43,206 --> 00:00:46,356
who explains the science
behind welding and why a weld

12

00:00:46,356 --> 00:00:49,256
that works on Earth doesn't
mean it will hold up in space.

13
00:00:50,146 --> 00:00:53,976
That's ahead, first here's
what's happening at NASA Now.

14
00:00:54,516 --> 00:00:57,536
[Sound Effects]

15
00:00:58,036 --> 00:01:00,136
Did water ever exist on Mars?

16
00:01:00,776 --> 00:01:03,856
Recent images taken from NASA's
Mars Reconnaissance Orbiter

17
00:01:03,886 --> 00:01:05,096
reveal that it could have.

18
00:01:05,626 --> 00:01:09,136
This image of the McLaughlin
Crater, stretching 57 miles wide

19
00:01:09,186 --> 00:01:11,716
by 1.4 miles deep,
shows layered,

20
00:01:11,926 --> 00:01:14,826
flat rocks containing
carbonate and clay minerals

21
00:01:15,026 --> 00:01:17,166
that usually form in
the presence of water.

22
00:01:18,076 --> 00:01:21,226
Scientists also observed small
channels close to the bottom

23
00:01:21,226 --> 00:01:24,146
of the crater that could have
marked the surface of a lake.

24
00:01:24,546 --> 00:01:26,686
This observation,
combined with the lack

25
00:01:26,686 --> 00:01:28,276
of any large inflow channels,

26
00:01:28,526 --> 00:01:31,216
suggest this may have
once been the site

27
00:01:31,216 --> 00:01:32,906
of a groundwater-fed lake.

28
00:01:33,516 --> 00:01:35,816
[Sound Effects]

29
00:01:36,316 --> 00:01:38,616
Building a spacecraft that
can withstand the rigors

30
00:01:38,616 --> 00:01:41,336
of space takes a lot
of testing and design.

31
00:01:41,656 --> 00:01:44,286
When the design is ready and
it's time to build a prototype,

32
00:01:44,606 --> 00:01:47,316
that's where welding engineer
Shane Brooke and hundreds

33
00:01:47,316 --> 00:01:49,046

of other people have a big role.

34
00:01:49,566 --> 00:01:52,256
Shane took some time to
give us a firsthand look

35
00:01:52,346 --> 00:01:54,456
at the important
role welding plays

36
00:01:54,646 --> 00:01:57,976
as human beings push further
and further into space.

37
00:01:58,411 --> 00:02:00,411
[Music]

38
00:02:00,806 --> 00:02:03,006
Welding is used on everything.

39
00:02:03,546 --> 00:02:04,576
We use it on engines.

40
00:02:04,576 --> 00:02:06,766
We use it on cryogenic tanks.

41
00:02:07,476 --> 00:02:09,936
It's used with the space
frame of the shuttle.

42
00:02:10,106 --> 00:02:14,046
It's used in electronics,
so there's a wide array

43
00:02:14,046 --> 00:02:17,626
of welding processes that a lot
of people don't give credit to,

44
00:02:18,156 --> 00:02:20,036

but that are, indeed,
welding processes.

45
00:02:21,516 --> 00:02:24,896
[Music]

46
00:02:25,396 --> 00:02:29,026
Generally speaking, there
are two types of welding.

47
00:02:29,026 --> 00:02:30,946
There's fusion welding
and solid-state welding.

48
00:02:31,276 --> 00:02:33,576
Some of the fusion processes,
we're more familiar with,

49
00:02:33,866 --> 00:02:35,716
you know, that's
the stick electrode

50
00:02:35,716 --> 00:02:39,826
or the gas metal arc welding,
mostly what you find in shops

51
00:02:39,826 --> 00:02:41,196
and garages across America.

52
00:02:41,796 --> 00:02:44,136
The solid-state welding
is a bit different

53
00:02:44,136 --> 00:02:45,406
in that it doesn't use melting.

