Practical Applications of the ISA 95 standard

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MESA KNOWS
SUSTAINABILITY & ECO-EFFICIENCY - LEAN - METRICS & PERFORMANCE MANAGEMENT
INFORMATION INTEGRATION - SAFETY - ASSET PERFORMANCE MANAGEMENT - B2MML
QUALITY & COMPLIANCE - PRODUCT LIFECYCLE MANAGEMENT - AUTOMATION

Do you know MESA?
Dennis Brandl

- Dennis Brandl has been an active member of ISA’s SP88 Batch Control System committee since 1990, a U.S. expert in batch control to IEC, editor of the ISA95 Enterprise-Control System Integration standard, and convener of the IEC SC65E JWG 5 working group.

- He has been involved in automation system design and implementation for the past 30 years including Apollo and Space Shuttle test systems for Rockwell Space Division, as well as work with Shell Oil, Texas Instruments, Siemens, Square D, Sequencia, Telemecanique, Modicon, Pfizer, Lilly, Merck, GSK, Genentech, P&G, DOW, and other process industry companies.

- Dennis has a B.S. in Physics, an M.S. in Measurement and Control from Carnegie Mellon University, and an M.S. in Computer Science from California State University.
Agenda

• Introduction to ISA 95 & MES
• Advantages of the ISA95 standard
• Most important models of ISA95
• Practical applicability of the ISA95 models for end users, consultants and engineers
• Practical examples and descriptions of typical application structures
• Questions and answers
What is ISA 95

- USA ANSI standard developed by an ISA Committee of volunteer experts
- ANSI/ISA 95.01 ed2 “Enterprise - Control System Integration – Part 1: Models and Terminology”
- ANSI-ISA 95.02 ed2 “Enterprise - Control System Integration – Part 2: Objects and Attributes”
- ANSI/ISA 95.03 ed2 “Enterprise - Control System Integration – Part 3: Models of Manufacturing Operations”
- ANSI/ISA 95.04 ed1 “Enterprise - Control System Integration – Part 4: Objects and attributes for manufacturing operations management integration”
- ANSI/ISA 95.05 ed3 “Enterprise - Control System Integration – Business to Manufacturing Transactions
- Also available as IEC/ISO 62264 standards
A Bit Of History

• Prior to ISA 95
  – MES was not a well defined area, slow growth in deployments
  – MES was sometime viewed as a solution in search of a problem
  – Hard to integrate with business level systems and shop floor control
  – Very, very, very industry specific
  – No common definitions or terminology

• After ISA 95
  – Redefined MES as MOM (Manufacturing Operation Management)
  – MOM activities are well defined
  – Standard definitions and terminology, common requirements
  – Well understood and supported business level to ship floor control integration
  – More cross-industry solutions becoming available
  – Significant competition and advances in solutions
  – Rapid growth in deployments
### Example Benefits from MES/MOM*

<table>
<thead>
<tr>
<th>Benefit Category</th>
<th>Range of Benefits</th>
<th>Reduction Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Document Review Approval (SOPs)</td>
<td>$100,000 - $3 Million</td>
<td>10% - 80%</td>
</tr>
<tr>
<td>Batch Record Preparation &amp; Handling</td>
<td>$11,000 - $1.3 Million</td>
<td>40% - 80%</td>
</tr>
<tr>
<td>Batch Record Review</td>
<td>$115,000 - $1.0 Million</td>
<td>40% - 80%</td>
</tr>
<tr>
<td>Data Entry &amp; Calculations</td>
<td>$20,000 - $4.6 Million</td>
<td>40% - 90%</td>
</tr>
<tr>
<td>Deviations</td>
<td>$6,000 - $1.3 Million</td>
<td>25% - 60%</td>
</tr>
<tr>
<td>Logbook Handling</td>
<td>$7,000 - $105,000</td>
<td>25% - 80%</td>
</tr>
<tr>
<td>Material Losses</td>
<td>Value of preventable discards</td>
<td>30% - 60%</td>
</tr>
<tr>
<td>Testing</td>
<td>Preventable deviations testing</td>
<td>30% - 50%</td>
</tr>
<tr>
<td>Inventory Carrying Costs</td>
<td>Reduced Inventory Carrying</td>
<td></td>
</tr>
<tr>
<td>Throughput</td>
<td>$value of additional batches</td>
<td></td>
</tr>
<tr>
<td><strong>RANGE OF TOTAL ANNUAL BENEFITS</strong></td>
<td><strong>$450,000 - &gt;$10 Million</strong></td>
<td></td>
</tr>
</tbody>
</table>

* CBINet Conference, INDUSTRY BEST PRACTICES FOR MES ARCHITECTURE, August 2009, *Key Considerations for MES Project Planning and Execution*, Michalle Adkins and Paul Brandenburg (Lilly)
The Advantages of the ISA 95 Standard

