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

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

MEL
innovation & productivity

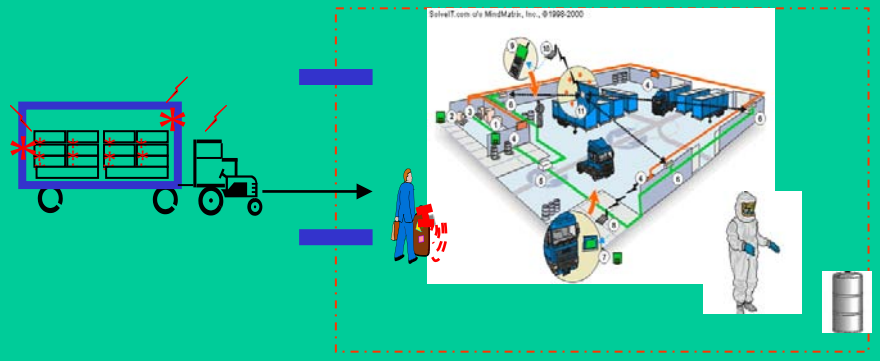
Introduction

- 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

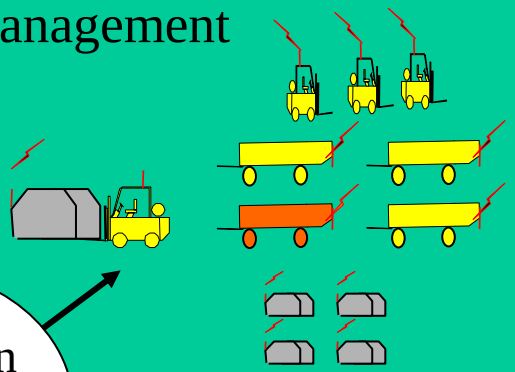
- NIST Core Manufacturing Simulation Data (CMSD) Information Model
- Boeing Material Handling System discrete event simulation model

A 777 Hypothetical Case

Logistics



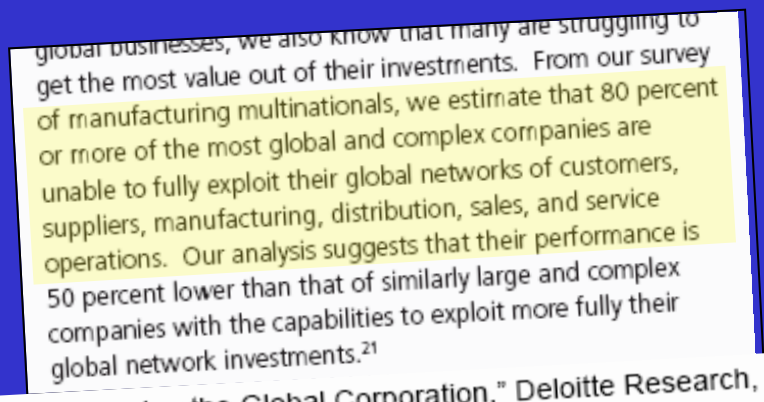
Asset /Vehicle / Equipment Management



Production System Data

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

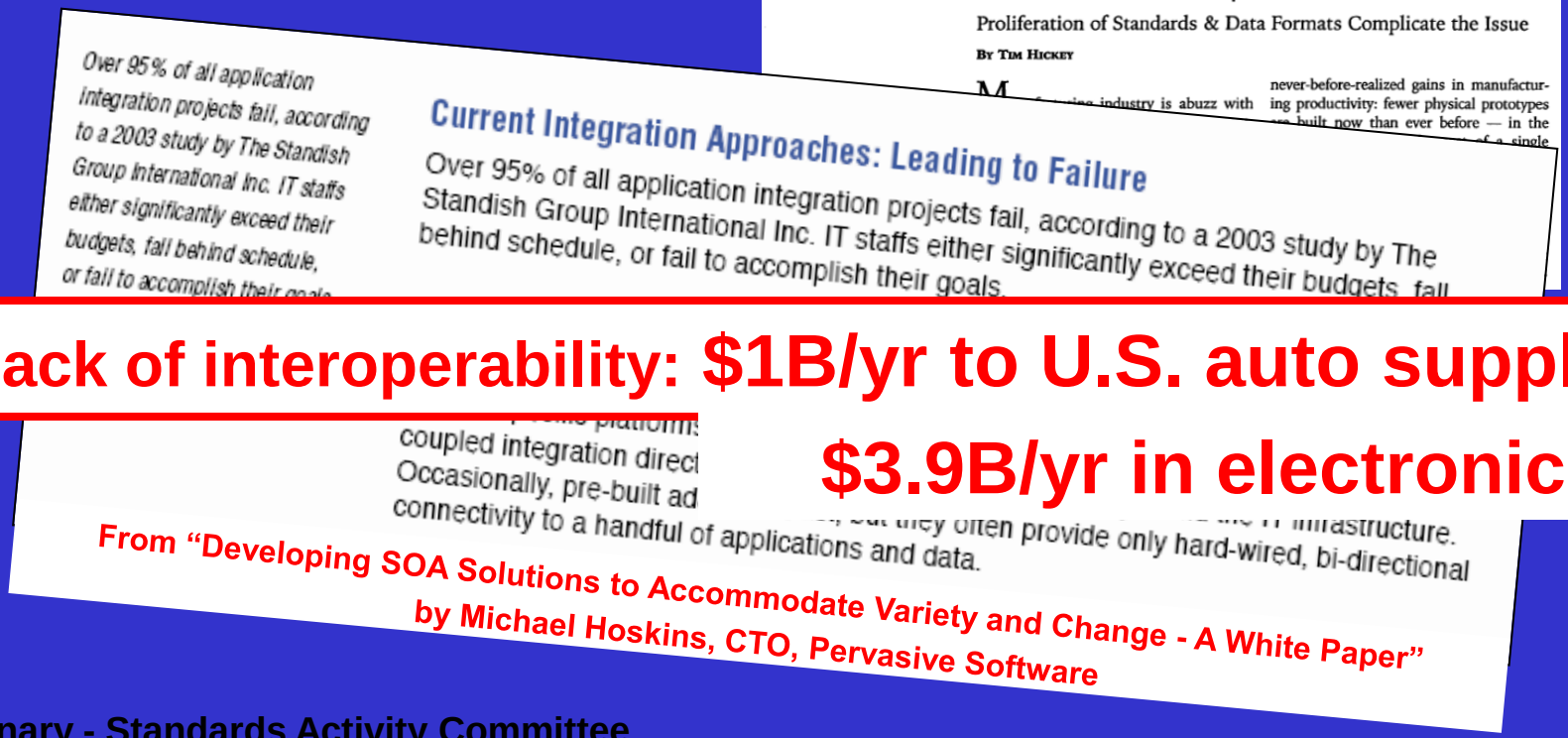
MUDDY WATERS

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

Proliferation of Standards & Data Formats Complicate the Issue

By Tim Hickey

never-before-realized gains in manufacturing productivity: fewer physical prototypes


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.

coupled integration direct

Occasionally, pre-built ad

connectivity to a handful of applications and data.