54
00:02:46,046 --> 00:02:48,876
For example if we have this
complicated aluminum alloy,

55
00:02:49,826 --> 00:02:51,916
it's difficult to
fusion weld some

56
00:02:51,916 --> 00:02:53,976
of these materials
that we create.

57
00:02:54,266 --> 00:02:56,456
But we can use the
friction stir process

58
00:02:56,596 --> 00:02:58,056
because it doesn't
melt the material

59
00:02:58,326 --> 00:02:59,616
to join the two parts together.

60
00:03:00,206 --> 00:03:01,716
There is no external
heat source.

61
00:03:02,436 --> 00:03:05,146
It's friction alone
to heat the material

62
00:03:05,456 --> 00:03:08,066
to reach this plastic
state, much like if you were

63
00:03:08,066 --> 00:03:10,836
to just rub your hands
together really hard

64
00:03:10,836 --> 00:03:12,826
and really fast,
you generate heat.

65

00:03:13,516 --> 00:03:16,546
[Music]

66
00:03:17,046 --> 00:03:19,196
There are two types of
friction stir welding.

67
00:03:19,306 --> 00:03:22,416
We classify them as
conventional and self-reacting.

68
00:03:22,546 --> 00:03:26,956
They both use similar
heating processes.

69
00:03:27,276 --> 00:03:29,406
Conventional has a
one-sided pin tool

70
00:03:29,956 --> 00:03:31,366
where we plunge into the part.

71
00:03:31,546 --> 00:03:35,616
We plasticize it, form it
into like a taffy or a putty.

72
00:03:35,946 --> 00:03:38,526
We have an anvil
behind the part.

73
00:03:38,786 --> 00:03:41,626
So as we plunge into the part,
the anvil reacts that load

74
00:03:41,656 --> 00:03:44,146
so the part doesn't move, and
then it's forged together.

75
00:03:44,986 --> 00:03:48,006
The self-reacting process

does not have an anvil.

76
00:03:48,216 --> 00:03:52,796
So we basically have a
shoulder on both sides pushing,

77
00:03:53,226 --> 00:03:56,116
canceling out the loads,
traversing through the joint.

78
00:03:56,576 --> 00:03:58,146
So as both shoulders rotate,

79
00:03:58,366 --> 00:04:00,576
the pin will traverse
through the joint.

80
00:04:00,576 --> 00:04:03,226
The material is plasticized
and forged together

81
00:04:03,226 --> 00:04:07,976
with a pinching load and we
have a perfectly welded part.

82
00:04:08,516 --> 00:04:13,616
[Music]

83
00:04:14,116 --> 00:04:15,906
Currently, we're using
friction stir welding

84
00:04:16,136 --> 00:04:18,756
for large space vehicle
cryogenic tank production.

85
00:04:19,356 --> 00:04:21,836
These large vehicle tank
structures are aluminum,

86
00:04:22,366 --> 00:04:25,646
and aluminum, as we know, is
a softer metal than steel.

87
00:04:26,466 --> 00:04:30,016
So for the larger space
applications, it works great

88
00:04:30,066 --> 00:04:31,696
for cryogenic tank production.

89
00:04:32,106 --> 00:04:35,706
Looking towards the future at
different high-strength steels,

90
00:04:36,146 --> 00:04:38,736
we're currently working on
friction stir technology

91
00:04:38,736 --> 00:04:41,926
that will allow us to weld
these higher strength steels.

92
00:04:42,516 --> 00:04:46,376
[Music]

93
00:04:46,876 --> 00:04:50,246
Not necessarily, different
materials have different

94
00:04:50,246 --> 00:04:51,616
properties at different
temperatures.

95
00:04:52,456 --> 00:04:58,596
So here on earth at 70 degrees a
weld may be great but if you get

96
00:04:58,596 --> 00:05:03,076

into space at -300 degrees
where it's very, very cold now

97
00:05:03,076 --> 00:05:04,286
that weld may be very brittle.

