1
00:00:19,439 --> 00:01:30,070
okay

2
00:01:30,080 --> 00:02:01,670
so

3
00:02:05,910 --> 00:02:03,670
many of the advances that have taken

4
00:02:09,109 --> 00:02:05,920
place since that of dr goddard's first

5
00:02:11,910 --> 00:02:09,119
rocket in the 1920s have emerged from

6
00:02:13,110 --> 00:02:11,920
nasa lewis research center in cleveland

7
00:02:15,589 --> 00:02:13,120
ohio

8
00:02:18,390 --> 00:02:15,599
dr larry diehl chief of the space

9
00:02:21,430 --> 00:02:18,400
propulsion technology division gives us

10
00:02:29,830 --> 00:02:21,440
insight to the technology and the future

11
00:02:33,910 --> 00:02:32,150
we in lewis space propulsion technology

12
00:02:36,150 --> 00:02:33,920
division are striving to advance the

13
00:02:38,309 --> 00:02:36,160

technologies that will open pathways for

14
00:02:40,150 --> 00:02:38,319
the nation's ride to space

15
00:02:43,110 --> 00:02:40,160
we conduct research and develop

16
00:02:45,910 --> 00:02:43,120
technology for launch vehicles space

17
00:02:47,270 --> 00:02:45,920
transfer vehicles satellites and space

18
00:02:49,670 --> 00:02:47,280
platforms

19
00:02:51,670 --> 00:02:49,680
this wide range of applications requires

20
00:02:53,990 --> 00:02:51,680
a propulsion research and technology

21
00:02:55,509 --> 00:02:54,000
program that encompasses a number of

22
00:02:57,430 --> 00:02:55,519
options

23
00:03:00,070 --> 00:02:57,440
chemical nuclear

24
00:03:02,309 --> 00:03:00,080
electric propulsion as well as far term

25
00:03:04,390 --> 00:03:02,319
concepts like laser and microwave

26
00:03:06,550 --> 00:03:04,400
propulsion

27
00:03:09,030 --> 00:03:06,560
our current emphasis is on chemical and

28
00:03:10,470 --> 00:03:09,040
electric propulsion systems

29
00:03:12,390 --> 00:03:10,480
in some ways

30
00:03:14,390 --> 00:03:12,400
visions of the future begin with us

31
00:03:16,309 --> 00:03:14,400
because we must answer the questions

32
00:03:17,830 --> 00:03:16,319
asked when these systems are still on

33
00:03:20,149 --> 00:03:17,840
the drawing board

34
00:03:22,710 --> 00:03:20,159
let me share with you a vision of what

35
00:03:24,869 --> 00:03:22,720
is possible in the next 20 to 30 years

36
00:03:27,430 --> 00:03:24,879
and what is needed to get there

37
00:03:29,270 --> 00:03:27,440
we begin with new earth orbit propulsion

38
00:03:45,910 --> 00:03:29,280

systems that will benefit the space

39
00:03:51,509 --> 00:03:48,869
construction and long-term operation of

40
00:03:53,830 --> 00:03:51,519
the orbital outpost will depend on an

41
00:03:56,470 --> 00:03:53,840
advanced earth-to-orbit transportation

42
00:03:59,670 --> 00:03:56,480
system that will make regular trips to

43
00:04:01,589 --> 00:03:59,680
and from low earth orbit an improved

44
00:04:02,869 --> 00:04:01,599
shuttle will transport freedom's

45
00:04:05,670 --> 00:04:02,879
workforce

46
00:04:08,390 --> 00:04:05,680
economical low thrust rockets designed

47
00:04:11,350 --> 00:04:08,400
for reliability and flexibility will be

48
00:04:12,869 --> 00:04:11,360
used to counteract atmospheric drag and

49
00:04:15,429 --> 00:04:12,879
vibrations

50
00:04:18,629 --> 00:04:15,439
a powerful unmanned cargo vehicle will

51
00:04:20,870 --> 00:04:18,639
carry materials and supplies from earth

52
00:04:23,670 --> 00:04:20,880
low thrust rockets will also help

53
00:04:26,150 --> 00:04:23,680
enhance our knowledge of earth and space

