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1
00:00:18,230 --> 00:00:13,580
the factory of the future we're making a

2
00:00:20,450 --> 00:00:18,240
new pot or replacing an old one will be

3
00:00:24,679 --> 00:00:20,460
as automatic as getting a hardcopy on

4
00:00:26,810 --> 00:00:24,689
your home computer printer it may sound

5
00:00:28,970 --> 00:00:26,820
like science fiction but it's being

6
00:00:31,279 --> 00:00:28,980
developed right now in the automated

7
00:00:33,080 --> 00:00:31,289
manufacturing research facility at the

8
00:00:41,600 --> 00:00:33,090
National Institute of Standards and

9
00:00:44,270 --> 00:00:41,610
Technology manufacturing is important to

10
00:00:47,360 --> 00:00:44,280
the United States economy wherever we

11
00:00:49,220 --> 00:00:47,370
have trouble with offshore competition

12
00:00:52,610 --> 00:00:49,230
it turns out that manufacturing is a

13
00:00:55,639 --> 00:00:52,620

major part of the problem this shows up

14
00:01:00,349 --> 00:00:55,649
in terms of quality cost and speed in

15
00:01:02,180 --> 00:01:00,359
going to market from its initial work in

16
00:01:04,490 --> 00:01:02,190
discrete parts manufacturing in the

17
00:01:07,550 --> 00:01:04,500
early eighties to its more recent work

18
00:01:10,190 --> 00:01:07,560
on composites and metal atomization the

19
00:01:12,350 --> 00:01:10,200
AM RF has concentrated on integrating a

20
00:01:20,109 --> 00:01:12,360
variety of manufacturing components

21
00:01:24,459 --> 00:01:22,539
the first phase was the development of

22
00:01:27,270 --> 00:01:24,469
techniques and software needed to

23
00:01:29,590 --> 00:01:27,280
integrate machines on the shop floor a

24
00:01:31,330 --> 00:01:29,600
great deal of effort was devoted to

25
00:01:45,290 --> 00:01:31,340
simply getting these machines to work

26
00:01:49,710 --> 00:01:48,120
we are now in the second phase of

27
00:01:53,250 --> 00:01:49,720
development concerned with determining

28
00:01:56,220 --> 00:01:53,260
how data needed to manufacture a part is

29
00:01:58,740 --> 00:01:56,230
generated stored is made available when

30
00:02:04,779 --> 00:01:58,750
needed and how to make sure it is in the

31
00:02:09,609 --> 00:02:07,399
to understand the complexities of this

32
00:02:12,170 --> 00:02:09,619
task one must first look at five

33
00:02:16,600 --> 00:02:12,180
manufacturing steps in the factory of

34
00:02:19,970 --> 00:02:16,610
the future designed process planning

35
00:02:24,530 --> 00:02:19,980
offline programming shop floor control

36
00:02:26,900 --> 00:02:24,540
and manufacturing processes the first

37
00:02:28,940 --> 00:02:26,910
step is to create the specifications for

38
00:02:32,839 --> 00:02:28,950

a part with the help of computer-aided

39
00:02:35,449 --> 00:02:32,849
design programs once the part has been

40
00:02:38,360 --> 00:02:35,459
designed using the CAD system and other

41
00:02:40,400 --> 00:02:38,370
engineering analysis tools that data is

42
00:02:44,390 --> 00:02:40,410
communicated to a process planning

43
00:02:46,520 --> 00:02:44,400
system this system determines the steps

44
00:02:49,339 --> 00:02:46,530
to be taken in order to make the part

45
00:02:56,600 --> 00:02:49,349
the kind of tools needed and the

46
00:02:58,880 --> 00:02:56,610
sequence in which they will be used the

47
00:03:01,130 --> 00:02:58,890
next step is to use offline programming

48
00:03:03,289 --> 00:03:01,140
to generate the data to drive each piece

49
00:03:04,960 --> 00:03:03,299
of equipment specified in the process

50
00:03:07,870 --> 00:03:04,970
plan

51
00:03:10,450 --> 00:03:07,880
offline programming along with process

52
00:03:16,030 --> 00:03:10,460