• Common terminology and definition of functions
  – Simplifies writing requirements for end-users
  – Simplified vendor understanding of end-user requirements

• Integration of ERP with MES/MOM systems
  – Prior to ISA 95, projects took 1-2 years & <50% successful
  – After ISA 95, projects take 2-4 months & >90% successful

• Definition of MES/MOM systems
  – Prior to ISA 95, specification took years to reach agreement
  – After ISA 95, typical specifications complete in < 6 months
  – Possible to compare different vendor solutions
    • Better match to requirements
  – Possible to compare different facilities
Most Important ISA 95 Models

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Do you know MESA?
Levels and Functions

Level 4

Business Planning & Logistics
- Establishing the basic plant schedule - production, material use, delivery, and shipping. Determining inventory levels.
- Plant Production Scheduling, Operational Management, etc

Time Frame
- Months, weeks, days, shifts

Level 3

Manufacturing Operations Management
- Work flow / recipe control to produce the desired end products. Maintaining records and optimizing the production process.
- Dispatching Production, Detailed Production Scheduling, Reliability Assurance, ...

Time Frame
- Shifts, hours, minutes, seconds

Level 2

Manufacturing Control
- Monitoring, supervisory control and automated control of the production process
- Basic Control, Supervisory Control, Process Sensing, Process Manipulation, ...

Level 1

1 - Sensing the production process, manipulating the production process

Level 0

Production Process

0 - The physical production process

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ISA95 Domain Definitions

• Provides a method to answer the question;

“What is in logistics and what is in operations?“

• What is in Level 4 or Level 1-2-3?
Criteria for Level 3, 2, 1

- Activities to be included in Level 3, 2, or 1 are directly involved in manufacturing and includes information about personnel, equipment, or material and meets any of the following conditions.
  - The activity is critical to plant safety.
  - The activity is critical to plant reliability.
  - The activity is critical to plant efficiency.
    - NOTE: Absolute plant efficiencies may be dependent upon factors that are outside the control of a facility (MRP schedules, product mixes, etc.).
  - The activity is critical to product quality.
  - The activity is critical to maintaining regulatory compliance.
    - EXAMPLE: Maintaining regional, government and other agency compliance related to products and production.
    - NOTE: This includes such factors as safety, environmental and cGMP (current good manufacturing practices) compliance.
  - NOTE: There are other criteria such as company policy and organizational structure, or the nature of the operations that could expand the scope of manufacturing operations management.
  - NOTE: Such activities as personnel management of salaries and job titles may be important for running a manufacturing business, but they are not considered part of manufacturing operations management.
Level Overlap with Systems

Level 4
- Business Logistics Systems (ERP)
  - Establishing the basic plant schedule - production, material use, delivery, and shipping. Determining inventory levels.
  - Time Frame: Months, weeks, days, shifts

Level 3
- Manufacturing Operations Management Systems (MES, Batch, LIMS, AM, ...)
  - Work flow / recipe control to produce the desired end products. Maintaining records and optimizing the production process.
  - Time Frame: Shifts, hours, minutes, seconds

Level 2
- Control Systems (PLC, DCS, OCS, ...)
  - Monitoring, supervisory control and automated control of the production process

Level 1
- Intelligent devices (Vision, Flow, ...)
  - Sensing the production process, manipulating the production process

Level 0
- Batch, Discrete, Continuous
  - The physical production process

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ISA 95 Formal Models

- Interfaces to business systems (ERP, MDM, PLM) through XML and WBF B2MML Standard (www.wbf.org)
- Standard model for MOM tasks and activities
Process Segments

- Defines the **Business View** of production

**Pharmaceutical Manufacturing Example**

1. **Make Active Ingredient**
   - Inventory tracked for Active Ingredient
   - Know throughput, resources and time to make Active Ingredient

2. **Make Pills**
   - Inventory tracked for Pills
   - Know throughput, resources and time to make Pills

3. **Package Doses**
   - Inventory tracked for Pill Packs
   - Know throughput, resources and time to make Pill Packs

Finished Products

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Integration Models

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*Do you know MESA?*
Enterprise Integration – ISA 95 & B2MML

• Integration of business systems to shop floor systems is an important final phase in an ERP implementation
  – Companies are discovering that the true value in a logistics system only comes when it is connected to real world shop floor information.

• The ISA 95 and IEC 62264 standards define the standard terminology for business to manufacturing integration

• The WBF B2MML (Business to Manufacturing Markup Language) defines an implementation emerging as the preferred integration method
How Does ISA 95 & B2MML Help?

