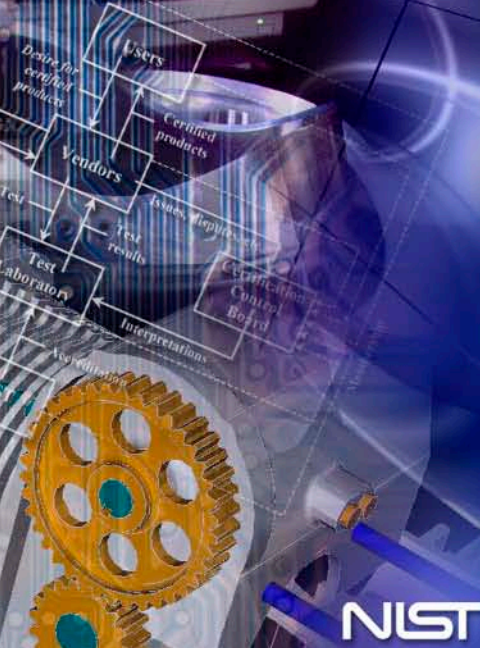


Interoperability



NDIA 12th Annual Systems Engineering Conference The Role of Simulation to Track Mobile Assets Using Automatic Identification Systems

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October 26-29, 2009

NIST

National Institute of Standards and Technology
Technology Administration, U.S. Department of Commerce

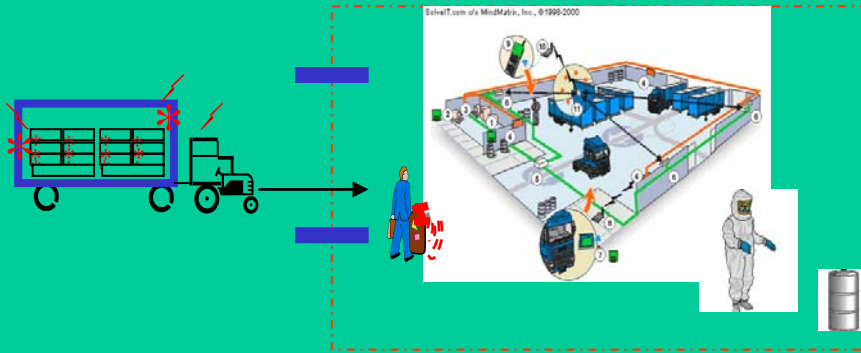
MEL
Innovation & productivity

Introduction

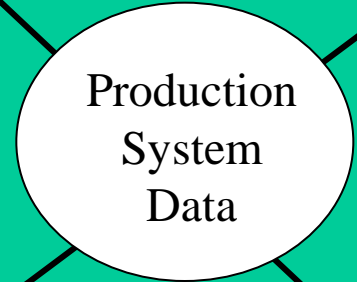
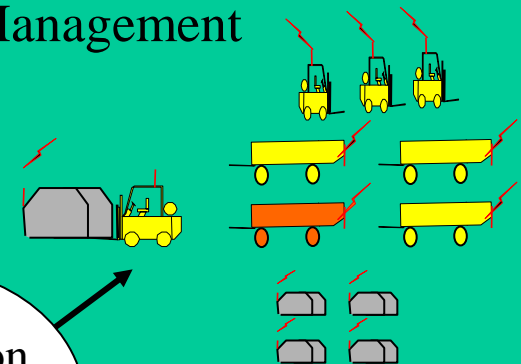
- Boeing is collaborating with the National Institute of Standards and Technology (NIST) to model mobile assets for 777 and 787 final assembly operations
- Evaluations will be applied to assess the business case in the use of auto ID technologies
- NIST Core Manufacturing Simulation Data (CMSD) Information Model
- Boeing Material Handling System discrete event simulation model

A 777 Hypothetical Case

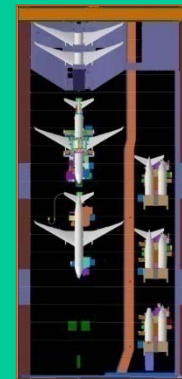
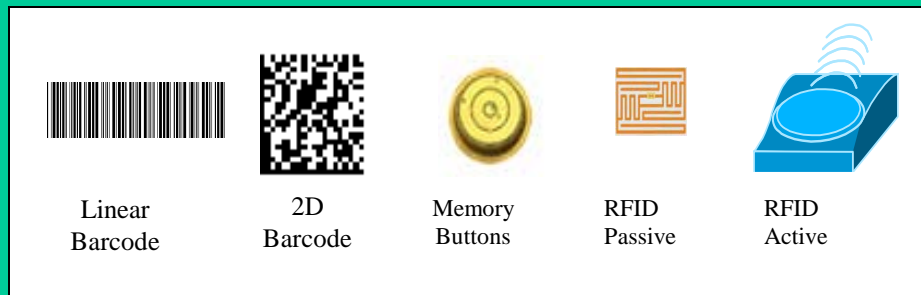
Logistics



Asset / Vehicle / Equipment Management



Sample Automatic Identification Technologies (AIT)



Problem Statement

global businesses, we also know that many are struggling to get the most value out of their investments. From our survey of manufacturing multinationals, we estimate that 80 percent or more of the most global and complex companies are unable to fully exploit their global networks of customers, suppliers, manufacturing, distribution, sales, and service operations. Our analysis suggests that their performance is 50 percent lower than that of similarly large and complex companies with the capabilities to exploit more fully their global network investments.²¹

Peter, "Growing the Global Corporation," Deloitte Research, March 2005.

DARATECH, Inc.



industry update

Vol 17 Issue 4 APRIL 2005

IT for MANUFACTURING, ENGINEERING, CONSTRUCTION AND PLANT OPERATIONS

MUDDY WATERS

Lack of Interoperability Continues to Vex Manufacturing Industry; Diminishes PLM Spoils

Proliferation of Standards & Data Formats Complicate the Issue

By **TIM HICKEY**

Manufacturing industry is abuzz with never-before-realized gains in manufacturing productivity: fewer physical prototypes built now than ever before — in the

Over 95% of all application integration projects fail, according to a 2003 study by The Standish Group International Inc. IT staffs either significantly exceed their budgets, fall behind schedule, or fail to accomplish their goals.

Current Integration Approaches: Leading to Failure

Over 95% of all application integration projects fail, according to a 2003 study by The Standish Group International Inc. IT staffs either significantly exceed their budgets, fall behind schedule, or fail to accomplish their goals.

Lack of interoperability: \$1B/yr to U.S. auto suppliers

\$3.9B/yr in electronics

From "Developing SOA Solutions to Accommodate Variety and Change - A White Paper" by Michael Hoskins, CTO, Pervasive Software

Motivation / Issues

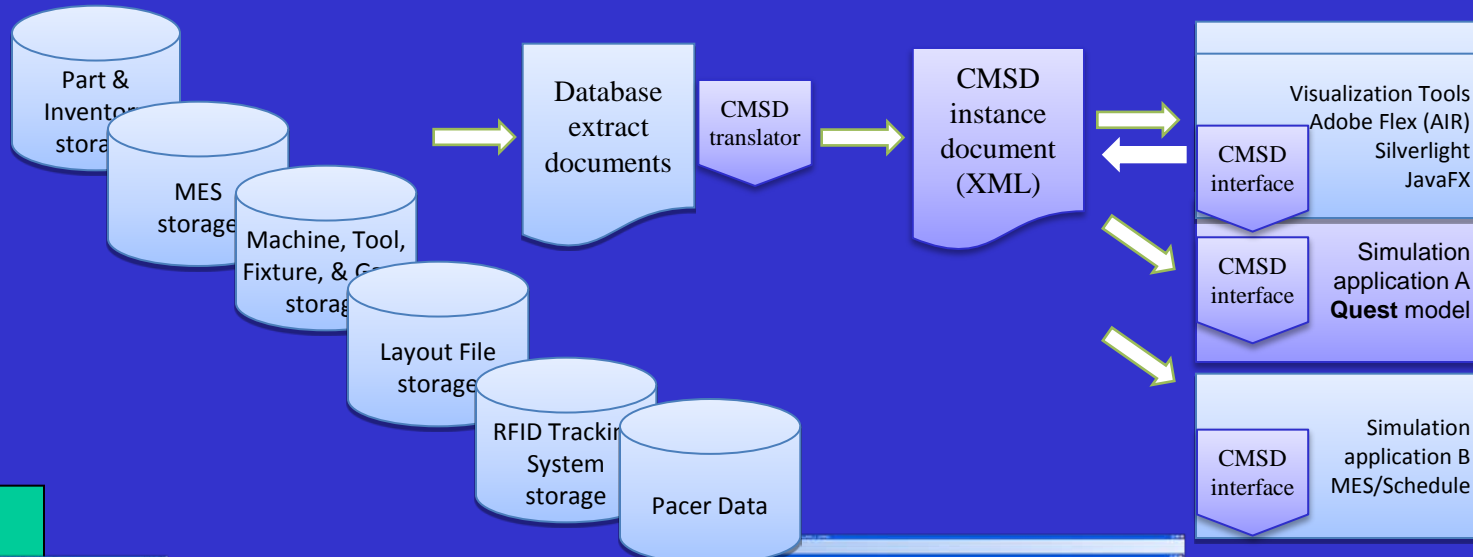
Industry

- Use visualization and simulation to analyze bottleneck and equipment downtime to increase capacity and improve throughput
- Engineers spent too much time and effort to prepare and process input data to simulation
- Engineers take too long to create simulation models