they often provide only hard-wired, bi-directional

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

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

$3.9B/yr in electronics

Motivation / Issues

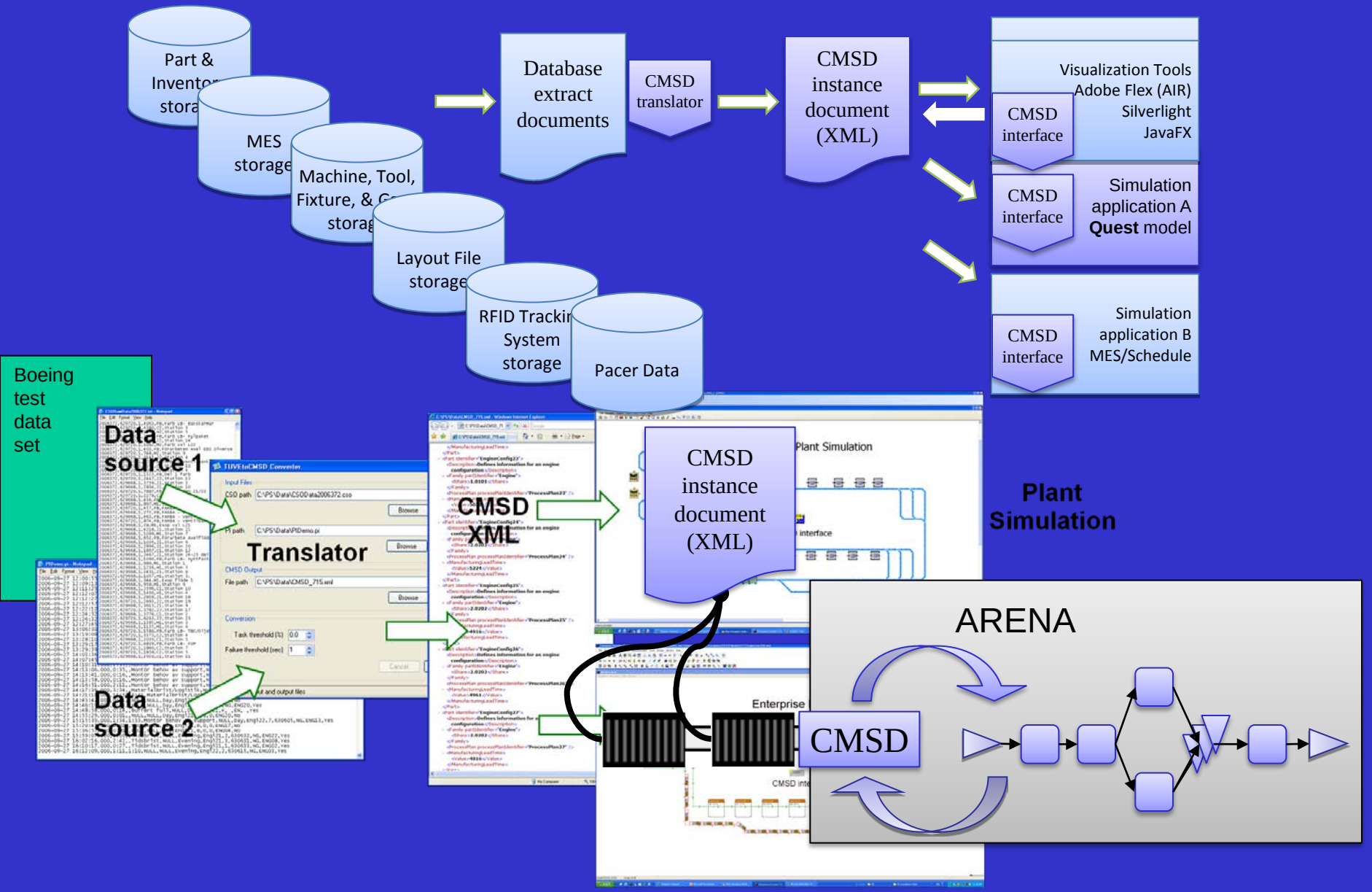
Industry

- 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



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.