54
00:04:28,790 --> 00:04:26,160
by keeping satellites properly located

55
00:04:31,270 --> 00:04:28,800
and correctly oriented and by assisting

56
00:04:33,670 --> 00:04:31,280
the unmanned spacecraft that will map

57
00:04:37,990 --> 00:04:33,680
and explore the solar system as they

58
00:04:43,350 --> 00:04:41,110
using advanced expander cycle engines

59
00:04:45,909 --> 00:04:43,360
space transfer vehicles based in earth

60
00:04:49,510 --> 00:04:45,919
orbit will enable us to maneuver freely

61
00:04:51,990 --> 00:04:49,520
in space working traveling and exploring

62
00:04:53,510 --> 00:04:52,000
they'll aid us in creating another key

63
00:05:06,550 --> 00:04:53,520

path to the future

64
00:05:11,510 --> 00:05:08,870
on the moon we'll learn the necessary

65
00:05:14,469 --> 00:05:11,520
skills for survival an experience that

66
00:05:17,670 --> 00:05:14,479
will prepare us for a more rigorous but

67
00:05:20,629 --> 00:05:17,680
even more rewarding ride

68
00:05:22,629 --> 00:05:20,639
a ride that will take us ever further

69
00:05:26,310 --> 00:05:22,639
from home

70
00:05:44,950 --> 00:05:26,320
until finally we take our first steps

71
00:05:49,990 --> 00:05:47,430
interplanetary spacecraft will use a

72
00:05:52,390 --> 00:05:50,000
variety of propulsion methods that offer

73
00:05:55,270 --> 00:05:52,400
the high efficiency and long running

74
00:05:58,070 --> 00:05:55,280
times needed to achieve our goal of

75
00:06:07,749 --> 00:05:58,080
transforming a distant planet into a

76
00:06:12,950 --> 00:06:10,790
along with advanced chemical and nuclear

77
00:06:15,270 --> 00:06:12,960
thermal propulsion systems many

78
00:06:18,309 --> 00:06:15,280
spacecraft will be propelled by electric

79
00:06:22,950 --> 00:06:18,319
thrusters and powered by solar or

80
00:06:27,189 --> 00:06:25,189
these plans for the future require

81
00:06:30,150 --> 00:06:27,199
prediction of the performance of such

82
00:06:31,350 --> 00:06:30,160
propulsion systems exact simulation is

83
00:06:34,070 --> 00:06:31,360
necessary

84
00:06:38,150 --> 00:06:34,080
often the computer serves as a cost

85
00:06:42,150 --> 00:06:39,990
taking advantage of lewis research

86
00:06:44,309 --> 00:06:42,160
center's high performance computers and

87
00:06:46,550 --> 00:06:44,319
advanced networks division members

88
00:06:48,950 --> 00:06:46,560

develop computational tools and

89
00:06:51,590 --> 00:06:48,960
techniques that model a propulsion

90
00:06:53,909 --> 00:06:51,600
system and simulate the complex physical

91
00:06:56,550 --> 00:06:53,919
processes taking place during its

92
00:06:58,950 --> 00:06:56,560
operation the speed of propellants as

93
00:07:00,710 --> 00:06:58,960
they flow through the turbo pump changes

94
00:07:03,589 --> 00:07:00,720
in temperature within the combustion

95
00:07:06,469 --> 00:07:03,599
chamber and the onset of turbulence as

96
00:07:08,950 --> 00:07:06,479
exhaust gases exit the nozzle can all be

97
00:07:13,830 --> 00:07:08,960
predicted quickly and economically

98
00:07:18,870 --> 00:07:16,870
computers however cannot do it all

99
00:07:21,430 --> 00:07:18,880
fully understanding the performance of

100
00:07:30,469 --> 00:07:21,440
propulsion components and systems often

101
00:07:34,790 --> 00:07:32,710
in lewis's experimental facilities

102
00:07:37,029 --> 00:07:34,800
research hardware is a symbol that

103
00:07:39,589 --> 00:07:37,039