NIST

- Mission: help industry improves productivity and competitiveness with visualization, modeling and simulation
- Validate CMSD: exchange manufacturing resource data
- Require systems integration to address interoperability among manufacturing applications

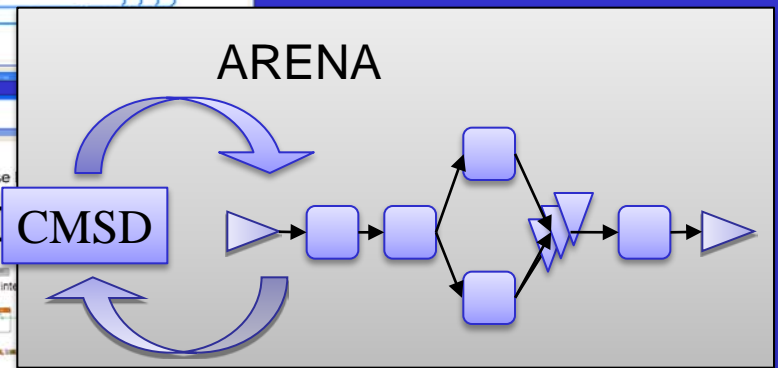
A CMSD Pilot Implementation



Boeing test data set

Two screenshots are shown. The top one is a 'Data source 1' window displaying a list of data entries. The bottom one is a 'Translator' window with fields for 'Input Files', 'CSD path', 'PI path', 'CMSD Output', and 'File path', along with 'Conversion' settings like 'Task threshold (%)' and 'Failure threshold (sec)'.

Two screenshots are shown. The top one is a 'CMSD XML' window displaying XML code for an engine configuration. The bottom one is a 'Plant Simulation' window showing a graphical interface with various components and a 'CMSD instance document (XML)' box overlaid on it.



Plant Simulation

Goal

The CMSD Information Model defines a data specification for efficient exchange of manufacturing data in a manufacturing simulation environment. The specification provides a neutral data format for integrating manufacturing applications and simulation.

- Enable data exchange between manufacturing simulation systems, other software applications, and databases
- Support the construction of manufacturing simulators
- Support testing and evaluation of manufacturing software
- Support manufacturing software application interoperability.

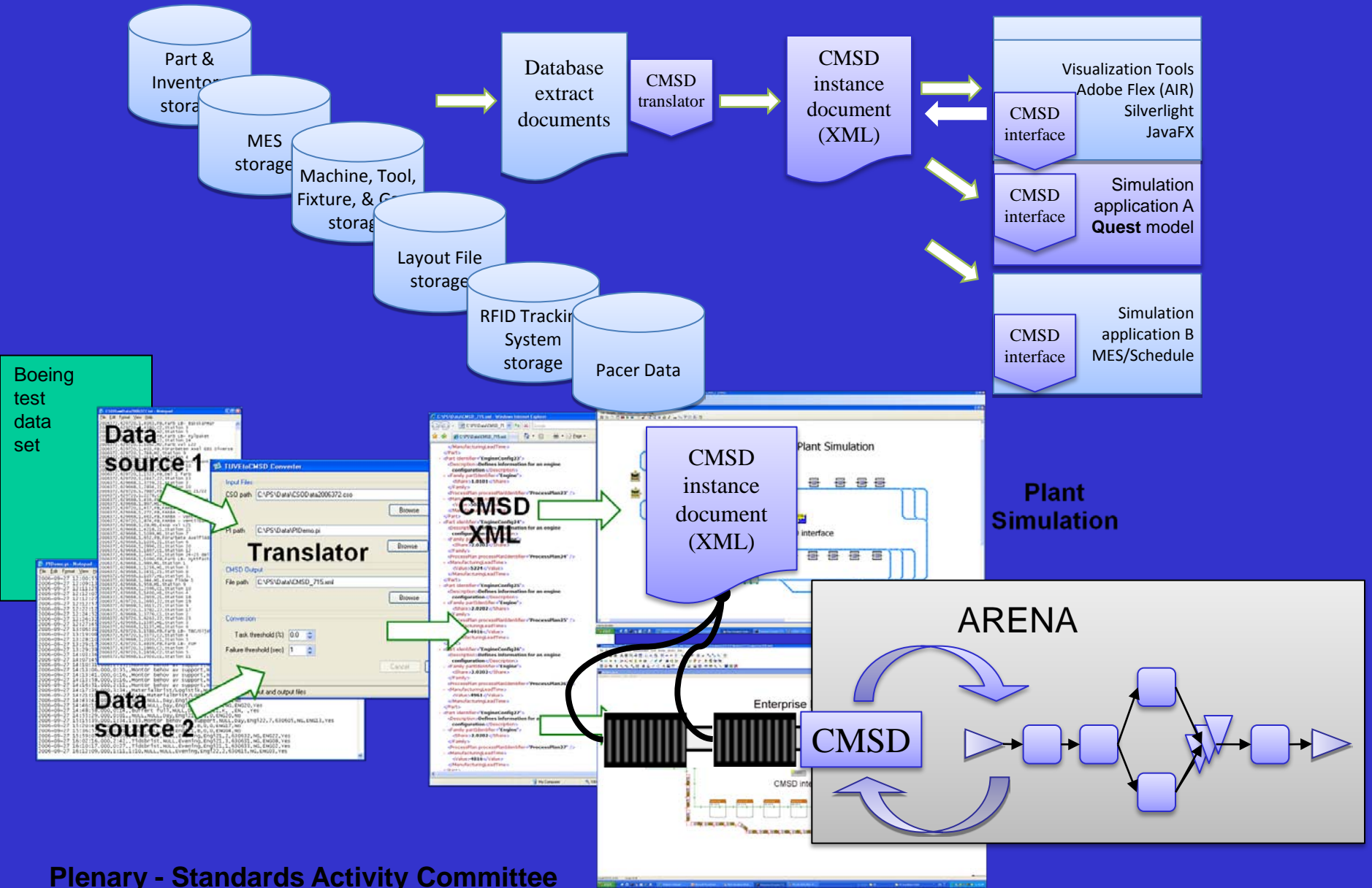
Scope

- The CMSD Information Model describes the entities in the manufacturing domain and the relationship between these entities that are necessary to create manufacturing simulations.
- Manufacturing data includes, but not limited to:
 - Resource information
 - Part and Inventory information
 - Process planning
 - Production operations
- No specification of implementation methods and execution behavior of manufacturing system

Major Data Categories

- Organization
- Calendar
- Schedule
- Work
- Process plan
- Operation definition
- Resource
- Skill definition
- Setup definition
- Part
- Bill-of-Materials
- Inventory
- Maintenance plan
- Revision
- Probability distribution
- Reference