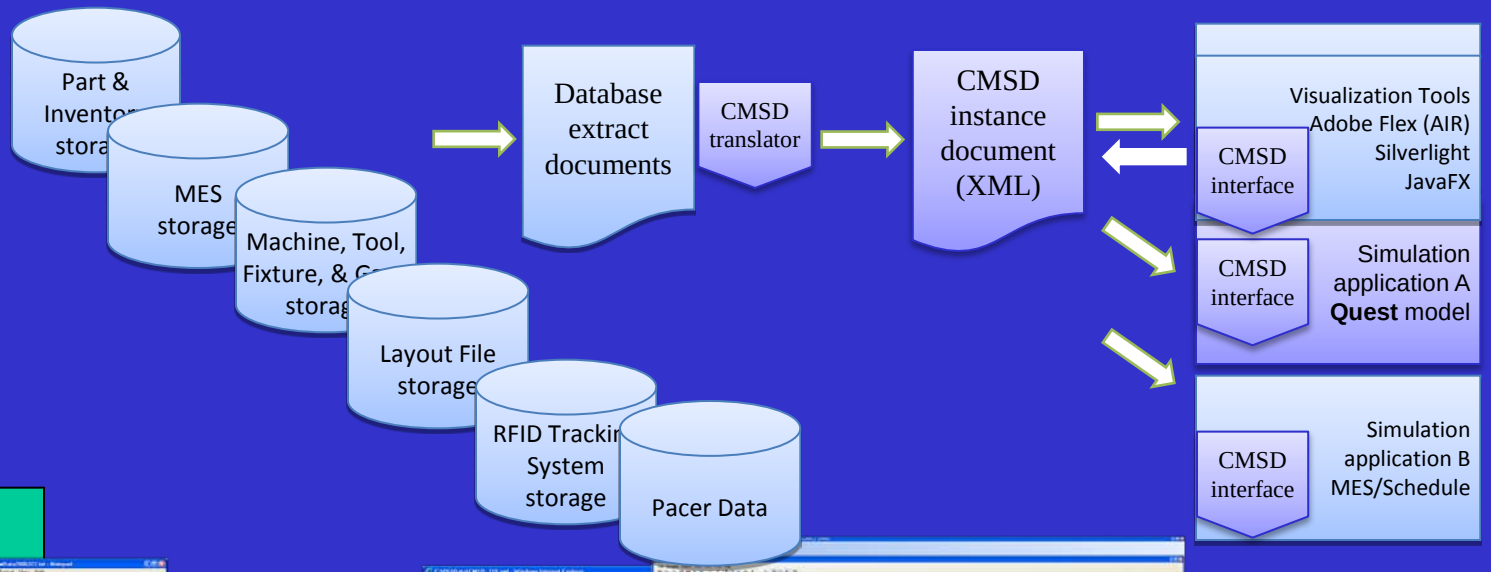
Scope

- 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

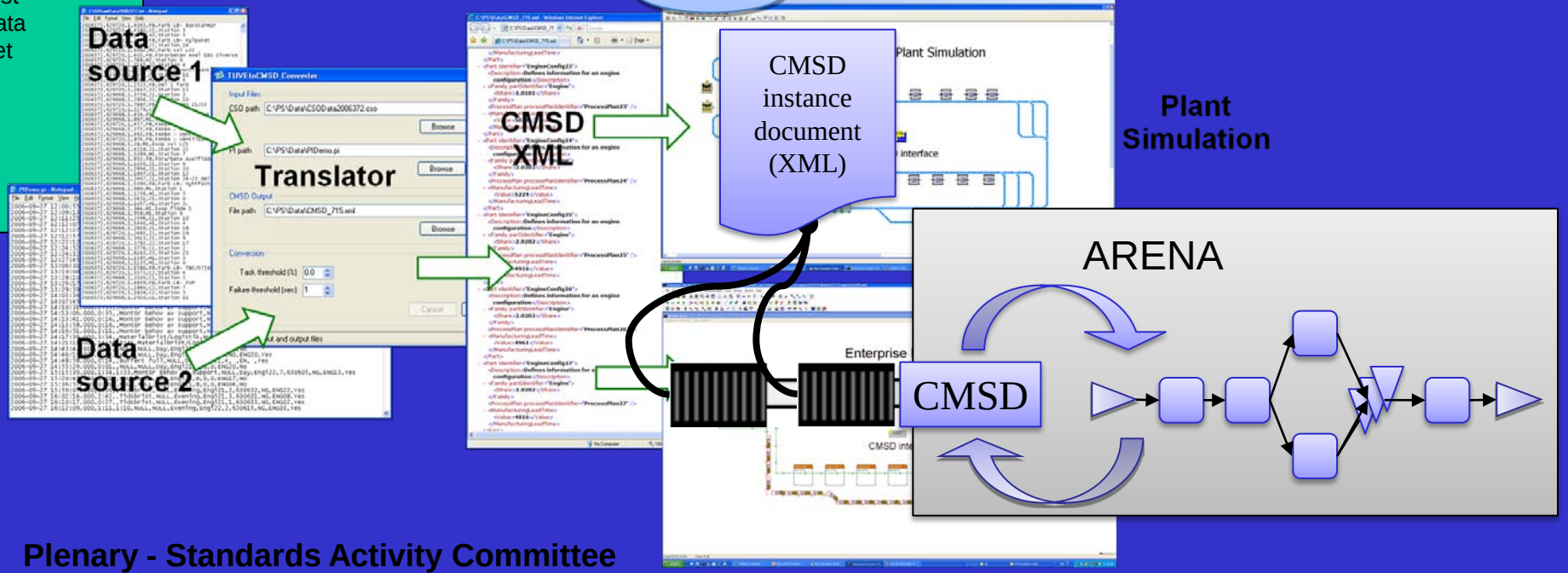
Major Data Categories

- 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



Boeing test data set



Pacer Test Data Set

Microsoft Excel - Input data

File Edit View Insert Format Tools Data Window Help

A2 15232

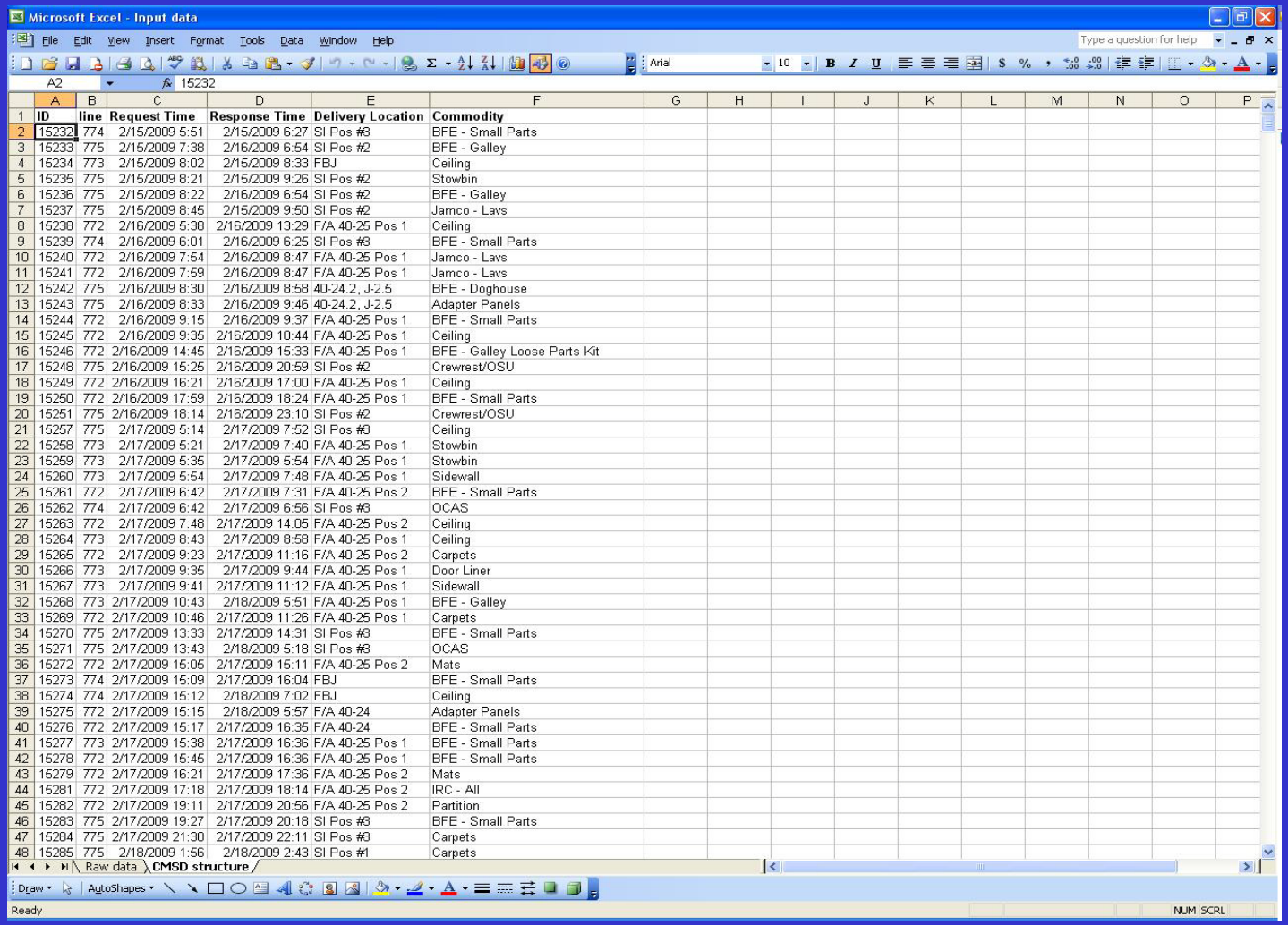
	A	B	C	D	E	F	G	H
1	ID	Cor	line	CC	Request Time	Response Time	Request Message	Response Message
2	15232	777	774	330	2/15/2009 5:51	2/15/2009 6:27	Ln=774,CC=330,Com=BFE - Small Parts,LnPs=SI Pos #3,Jobs= , Please send me the Galley ch	I'm soory that job is not avl. for line 774
3	15233	777	775	330	2/15/2009 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 f1 f	Good Morning John,□□ We are working on your request.
4	15233	777	775	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 f1 f	Good Morning John,□□ Transportation called @6:32 AM.
5	15234	777	773	330	2/15/2009 8:02	2/15/2009 8:33	Ln=773,CC=330,Com=Ceiling,LnPs=FBJ,Jobs= IP-00DGU7000W, Please send ceiling for GU1000	at planeside 2/15
6	15235	777	775	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-000003	7 carts FWD & AFT centers, 1 cart -30 & -35D closeouts
7	15236	777	775	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.
8	15236	777	775	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.
9	15237	Jam	772	122	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, LA	tagged and called 2/15/09 10:00
10	15238	777	772	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-00DGU6201W, IP-00DGU6202W,	I/W
11	15238	777	772	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-00DGU6201W, IP-00DGU6202W,	Delivered 1 cart thru transportation.
12	15238	777	772	122	2/16/2009 5:38	2/16/2009 13:29	Ln=772,CC=122,Com=Ceiling,LnPs=F/A 40-25 Pos 1,Jobs= IP-00DGU6201W, IP-00DGU6202W,	correct parts received at planeside 2/16/09 a.m.
13	15239	777	774	330	2/16/2009 6:01	2/16/2009 6:25	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
14	15240	Jam	772	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 3f-lc,ip # dgt 610	all lavs at planeside 2/16
15	15241	Jam	772	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
16	15242	777	775	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= , 1030g53a00000□□1030g55a	Good Morning Steven,□□ Will pick & pack your dogs and
17	15243	777	775	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
18	15243	777	775	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
19	15244	777	772	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.
20	15245	777	772	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
21	15245	777	772	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
22	15245	777	772	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	4 carts at planeside 2/16/09
23	15246	777	772	330	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	I have looked around and see nothing left for this a/p, sorr
24	15248	777	775	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
25	15248	777	775	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!!
26	15248	777	775	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
27	15248	777	775	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
28	15249	777	772	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-0	loc @ pos f/a pos #1
29	15249	777	772	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-0	in work
30	15249	777	772	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-0	Hey John - 2 carts , no shorts , at 40-56 trans. aisle . Trar
31	15250	777	772	122	2/16/2009 17:59	2/16/2009 18:24	Ln=772,CC=122,Com=BFE - Small Parts,LnPs=F/A 40-25 Pos 1,Jobs= , Requesting IP-00DGS85	I have no I-P in BFE with this number, If you are looking fo
32	15251	777	775	330	2/16/2009 18:14	2/16/2009 18:41	Ln=775,CC=330,Com=Crewrest/OSU,LnPs=SI Pos #2,Jobs= IP-00DGR8502W, thanks	In work.
33	15251	777	775	330	2/16/2009 18:14	2/16/2009 19:41	Ln=775,CC=330,Com=Crewrest/OSU,LnPs=SI Pos #2,Jobs= IP-00DGR8502W, thanks	Sent five units 449W5110-45B,-50B,-51B,-52B,-53B.to Ln
34	15251	777	775	330	2/16/2009 18:14	2/16/2009 20:11	Ln=775,CC=330,Com=Crewrest/OSU,LnPs=SI Pos #2,Jobs= IP-00DGR8502W, thanks	Notified at approximately 7:45 P.M. that the Factory is □□
35	15251	777	775	330	2/16/2009 18:14	2/16/2009 20:58	Ln=775,CC=330,Com=Crewrest/OSU,LnPs=SI Pos #2,Jobs= IP-00DGR8502W, thanks	loc @ pos #3
36	15251	777	775	330	2/16/2009 18:14	2/16/2009 23:10	Ln=775,CC=330,Com=Crewrest/OSU,LnPs=SI Pos #2,Jobs= IP-00DGR8502W, thanks	Called transportation again, will be delivered after 1st brea
37	15257	777	775	330	2/17/2009 5:14	2/17/2009 5:27	Ln=775,CC=330,Com=Ceiling,LnPs=SI Pos #3,Jobs= IP-0000041212, IP-0000041213, IP-0000041	forwarding to first shift
38	15257	777	775	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
39	15257	777	775	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
40	15258	777	773	122	2/17/2009 5:21	2/17/2009 7:40	Ln=773,CC=122,Com=Stowbin,LnPs=F/A 40-25 Pos 1,Jobs= IP-0000022034, IP-0000022035, IP-(	At planeside 2/17/09
41	15259	777	773	122	2/17/2009 5:35	2/17/2009 5:54	Ln=773,CC=122,Com=Stowbin,LnPs=F/A 40-25 Pos 1,Jobs= IP-0000072551, IP-0000072552, ple	27 carts in all includes centers-□□□□IP-0000022034, IP-(
42	15260	777	773	122	2/17/2009 5:54	2/17/2009 6:08	Ln=773,CC=122,Com=Sidewall,LnPs=F/A 40-25 Pos 1,Jobs= IP-00DGW3207W, IP-00DGW3208	I/W
43	15260	777	773	122	2/17/2009 5:54	2/17/2009 6:08	Ln=773,CC=122,Com=Sidewall,LnPs=F/A 40-25 Pos 1,Jobs= IP-00DGW3207W, IP-00DGW3208	I am notifying Transportation...□□I am shipping 3 sidewall
44	15260	777	773	122	2/17/2009 5:54	2/17/2009 7:48	Ln=773,CC=122,Com=Sidewall,LnPs=F/A 40-25 Pos 1,Jobs= IP-00DGW3207W, IP-00DGW3208	At planeside 2/17/09
45	15261	777	772	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-00DGA3451W, Please	Avl inside 124W, pls sign for parts
46	15262	777	774	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	772	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-00DGU6001W, Ceiling pnl. 413w3	I/W
48	15263	777	772	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-00DGU6001W, Ceiling pnl. 413w3	Good morning James,I spoke to our lead in the shop. The