planning and design form the foundation

53
00:03:18,010 --> 00:03:16,040
for concurrent engineering all this data

54
00:03:21,820 --> 00:03:18,020
is then made available to the control

55
00:03:26,800 --> 00:03:21,830
function then the real-time planning and

56
00:03:29,080 --> 00:03:26,810
scheduling of the work can be done the

57
00:03:34,200 --> 00:03:29,090
data is then communicated to a system of

58
00:03:39,880 --> 00:03:34,210
workstations the part is machined

59
00:03:43,680 --> 00:03:39,890
deburred and inspected using the control

60
00:03:45,940 --> 00:03:43,690
and machining system developed by NIS T

61
00:03:47,500 --> 00:03:45,950
the first step in this integrated

62
00:03:49,390 --> 00:03:47,510
process is to build a detailed

63
00:03:52,180 --> 00:03:49,400

architecture which describes the

64
00:03:53,830 --> 00:03:52,190
functionality the relationships and the

65
00:03:57,400 --> 00:03:53,840
interfaces of those manufacturing

66
00:03:59,290 --> 00:03:57,410
components the second step is to provide

67
00:04:00,610 --> 00:03:59,300
the protocols and standards which allow

68
00:04:03,340 --> 00:04:00,620
the computers to talk to one another

69
00:04:05,110 --> 00:04:03,350
across their assigned interfaces the

70
00:04:06,660 --> 00:04:05,120
third step is to provide the standards

71
00:04:08,890 --> 00:04:06,670
which allow for storing retrieving

72
00:04:10,990 --> 00:04:08,900
displaying and exchanging the

73
00:04:15,670 --> 00:04:11,000
information they need to carry out their

74
00:04:17,470 --> 00:04:15,680
assigned functions NIH team strategy was

75
00:04:20,440 --> 00:04:17,480
to develop two separate kinds of

76
00:04:22,240 --> 00:04:20,450
interfaces one to manage the retrieval

77
00:04:26,140 --> 00:04:22,250
of data from a variety of data

78
00:04:28,000 --> 00:04:26,150
repositories and another to enable the

79
00:04:31,390 --> 00:04:28,010
engineering and control functions to

80
00:04:34,570 --> 00:04:31,400
communicate with each other let's

81
00:04:37,420 --> 00:04:34,580
examine the second interface first in

82
00:04:39,730 --> 00:04:37,430
manufacturing a complex part it is often

83
00:04:41,920 --> 00:04:39,740
necessary for a wide variety of CAD

84
00:04:46,120 --> 00:04:41,930
systems at different companies to be

85
00:04:52,090 --> 00:04:48,980
the first attempt to do this was called

86
00:04:55,340 --> 00:04:52,100
ages the initial graphics exchange

87
00:04:57,020 --> 00:04:55,350
specification it provides a neutral

88
00:05:00,080 --> 00:04:57,030

format for the exchange of

89
00:05:02,480 --> 00:05:00,090
computer-aided design data but it has

90
00:05:04,730 --> 00:05:02,490
some limitations for use by downstream

91
00:05:06,909 --> 00:05:04,740
planning and manufacturing process

92
00:05:09,409 --> 00:05:06,919
I just drawing notes and annotations

93
00:05:12,220 --> 00:05:09,419
were really intended for human

94
00:05:15,500 --> 00:05:12,230
consumption tolerance and surface finish

95
00:05:17,960 --> 00:05:15,510
information is not tied directly to the

96
00:05:21,890 --> 00:05:17,970
geometry of the part and this makes it

97
00:05:23,270 --> 00:05:21,900
unusable by automated systems the most

98
00:05:25,850 --> 00:05:23,280
recent attempt to extend the

99
00:05:28,610 --> 00:05:25,860
capabilities of August is called step

100
00:05:33,170 --> 00:05:28,620
the standard for the exchange of product

101
00:05:36,170 --> 00:05:33,180
model data step is intended to support a

102
00:05:38,480 --> 00:05:36,180
wide variety of applications which cover

103
00:05:40,879 --> 00:05:38,490
the life cycle of the product from

104
00:05:43,280 --> 00:05:40,889
design through manufacture and support

105
00:05:46,010 --> 00:05:43,290