98
00:05:04,976 --> 00:05:09,446
So we don't want it to fail when
the astronauts need it most.

99
00:05:10,276 --> 00:05:12,856
We do all sorts of testing,
as you could imagine.

100
00:05:13,036 --> 00:05:16,016
There is testing called,
nondestructive evaluation,

101
00:05:16,856 --> 00:05:21,106
where we use ultrasonic
technology, x-ray technology,

102
00:05:21,976 --> 00:05:25,346
dye penetrate inspection, where
we inspect these welds to see

103
00:05:25,436 --> 00:05:28,176
if there are any surface
defects or volumetric defects.

104
00:05:28,846 --> 00:05:30,376
We also do mechanical testing

105
00:05:30,376 --> 00:05:32,276
where we will weld
up a test panel.

106
00:05:32,726 --> 00:05:33,766
We'll cut it into strips,

107
00:05:33,996 --> 00:05:37,536
and we will mechanically
pull the weld until it fails.

108
00:05:38,446 --> 00:05:40,816
And then based on that
strength or that number,

109
00:05:40,986 --> 00:05:42,556
we know how strong that weld is.

110
00:05:43,356 --> 00:05:44,946
And then we can use
those numbers

111
00:05:45,056 --> 00:05:48,896
to factor how safe is
it to fly this vehicle.

112
00:05:49,516 --> 00:05:52,546
[Sound Effects]

113
00:05:53,046 --> 00:05:54,706
Did you know that
a material used

114
00:05:54,706 --> 00:05:57,676
to make jet engine fan
cases is also being used

115
00:05:57,676 --> 00:05:58,796
in sports and healthcare?

116
00:05:59,536 --> 00:06:02,836
Together, NASA and private
industry have developed a carbon

117
00:06:02,916 --> 00:06:04,736
fiber, reinforced composite.

118
00:06:05,356 --> 00:06:07,966
This braided, lightweight
material is being used

119
00:06:07,966 --> 00:06:10,536
to create jet engine fan
cases that are stronger

120
00:06:10,606 --> 00:06:13,916
and lighter-making them safer
and more fuel-efficient.

121
00:06:14,506 --> 00:06:17,526
This same technology is being
used to create more durable,

122
00:06:17,876 --> 00:06:20,246
lightweight sports equipment
and prosthetic devices.

123
00:06:20,976 --> 00:06:21,646
Now you know.

124
00:06:22,516 --> 00:06:24,546
[Sound Effects]

125
00:06:25,046 --> 00:06:26,656
You've just learned
how welding is critical

126
00:06:26,656 --> 00:06:29,726
to holding together a spacecraft
during the launch process

127
00:06:29,726 --> 00:06:31,826
and in the harsh
environment of space.

128

00:06:32,396 --> 00:06:35,096
Now it's time to test your
own engineering ability.

129
00:06:36,156 --> 00:06:37,576
Here's a great project where you

130
00:06:37,576 --> 00:06:40,836
and your students can build
a spacecraft structure strong

131
00:06:40,836 --> 00:06:43,016
enough to withstand three
successful launches.

132
00:06:43,846 --> 00:06:45,596
Look for Engineering
Design Challenge:

133
00:06:45,816 --> 00:06:47,006
Spacecraft Structures.

134
00:06:47,666 --> 00:06:49,896
You'll find it by checking
out the extension activity

135
00:06:49,896 --> 00:06:53,696
for this program on the NASA
Explorer Schools Virtual Campus.

136
00:06:54,526 --> 00:06:56,126
Well that's it for NASA NOW.

137
00:06:56,186 --> 00:06:58,686
Be sure to visit our facebook
page and leave a comment.

138
00:06:59,016 --> 00:07:01,476
We'll see you next
time on NASA NOW!

139
00:07:02,516 --> 00:07:08,176
[Sound Effects]