Raw data | CMSD structure

Ready NUM SCRL

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

Sorted Pacer Data



Microsoft Excel - Input data

File Edit View Insert Format Tools Data Window Help

A2 15232

	ID	line	Request Time	Response Time	Delivery Location	Commodity
2	15232	774	2/15/2009 5:51	2/15/2009 6:27	SI Pos #3	BFE - Small Parts
3	15233	775	2/15/2009 7:38	2/16/2009 6:54	SI Pos #2	BFE - Galley
4	15234	773	2/15/2009 8:02	2/15/2009 8:33	FBJ	Ceiling
5	15235	775	2/15/2009 8:21	2/15/2009 9:26	SI Pos #2	Stowbin
6	15236	775	2/15/2009 8:22	2/16/2009 6:54	SI Pos #2	BFE - Galley
7	15237	775	2/15/2009 8:45	2/15/2009 9:50	SI Pos #2	Jamco - Lavs
8	15238	772	2/16/2009 5:38	2/16/2009 13:29	F/A 40-25 Pos 1	Ceiling
9	15239	774	2/16/2009 6:01	2/16/2009 6:25	SI Pos #3	BFE - Small Parts
10	15240	772	2/16/2009 7:54	2/16/2009 8:47	F/A 40-25 Pos 1	Jamco - Lavs
11	15241	772	2/16/2009 7:59	2/16/2009 8:47	F/A 40-25 Pos 1	Jamco - Lavs
12	15242	775	2/16/2009 8:30	2/16/2009 8:58	40-24.2, J-2.5	BFE - Doghouse
13	15243	775	2/16/2009 8:33	2/16/2009 9:46	40-24.2, J-2.5	Adapter Panels
14	15244	772	2/16/2009 9:15	2/16/2009 9:37	F/A 40-25 Pos 1	BFE - Small Parts
15	15245	772	2/16/2009 9:35	2/16/2009 10:44	F/A 40-25 Pos 1	Ceiling
16	15246	772	2/16/2009 14:45	2/16/2009 15:33	F/A 40-25 Pos 1	BFE - Galley Loose Parts Kit
17	15248	775	2/16/2009 15:25	2/16/2009 20:59	SI Pos #2	Crewrest/OSU
18	15249	772	2/16/2009 16:21	2/16/2009 17:00	F/A 40-25 Pos 1	Ceiling
19	15250	772	2/16/2009 17:59	2/16/2009 18:24	F/A 40-25 Pos 1	BFE - Small Parts
20	15251	775	2/16/2009 18:14	2/16/2009 23:10	SI Pos #2	Crewrest/OSU
21	15257	775	2/17/2009 5:14	2/17/2009 7:52	SI Pos #3	Ceiling
22	15258	773	2/17/2009 5:21	2/17/2009 7:40	F/A 40-25 Pos 1	Stowbin
23	15259	773	2/17/2009 5:35	2/17/2009 5:54	F/A 40-25 Pos 1	Stowbin
24	15260	773	2/17/2009 5:54	2/17/2009 7:48	F/A 40-25 Pos 1	Sidewall
25	15261	772	2/17/2009 6:42	2/17/2009 7:31	F/A 40-25 Pos 2	BFE - Small Parts
26	15262	774	2/17/2009 6:42	2/17/2009 6:56	SI Pos #3	OCAS
27	15263	772	2/17/2009 7:48	2/17/2009 14:05	F/A 40-25 Pos 2	Ceiling
28	15264	773	2/17/2009 8:43	2/17/2009 8:58	F/A 40-25 Pos 1	Ceiling
29	15265	772	2/17/2009 9:23	2/17/2009 11:16	F/A 40-25 Pos 2	Carpets
30	15266	773	2/17/2009 9:35	2/17/2009 9:44	F/A 40-25 Pos 1	Door Liner
31	15267	773	2/17/2009 9:41	2/17/2009 11:12	F/A 40-25 Pos 1	Sidewall
32	15268	773	2/17/2009 10:43	2/18/2009 5:51	F/A 40-25 Pos 1	BFE - Galley
33	15269	772	2/17/2009 10:46	2/17/2009 11:26	F/A 40-25 Pos 1	Carpets
34	15270	775	2/17/2009 13:33	2/17/2009 14:31	SI Pos #3	BFE - Small Parts
35	15271	775	2/17/2009 13:43	2/18/2009 5:18	SI Pos #3	OCAS
36	15272	772	2/17/2009 15:05	2/17/2009 15:11	F/A 40-25 Pos 2	Mats
37	15273	774	2/17/2009 15:09	2/17/2009 16:04	FBJ	BFE - Small Parts
38	15274	774	2/17/2009 15:12	2/18/2009 7:02	FBJ	Ceiling
39	15275	772	2/17/2009 15:15	2/18/2009 5:57	F/A 40-24	Adapter Panels
40	15276	772	2/17/2009 15:17	2/17/2009 16:35	F/A 40-24	BFE - Small Parts
41	15277	773	2/17/2009 15:38	2/17/2009 16:36	F/A 40-25 Pos 1	BFE - Small Parts
42	15278	772	2/17/2009 15:45	2/17/2009 16:36	F/A 40-25 Pos 1	BFE - Small Parts
43	15279	772	2/17/2009 16:21	2/17/2009 17:36	F/A 40-25 Pos 2	Mats
44	15281	772	2/17/2009 17:18	2/17/2009 18:14	F/A 40-25 Pos 2	IRC - All
45	15282	772	2/17/2009 19:11	2/17/2009 20:56	F/A 40-25 Pos 2	Partition
46	15283	775	2/17/2009 19:27	2/17/2009 20:18	SI Pos #3	BFE - Small Parts
47	15284	775	2/17/2009 21:30	2/17/2009 22:11	SI Pos #3	Carpets
48	15285	775	2/18/2009 1:56	2/18/2009 2:43	SI Pos #1	Carpets