A CMSD Pilot Implementation



Pacer Test Data Set

Microsoft Excel - Input data

ID	Cor	line	CC	Request Time	Response Time	Request Message	Response Message
1	777	774	330	2/15/2009 5:51	2/15/2009 6:27	Ln=774,CC=330,Com=BFE - Small Parts,LnPs=SI Pos #3,Jobs= , Please send me the Galley ch	I'm sorry that job is not avl for line 774
2	15233	777	330	2/15/2009 7:38	2/16/2009 6:07	Ln=775,CC=330,Com=BFE - Galley,LnPs=SI Pos #2,Jobs= , Please send the Door 1 Galley's fl	Good Morning John, We are working on your request.
3	15233	777	330	2/15/2009 7:38	2/16/2009 6:54	Ln=775,CC=330,Com=BFE - Galley,LnPs=SI Pos #2,Jobs= , Please send the Door 1 Galley's fl	Good Morning John, Transportation called @6:32 AM.
4	15234	777	330	2/15/2009 8:02	2/15/2009 8:33	Ln=773,CC=330,Com=Ceiling,LnPs=SI Pos #3,Jobs= IP-000DGU7000W, Please send ceiling	for GU1000 at planeside 2/15
5	15235	777	330	2/15/2009 8:21	2/15/2009 9:26	Ln=775,CC=330,Com=Stowbin,LnPs=SI Pos #2,Jobs= IP-0000003455, IP-0000033238, IP-0000037	cars FWD & AFT centers, 1 cart -30 & -35D closeouts
6	15236	777	330	2/15/2009 8:22	2/16/2009 6:08	Ln=775,CC=330,Com=BFE - Galley,LnPs=SI Pos #2,Jobs= , please send me the FWD center BA	Good Morning John, We are working on your request.
7	15236	777	330	2/15/2009 8:22	2/16/2009 6:54	Ln=775,CC=330,Com=BFE - Galley,LnPs=SI Pos #2,Jobs= , please send me the FWD center BA	Good Morning John, Transportation called @6:32 AM.
8	15237	777	330	2/15/2009 8:45	2/15/2009 9:50	Ln=775,CC=330,Com=Jamco - Lavs,LnPs=SI Pos #2,Jobs= , Please send LAV2A-1L/2A-2L, LAV	tagged and called 2/15/09 10:00
9	15238	777	122	2/16/2009 5:38	2/16/2009 5:49	Ln=772,CC=122,Com=Ceiling,LnPs=F/A 40-25 Pos 1,Jobs= IP-000DGU6201W, IP-000DGU6202W,	I/W
10	15238	777	122	2/16/2009 5:38	2/16/2009 6:07	Ln=772,CC=122,Com=Ceiling,LnPs=F/A 40-25 Pos 1,Jobs= IP-000DGU6201W, IP-000DGU6202W,	Delivered 1 cart thru transportation.
11	15238	777	122	2/16/2009 5:38	2/16/2009 6:25	Ln=772,CC=122,Com=Ceiling,LnPs=F/A 40-25 Pos 1,Jobs= IP-000DGU6201W, IP-000DGU6202W,	correct parts received at planeside 2/16/09 a.m.
12	15239	777	330	2/16/2009 6:01	2/16/2009 8:47	Ln=774,CC=330,Com=BFE - Small Parts,LnPs=SI Pos #3,Jobs= , please send me the Galley chi	Line 774 does not call out for job 14167 per PQR340. So
13	15240	Jarr	122	2/16/2009 7:54	2/16/2009 8:47	Ln=772,CC=122,Com=Jamco - Lavs,LnPs=F/A 40-25 Pos 1,Jobs= , please send 3flc, ip # dgt 61C	all lavs at planeside 2/16
14	15241	Jarr	122	2/16/2009 7:59	2/16/2009 8:47	Ln=772,CC=122,Com=Jamco - Lavs,LnPs=F/A 40-25 Pos 1,Jobs= , please send the other 2 lavs	all your lavs are at planeside 2/16
15	15242	777	140	2/16/2009 8:30	2/16/2009 8:58	Ln=775,CC=140,Com=BFE - Doghouse,LnPs=40-24.2, J-2.5,Jobs= , 1030g53a00000d1030g55a	Good Morning Steven, Will pick & pack your dogs and
16	15243	777	140	2/16/2009 8:33	2/16/2009 9:02	Ln=775,CC=140,Com=Adapter Panels,LnPs=40-24.2, J-2.5,Jobs= , Send all 140 panels please	They are ready and waiting for Trans. to be shipped over.
17	15243	777	140	2/16/2009 8:33	2/16/2009 9:46	Ln=775,CC=140,Com=Adapter Panels,LnPs=40-24.2, J-2.5,Jobs= , Send all 140 panels please	Delivered to Steve Evans for line 775 2/16/09
18	15244	777	122	2/16/2009 9:15	2/16/2009 9:37	Ln=772,CC=122,Com=BFE - Small Parts,LnPs=F/A 40-25 Pos 1,Jobs= , Please send down seat	available at 124w pls paper work thank you.
19	15245	777	122	2/16/2009 9:35	2/16/2009 9:44	Ln=772,CC=122,Com=Ceiling,LnPs=F/A 40-25 Pos 1,Jobs= IP-0000004074, IP-0000004075, Plea	I/W
20	15245	777	122	2/16/2009 9:35	2/16/2009 10:04	Ln=772,CC=122,Com=Ceiling,LnPs=F/A 40-25 Pos 1,Jobs= IP-0000004074, IP-0000004075, Plea	Hi shipping out 4 carts
21	15245	777	122	2/16/2009 9:35	2/16/2009 10:44	Ln=772,CC=122,Com=Ceiling,LnPs=F/A 40-25 Pos 1,Jobs= IP-0000004074, IP-0000004075, Plea	Hi shipping out 4 carts
22	15246	777	122	2/16/2009 14:45	2/16/2009 15:33	Ln=772,CC=330,Com=BFE - Galley Loose Parts Kit,LnPs=F/A 40-25 Pos 1,Jobs= IP-0000014211	have looked around and see nothing left for this a/p, sorr
23	15247	777	330	2/16/2009 15:25	2/16/2009 15:42	Ln=775,CC=330,Com=Crewrest/OSU,LnPs=SI Pos #2,Jobs= , Please send me the dgr8501w and 8503w?	Is this the correct IP? Are you looking for the bur
24	15248	777	330	2/16/2009 15:25	2/16/2009 15:56	Ln=775,CC=330,Com=Crewrest/OSU,LnPs=SI Pos #2,Jobs= , Please send me the dgr8501w and dgr8501w	ready for p/u called trans at 3:50pm. Thanks!!
25	15248	777	330	2/16/2009 15:25	2/16/2009 15:34	Ln=775,CC=330,Com=Crewrest/OSU,LnPs=SI Pos #2,Jobs= , Please send me the dgr8501w and in work	
26	15248	777	330	2/16/2009 15:25	2/16/2009 20:59	Ln=775,CC=330,Com=Crewrest/OSU,LnPs=SI Pos #2,Jobs= , Please send me the dgr8501w and dgr 8501	@ pos#3
27	15248	777	330	2/16/2009 16:21	2/16/2009 21:00	Ln=772,CC=330,Com=Ceiling,LnPs=F/A 40-25 Pos 1,Jobs= , We need the ceiling panels for IP-0C	loc @ pos f/a pos #1
28	15249	777	330	2/16/2009 16:21	2/16/2009 16:33	Ln=772,CC=330,Com=Ceiling,LnPs=F/A 40-25 Pos 1,Jobs= , We need the ceiling panels for IP-0C	in work
29	15249	777	330	2/16/2009 16:21	2/16/2009 17:00	Ln=772,CC=330,Com=Ceiling,LnPs=F/A 40-25 Pos 1,Jobs= , We need the ceiling panels for IP-0C	Hey John - 2 carts , no shorts , at 40-56 trans. aisle. Tra
30	15249	777	330	2/16/2009 16:21	2/16/2009 18:24	Ln=772,CC=122,Com=BFE - Small Parts,LnPs=F/A 40-25 Pos 1,Jobs= , Requesting IP-00DGS8	I have no I-P in BFE with this number, if you are looking f
31	15250	777	122	2/16/2009 17:59	2/16/2009 18:41	Ln=775,CC=330,Com=Crewrest/OSU,LnPs=SI Pos #2,Jobs= IP-000DGR8502W, thanks	in work.
32	15251	777	330	2/16/2009 18:14	2/16/2009 19:41	Ln=775,CC=330,Com=Crewrest/OSU,LnPs=SI Pos #2,Jobs= IP-000DGR8502W, thanks	Sent five units 449W5110-45B,-50B,-51B,-52B,-53B to Ln
33	15251	777	330	2/16/2009 18:14	2/16/2009 20:11	Ln=775,CC=330,Com=Crewrest/OSU,LnPs=SI Pos #2,Jobs= IP-000DGR8502W, thanks	Notified at approximately 7:45 P.M. that the Factory is O
34	15251	777	330	2/16/2009 18:14	2/16/2009 20:58	Ln=775,CC=330,Com=Crewrest/OSU,LnPs=SI Pos #2,Jobs= IP-000DGR8502W, thanks	loc @ pos #3
35	15251	777	330	2/16/2009 18:14	2/16/2009 23:10	Ln=775,CC=330,Com=Crewrest/OSU,LnPs=SI Pos #2,Jobs= IP-000DGR8502W, thanks	Called transportation again, will be delivered after 1st brea
36	15251	777	330	2/16/2009 18:14	2/17/2009 5:14	Ln=775,CC=330,Com=Ceiling,LnPs=SI Pos #3,Jobs= IP-0000041212, IP-0000041213, IP-0000041	forwarding to first shift
37	15257	777	330	2/17/2009 5:14	2/17/2009 5:38	Ln=775,CC=330,Com=Ceiling,LnPs=SI Pos #3,Jobs= IP-0000041212, IP-0000041213, IP-0000041	I/W
38	15257	777	330	2/17/2009 5:14	2/17/2009 7:52	Ln=775,CC=330,Com=Ceiling,LnPs=SI Pos #3,Jobs= IP-0000041212, IP-0000041213, IP-0000041	Hi Kenneth, all IP's are on there wy. waiting for transpo. th
39	15257	777	330	2/17/2009 5:14	2/17/2009 7:40	Ln=773,CC=122,Com=Stowbin,LnPs=F/A 40-25 Pos 1,Jobs= IP-0000022034, IP-0000022035, IP-0	At planeside 2/17/09
40	15258	777	122	2/17/2009 5:21	2/17/2009 5:54	Ln=773,CC=122,Com=Stowbin,LnPs=F/A 40-25 Pos 1,Jobs= IP-0000022034, IP-0000022035, IP-	27 carts in all includes centers- O O O IP-0000022034, IP-
41	15259	777	122	2/17/2009 5:35	2/17/2009 6:08	Ln=773,CC=122,Com=Stowbin,LnPs=F/A 40-25 Pos 1,Jobs= IP-000GW3207W, IP-000GW3208W	I/W
42	15260	777	122	2/17/2009 5:54	2/17/2009 6:08	Ln=773,CC=122,Com=Stowbin,LnPs=F/A 40-25 Pos 1,Jobs= IP-000GW3207W, IP-000GW3208W	I/W
43	15260	777	122	2/17/2009 5:54	2/17/2009 6:08	Ln=773,CC=122,Com=Stowbin,LnPs=F/A 40-25 Pos 1,Jobs= IP-000GW3207W, IP-000GW3208W	I/W
44	15260	777	122	2/17/2009 5:54	2/17/2009 7:48	Ln=773,CC=122,Com=Stowbin,LnPs=F/A 40-25 Pos 1,Jobs= IP-000GW3207W, IP-000GW3208W	At planeside 2/17/09
45	15261	777	122	2/17/2009 6:42	2/17/2009 7:31	Ln=772,CC=122,Com=BFE - Small Parts,LnPs=F/A 40-25 Pos 2,Jobs= IP-000DGA3451W, Please	Avl inside 124W, pls sign for parts
46	15262	777	330	2/17/2009 6:42	2/17/2009 6:56	Ln=774,CC=330,Com=OCAS,LnPs=SI Pos #3,Jobs= , Please send me the OCAS thank you	Good Morning John, Transportation called @6:52 AM.
47	15263	777	122	2/17/2009 7:48	2/17/2009 8:18	Ln=772,CC=122,Com=Ceiling,LnPs=F/A 40-25 Pos 2,Jobs= IP-000DGU6001W, Ceiling pnl. 413w3	I/W
48	15263	777	122	2/17/2009 7:48	2/17/2009 8:34	Ln=772,CC=122,Com=Ceiling,LnPs=F/A 40-25 Pos 2,Jobs= IP-000DGU6001W, Ceiling pnl. 413w3	Good morning James, I spoke to our lead in the shop. The