- ISA 95 Part 1, Part 2, and Part 5
  - Provides a clear description of exchanged information
    - Does not use vendor specific terminology
  - Each piece of exchanged information has an unambiguous meaning
    - Uses a “Property” model to describe company specific exchange information
  - Allows separation of business processes from manufacturing processes
    - Allows changes in production processes without requiring unnecessary changes to scheduling and logistics processes

- B2MML
  - Defines an implementation of the ISA models in an XML format
  - Defines a standard language for representing exchanged information
ISA 95 & B2MML Data Models

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Exchanged Level 3-4 Information

Enterprise Information
Plant Production Scheduling, Operational Management, etc

Operations Capability Information
(What is available for use)

Operations Definition Information
(How to make a product)

Operations Schedule
(What to make and what to use)

Operations Performance
(What was made and what was used)

Resource Information
(Personnel, Equipment, Physical Asset, Material, Segments)

Manufacturing Control Information
Area Supervision, Production Planning, Reliability, Assurance, etc

Most Used Exchanges Today

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Material Information

• What is shared
• Material Master & Material Inventory information

Material Class
HCl Acid

Material Definition
HCl 50%

Lot
HCL-50-100019

Sublot
HCL-50-100019
Barrel 15

Material Test Results

Material Test Specification

pH Density Color Purity

7.0 1.05 Straw 99.5%

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Material Information

• Material Master
  – Represented in “Material Definition” & “Material Class”
  – Usually sent from ERP (SAP) to MOM systems
    • Triggered by changes to material masters or changes sent on a regular basis (every shift, once a day, ...)
  – Widely used in MOM activities to identify materials

• Material Inventory
  – Represented in “Material Lot” & “Material Sublot”
  – Contains quantity, location, status information and company specific properties
    • Example: pH, octane, “Use by date”, QA status, ...
Material Information – ISA 95 Model

- Exchange information about properties of material lots, sublots, definitions, and classes
<Material>
  <MaterialLot>
    <ID> W89 </ID>
    <Description> A lot of material </Description>
    <MaterialDefinitionID "WXE908" />
    <Location> Tank 1 </Location>
    <Quantity UnitOfMeasure = "KL" > 4500 </Quantity>
    <MaterialLotProperty>
      <ID> dateTimeProduction </ID>
      <Value> 2001-01-06T00:14:23+11:30 </Value>
    </MaterialLotProperty>
    <MaterialLotProperty>
      <ID> Quality Status </ID>
      <Value> Good </Value>
    </MaterialLotProperty>
  </MaterialLot>
</Material>
Role Based Equipment Information

- Exchange information about properties of specific equipment and equipment classes
- The specific properties are defined by the end user
  - Example: Validated for specific equipment, in-use, sterile, benchmark capacity, heat transfer efficiency, ...

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• Exchange information about properties of specific physical assets and physical asset classes

• The specific properties are defined by the end user
  – Example: In maintenance, last used date, stock power, ...

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Operations Schedule

• What actions to perform
  – Materials to make
  – Priority and/or dates
  – What materials to use
  – What equipment to use
  – What personnel to use
  – Production parameters (e.g. Color, Options, ...)
• Per Segment (step in production)
• Per location (Site, Area, ...)
• Per week, day, shift, order, ...
Scheduling Hierarchy

**Business Plan (APICS)**
(Per Business Area, Per Time)

**Marketing Plan (APICS)**
(Per Product Family, Per Time)

ISA-95.00.01 - 1.1 Production Forecasting Activity

**Production Plan (APICS)**
(Per Product, Per Time)

ISA-95.00.01 - 2.4 Production Scheduling Activity

**Operations Schedule (ISA 95) - Master Production Schedule (APICS)**
(Per Site, Per Product, Per Time)

ISA-95.00.03 Detailed Production Scheduling Activity

**Work Schedule (ISA 95)**
(Per Line, Per Product, Per Time)

ISA 95.00.03 - Production Dispatching Activity

**Job List (ISA 95) & Batch List (ISA 88)**
(Per Process Cell, Per Batch)

ISA 88.00.01 - Process Management Activity - ISA 95.00.03 Production Execution Activity

**Work Directive (ISA 95) & Control Recipe (ISA 88)**
(Per Unit, Per Batch)
Operations Schedule

- Operations Definition
- Operations Request
- Process Segment
  - Segment Requirement
    - Segment Parameter
    - Personnel Requirement
    - Equipment Requirement
    - Physical Asset Requirement
    - Material Requirement
      - Personnel Requirement Property
      - Equipment Requirement Property
      - Physical Asset Requirement Property
      - Material Requirement Property
Operations Performance

• What was done
  – What material was produced & how much
  – What material was consumed or used & how much
  – What equipment was used & how long
  – What personnel were used & how long