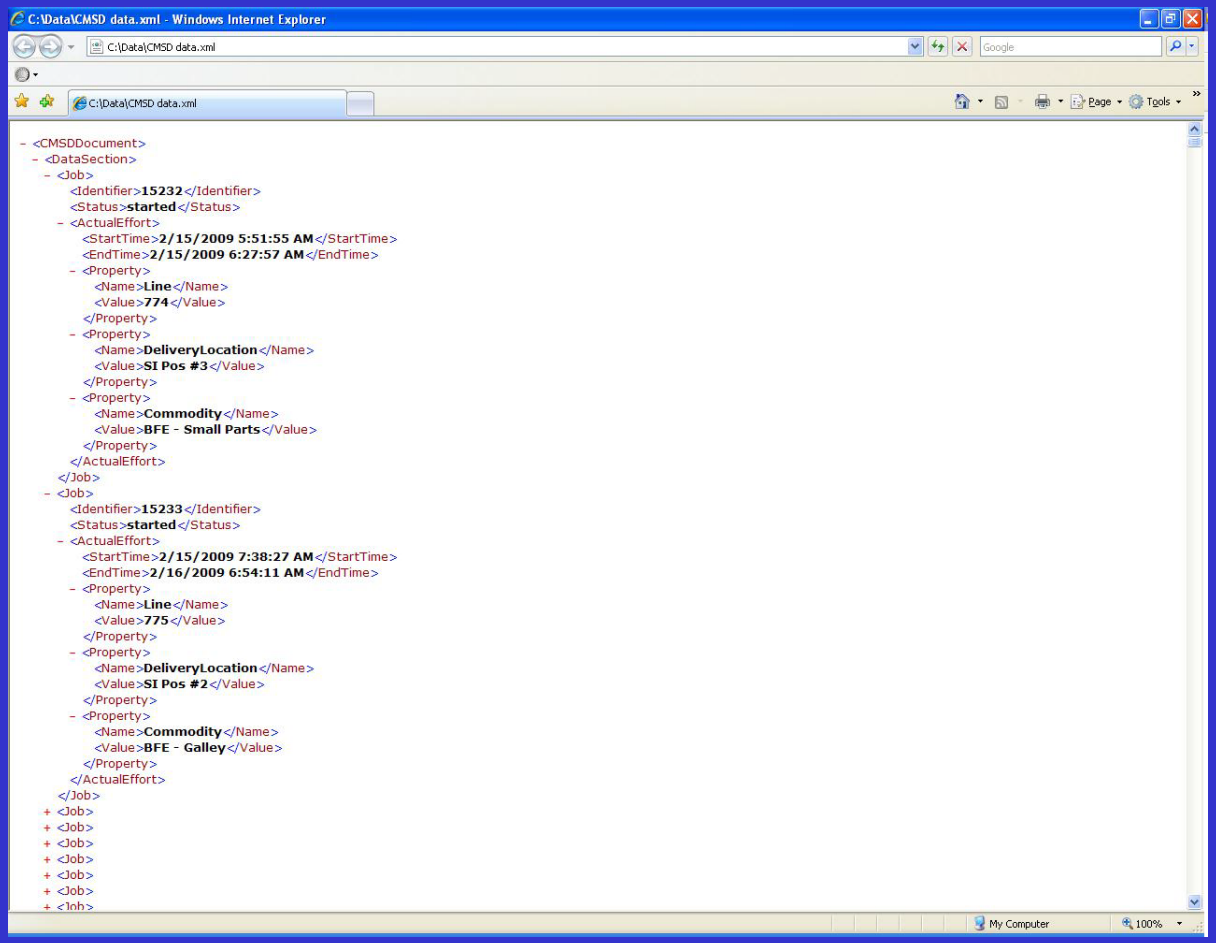
Raw data | CMSD structure

Draw AutoShapes

Ready NUM SCRL

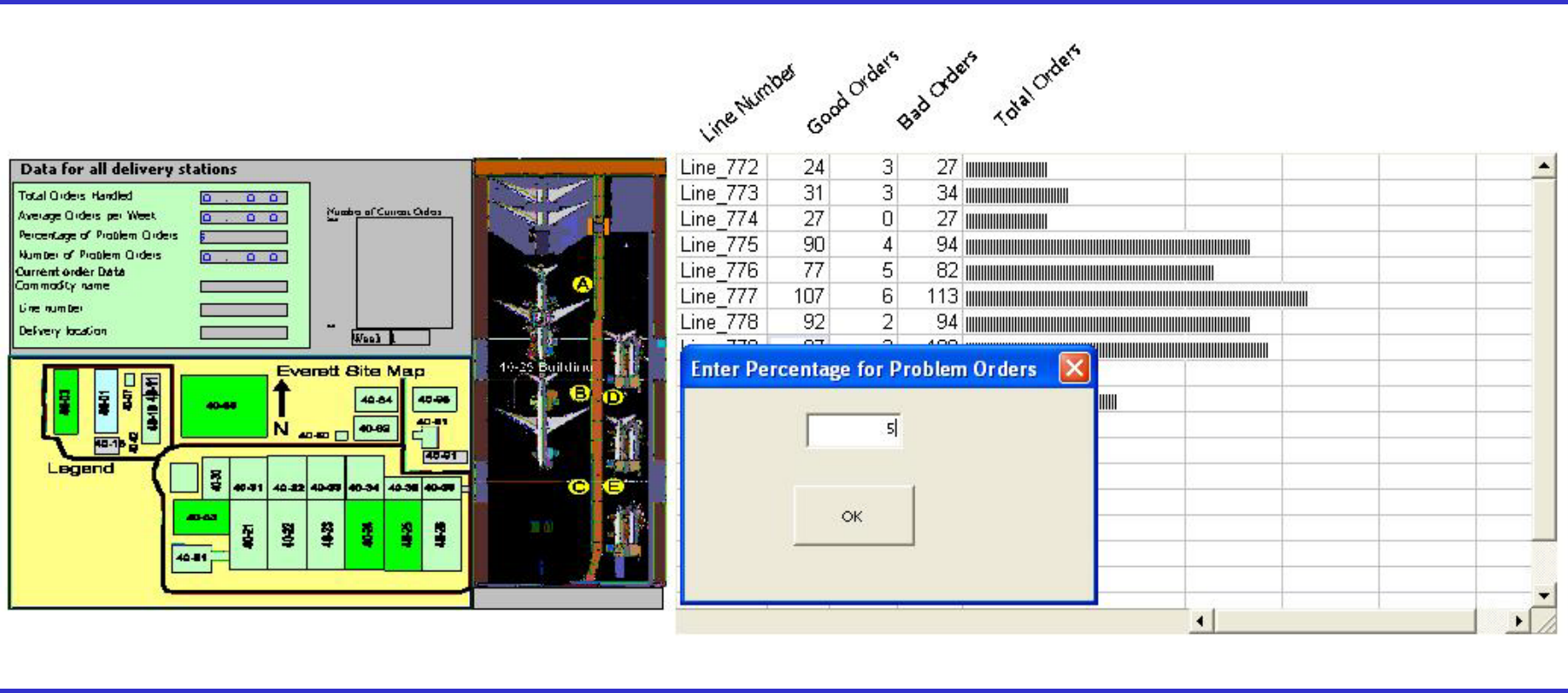
- The Pacer test data has been sorted, edited, and ready to be mapped to the CMSD data structures

Sample CMSD XML



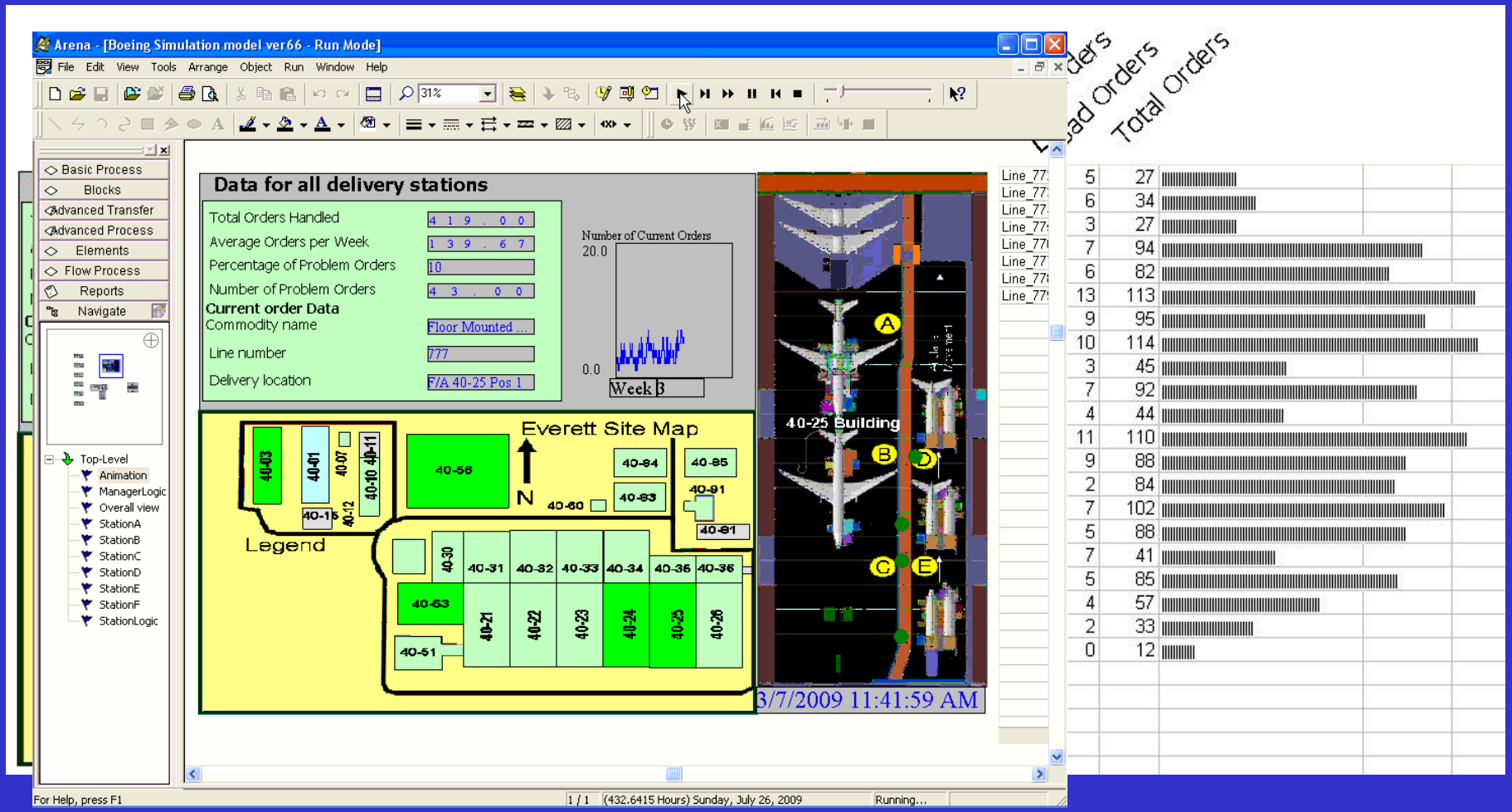
- The first row of the Excel file mapped into the CMSD structure