Raw data / CMSD structure /

- The Pacer data will be mapped into the Core Manufacturing Simulation Data (CMSD) structure

Sorted Pacer Data

Microsoft Excel - Input data

ID	line	Request Time	Response Time	Delivery Location	Commodity
15232	774	2/15/2009 5:51	2/15/2009 6:27	SI Pos #3	BFE - Small Parts
15233	775	2/15/2009 7:38	2/16/2009 6:54	SI Pos #2	BFE - Galley
15234	773	2/15/2009 8:02	2/15/2009 8:33	FBJ	Ceiling
15235	775	2/15/2009 8:21	2/15/2009 9:26	SI Pos #2	Stowbin
15236	775	2/15/2009 8:22	2/16/2009 6:54	SI Pos #2	BFE - Galley
15237	775	2/15/2009 8:45	2/15/2009 9:50	SI Pos #2	Jamco - Lavs
15238	772	2/16/2009 5:38	2/16/2009 13:29	F/A 40-25 Pos 1	Ceiling
15239	774	2/16/2009 6:01	2/16/2009 6:25	SI Pos #3	BFE - Small Parts
15240	772	2/16/2009 7:54	2/16/2009 8:47	F/A 40-25 Pos 1	Jamco - Lavs
15241	772	2/16/2009 7:59	2/16/2009 8:47	F/A 40-25 Pos 1	Jamco - Lavs
15242	775	2/16/2009 8:30	2/16/2009 8:58	40-24.2, J-2.5	BFE - Doghouse
15243	775	2/16/2009 8:33	2/16/2009 9:46	40-24.2, J-2.5	Adapter Panels
15244	772	2/16/2009 9:15	2/16/2009 9:37	F/A 40-25 Pos 1	BFE - Small Parts
15245	772	2/16/2009 9:35	2/16/2009 10:44	F/A 40-25 Pos 1	Ceiling
15246	772	2/16/2009 14:45	2/16/2009 15:33	F/A 40-25 Pos 1	BFE - Galley Loose Parts Kit
15248	775	2/16/2009 15:25	2/16/2009 20:59	SI Pos #2	Crewrest/OSU
15249	772	2/16/2009 16:21	2/16/2009 17:00	F/A 40-25 Pos 1	Ceiling
15250	772	2/16/2009 17:59	2/16/2009 18:24	F/A 40-25 Pos 1	BFE - Small Parts
15251	775	2/16/2009 18:14	2/16/2009 23:10	SI Pos #2	Crewrest/OSU
15257	775	2/17/2009 5:14	2/17/2009 7:52	SI Pos #3	Ceiling
15258	773	2/17/2009 5:21	2/17/2009 7:40	F/A 40-25 Pos 1	Stowbin
15259	773	2/17/2009 5:35	2/17/2009 5:54	F/A 40-25 Pos 1	Stowbin
15260	773	2/17/2009 5:54	2/17/2009 7:48	F/A 40-25 Pos 1	Sidewall
15261	772	2/17/2009 6:42	2/17/2009 7:31	F/A 40-25 Pos 2	BFE - Small Parts
15262	774	2/17/2009 6:42	2/17/2009 6:56	SI Pos #3	OCAS
15263	772	2/17/2009 7:48	2/17/2009 14:05	F/A 40-25 Pos 2	Ceiling
15264	773	2/17/2009 8:43	2/17/2009 8:58	F/A 40-25 Pos 1	Ceiling
15265	772	2/17/2009 9:23	2/17/2009 11:16	F/A 40-25 Pos 2	Carpets
15266	773	2/17/2009 9:35	2/17/2009 9:44	F/A 40-25 Pos 1	Door Liner
15267	773	2/17/2009 9:41	2/17/2009 11:12	F/A 40-25 Pos 1	Sidewall
15268	773	2/17/2009 10:43	2/18/2009 5:51	F/A 40-25 Pos 1	BFE - Galley
15269	772	2/17/2009 10:46	2/17/2009 11:26	F/A 40-25 Pos 1	Carpets
15270	775	2/17/2009 13:33	2/17/2009 14:31	SI Pos #3	BFE - Small Parts
15271	775	2/17/2009 13:43	2/18/2009 5:18	SI Pos #3	OCAS
15272	772	2/17/2009 15:05	2/17/2009 15:11	F/A 40-25 Pos 2	Mats
15273	774	2/17/2009 15:09	2/17/2009 16:04	FBJ	BFE - Small Parts
15274	774	2/17/2009 15:12	2/18/2009 7:02	FBJ	Ceiling
15275	772	2/17/2009 15:15	2/18/2009 5:57	F/A 40-24	Adapter Panels
15276	772	2/17/2009 15:17	2/17/2009 16:35	F/A 40-24	BFE - Small Parts
15277	773	2/17/2009 15:38	2/17/2009 16:36	F/A 40-25 Pos 1	BFE - Small Parts
15278	772	2/17/2009 15:45	2/17/2009 16:36	F/A 40-25 Pos 1	BFE - Small Parts
15279	772	2/17/2009 16:21	2/17/2009 17:36	F/A 40-25 Pos 2	Mats
15281	772	2/17/2009 17:18	2/17/2009 18:14	F/A 40-25 Pos 2	IRC - All
15282	772	2/17/2009 19:11	2/17/2009 20:56	F/A 40-25 Pos 2	Partition
15283	775	2/17/2009 19:27	2/17/2009 20:18	SI Pos #3	BFE - Small Parts
15284	775	2/17/2009 21:30	2/17/2009 22:11	SI Pos #3	Carpets
15285	775	2/18/2009 1:56	2/18/2009 2:43	SI Pos #1	Carpets