the step standard is designed to be

106
00:05:50,120 --> 00:05:46,020
extensible and not limited to file

107
00:05:52,430 --> 00:05:50,130
exchange technology the u.s. effort to

108
00:05:55,340 --> 00:05:52,440
develop the international standard step

109
00:06:00,500 --> 00:05:55,350
is known as pedis which stands for

110
00:06:02,630 --> 00:06:00,510
product data exchange using step a major

111
00:06:04,490 --> 00:06:02,640
focus of the product data sharing effort

112
00:06:06,950 --> 00:06:04,500
is the development of the national PDS

113
00:06:09,050 --> 00:06:06,960

testbed the national PDS testbed will

114
00:06:10,310 --> 00:06:09,060
provide a testing based foundation for

115
00:06:13,700 --> 00:06:10,320
the development of product data

116
00:06:15,879 --> 00:06:13,710
standards the testbed supports PDS Inc a

117
00:06:18,379 --> 00:06:15,889
major industrial consortium the

118
00:06:20,360 --> 00:06:18,389
consortium consists of more than 25

119
00:06:21,980 --> 00:06:20,370
member companies that have a strong

120
00:06:25,000 --> 00:06:21,990
interest in product data sharing

121
00:06:27,890 --> 00:06:25,010
technology the testbed provides systems

122
00:06:30,469 --> 00:06:27,900
software and personnel to these tests

123
00:06:32,750 --> 00:06:30,479
and evaluation efforts what I've

124
00:06:35,659 --> 00:06:32,760
observed is that within the peta sync

125
00:06:37,940 --> 00:06:35,669
effort itself there's an enormous amount

126
00:06:40,190 --> 00:06:37,950
of sharing and that accelerates the

127
00:06:42,590 --> 00:06:40,200
whole process companies that become

128
00:06:44,900 --> 00:06:42,600
involved early on in the pedis

129
00:06:48,590 --> 00:06:44,910
initiative will have a great opportunity

130
00:06:50,990 --> 00:06:48,600
to develop a competitive edge NISD is

131
00:06:53,300 --> 00:06:51,000
also continuing to refine the rest of

132
00:06:54,830 --> 00:06:53,310
the interfaces which drive the functions

133
00:06:58,159 --> 00:06:54,840
that generate all the day

134
00:07:01,730 --> 00:06:58,169
needing to plan schedule manufacture and

135
00:07:03,830 --> 00:07:01,740
inspect each individual part step

136
00:07:06,140 --> 00:07:03,840
provides one of the key interfaces for

137
00:07:08,900 --> 00:07:06,150
exchanging data between manufacturing

138
00:07:11,260 --> 00:07:08,910

functions these interfaces will allow

139
00:07:13,640 --> 00:07:11,270
the paperless exchange of data between

140
00:07:16,520 --> 00:07:13,650
manufacturing functions which control

141
00:07:18,830 --> 00:07:16,530
the flow of production across different

142
00:07:21,890 --> 00:07:18,840
factory equipment three of these

143
00:07:24,500 --> 00:07:21,900
manufacturing functions include process

144
00:07:27,260 --> 00:07:24,510
planning scheduling and offline

145
00:07:30,500 --> 00:07:27,270
programming offline programming is also

146
00:07:34,310 --> 00:07:30,510
used to create simulations or animations

147
00:07:36,980 --> 00:07:34,320
of actual manufacturing activities here

148
00:07:39,140 --> 00:07:36,990
a programmer manipulates a graphical

149
00:07:42,469 --> 00:07:39,150
representation of the robot to perform a

150
00:07:45,680 --> 00:07:42,479
task that he'd like to perform once the

151
00:07:47,480 --> 00:07:45,690
programmer is satisfied that the program

152
00:07:50,000 --> 00:07:47,490
is actually operating the way he'd like

153
00:07:52,250 --> 00:07:50,010
he can then download that information to

154
00:07:55,700 --> 00:07:52,260
an actual robot which will then perform

155
00:07:57,740 --> 00:07:55,710
the task determining the information

156
00:07:59,420 --> 00:07:57,750
that goes across functional components