• Per Segment (step in production)
• Per location (Site, Area, ...)
• Per week, day, shift, order, ...
It Takes More Than Just Schemas

• The B2MML standard defines the structure of integration data
• But, it does not define the detailed definition of the source and target exchanged data
• B2MML provides a template or format, much as a blank check, but does not specify the source or destination of the data in the application name space
• Multiple methods exist for data mapping
An XML Example
Production Schedule

```xml
<?xml version="1.0" encoding="iso-8859-1" ?>
<OperationsSchedule>
    <ID>00000000072</ID>
    <OperationsRequest>
        <ID>0010</ID>
        <Description>Use Case</Description>
        <OperationsType>Production</OperationsType>
        <OperationsDefinitionID>6005-3</OperationsDefinitionID>
        <SegmentRequirement>
            <ID>0011</ID>
            <EquipmentRequirement>
                <EquipmentID>MT60</EquipmentID>
            </EquipmentRequirement>
            <MaterialRequirement>
                <MaterialUse>Produced</MaterialUse>
                <Quantity>400</Quantity>
            </MaterialRequirement>
        </SegmentRequirement>
    </OperationsRequest>
</OperationsSchedule>
```

Operation Schedule
Operation Request
Segment Requirement
Material Produced
Production Performance Mapped to SAP PI-PCS Interface
Material Produced,
Material Consumed to SAP

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Data Mapping
B2MML Mapping Spreadsheets

- Document mapping in format suitable for implementation
- Available on the WBF web site

<table>
<thead>
<tr>
<th>SyncProductionSchedule</th>
<th>From Zeus</th>
<th>To Apollo</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Specification ID</td>
<td>Specification ID</td>
</tr>
<tr>
<td></td>
<td>Note</td>
<td>Xpath</td>
</tr>
<tr>
<td>Mapped /SyncProductionSchedule</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>71 Mapped /SyncProductionSchedule</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>86 Mapped /SyncProductionSchedule</td>
<td>--PersonnelRequirement</td>
<td>-</td>
</tr>
<tr>
<td>106 Mapped /SyncProductionSchedule</td>
<td>--EquipmentRequirement</td>
<td>-</td>
</tr>
<tr>
<td>121 Mapped /SyncProductionSchedule</td>
<td>--EquipmentRequirementProperty</td>
<td>-</td>
</tr>
<tr>
<td>141 Mapped /SyncProductionSchedule</td>
<td>--MaterialRequirement</td>
<td>One Material Requirement for the Produced Material</td>
</tr>
<tr>
<td>143 Mapped /SyncProductionSchedule</td>
<td>--MaterialDefinitionID</td>
<td>.\ProductionOrderMaterialIdentification\ID Produced Item Code</td>
</tr>
<tr>
<td>151 Mapped /SyncProductionSchedule</td>
<td>--MaterialUse</td>
<td>Fixed text “Produced”</td>
</tr>
<tr>
<td>153 Mapped /SyncProductionSchedule</td>
<td>--QuantityString</td>
<td>.\ProductionOrderMaterial\PlannedQuantity Produced Quantity Code</td>
</tr>
<tr>
<td>155 Mapped /SyncProductionSchedule</td>
<td>--DataType</td>
<td>Fixed text</td>
</tr>
<tr>
<td>156 Mapped /SyncProductionSchedule</td>
<td>--UnitOfMeasure</td>
<td>.\ProductionOrderMaterial\PlannedQuantity@unitC Produced Quantity UOM</td>
</tr>
<tr>
<td>159 Mapped /SyncProductionSchedule</td>
<td>--MaterialRequirementProperty</td>
<td>-</td>
</tr>
<tr>
<td>160 Mapped /SyncProductionSchedule</td>
<td>--ID</td>
<td>Fixed text “Expiration Date”</td>
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<tr>
<td>163 Mapped /SyncProductionSchedule</td>
<td>--ValueString</td>
<td>.\ProductionOrderMaterial\ItemReference\Specific Planned Expiration Date</td>
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<td>166 Mapped /SyncProductionSchedule</td>
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<td>Fixed text</td>
</tr>
<tr>
<td>179 Mapped /SyncProductionSchedule</td>
<td>--MaterialRequirementProperty</td>
<td>-</td>
</tr>
<tr>
<td>180 Mapped /SyncProductionSchedule</td>
<td>--ID</td>
<td>Fixed text “Potency”</td>
</tr>
<tr>
<td>183 Mapped /SyncProductionSchedule</td>
<td>--ValueString</td>
<td>.\ProductionOrderMaterial\ItemReference\Specific Planned Potency</td>
</tr>
<tr>
<td>185 Mapped /SyncProductionSchedule</td>
<td>--ItemType</td>
<td>Fixed text</td>
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<tr>
<td>186 Mapped /SyncProductionSchedule</td>
<td>--UnitOfMeasure</td>
<td>One MaterialRequirement for each Consumed Material</td>
</tr>
<tr>
<td>199 Mapped /SyncProductionSchedule</td>
<td>--MaterialRequirement</td>
<td>One Line Per Consumed Material</td>
</tr>
<tr>
<td>203 Mapped /SyncProductionSchedule</td>
<td>--MaterialDefinitionID</td>
<td>.\ProductionOrderMaterial\ItemReference\Specific Consumed Item Code</td>
</tr>
</tbody>
</table>
## ISA 95 Part 5 - Transactions