- The Pacer test data has been sorted, edited, and ready to be mapped to the CMSD data structures

Sample CMSD XML

The screenshot shows a Windows Internet Explorer browser window with the address bar set to 'C:\Data\CMSD data.xml'. The page content displays XML data for two jobs. The first job has an identifier of 15232, a status of 'started', and an actual effort period from 2/15/2009 5:51:55 AM to 2/15/2009 6:27:57 AM. It includes properties for Line (774), Delivery Location (SI Pos #3), and Commodity (BFE - Small Parts). The second job has an identifier of 15233, a status of 'started', and an actual effort period from 2/15/2009 7:38:27 AM to 2/16/2009 6:54:11 AM. It includes properties for Line (775), Delivery Location (SI Pos #2), and Commodity (BFE - Galley). There are several collapsed job entries at the bottom of the XML structure.

```
<CMSDDocument>  
  <DataSection>  
    <Job>  
      <Identifier>15232</Identifier>  
      <Status>started</Status>  
      <ActualEffort>  
        <StartTime>2/15/2009 5:51:55 AM</StartTime>  
        <EndTime>2/15/2009 6:27:57 AM</EndTime>  
      <Property>  
        <Name>Line</Name>  
        <Value>774</Value>  
      </Property>  
      <Property>  
        <Name>DeliveryLocation</Name>  
        <Value>SI Pos #3</Value>  
      </Property>  
      <Property>  
        <Name>Commodity</Name>  
        <Value>BFE - Small Parts</Value>  
      </Property>  
    </ActualEffort>  
  </Job>  
  <Job>  
    <Identifier>15233</Identifier>  
    <Status>started</Status>  
    <ActualEffort>  
      <StartTime>2/15/2009 7:38:27 AM</StartTime>  
      <EndTime>2/16/2009 6:54:11 AM</EndTime>  
    <Property>  
      <Name>Line</Name>  
      <Value>775</Value>  
    </Property>  
    <Property>  
      <Name>DeliveryLocation</Name>  
      <Value>SI Pos #2</Value>  
    </Property>  
    <Property>  
      <Name>Commodity</Name>  
      <Value>BFE - Galley</Value>  
    </Property>  
  </ActualEffort>  
</Job>  
+ <Job>  
+ <Job>  
+ <Job>  
+ <Job>  
+ <Job>  
+ <Job>  
+ <Job>  
+ <Job>  
</h>
```

- The first row of the Excel file mapped into the CMSD structure

A Hypothetical Case Simulation

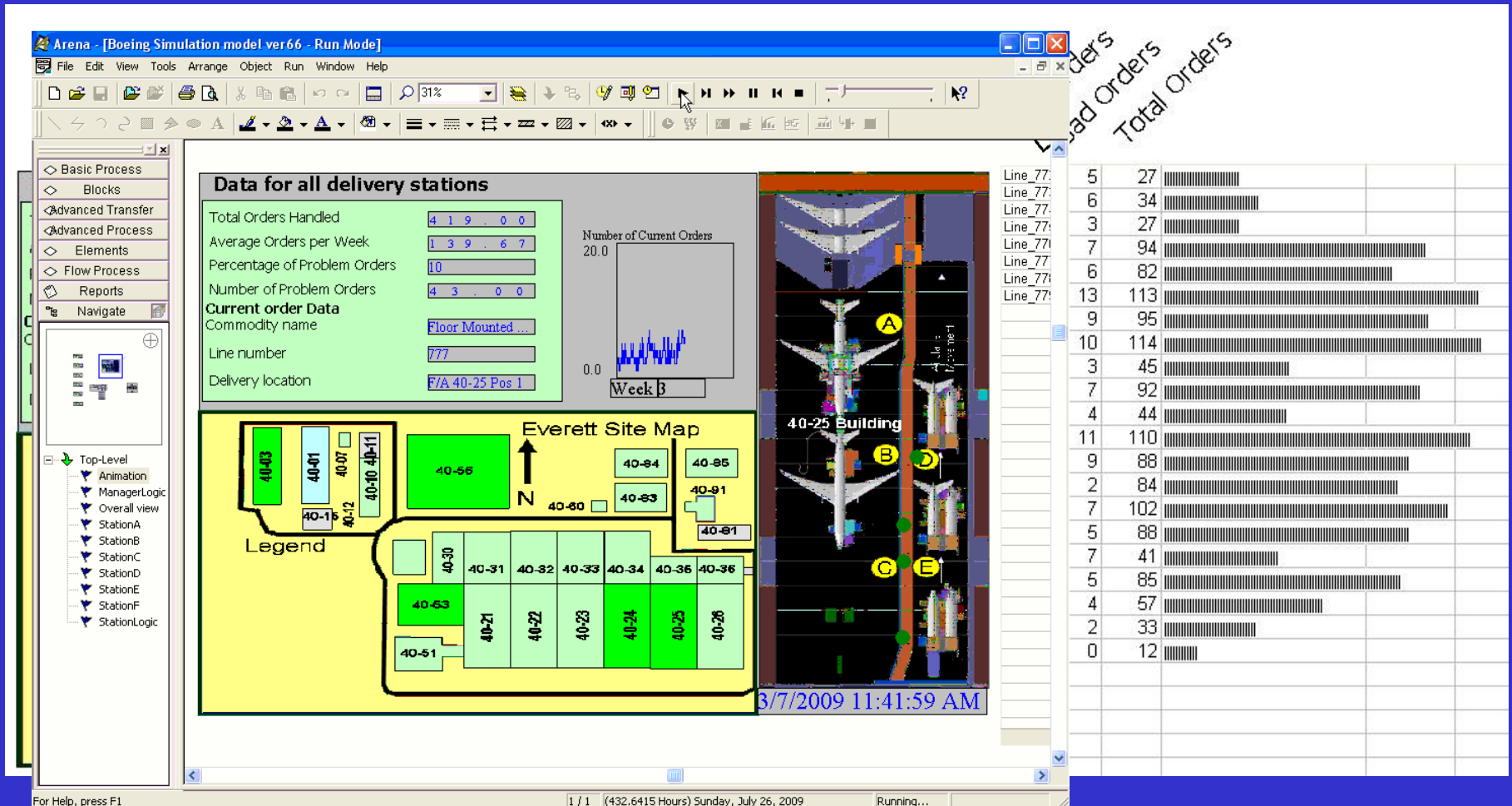
The screenshot displays a simulation software interface with several components:

- Data for all delivery stations:** A control panel with input fields for Total Orders Handled, Average Orders per Week, Percentage of Problem Orders, Number of Problem Orders, Current order Data (Commodity name, Line number, Delivery location), and Number of Current Orders.
- Everett Site Map:** A 2D map showing various delivery stations (e.g., 40-01, 40-02, 40-03, 40-04, 40-05, 40-06, 40-07, 40-08, 40-09, 40-10, 40-11, 40-12, 40-13, 40-14, 40-15, 40-16, 40-17, 40-18, 40-19, 40-20, 40-21, 40-22, 40-23, 40-24, 40-25, 40-26, 40-27, 40-28, 40-29, 40-30, 40-31, 40-32, 40-33, 40-34, 40-35, 40-36, 40-37, 40-38, 40-39, 40-40, 40-41, 40-42, 40-43, 40-44, 40-45, 40-46, 40-47, 40-48, 40-49, 40-50, 40-51, 40-52, 40-53, 40-54, 40-55, 40-56, 40-57, 40-58, 40-59, 40-60, 40-61, 40-62, 40-63, 40-64, 40-65, 40-66, 40-67, 40-68, 40-69, 40-70, 40-71, 40-72, 40-73, 40-74, 40-75, 40-76, 40-77, 40-78, 40-79, 40-80, 40-81, 40-82, 40-83, 40-84, 40-85, 40-86, 40-87, 40-88, 40-89, 40-90, 40-91, 40-92, 40-93, 40-94, 40-95, 40-96, 40-97, 40-98, 40-99, 40-100) and a legend.
- 3D Building Model:** A 3D rendering of a building structure with labels A, B, C, D, and E.
- Data Table:** A table showing the following data:

Line Number	Good Orders	Bad Orders	Total Orders
Line_772	24	3	27
Line_773	31	3	34
Line_774	27	0	27
Line_775	90	4	94
Line_776	77	5	82
Line_777	107	6	113
Line_778	92	2	94
- Dialog Box:** A dialog box titled "Enter Percentage for Problem Orders" with a text input field containing the value "5" and an "OK" button.