157
00:08:01,250 --> 00:07:59,430
is one of the main problems of

158
00:08:06,050 --> 00:08:01,260
integrating commercial hardware and

159
00:08:09,050 --> 00:08:06,060
software packages one candidate

160
00:08:13,040 --> 00:08:09,060
developed at NIS T is known as out a

161
00:08:15,409 --> 00:08:13,050
language for process specification Alpes

162
00:08:17,870 --> 00:08:15,419
provides a single representation for

163
00:08:20,750 --> 00:08:17,880

process plans which can be used by

164
00:08:22,940 --> 00:08:20,760
individual shop floor control subsystems

165
00:08:25,940 --> 00:08:22,950
to generate their own plans and

166
00:08:26,810 --> 00:08:25,950
schedules it's important to test the

167
00:08:29,180 --> 00:08:26,820
interaction between the various

168
00:08:31,010 --> 00:08:29,190
subsystems on a factory floor however a

169
00:08:33,019 --> 00:08:31,020
lot of this testing doesn't require any

170
00:08:34,190 --> 00:08:33,029
actual manufacturing to take place what

171
00:08:35,779 --> 00:08:34,200
you're looking for is the orderly

172
00:08:38,870 --> 00:08:35,789
startup and shutdown in the various

173
00:08:41,180 --> 00:08:38,880
systems identifying deadlock situations

174
00:08:43,040 --> 00:08:41,190
or unstable situations so to do that

175
00:08:44,480 --> 00:08:43,050
kind of testing with the actual factory

176
00:08:46,880 --> 00:08:44,490
floor equipment would be prohibitively

177
00:08:48,620 --> 00:08:46,890
expensive instead what's better is to

178
00:08:51,260 --> 00:08:48,630
try and do as much as that testing as

179
00:08:53,900 --> 00:08:51,270
possible with emulated systems and that

180
00:08:55,640 --> 00:08:53,910
way you can identify the weaknesses and

181
00:08:57,500 --> 00:08:55,650
only at the end of the testing phase do

182
00:08:59,280 --> 00:08:57,510
you actually swap in the real factory

183
00:09:01,930 --> 00:08:59,290
floor equipment

184
00:09:04,450 --> 00:09:01,940
the answer was to develop a control

185
00:09:08,080 --> 00:09:04,460
system in which shop floor hardware is

186
00:09:10,810 --> 00:09:08,090
simulated or animated but this is only a

187
00:09:12,730 --> 00:09:10,820
partial test to validate that product

188
00:09:16,870 --> 00:09:12,740

data is communicated completely

189
00:09:19,330 --> 00:09:16,880
accurately and unambiguously to finish

190
00:09:23,470 --> 00:09:19,340
the validation process the software must

191
00:09:25,630 --> 00:09:23,480
also drive the real hardware at the

192
00:09:27,280 --> 00:09:25,640
cleaning and deburring workstation both

193
00:09:30,010 --> 00:09:27,290
types of validation are being

194
00:09:32,470 --> 00:09:30,020
demonstrated the same information used

195
00:09:35,800 --> 00:09:32,480
to drive simulations drives the real

196
00:09:38,470 --> 00:09:35,810
equipment here when the factory sends

197
00:09:40,870 --> 00:09:38,480
information to the workstation you can

198
00:09:42,880 --> 00:09:40,880
no longer tell whether the robot or a

199
00:09:45,490 --> 00:09:42,890
simulation of the robot is actually

200
00:09:47,530 --> 00:09:45,500
performing the operation this allows us

201
00:09:50,080 --> 00:09:47,540
to debug high-level programs without

202
00:09:52,390 --> 00:09:50,090
using the robot the second type of

203
00:09:54,490 --> 00:09:52,400
standards called for by n is T's

204
00:09:55,990 --> 00:09:54,500
strategy our standards for the

205
00:10:01,180 --> 00:09:56,000
structuring and retrieving of

206
00:10:02,740 --> 00:10:01,190
manufacturing data the major problem in

207
00:10:05,470 --> 00:10:02,750
sharing and integrating manufacturing

208
00:10:08,230 --> 00:10:05,480
information is diversity there is no

209
00:10:10,810 --> 00:10:08,240