<table>
<thead>
<tr>
<th>Verb</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>GET</td>
<td>Request to a receiver for information on one or more objects. The response is a SHOW message. The receiver returns a SHOW message containing all the specified attributes and all the specified contained elements of the specified nouns. If no attribute or contained element is specified in the noun area, then all attributes and/or contained elements shall be returned. When wildcards are applied to the noun and property IDs, it shall be possible to further filter the information to be returned by specifying a value for one or more attributes of the noun. Only objects whose attributes match the specified value (out of the list of objects matching the wildcards applied to noun and property IDs) shall be returned.</td>
</tr>
<tr>
<td>PROCESS</td>
<td>Request to a receiver to process new information. The response is an ACKNOWLEDGE message. A new noun is added.</td>
</tr>
<tr>
<td>CANCEL</td>
<td>Request to a receiver to remove information. The specified noun is canceled.</td>
</tr>
<tr>
<td>CHANGE</td>
<td>Request to a receiver to change information. The response is a RESPOND message. The specified attributes and contained elements of the noun are changed.</td>
</tr>
<tr>
<td>SYNC ADD</td>
<td>Request from the owner of the object to add information.</td>
</tr>
<tr>
<td>SYNC CHANGE</td>
<td>Request from the owner of the object to change information.</td>
</tr>
<tr>
<td>SYNC DELETE</td>
<td>Request from the owner of the object to delete information.</td>
</tr>
<tr>
<td>CONFIRM</td>
<td>Confirmation response to a request.</td>
</tr>
</tbody>
</table>
Push Transactions in Business Process

Scenario assumptions:
1. ERP send production schedule to MOM for processing
2. MOM (Manufacturing Operations Management) sends production performance to ERP for processing

* Message contains a FINAL flag to indicate that the message is the final production performance for the associated production schedule.
Push and Pull
Manage Material Lot Quantity

Scenario assumptions:
1. MOM requests material lot information from ERP
2. ERP sends information on new material lots (lots with no changes)
3. MOM pushes quantity changes in material lot to ERP

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Applications Need To “Talk”

- Integration is application-to-application data exchange
- Across firewalls, through APIs, web services or flat files, across a wire, often in different languages, data formats, at different time cycles, on different systems, of different ages, supported by different departments, ...
- ISA 95 and B2MML only provide part of the solution
Integration - The Current Situation

- **Message based protocols** have become the standard model for enterprise integration
- **Enterprise Service Buses** (ESB) have become the standard model for exchanging integration messages
- **XML** has become the standard model for data representation within messages
- **SOAP** and **REST** have become the standard interfaces to ESBs
- **Web services** have become the standard for SOAP implementations
Integration: The Hidden Complexity

- Every integration project needs the following elements
- Some communication is one way 1 → 2
Integration – Two Way Communication

- Multiple translations, copies, services, ...
- Some communication is two-way 1 \rightarrow 2 \rightarrow 3 \rightarrow 4

1. Application “Thor”
   - Convert Local format to Global format
   - Convert Local names to Global names
   - Send information to ESB

2. Application “Apollo”
   - Convert Global format to Local format
   - Convert Global names to Local names
   - Receive information from ESB

3. Handle Transaction Logic

4. ESB Server
   - Convert Global names to Local names
   - Convert Local names to Global names
   - Send information to ESB
   - Receive information from ESB

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Many Layers for Integration

- Convert Formats (B2MML)
  - From local to project selected common (canonical) formats
  - From canonical to local format
- Convert Names (Planned ISA 95 TR.02)
  - From local names to common names (tags, status, ...)
  - From common names to local names
- Send/Receive messages (Planned ISA 95 TR.03)
  - Publish-Subscribe methods
  - Query-Response methods
- Link to ESB
  - API, Web Service, ...
- Exchange Messages across ESB
  - IP, Internet, Ethernet, WAN, VPN, ...
- Transaction Logic
  - Rules for handling of messages
B2MML Implementations

• Multiple publicly discussed implementations:
  – Nestle, Arla Food, Cerveceria Polar, P&G
  – All have SAP as at least one of the ERP systems connected

• Technically
  – The solutions are not much different from each other
  – All using Business Connector combined with different access to R/3: PI-PCS, IDOCS, BAPI calls, XI.