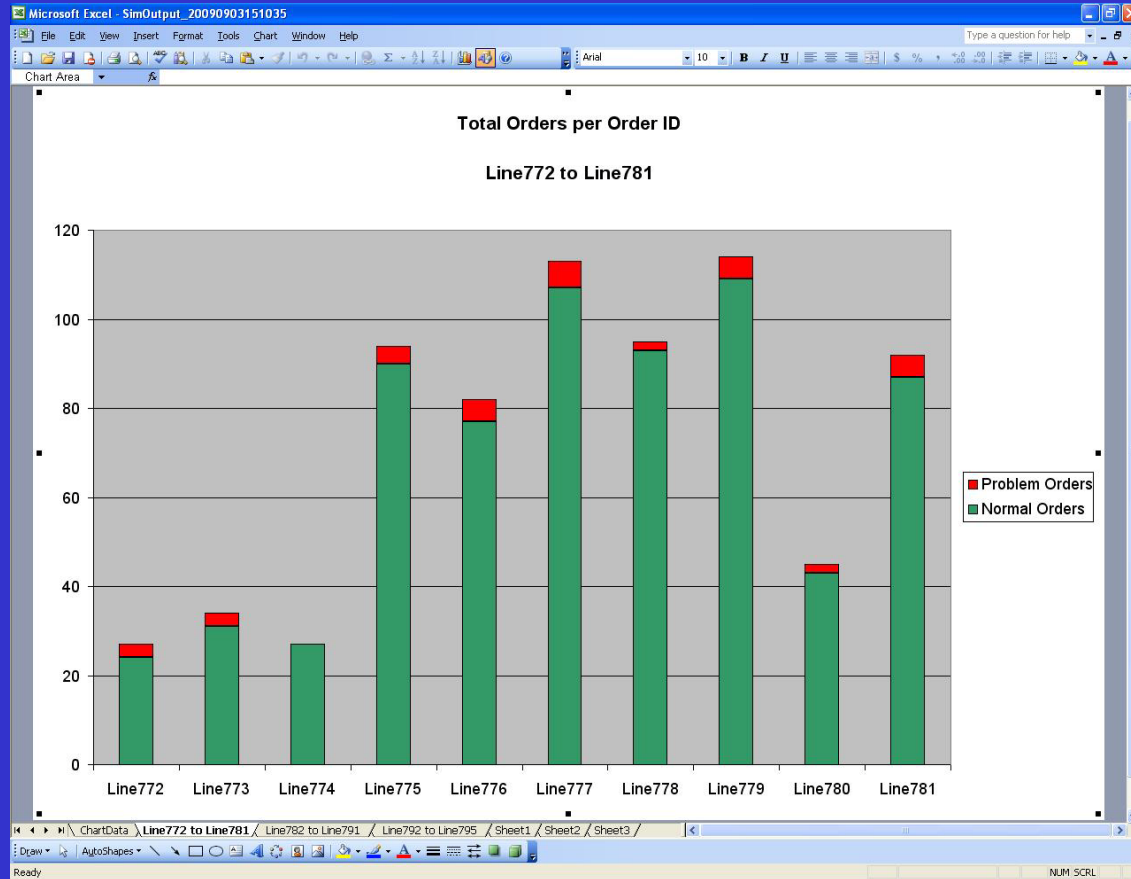
- Develop a front end for manufacturing engineer to perform what-if scenarios and iterations of simulation and analysis

Sample Arena output



- Arena animation and bar chart for the total number of delivery orders processed.

Sample Arena output



- Total number of orders per line number in Microsoft Excel

Value Stream Mapping to Quest Model

The screenshot displays a Microsoft Visio window titled "CMSLayoutData.vsd - Microsoft Visio". The main canvas shows a Value Stream Map (VSM) diagram with six processes arranged in two rows. Each process is represented by a rectangular box containing a table with specific data. The processes are connected by dashed arrows indicating the flow of materials or information.

Process 1 (A010)

Cycle Time	5	Min
Workstation	A	Unit
Product	Product	Unit

Process 2 (A020)

Cycle Time	3	Min
Workstation	B	Unit
Product	Product	Unit

Process 3 (A030)

Cycle Time	24	Min
Workstation	C	Unit
Product	Product	Unit

Process 4 (A040)

Cycle Time		
Workstation		
Product		

Process 5 (A050)

Cycle Time	2	Min
Workstation	E	Unit
Product	Product	Unit

Process 6 (A060)

Cycle Time	25	Min
Workstation	F	Unit
Product	Product	Unit

The diagram also includes a "Shapes" pane on the left with a search bar and a list of shapes, and a "Custom Properties" pane on the right showing "No Custom Properties". The status bar at the bottom indicates "Page 1 | Layout" and "Page 1/2".

Value Stream Mapping process data to a basic Delmia Quest Model

Industry

- Use visualization and simulation to meet the DoD's Manufacturing Readiness Level (MRL) : Value Stream Map (VSM) process data and simulation to demonstrate manufacturing readiness.
- Engineers spent too much time and effort to prepare and process input data to simulation
- Engineers take too long to create simulation models

Automatically create a basic Delmia Quest Model from Value Stream Mapping (VSM) process data.

Simulation Standards Consortium

Government

- *Modeling & Simulation Coordination Office*
- *NIST (Coordinator)*
- *DoD/Air Force Research Lab*

Software Vendors

- *Brooks Automation - AutoSimulation*
- *Delmia Company*
- *Siemen/UGS Plant Simulation*
- *Enterprise Dynamics*
- *Geer Mountain Software*
- *ProModel Corporation*
- *Rockwell Software – Arena*
- *Flexsim*
- *Simul8*
- *Visual Component*
- *Virtools*
- *Witness*
- *Wolverine Software*