possesses the important characteristics

104
00:07:41,110 --> 00:07:39,599
of a component or system

105
00:07:43,189 --> 00:07:41,120
they then simulate the range of

106
00:07:44,390 --> 00:07:43,199
conditions that will be encountered

107
00:07:45,749 --> 00:07:44,400
during operation

108
00:07:48,870 --> 00:07:45,759
and measure the effects of these

109
00:07:51,189 --> 00:07:48,880
conditions on the test article

110
00:07:53,350 --> 00:07:51,199
teams conduct propulsion experiments

111
00:07:55,749 --> 00:07:53,360
from state-of-the-art control rooms

112
00:07:59,029 --> 00:07:55,759
where computerized systems automatically

113
00:08:20,469 --> 00:07:59,039

control and monitor facility operations

114
00:08:26,070 --> 00:08:23,189
in many facilities optical diagnostic

115
00:08:28,550 --> 00:08:26,080
systems are used as tools of measurement

116
00:08:31,270 --> 00:08:28,560
because laser beams can withstand higher

117
00:08:33,909 --> 00:08:31,280
temperature and are less intrusive

118
00:08:36,709 --> 00:08:33,919
optical diagnostics help researchers

119
00:08:44,070 --> 00:08:36,719
probe the physics of combustion and flow

120
00:08:48,710 --> 00:08:46,230
lewis's test facilities have supported

121
00:08:51,110 --> 00:08:48,720
investigations of many new concepts and

122
00:08:53,430 --> 00:08:51,120
technologies stronger thrust chamber

123
00:08:55,829 --> 00:08:53,440
material better cooling techniques

124
00:08:57,990 --> 00:08:55,839
efficient propellants reliable ignition

125
00:09:08,470 --> 00:08:58,000
methods and durable chemical and

126
00:09:13,750 --> 00:09:11,030
the electric propulsion laboratory is a

127
00:09:15,670 --> 00:09:13,760
world-class space simulation facility

128
00:09:18,389 --> 00:09:15,680
containing simulation chambers in a

129
00:09:20,550 --> 00:09:18,399
variety of sizes the vacuum in these

130
00:09:23,190 --> 00:09:20,560
chambers is comparable to that of the

131
00:09:26,070 --> 00:09:23,200
cold highly charged vacuum of space

132
00:09:31,350 --> 00:09:26,080
created by an immense system of pumps

133
00:09:35,670 --> 00:09:33,750
this laboratory makes it possible to

134
00:09:38,949 --> 00:09:35,680
predict performance of spacecraft

135
00:09:41,590 --> 00:09:38,959
elements such as solar arrays as well as

136
00:09:44,470 --> 00:09:41,600
electric propulsion devices like ion

137
00:10:01,430 --> 00:09:44,480
thrusters and magnetoplasma dynamic

138
00:10:06,070 --> 00:10:03,990

during testing researchers gather data

139
00:10:07,829 --> 00:10:06,080
to predict performance life and

140
00:10:10,470 --> 00:10:07,839
efficiency

141
00:10:13,030 --> 00:10:10,480
to allow full utilization the electric

142
00:10:15,190 --> 00:10:13,040
propulsion laboratory's vacuum chambers

143
00:10:16,230 --> 00:10:15,200
are divided into several isolated

144
00:10:18,470 --> 00:10:16,240
sections

145
00:10:20,550 --> 00:10:18,480
each accessed by a port

146
00:10:23,190 --> 00:10:20,560
these separate ports make it possible to

147
00:10:24,949 --> 00:10:23,200
install or remove experiments without

148
00:10:27,509 --> 00:10:24,959
affecting the vacuum in the rest of the

149
00:10:31,350 --> 00:10:27,519
chamber and to conduct more than one

150
00:10:36,069 --> 00:10:33,509
lewis research center's largest chemical

151
00:10:38,550 --> 00:10:36,079
rocket testing complex is the rocket

152
00:10:40,550 --> 00:10:38,560