• All experienced significant improvements in integration efforts
  – For connection to different ERP systems
  – For connection to different MES and control systems
ISA95 Part 3

Models of Manufacturing Operations

The new model for MES

**MESA KNOWS**

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*Do you know MESA?*
ISA 95
4 Categories of MOM Activities

• Production Operations Management
  – Activities that coordinate, direct, manage & track the functions that use raw materials, energy, equipment, personnel and information to produce products

• Quality Operations Management
  – Activities which coordinate, direct & track the functions that measure and report on quality

• Inventory Operations Management
  – Activities which coordinate, direct & track the functions that manage and track the inventory of product and/or material and their movements

• Maintenance Operations Management
  – Activities which coordinate, direct and track the functions that maintain the equipment, tools and related assets to ensure their availability for manufacturing

• Models have also been applied to:
  – Shipping, Receiving, Transportation, ...

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Models of Production Activities & Data

- Operation definition
- Resource information
- Operations capability
- Operations schedule
- Operations performance

- Detailed production scheduling
- Production resource management
- Production dispatching
- Production tracking
- Production data collection

- Product definition management
- Production execution management

- Equipment and process specific production rules
- Operational commands
- Operational responses
- Equipment and process specific data

KPIs (ISO 22400)

Level 1-2 Functions

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Maintenance Operations

- Maintenance definitions
- Maintenance capability
- Maintenance request
- Maintenance response

Detailed maintenance scheduling

Maintenance resource management

Maintenance dispatching

Maintenance tracking

Maintenance data collection

Maintenance analysis

Equipment specific maintenance procedures

Maintenance commands and procedures

Maintenance results

Equipment state of health data

Level 0-1-2 personnel & equipment

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Material Movement and Inventory Transfer Activities

Inventory definitions

Inventory capability

Inventory request

Inventory response

Detailed inventory scheduling

Inventory resource management

Inventory dispatching

Inventory tracking

Inventory definition management

Inventory execution management

Inventory data collection

Inventory analysis

Inventory commands

Inventory replies

Inventory specific data

Inventory storage definitions

Level 0-1-2 inventory equipment

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All Operations Categories

- Operations definition
- Resource information
- Operations capability
- Operations schedule
- Operations performance

KPIs (ISO 22400)

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ISA 95
Requirements for MOM

• The ISA 95 Part 3 standard defines about > 80% of the activities that occur in Manufacturing Operations Management (MOM)
  – Production Operations Management
  – Maintenance Operations Management
  – Laboratory (Quality) Operations Management
  – Material Handling & Storage (Inventory) Operations Management
  – Supporting activities
    • Management of security
    • Management of information
    • Management of configuration
    • Management of documents
    • Management of regulatory compliance
    • Management of incidents and deviations

• Activities are used as a map to identify MOM requirements
### ISA 95.03 Format

- **Part 3** defines the tasks and activities for all 4 categories of MOM
  - It is a straightforward process to convert these into requirements
- **Most MOM/MES users** are using this outline to generate their MOM requirements
  - Not all projects cover all categories
  - Not all projects cover all activities within a category

