
Testing

1
00:00:01,689 --> 00:00:03,165
Hi. I am Erin Betts,

2
00:00:03,200 --> 00:00:04,204
a propulsion engineer

3
00:00:04,239 --> 00:00:05,533
at NASA's Marshall

4
00:00:05,568 --> 00:00:06,628
Space Flight Center.

5
00:00:06,663 --> 00:00:07,523
I have led and

6
00:00:07,558 --> 00:00:08,244
participated in several

7
00:00:08,279 --> 00:00:09,300
projects that evaluate

8
00:00:09,335 --> 00:00:10,348
how digital design tools

9
00:00:10,383 --> 00:00:11,661
and new fabrication

10
00:00:11,696 --> 00:00:13,228
processes can improve

11
00:00:13,263 --> 00:00:14,181
our ability to build

12
00:00:14,216 --> 00:00:15,292
sustainable, affordable

13
00:00:15,327 --> 00:00:16,676

space hardware.

14
00:00:16,711 --> 00:00:18,101
Before you even start

15
00:00:18,136 --> 00:00:18,981
designing a large launch

16
00:00:19,016 --> 00:00:20,125
vehicle, or any large

17
00:00:20,160 --> 00:00:21,300
system, it is important

18
00:00:21,335 --> 00:00:22,476
to compare several

19
00:00:22,511 --> 00:00:23,877
concepts and pick a winner.

20
00:00:23,912 --> 00:00:24,772
From a management

21
00:00:24,807 --> 00:00:25,548
perspective, you want a

22
00:00:25,583 --> 00:00:26,876
concept that not only

23
00:00:26,911 --> 00:00:27,940
accomplishes a specific

24
00:00:27,975 --> 00:00:29,284
NASA mission but is

25
00:00:29,319 --> 00:00:31,484
affordable and sustainable.

26
00:00:31,519 --> 00:00:33,084
New tools, such as video

27
00:00:33,119 --> 00:00:34,708
walls, enhance our ability

28
00:00:34,743 --> 00:00:36,172
to actually see the

29
00:00:36,207 --> 00:00:37,996
design from many angles.

30
00:00:38,031 --> 00:00:39,444
Teams of engineers from

31
00:00:39,479 --> 00:00:40,972
different disciplines

32
00:00:41,007 --> 00:00:42,388
can collaborate. This

33
00:00:42,423 --> 00:00:43,357
helps us start with a

34
00:00:43,392 --> 00:00:44,180
concept that is already

35
00:00:44,215 --> 00:00:46,173
far ahead of the curve.

36
00:00:46,208 --> 00:00:47,820
Time is money. CAD models

37
00:00:47,855 --> 00:00:49,228
and high-resolution

38
00:00:49,263 --> 00:00:50,420

integrated analytical

39
00:00:50,455 --> 00:00:51,588
models have become part

40
00:00:51,623 --> 00:00:52,739
of the manufacturing

41
00:00:52,774 --> 00:00:54,124
process, which helps

42
00:00:54,159 --> 00:00:55,436
shorten the time from

43
00:00:55,471 --> 00:00:57,140
design to manufacturing

44
00:00:57,175 --> 00:00:58,684
for everything from small

45
00:00:58,719 --> 00:00:59,564
components to entire

46
00:00:59,599 --> 00:01:00,916
hardware systems.

47
00:01:00,951 --> 00:01:02,732
3D CAD models are now

48
00:01:02,767 --> 00:01:03,813
being carried from the

49
00:01:03,848 --> 00:01:05,028
design and development

50
00:01:05,063 --> 00:01:06,228
phase all the way through

51
00:01:06,263 --> 00:01:07,692
manufacturing, inspection,

52
00:01:07,727 --> 00:01:10,204
test and operation. 3-D

53
00:01:10,239 --> 00:01:11,589
models and simulations

54
00:01:11,624 --> 00:01:12,660
let us fly through a

55
00:01:12,695 --> 00:01:13,476
virtual design of

56
00:01:13,511 --> 00:01:14,749
components and entire

57
00:01:14,784 --> 00:01:16,525
systems. We can quickly

58
00:01:16,560 --> 00:01:17,876
see design flaws and

59
00:01:17,911 --> 00:01:19,772
mismatched interfaces.

60
00:01:19,807 --> 00:01:20,980
Then, we can fix the

61
00:01:21,015 --> 00:01:21,876
problems before they

62
00:01:21,911 --> 00:01:22,756
become so central to

63
00:01:22,791 --> 00:01:24,244

the design that they

64
00:01:24,279 --> 00:01:25,348
are impossible or

65
00:01:25,383 --> 00:01:27,125
costly to change.

66
00:01:27,160 --> 00:01:28,685
Additive manufacturing

67
00:01:28,720 --> 00:01:29,901
lets us try out designs

68
00:01:29,936 --> 00:01:31,404
early in a product's life

69
00:01:31,439 --> 00:01:32,829
cycle. There is no need to

70
00:01:32,864 --> 00:01:33,925
fabricate costly tooling

71
00:01:33,960 --> 00:01:35,412
that is often required

72
00:01:35,447 --> 00:01:36,564
using traditional

73
00:01:36,599 --> 00:01:38,236
fabrication methods.