Industry

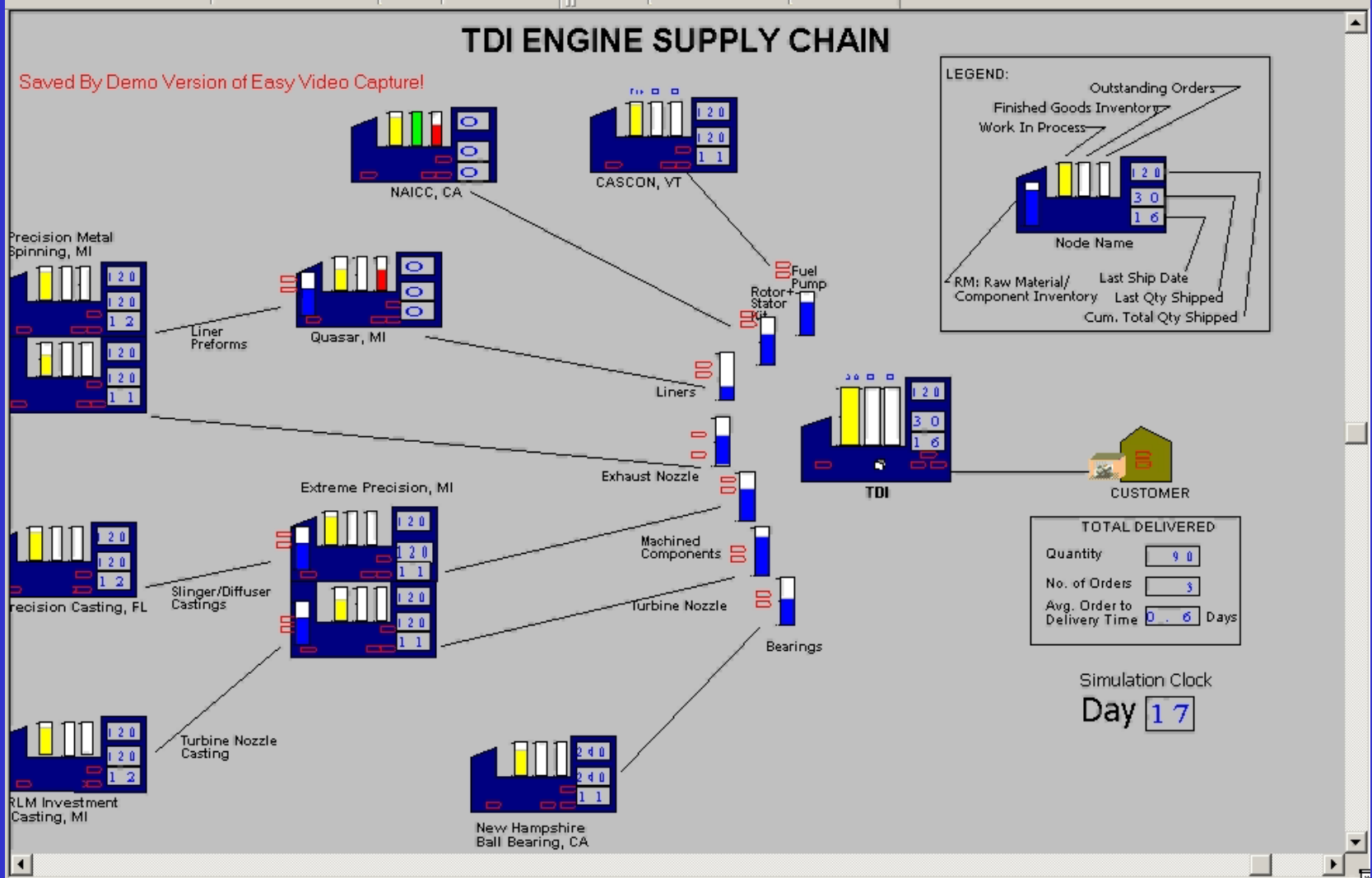
- *The Boeing Company*
- *Volvo Car Company*
- *Lockheed Martin*
- *Raytheon*
- *Rockwell Collins*
- *Connecticut Center for Advanced Technology*
- *CostVision*
- *DSN Innovations*
- *Ford Motor Company*
- *General Motors*
- *John Deere*

Academia

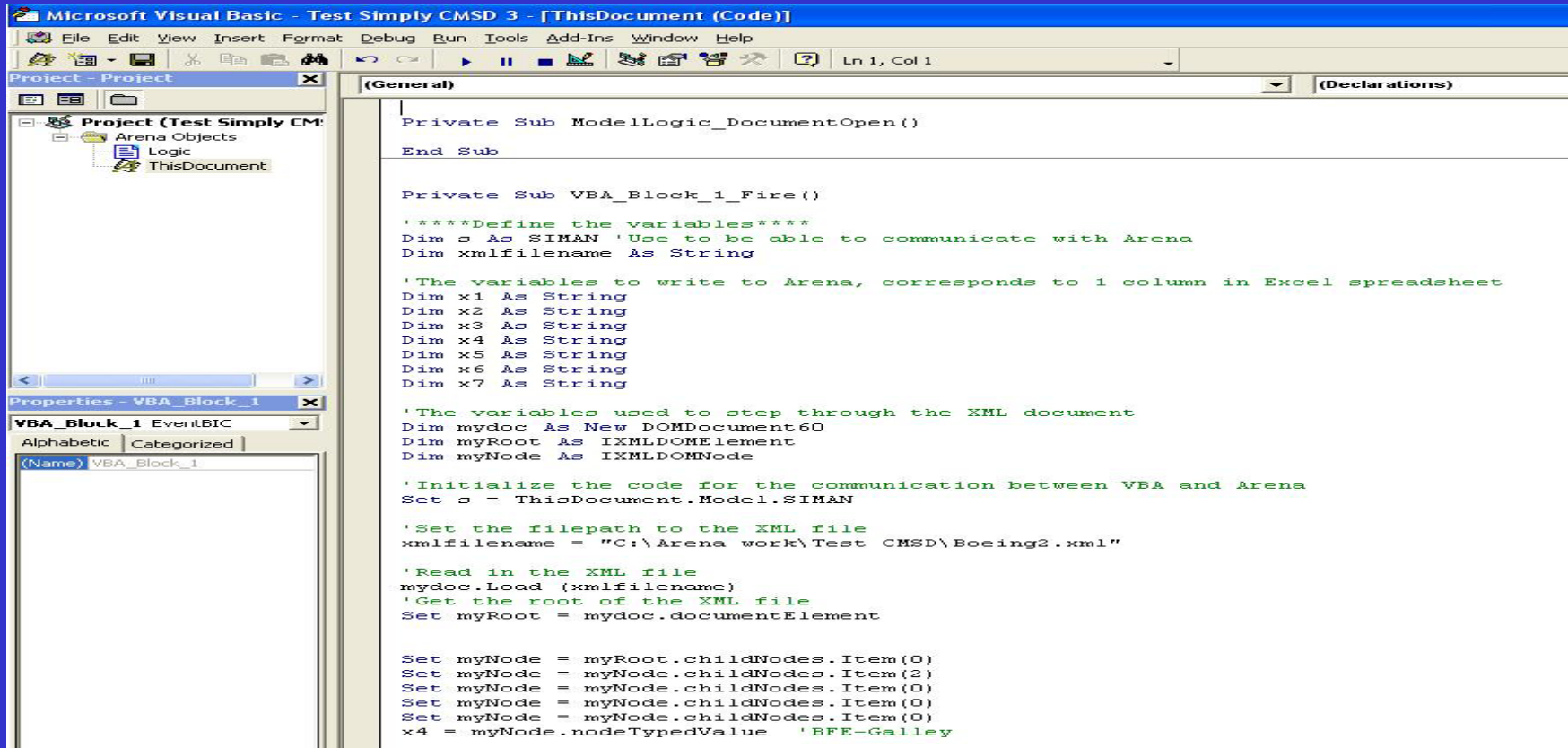
- *Chalmers University*
- *George Washington University*
- *University of Arizona*
- *Georgia Tech*
- *Florida International University*
- *Carnegie Mellon University*