engine test facility its versatile

153
00:10:42,870 --> 00:10:40,560
system for supplying cryogenic

154
00:10:45,110 --> 00:10:42,880
propellants and a safe and effective

155
00:10:47,670 --> 00:10:45,120
method of cooling exhaust gases and

156
00:10:55,590 --> 00:10:47,680
removing contaminants make it possible

157
00:11:00,710 --> 00:10:57,910
technologists in the rocket engine test

158
00:11:03,670 --> 00:11:00,720
facility operate chemical rockets at sea

159
00:11:05,590 --> 00:11:03,680
level and altitude conditions to better

160
00:11:07,670 --> 00:11:05,600
understand the performance

161
00:11:10,230 --> 00:11:07,680
they study the behavior of turbo pump

162
00:11:12,870 --> 00:11:10,240
components and explore ways to enhance

163
00:11:15,350 --> 00:11:12,880

their performance and life by simulating

164
00:11:16,389 --> 00:11:15,360
the conditions in a rocket engine turbo

165
00:11:19,030 --> 00:11:16,399
pump

166
00:11:21,590 --> 00:11:19,040
by conducting repeated test firings they

167
00:11:24,389 --> 00:11:21,600
determine how various material cooling

168
00:11:26,870 --> 00:11:24,399
techniques and fabrication methods will

169
00:11:45,430 --> 00:11:26,880
help rocket engines withstand extremely

170
00:11:50,630 --> 00:11:48,230
working toward goals of top performance

171
00:11:53,430 --> 00:11:50,640
as well as efficiency economy and

172
00:11:56,389 --> 00:11:53,440
dependability required for the large

173
00:11:58,949 --> 00:11:56,399
variety of propulsion systems members of

174
00:12:02,069 --> 00:11:58,959
the space propulsion technology division

175
00:12:05,430 --> 00:12:02,079
gather knowledge test ideas and solve

176
00:12:08,389 --> 00:12:05,440
problems using computers experiments and

177
00:12:11,269 --> 00:12:08,399
diagnostics it's an endless spiral of

178
00:12:14,470 --> 00:12:11,279
exploration that draws ever closer to

179
00:12:29,910 --> 00:12:14,480
the ideals of exact simulation and

180
00:12:33,590 --> 00:12:31,750
vacuum chambers

181
00:12:36,949 --> 00:12:33,600
computer codes

182
00:12:38,629 --> 00:12:36,959
test rigs and highly skilled people

183
00:12:40,710 --> 00:12:38,639
these are some of the ingredients that

184
00:12:42,949 --> 00:12:40,720
allow the space propulsion technology

185
00:12:44,710 --> 00:12:42,959
division to contribute to our nation's

186
00:12:46,790 --> 00:12:44,720
ride to space

187
00:12:49,509 --> 00:12:46,800
we know our travels are only the first

188
00:12:51,269 --> 00:12:49,519

steps of a long and difficult journey

189
00:12:52,790 --> 00:12:51,279
the vision we have shared with you is

190
00:12:55,110 --> 00:12:52,800
only the beginning

191
00:12:57,110 --> 00:12:55,120
the solar system and the universe are

192
00:12:59,190 --> 00:12:57,120
waiting to be explored

193
00:13:01,509 --> 00:12:59,200
propulsion will lead the way

194
00:13:09,990 --> 00:13:01,519
we are proud to help pave the way for

195
00:13:15,030 --> 00:13:12,470
propulsion technology will reach beyond

196
00:13:17,750 --> 00:13:15,040
the space shuttle as we continue the

197
00:13:21,430 --> 00:13:17,760
technologies for communications earth

198
00:13:24,389 --> 00:13:21,440
observations and earth space operations

199
00:13:26,870 --> 00:13:24,399
the ability to launch and explore from

200
00:13:29,990 --> 00:13:26,880
the platform of space station freedom

201
00:13:46,870 --> 00:13:30,000
and a lunar base will help us ultimately