### Table of Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production Operations Management</td>
<td>22</td>
</tr>
<tr>
<td>General activities in production operations management</td>
<td>22</td>
</tr>
<tr>
<td>Production operations management activity model</td>
<td>23</td>
</tr>
<tr>
<td>Information exchange in production operations management</td>
<td>24</td>
</tr>
<tr>
<td>Product definition management</td>
<td>24</td>
</tr>
<tr>
<td>Production resource management</td>
<td>25</td>
</tr>
<tr>
<td>Detailed production scheduling</td>
<td>29</td>
</tr>
<tr>
<td>Production dispatching</td>
<td>32</td>
</tr>
<tr>
<td>Production execution management</td>
<td>35</td>
</tr>
<tr>
<td>Production data collection</td>
<td>37</td>
</tr>
<tr>
<td>Production tracking</td>
<td>38</td>
</tr>
<tr>
<td>Production performance analysis</td>
<td>40</td>
</tr>
<tr>
<td>Maintenance Operations Management</td>
<td>45</td>
</tr>
<tr>
<td>General activities in maintenance operations management</td>
<td>45</td>
</tr>
<tr>
<td>Maintenance operations management activity model</td>
<td>45</td>
</tr>
<tr>
<td>Information exchanged in maintenance operations management</td>
<td>46</td>
</tr>
<tr>
<td>Maintenance definition management</td>
<td>48</td>
</tr>
<tr>
<td>Maintenance resource management</td>
<td>48</td>
</tr>
<tr>
<td>Detailed maintenance scheduling</td>
<td>49</td>
</tr>
<tr>
<td>Maintenance dispatching</td>
<td>49</td>
</tr>
<tr>
<td>Maintenance execution management</td>
<td>50</td>
</tr>
<tr>
<td>Maintenance data collection</td>
<td>50</td>
</tr>
<tr>
<td>Maintenance tracking</td>
<td>50</td>
</tr>
<tr>
<td>Maintenance analysis</td>
<td>50</td>
</tr>
<tr>
<td>Quality Operations Management</td>
<td>51</td>
</tr>
<tr>
<td>General activities in quality operations management</td>
<td>51</td>
</tr>
<tr>
<td>Quality test operations activity model</td>
<td>53</td>
</tr>
<tr>
<td>Information exchanged in quality test operations management</td>
<td>64</td>
</tr>
<tr>
<td>Quality test definition management</td>
<td>56</td>
</tr>
<tr>
<td>Quality test resource management</td>
<td>56</td>
</tr>
<tr>
<td>Detailed quality test scheduling</td>
<td>57</td>
</tr>
<tr>
<td>Quality test dispatching</td>
<td>67</td>
</tr>
<tr>
<td>Quality test execution management</td>
<td>67</td>
</tr>
<tr>
<td>Quality test data collection</td>
<td>69</td>
</tr>
<tr>
<td>Quality test tracking</td>
<td>69</td>
</tr>
<tr>
<td>Quality performance analysis</td>
<td>69</td>
</tr>
<tr>
<td>Supported activities</td>
<td>69</td>
</tr>
<tr>
<td>Inventory Operations Management</td>
<td>61</td>
</tr>
<tr>
<td>General activities in inventory operations management</td>
<td>61</td>
</tr>
<tr>
<td>Inventory operations management activity model</td>
<td>61</td>
</tr>
<tr>
<td>Information exchanged in inventory operations management</td>
<td>62</td>
</tr>
<tr>
<td>Inventory definition management</td>
<td>63</td>
</tr>
<tr>
<td>Inventory resource management</td>
<td>64</td>
</tr>
<tr>
<td>Detailed inventory scheduling</td>
<td>66</td>
</tr>
<tr>
<td>Inventory dispatching</td>
<td>66</td>
</tr>
<tr>
<td>Inventory execution management</td>
<td>66</td>
</tr>
<tr>
<td>Inventory data collection</td>
<td>66</td>
</tr>
<tr>
<td>Inventory tracking</td>
<td>66</td>
</tr>
</tbody>
</table>
Activities and Tasks

- Standard lists tasks that occur in each activity
- The standard does not specify an architecture or organization
- Task list can be quickly converted into requirements
- Identify which activities are to be supported
- Identify which resources (equipment, personnel, material) are to be supported
- Write requirements using ISA 95 terminology

6.4.3 Tasks in product definition management
Product definition management tasks may include:

a) Managing documents such as manufacturing instructions, recipes, product structure diagrams, manufacturing bills, and product variant definitions.

b) Managing new product definitions.

c) Managing changes to product definitions. This may include the ability to route designs and manufacturing bill changes through an appropriate approval process, management of versions, tracking of modifications, and security control of the information.

d) Providing product production rules to personnel or other activities.
   EXAMPLE:
   These may take the form of manufacturing steps, master recipes, machine setup rules, and process flowsheets.

e) Maintaining the feasible detailed production routings for products.

f) Providing the product segment route to manufacturing operations in the level of detail required by manufacturing operations.

g) Managing the exchange of product definition information with Level 4 functions at the level of detail required by the business operations.

h) Optimizing product production rules based on process analysis and production performance analysis.

i) Generating and maintaining local production rule sets indirectly related to products, such as for cleaning, startup, and shutdown.

j) Managing the Key Performance Indicator (KPI) definitions associated with products and production.

NOTE — There are a number of tools to assist in the product definition management activity, including mechanical and electronic computer-aided design (CAD), Computer-Aided Engineering (CAE), and Computer-Aided Software Engineering (CASEL), recipe management systems, Computer-Aided Process Engineering (CAPE), and Electronic Work Instructions (EWIs).
• Typical end user requirements (URS)

• Being used to compare different vendor’s functionality and capabilities

• We finally have a vendor independent description of MOM/MES

• We finally have a common way to compare different facilities

Table of Contents

1 INTRODUCTION..........................................................................................6
2 SUMMARY..................................................................................................12
3 PROCESS DESCRIPTIONS..........................................................................15
  3.1 SYSTEM OVERVIEW...........................................................................15
  3.2 AREA 1 ..............................................................................................17
  3.3 AREA 2..............................................................................................27