Q&A

Supply Chain Simulation



Sample CMSD interface to Arena



The screenshot shows the Microsoft Visual Basic editor window titled "Test Simply CMSD 3 - [ThisDocument (Code)]". The interface includes a menu bar (File, Edit, View, Insert, Format, Debug, Run, Tools, Add-Ins, Window, Help), a toolbar, and a Project Explorer on the left. The Project Explorer shows a project named "Test Simply CMSD" with sub-items "Arena Objects", "Logic", and "ThisDocument". The Properties window shows "VBA_Block_1" with "EventBIC" selected. The main code window displays the following VBA code:

```
(General) (Declarations)

Private Sub ModelLogic_DocumentOpen()
End Sub

Private Sub VBA_Block_1_Fire()
'****Define the variables****
Dim s As SIMAN 'Use to be able to communicate with Arena
Dim xmlfilename As String

'The variables to write to Arena, corresponds to 1 column in Excel spreadsheet
Dim x1 As String
Dim x2 As String
Dim x3 As String
Dim x4 As String
Dim x5 As String
Dim x6 As String
Dim x7 As String

'The variables used to step through the XML document
Dim mydoc As New DOMDocument60
Dim myRoot As IXMLDOMElement
Dim myNode As IXMLDOMNode

'Initialize the code for the communication between VBA and Arena
Set s = ThisDocument.Model.SIMAN

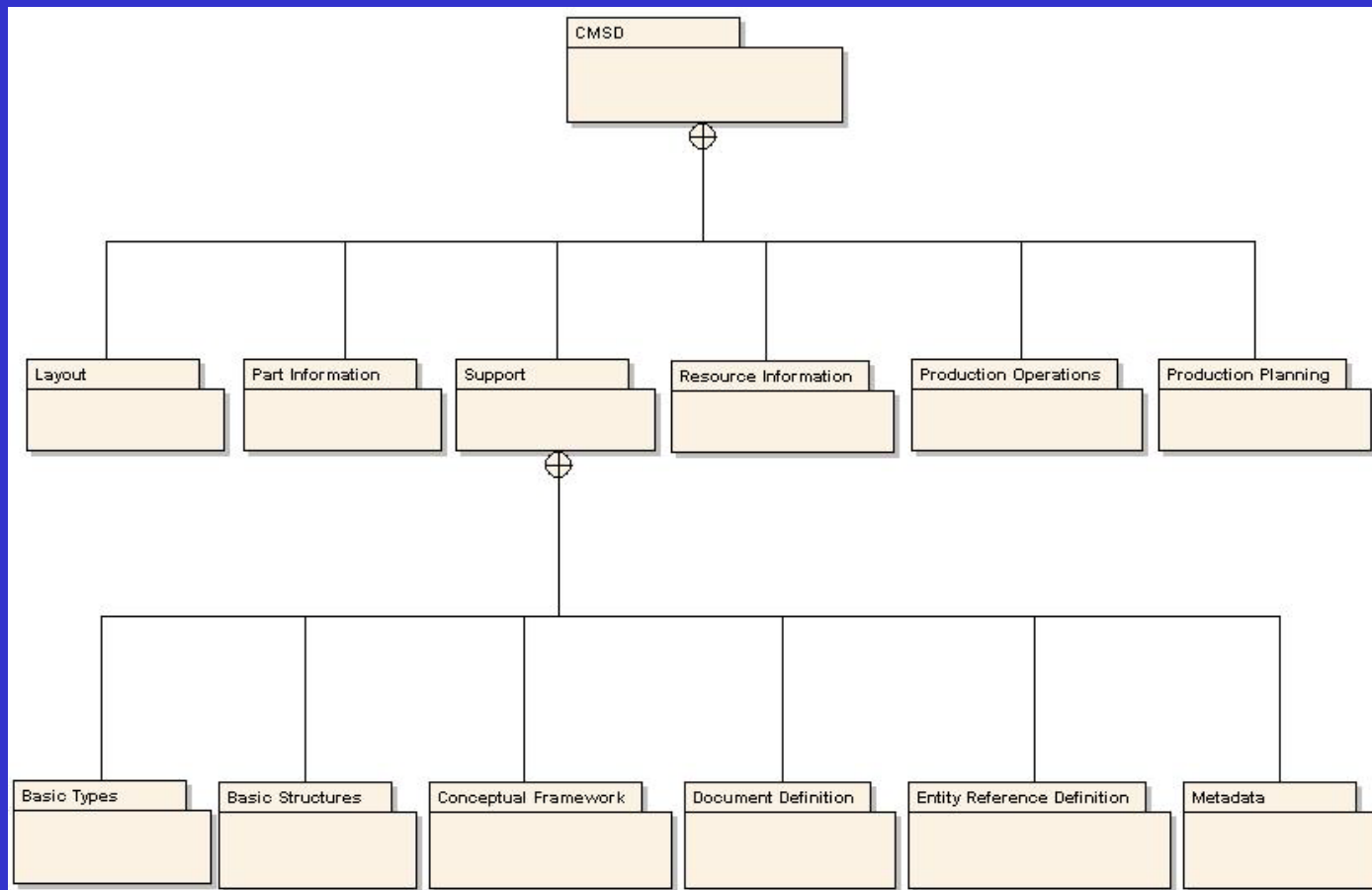
'Set the filepath to the XML file
xmlfilename = "C:\Arena work\Test CMSD\Boeing2.xml"

'Read in the XML file
mydoc.Load (xmlfilename)
'Get the root of the XML file
Set myRoot = mydoc.documentElement

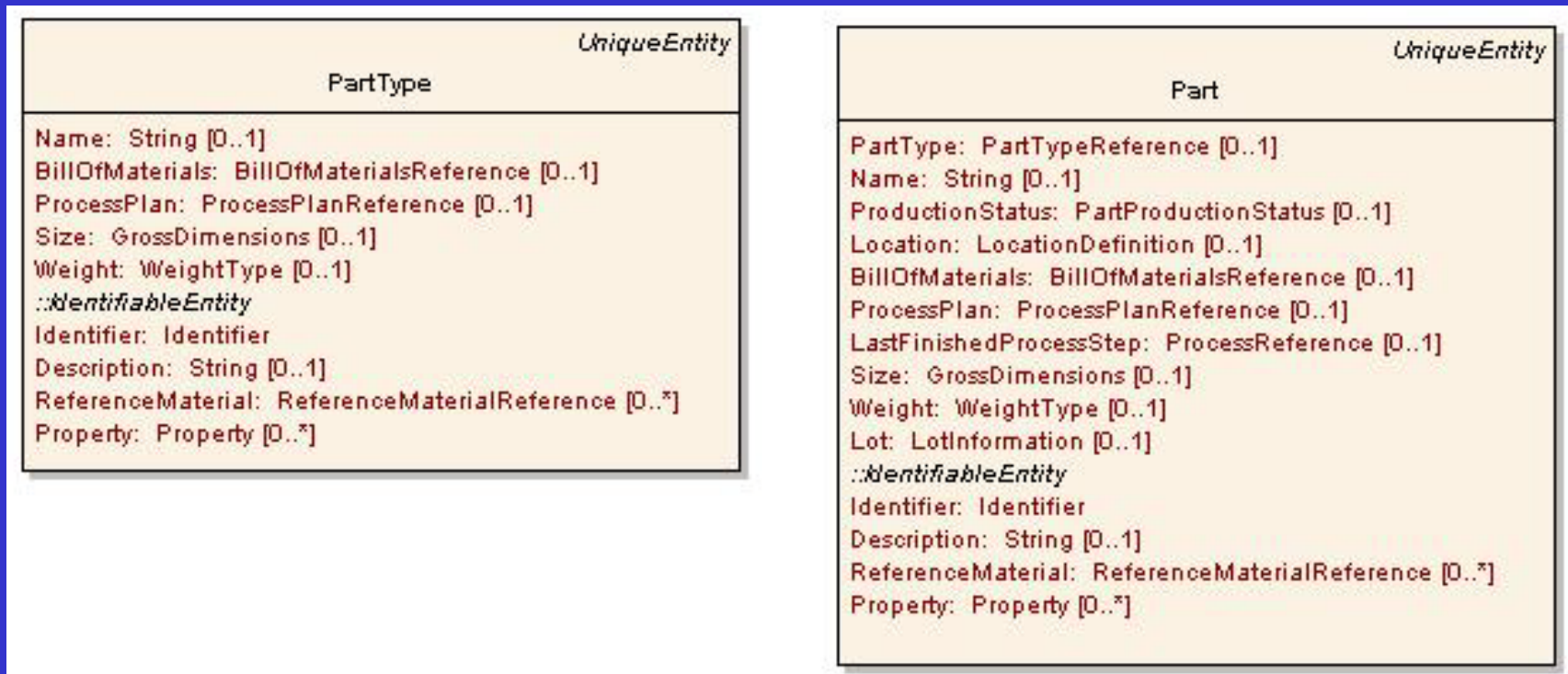
Set myNode = myRoot.childNodes.Item(0)
Set myNode = myNode.childNodes.Item(2)
Set myNode = myNode.childNodes.Item(0)
Set myNode = myNode.childNodes.Item(0)
Set myNode = myNode.childNodes.Item(0)
x4 = myNode.nodeTypeValue 'BFE-Galley
```

- Sample VBA script in Arena
- Using the XML DOM standard to read in the CMSD XML file
- Use Arena SIMAN code to set the variables in Arena model

Sample CMSD UML Diagram



Sample CMSD UML Diagram



Sample Arena output

Arena - [Boeing Simulation model ver66 - Run Mode]

File Edit View Tools Arrange Object Run Window Help

31%

Data for all delivery stations

Total Orders Handled	4 1 9 . 0 0
Average Orders per Week	1 3 9 . 6 7
Percentage of Problem Orders	10
Number of Problem Orders	4 3 . 0 0

Current order Data

Commodity name: Floor Mounted ...

Line number: 777

Delivery location: F/A 40-25 Pos 1

Number of Current Orders

Week 3

Everett Site Map

40-25 Building

3/7/2009 11:41:59 AM

Line 77:
Line 77:
Line 77:
Line 77:
Line 77:
Line 77:
Line 77:
Line 77:

For Help, press F1

1 / 1 (432.6415 Hours) Sunday, July 26, 2009

Running...

- Arena animation and bar chart for the total number of delivery orders processed.