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The Role of Simulation to Track Mobile Assets Using Automatic Identification Systems

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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)

Production System Data

- Linear Barcode
- 2D Barcode
- Memory Buttons
- RFID Passive
- RFID Active
Problem Statement

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
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

Data source 1

Part & Inventory storage

MES storage

Machine, Tool, Fixture, & Gage storage

Layout File storage

RFID Tracking System storage

Pacer Data

Database extract documents

CMSD translator

CMSD instance document (XML)

Visualization Tools
Adobe Flex (AIR)
Silverlight
JavaFX

Simulation application A
Quest model

Simulation application B
MES/Schedule

Plant Simulation

ARENA

CMSD

CMFD instance document (XML)

Translator

Data source 2

Boeing test data set
The Pacer data will be mapped into the Core Manufacturing Simulation Data (CMSD) structure.
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
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

```
PartType
Name: String [0..1]
BillOfMaterials: BillOfMaterialsReference [0..1]
ProcessPlan: ProcessPlanReference [0..1]
Size: GrossDimensions [0..1]
Weight: WeightType [0..1]
::IdentifiableEntity
Identifier: Identifier
Description: String [0..1]
ReferenceMaterial: ReferenceMaterialReference [0..*]
Property: Property [0..*]
```

```
Part
PartType: PartTypeReference [0..1]
Name: String [0..1]
ProductionStatus: PartProductionStatus [0..1]
Location: LocationDefinition [0..1]
BillOfMaterials: BillOfMaterialsReference [0..1]
ProcessPlan: ProcessPlanReference [0..1]
LastFinishedProcessStep: ProcessReference [0..1]
Size: GrossDimensions [0..1]
Weight: WeightType [0..1]
Lot: LotInformation [0..1]
::IdentifiableEntity
Identifier: Identifier
Description: String [0..1]
ReferenceMaterial: ReferenceMaterialReference [0..*]
Property: Property [0..*]
```
Sample Arena output

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