4 REQUIREMENTS SPECIFICATIONS..............................................................52
  4.1 GENERAL FUNCTIONAL REQUIREMENTS.............................................54
     4.1.1 Production Equipment Management Requirements .......................54
     4.1.2 Production Material Management Requirements .........................55
     4.1.3 Production Personnel Management Requirements ..........................58
     4.1.4 Production Recipe Management Requirements .................................58
     4.1.5 Detailed Production Scheduling Requirements .................................61
     4.1.6 Production Dispatching Requirements .............................................63
     4.1.7 Production Execution Requirements ..............................................64
     4.1.8 Production Data Collection Requirements ......................................68
     4.1.9 Production Tracking Requirements ..............................................69
     4.1.10 Production Analysis Requirements ..............................................71
  4.2 PROCESS AREA SPECIFIC REQUIREMENTS..........................................72
     4.2.1 Area 1 Requirements .....................................................................72
     4.2.2 Area 2 Requirements .....................................................................72
  4.3 NON-FUNCTIONAL REQUIREMENTS .....................................................78
     4.3.1 Management of Security ..................................................................78
     4.3.2 Management of Information ..........................................................79
     4.3.3 Management of Configurations ......................................................80
     4.3.4 Management of Documentation ....................................................80
     4.3.5 General Compliance Requirements ..............................................80

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MOM Boundary Defines the Requirement’s scope

- Product definition
- Production capability
- Production schedule
- Production performance

- Detailed production scheduling
- Production resource management
- Production dispatching
- Product definition management
- Production execution

- Production tracking
- Product data collection
- Production analysis
- (QA) Product analysis

Level 2 Process Control

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For All Categories

- Determine which areas are covered by the implementation
- Most implementations cover 1 or 2 categories
- Determine the line of responsibility for each category
Example: Equipment / Vessel Tracking

- At a process company one main issue was tracking transfer vessels, their status (clean, sterile, in use, ...) and location (in plant and between plants)
- Limited MES installed to track equipment resources
- Reduced delays due to vessel availability and eliminated errors due to incorrect equipment
Example: Investigations & RFT Studies

- Major company’s goal was to reduce incident investigation time & RFT study time, >80% spent collecting data
- Installed a limited MES for Data Collection & Analysis
- Initial implementations have significantly reduced study and investigation times
Typical Initial MES Implementation

1. **Product definition**
2. **Resource information**
3. **Production capability**
4. **Production schedule**
5. **Production performance**

- **Production resource management**
- **Production dispatching**
- **Production execution management**
- **Production tracking**
- **Production Performance analysis**
- **Production data collection**

**MES**

**Historian**

Level 1-2 Functions

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The Typical MES / DCS Pattern

- **Product definition**
- **Resource information**
- **Production capability**
- **Production schedule**
- **Production performance**

---

MES

- **Detailed production scheduling**
- **Production resource management**
- **Production dispatching**
- **Production tracking**
- **Production Performance analysis**
- **Production data collection**
- **Production execution management**

DCS

- **Product definition management**
- **Production resource management**
- **Production dispatching**
- **Production execution management**

---

**Level 1-2 Functions**

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Commercial MOM/MES Systems

- Mostly based on ISA 95 and ISA 88 standards
- Most solutions still focused on industry segments
  - Pharmaceutical
  - Automotive
  - Discrete Assembly
  - Food and Beverage
  - Process Industries
- Site implementations range from 200K – 2M USD depending on scope and customization required
- Paybacks come from 2%-3% year to year productivity improvements
  - Because of ability to “lock-in” best practice procedures
Summary

• ISA 95 provides a vendor independent description of MOM/MES
• Provides a vendor independent and user independent format for MOM requirements
• Vertical integration of system is usually required to achieve full MOM benefits
• Well documented benefits from MOM implementations are driving additional implementations
• Most vendors are supporting the ISA 95 standard and are using it to describe their products’ functionality
ISA 95 / MOM / B2MML Questions
Thank you

20 YEARS & KNOWING
OUR MEMBERS ARE THE MOST AGILE COMPANIES IN THE WORLD.
THEM KNOW THEY HAVE A RESPONSIBILITY TO INDUSTRY AND TO ONE ANOTHER.
THEM KNOW THE CONSEQUENCES OF AVOIDING A SINGLE IMPROVEMENT CAN
MEAN MILLIONS OF DOLLARS AND A POSSIBLE GLOBAL IMPACT.
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Global Education Program
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“At the Global Education Programs,
I learn from mistakes and successes of other
manufacturers, I network with the best, AND
the cost is credited to my membership fees.
Becoming a member was a no-brainer.”

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INFORMATION INTEGRATION - SAFETY - ASSET PERFORMANCE MANAGEMENT - B2MMXL
QUALITY & COMPLIANCE - PRODUCT LIFECYCLE MANAGEMENT - AUTOMATION

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