A Hypothetical Case Simulation



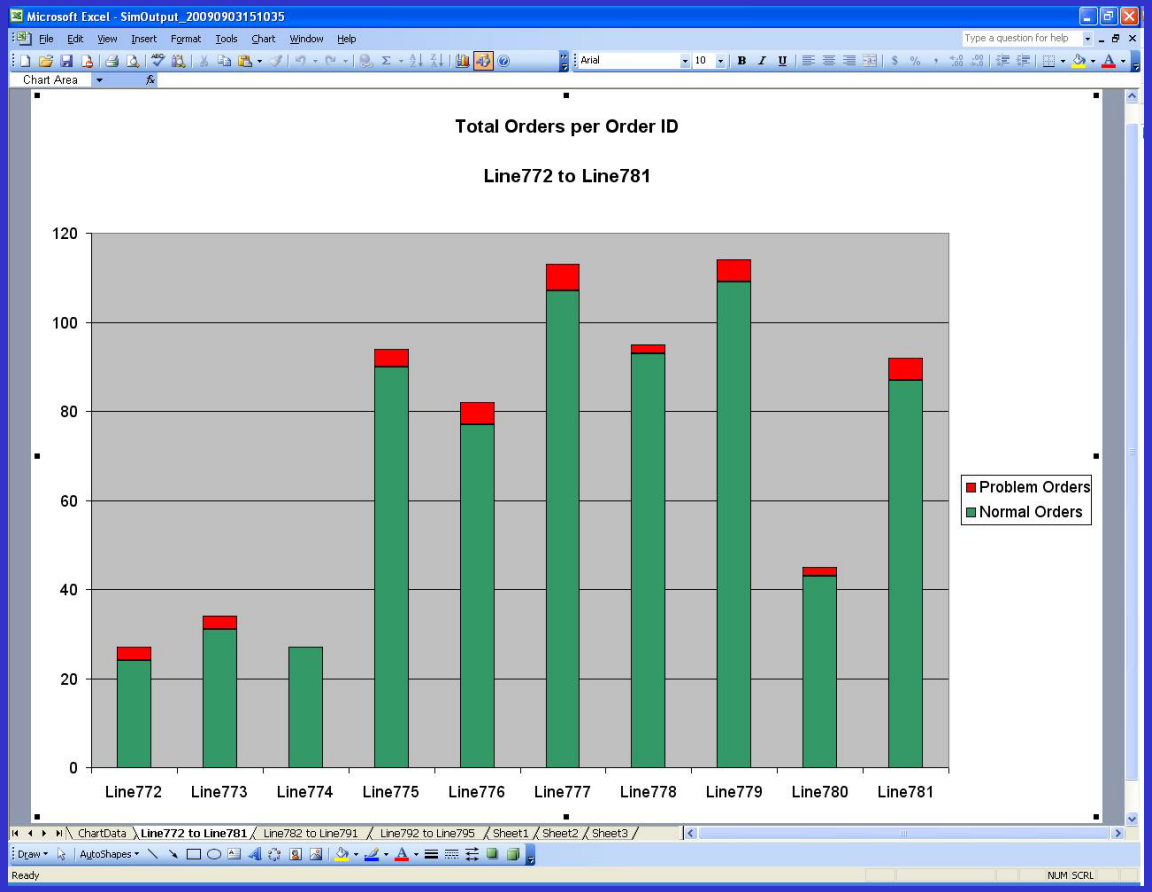
- Develop a front end for manufacturing engineer to perform what-if scenarios and iterations of simulation and analysis

Sample Arena output



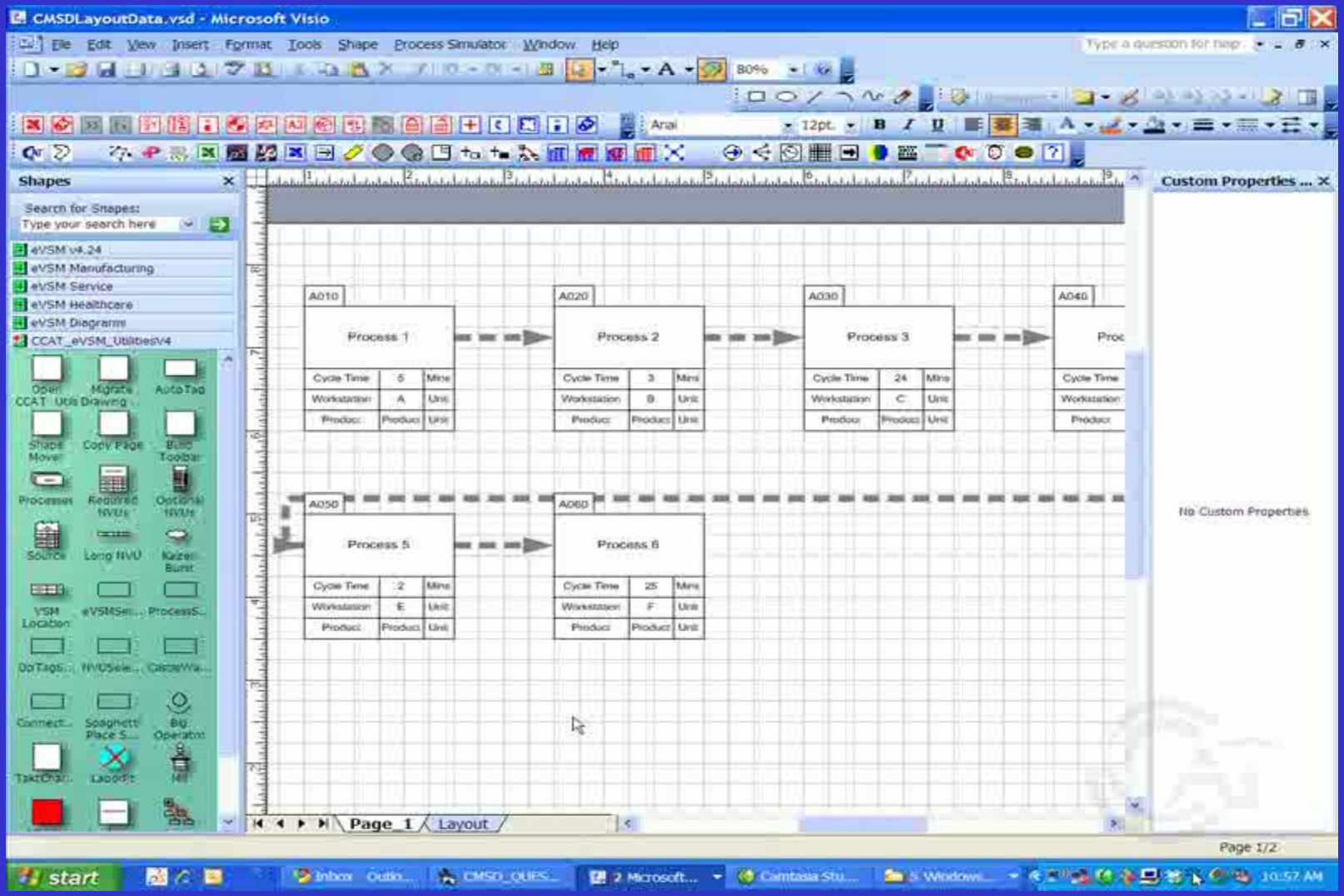
- Arena animation and bar chart for the total number of delivery orders processed.