commonality among database systems

210
00:10:12,280 --> 00:10:10,820
access methods or even the information

211
00:10:14,230 --> 00:10:12,290
model used by the various engineering

212
00:10:16,120 --> 00:10:14,240
systems production management and

213
00:10:20,470 --> 00:10:16,130

scheduling systems and control systems

214
00:10:23,640 --> 00:10:20,480
the solution was M dos the integrated

215
00:10:26,519 --> 00:10:23,650
manufacturing data administration system

216
00:10:29,400 --> 00:10:26,529
this is how it works

217
00:10:32,550 --> 00:10:29,410
when a user needs some data a query is

218
00:10:35,369 --> 00:10:32,560
sent to M dos which takes care of

219
00:10:38,129 --> 00:10:35,379
translation distribution and routing

220
00:10:41,309 --> 00:10:38,139
indus forwards the inquiry on to the

221
00:10:44,249 --> 00:10:41,319
appropriate Data Manager the data may

222
00:10:46,590 --> 00:10:44,259
reside in one computer or in many

223
00:10:50,400 --> 00:10:46,600
computers at locations all over the

224
00:10:54,299 --> 00:10:50,410
country him das receives the information

225
00:10:56,429 --> 00:10:54,309
the user needs and then assembles and

226
00:11:02,429 --> 00:10:56,439
delivers it back to the user in the

227
00:11:07,920 --> 00:11:02,439
appropriate form the entire in distress'

228
00:11:09,540 --> 00:11:07,930
parent to the user M das was originally

229
00:11:11,879 --> 00:11:09,550
designed it solve a very practical

230
00:11:14,179 --> 00:11:11,889
problem access from the control systems

231
00:11:16,350 --> 00:11:14,189
on the MRF floor to geometry information

232
00:11:17,549 --> 00:11:16,360
scheduling information and control

233
00:11:19,350 --> 00:11:17,559
programs and possibly other

234
00:11:22,079 --> 00:11:19,360
manufacturing information wherever it

235
00:11:24,660 --> 00:11:22,089
might reside as it turns out the

236
00:11:26,369 --> 00:11:24,670
standard interfaces the standard forms

237
00:11:28,079 --> 00:11:26,379
of data exchange and the integrating

238
00:11:30,600 --> 00:11:28,089

information model all of which were

239
00:11:32,129 --> 00:11:30,610
necessary to the distributed system may

240
00:11:34,499 --> 00:11:32,139
have turned out to be the most important

241
00:11:35,879 --> 00:11:34,509
parts of the project these systems have

242
00:11:38,129 --> 00:11:35,889
been shown to work with relational

243
00:11:39,990 --> 00:11:38,139
systems with object-oriented systems and

244
00:11:41,160 --> 00:11:40,000
with file systems in short with

245
00:11:45,480 --> 00:11:41,170
virtually any system in which

246
00:11:48,269 --> 00:11:45,490
manufacturing data might design one of a

247
00:11:50,699 --> 00:11:48,279
MRFs goals is to support development of

248
00:11:53,429 --> 00:11:50,709
international standards in all areas of

249
00:11:55,559 --> 00:11:53,439
manufacturing so that it is possible to

250
00:11:57,929 --> 00:11:55,569
easily substitute the hardware and

251
00:12:00,600 --> 00:11:57,939
software of different vendors in the

252
00:12:02,100 --> 00:12:00,610
system what we're trying to do here at

253
00:12:05,840 --> 00:12:02,110
the NIST automated manufacturing

254
00:12:08,069 --> 00:12:05,850
research facility is to do research to

255
00:12:10,619 --> 00:12:08,079
develop better measurement techniques

256
00:12:12,419 --> 00:12:10,629
and to help develop standards for the

257
00:12:14,220 --> 00:12:12,429
effective application of computer

258
00:12:15,319 --> 00:12:14,230
technology to these manufacturing

259
00:12:18,079 --> 00:12:15,329
problems

260
00:12:20,689 --> 00:12:18,089
to compete and win in the international

261
00:12:22,939 --> 00:12:20,699
arena the United States companies are