74
00:01:38,271 --> 00:01:39,540
It also allows us to

75
00:01:39,575 --> 00:01:40,747
fabricate designs that

76
00:01:40,782 --> 00:01:42,124
could not have been made

77
00:01:42,159 --> 00:01:43,236
before, allowing us to

78
00:01:43,271 --> 00:01:44,356
be more creative and

79
00:01:44,391 --> 00:01:46,052
innovative. Other fully

80
00:01:46,087 --> 00:01:47,220
automated processes,

81
00:01:47,255 --> 00:01:48,900
such as robotic welding

82
00:01:48,935 --> 00:01:50,428
and CNC milling and water

83
00:01:50,463 --> 00:01:52,053
jets, have evolved making

84
00:01:52,088 --> 00:01:53,173
it easier to manufacture

85
00:01:53,208 --> 00:01:54,541
prototypes or components

86
00:01:54,576 --> 00:01:56,284
quickly at any time

87
00:01:56,319 --> 00:01:58,212
during a product's life

88
00:01:58,247 --> 00:01:59,373

cycle.

89
00:01:59,408 --> 00:02:00,469
Once you've made a part,

90
00:02:00,504 --> 00:02:01,252
regardless of how you

91
00:02:01,287 --> 00:02:02,460
made it, you need to know

92
00:02:02,495 --> 00:02:04,061
if it is built correctly.

93
00:02:04,096 --> 00:02:05,420
Inspection time is also

94
00:02:05,455 --> 00:02:06,508
reduced when you use

95
00:02:06,543 --> 00:02:08,197
modern techniques, such

96
00:02:08,232 --> 00:02:09,165
as structured light

97
00:02:09,200 --> 00:02:10,428
scanning, to compare

98
00:02:10,463 --> 00:02:11,692
models of what you

99
00:02:11,727 --> 00:02:12,468
actually built to what

100
00:02:12,503 --> 00:02:13,732
you intended to build.

101
00:02:13,767 --> 00:02:15,028
Testing can be used in

102
00:02:15,063 --> 00:02:16,125
almost every phase of

103
00:02:16,160 --> 00:02:17,372
a product's development.

104
00:02:17,407 --> 00:02:18,516
With additive manufacturing,

105
00:02:18,551 --> 00:02:20,093
engineers at Marshall

106
00:02:20,128 --> 00:02:21,804
were able to build a

107
00:02:21,839 --> 00:02:22,924
one-piece injector and

108
00:02:22,959 --> 00:02:24,076
get it on the test stand

109
00:02:24,111 --> 00:02:25,340
in about a month. This

110
00:02:25,375 --> 00:02:26,565
injector was half the

111
00:02:26,600 --> 00:02:27,795
cost of an injector

112
00:02:27,830 --> 00:02:28,917
built using traditional

113
00:02:28,952 --> 00:02:29,972

methods, and performed

114
00:02:30,007 --> 00:02:32,052
just as well. This

115
00:02:32,087 --> 00:02:33,244
quick-turn-around testing

116
00:02:33,279 --> 00:02:34,628
allows designers to

117
00:02:34,663 --> 00:02:35,932
explore and compare the

118
00:02:35,967 --> 00:02:37,420
performance of various

119
00:02:37,455 --> 00:02:38,492
designs early in a

120
00:02:38,527 --> 00:02:39,925
product's development.

121
00:02:39,960 --> 00:02:41,212
This saves money in the

122
00:02:41,247 --> 00:02:42,508
long-run, and allows

123
00:02:42,543 --> 00:02:43,636
the program to proceed

124
00:02:43,671 --> 00:02:44,764
beyond development at a

125
00:02:44,799 --> 00:02:45,868
much lower risk and

126
00:02:45,903 --> 00:02:47,549
higher fidelity.

127
00:02:47,584 --> 00:02:49,108
Virtual 3-D simulations

128
00:02:49,143 --> 00:02:50,180
reduce the cost and time

129
00:02:50,215 --> 00:02:51,452
it takes to evaluate

130
00:02:51,487 --> 00:02:52,653
logistics and operations

131
00:02:52,688 --> 00:02:53,988
early in the development

132
00:02:54,023 --> 00:02:55,740
phase of a system. They

133
00:02:55,775 --> 00:02:57,012
also help the ground

134
00:02:57,047 --> 00:02:58,028
crew who is training

135
00:02:58,063 --> 00:02:59,388
to operate new space systems.

136
00:02:59,423 --> 00:03:01,188
In summary, modern digital

137
00:03:01,223 --> 00:03:02,589
tools and automated

138
00:03:02,624 --> 00:03:04,140

processes can help reduce

139
00:03:04,175 --> 00:03:05,700
the cost and time needed

140
00:03:05,735 --> 00:03:07,012
to develop complex space

141
00:03:07,047 --> 00:03:08,316
hardware. The challenge

142
00:03:08,351 --> 00:03:09,516
is in using these techniques

143
00:03:09,551 --> 00:03:10,716
in a way that aligns with

144
00:03:10,751 --> 00:03:12,108
your design space, whether

145
00:03:12,143 --> 00:03:13,700
heritage or blank sheet.

146
00:03:13,735 --> 00:03:14,948
As we have the opportunity

147
00:03:14,983 --> 00:03:16,180
to apply these techniques

148
00:03:16,215 --> 00:03:17,332
more broadly, the fidelity

149
00:03:17,367 --> 00:03:19,220
of the output will increase.

150
00:03:19,255 --> 00:03:20,572
Engineers like me at

151
00:03:20,607 --> 00:03:21,853
Marshall Space Flight Center

152
00:03:21,888 --> 00:03:22,997
are working hard to take

153
00:03:23,032 --> 00:03:24,556
advantage of, develop, and

154
00:03:24,591 --> 00:03:26,228
characterize new technologies

155
00:03:26,263 --> 00:03:27,661
that will be used to