Sample Arena output



- Total number of orders per line number in Microsoft Excel

Value Stream Mapping to Quest Model



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

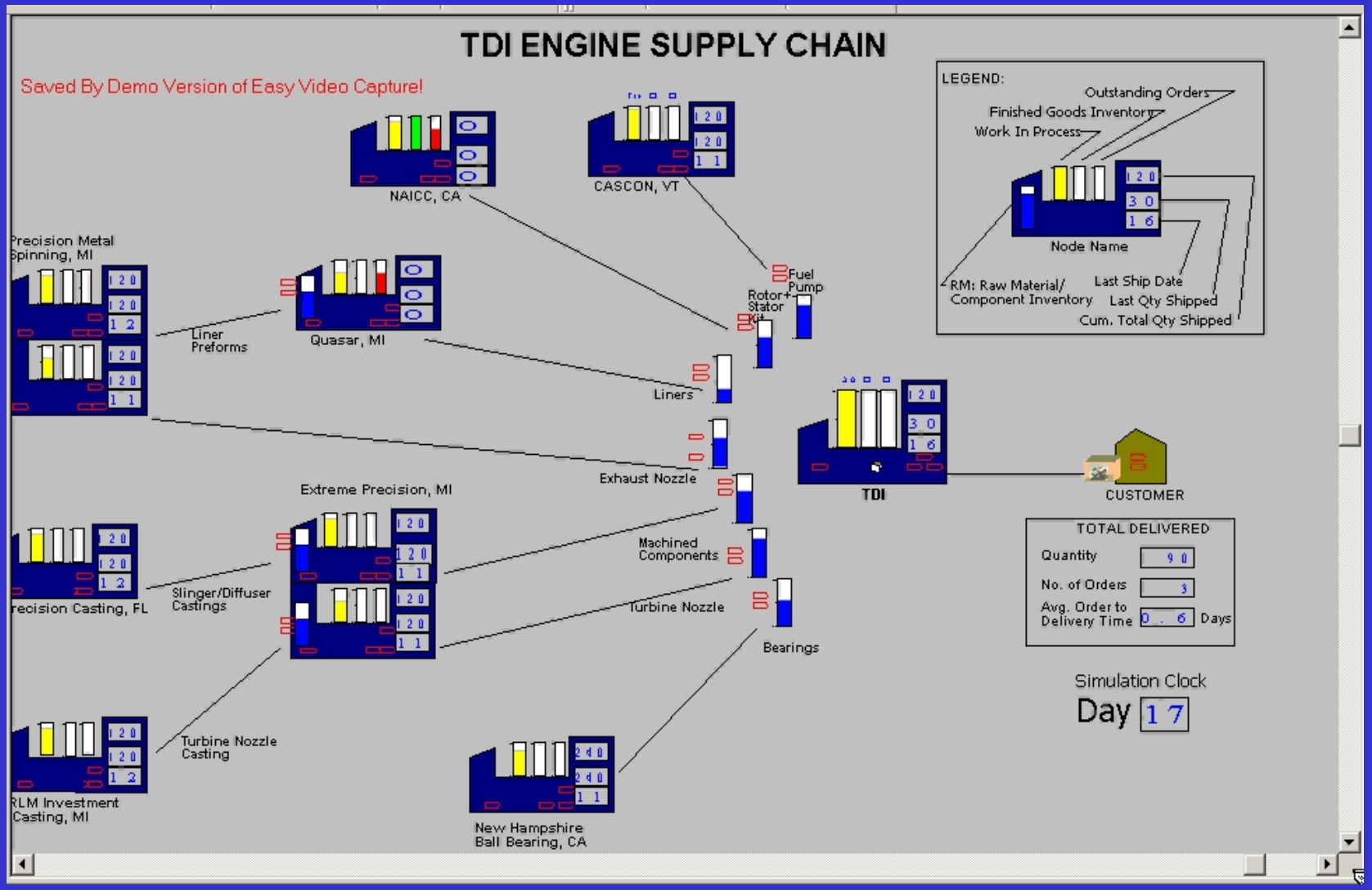
- *The Boeing Company*
- *Volvo Car Company*
- *Lockheed Martin*
- *Raytheon*
- *Rockwell Collins*
- *Connecticut Center for Advanced Technology*
- *CostVision*
- *DSN Innovations*
- *Ford Motor Company*
- *General Motors*
- *John Deere*

Academia

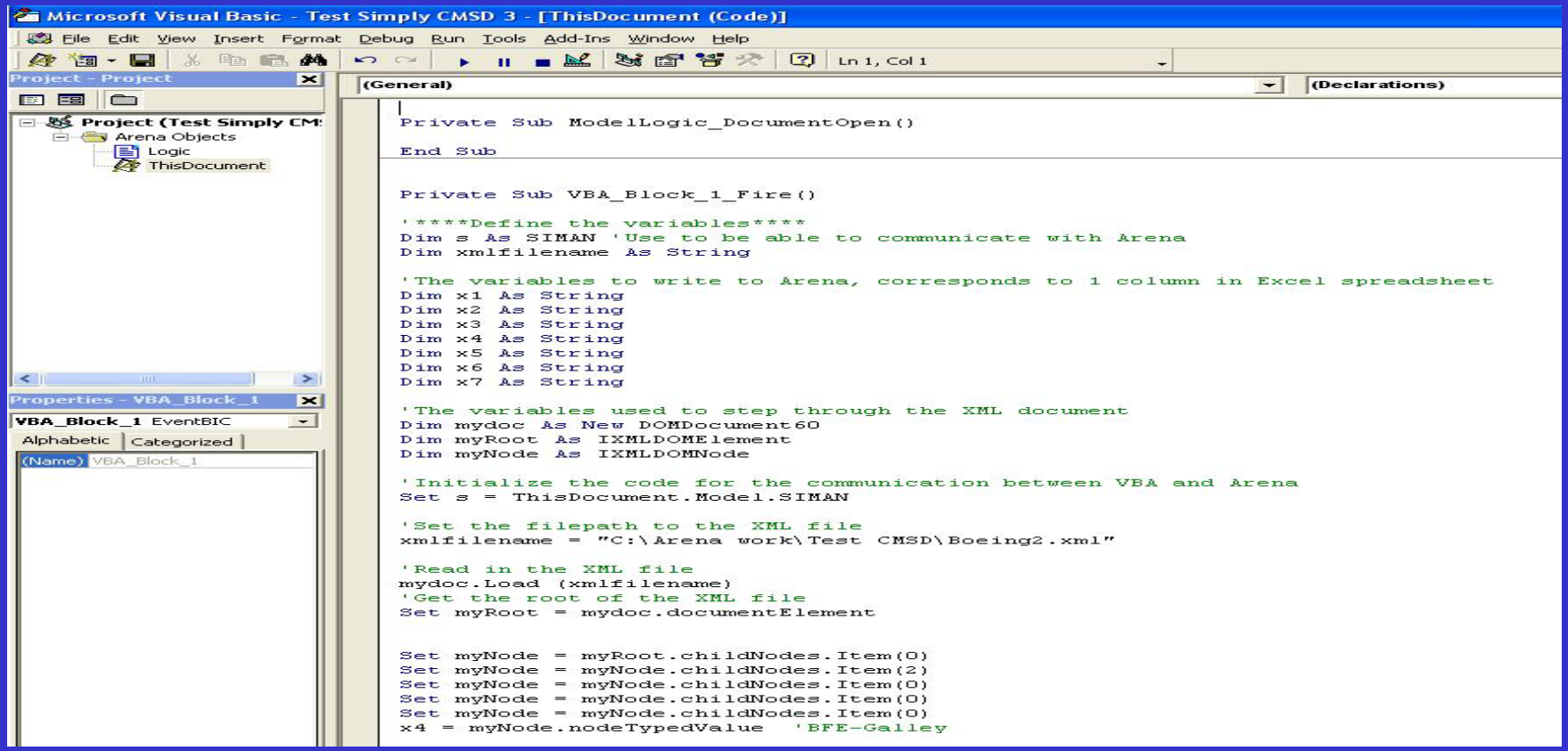
- *Chalmers University*
- *George Washington University*
- *University of Arizona*
- *Georgia Tech*
- *Florida International University*
- *Carnegie Mellon University*


Q&A

Supply Chain Simulation

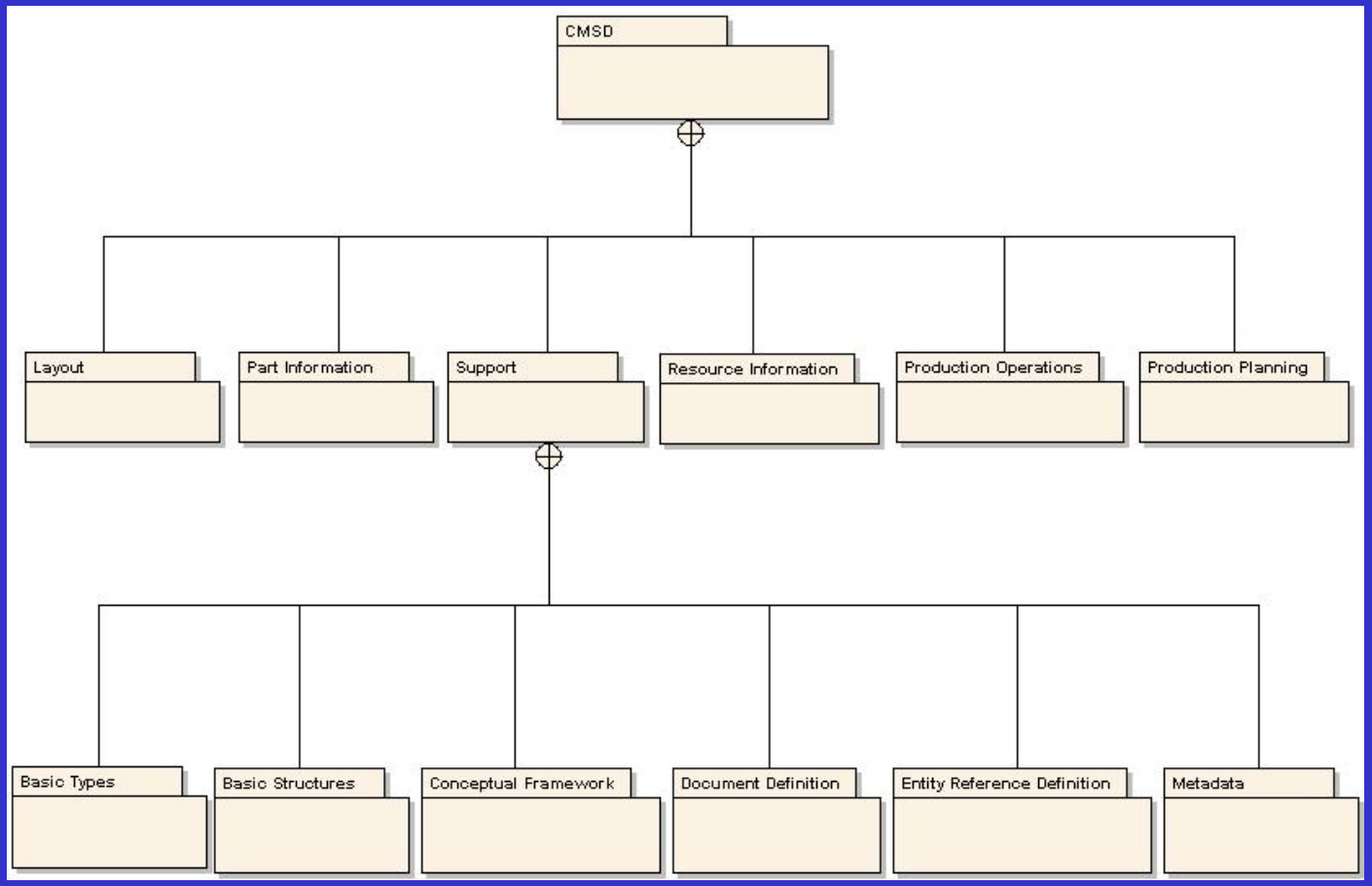


Sample CMSD interface to Arena

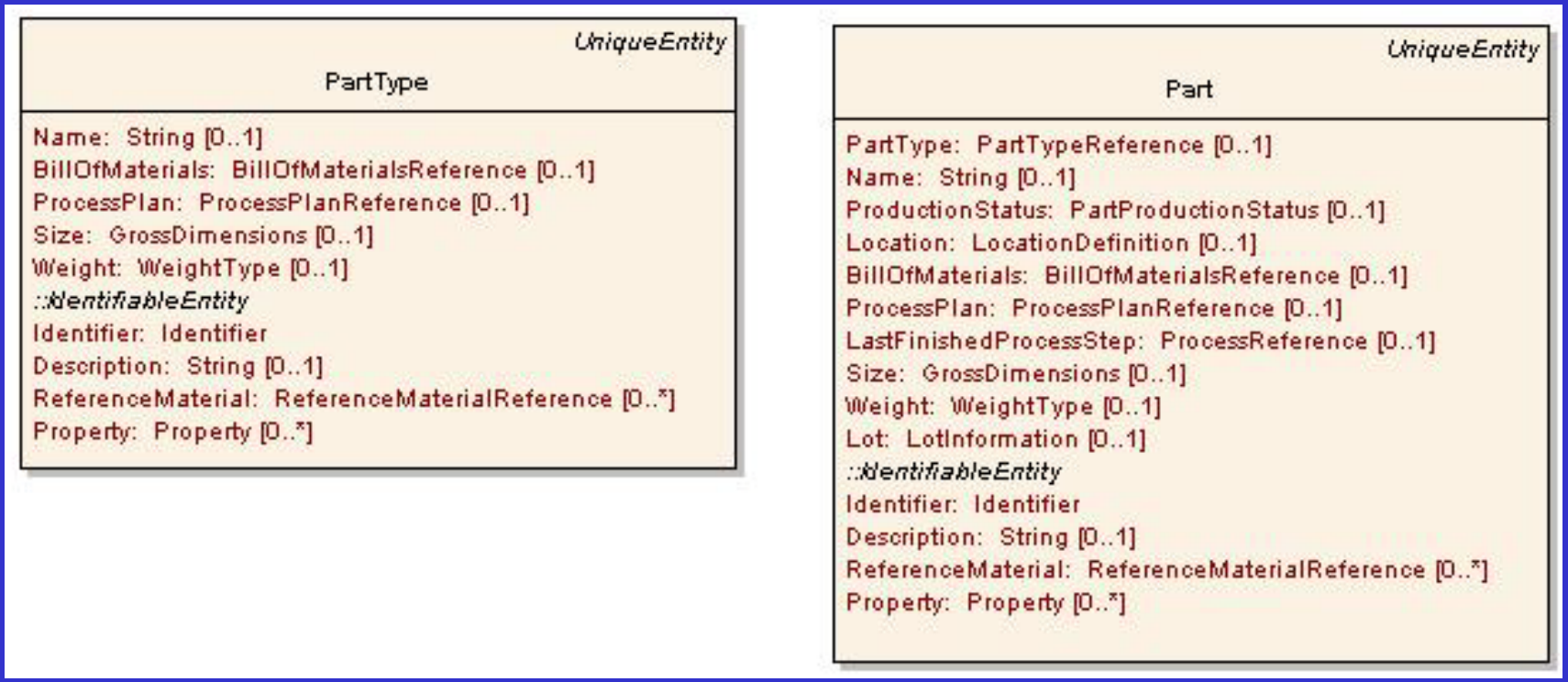


- Sample VBA script in Arena
- Using the XML DOM standard to read in the CMSD XML file
- Use Arena SIMAN code to set the variables in Arena model

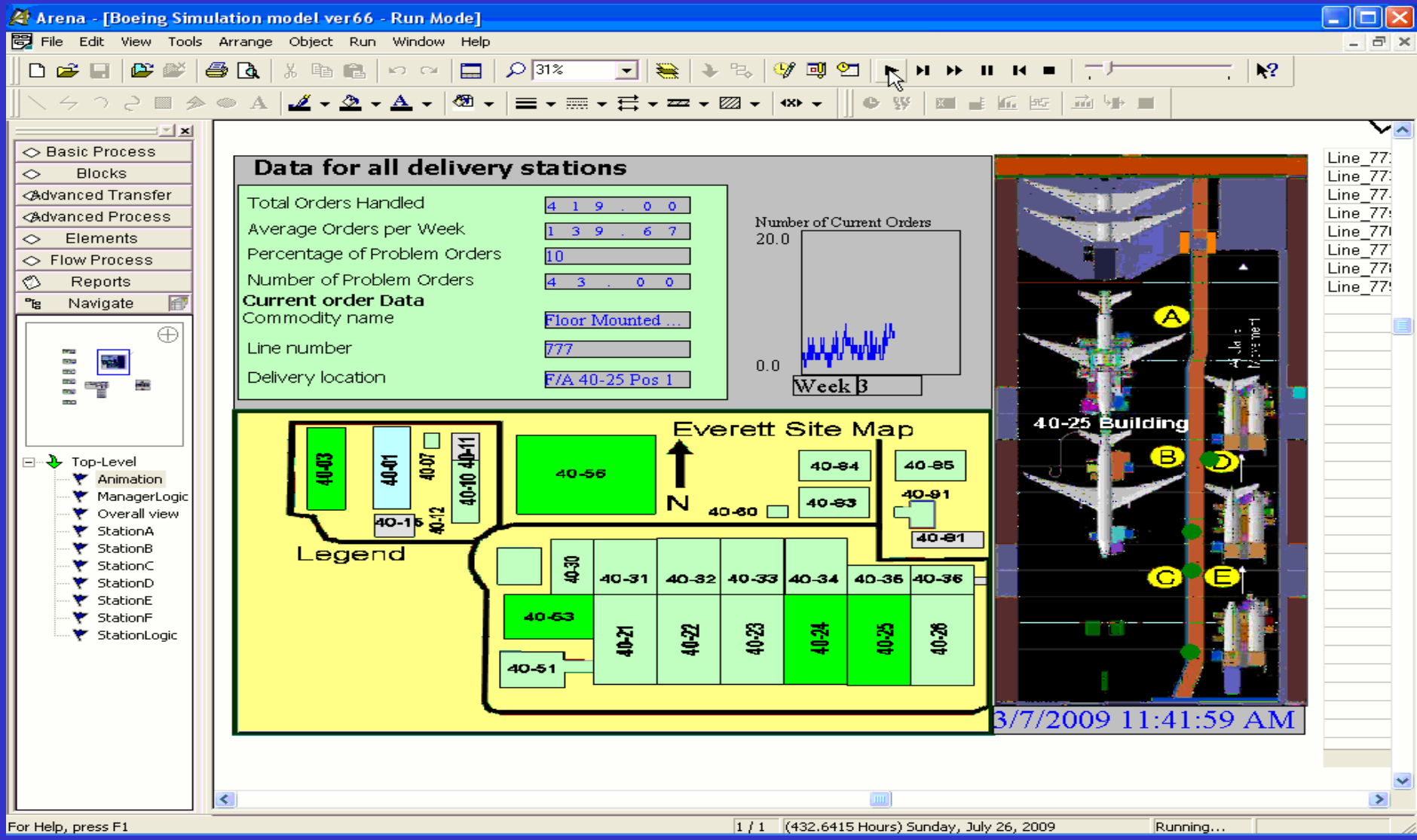
Sample CMSD UML Diagram



Sample CMSD UML Diagram



Sample Arena output



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