What is ISA-95?
Industrial Best Practices of Manufacturing Information Technologies with ISA-95 Models

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• Dennis Brandl has been an active member of ISA’s SP88 Batch Control System committee for the past seven years, a U.S. expert in batch control to IEC, editor of ISA’s SP95 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, and Modicon.

• 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.
What is ISA 95

- A USA ANSI standard developed by an ISA Committee of volunteer experts


- **ANSI-ISA 95.02-2001** “Enterprise - Control System Integration – Part 2: Object Attributes”

- **ANSI/ISA 95.03-2005** “Enterprise - Control System Integration – Part 3: Models of Manufacturing Operations”

- **ANSI/ISA 95.05-2007** “Enterprise - Control System Integration – Part 5: Business to Manufacturing Transactions”

- **SP95** is the committee developing the ISA95 standards

- Also available as **IEC/ISO 62264** standards
Why was ISA 95 Developed

• Integration of business logistics systems to manufacturing systems is difficult and expensive

• Effective operation of manufacturing is difficult to explain and compare

• Integration of manufacturing operations systems is difficult and expensive
Three Main Area

- Models of exchanged information between business logistics systems and manufacturing operations systems
  - Part 1, 2, and 5
- Models of activities in manufacturing operations systems
  - Part 3
- Models of exchanged information within manufacturing operations systems
  - Future Part 4 and 6
Why was ISA 95 Developed, Part 1,2,5

- Integration of business logistics systems to manufacturing systems was difficult and expensive
  - Integration projects typically took one or more years
  - Low success rate
  - Increasing use of ERP and need for integration
- Many reasons
  - Different terminology and technical languages
  - Different computer systems
  - Different organizational cultures
  - ...

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Why was ISA 95 Developed, Part 3

- Effective operation of manufacturing is difficult to explain and compare
  - Impossible to compare operations at different plants and determine best practices
  - Difficult to explain end user requirements to vendors, requirement projects took years
  - Difficult for vendors to explain solutions to end users, sales took years
  - Difficult to compare MES solutions
  - MES (Manufacturing Execution Systems) had no common definition
  - MES solutions were too related to processing methods and too industry-specific
Why was ISA 95 Developed, Part 4, 6

- Future Work for ISA SP95
- Integration of production, maintenance, laboratories, and material handling & storage is difficult
- Integration of manufacturing applications often takes 50% - 80% of a project cost
  - Many manufacturing sites have multiple systems from multiple vendors and different release versions
- Part 4 will define commonly shared information between manufacturing activities
- Part 6 will define transactions on the information
Integration of Business to Manufacturing Systems

ISA 95 Part 1, 2 and 5
and
WBF B2MML Schemas
Typical Key Business Drivers

• Key Business Drivers
  ► Key business drivers are the areas of performance that are most critical to an organization’s success

• Available To Promise
  ► Requires detailed knowledge of available capacity

• Reduced Cycle Time
  ► Major performance indicator with a direct impact on corporate profitability

• Supply Chain Optimization
  ► Optimizing the manufacturing link in the supply chain – agile & responsive

• Asset Efficiency
  ► Requires detailed knowledge of actual use

• Agile Manufacturing
  ► Requires ability to quickly synchronize planning and production
ISA 95 Level Definitions

- **Level 0**
  - Defines the actual physical processes.

- **Level 1**
  - Defines the activities involved in sensing and manipulating the physical processes.

- **Level 2**
  - Defines the activities of monitoring and controlling the physical processes.

- **Level 3**
  - Defines the activities of the work flow to produce the desired end-products.

- **Level 4**
  - Defines the business-related activities needed to manage a manufacturing organization.

- **NOTE:** There are other non manufacturing business-related activities that may be in Levels 1 through 4 or higher levels, but these are not defined in this standard, for example security activities.
ISA 95 Levels

Level 4
- Business Planning & Logistics
  - Plant Production Scheduling, Business Management, etc.
  - **Time Frame**: Months, weeks, days, shifts
  - 4 - Establishing the basic plant schedule - production, material use, delivery, and shipping. Determining inventory levels.

Level 3
- Manufacturing Operations Management
  - Dispatching Production, Detailed Production Scheduling, Reliability Assurance, ...
  - **Time Frame**: Shifts, hours, minutes, seconds
  - 3 - Work flow / recipe control to produce the desired end products. Maintaining records and optimizing the production process.

Level 2
- Manufacturing Control
  - Basic Control, Supervisory Control, Process Sensing, Process Manipulation, ...
  - 2 - Monitoring, supervisory control and automated control of the production process

Level 1
- 1 - Sensing the production process, manipulating the production process

Level 0
- 0 - The physical production process

5 - Sense the production process, manipulating the production process
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 Systems (MES, Batch, LIMS, AM, ...)**

- Work flow + recipe control to produce the desired end products. Maintaining records and optimizing the production process.

**Time Frame**
- Days, 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

**The physical production process**

ISA 95 Corresponds to Applications

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A function is in the manufacturing and control domain if:
1. The function is critical to product quality
2. The function is critical to plant safety
3. The function is critical to plant reliability
4. The function is critical to plant efficiency
5. The function is critical to maintaining product or production regulatory compliance
   • This includes such factors as safety, environmental, and cGMP compliance (FDA, EPA, USDA, OSHA, …)

Why?
► Answer - where is the responsibility.
Level 4-3 Exchanged Information

Business Information
- Plant Production Scheduling, Business Management, etc

Manufacturing Operations and Control Information
- Area Supervision, Production Planning, Reliability, Assurance, etc

Resource Definitions
- Personnel Equipment Material

Production Capability
- What is available to use

Product Definition
- How to make a product

Production Schedule
- What to make and use

Production Performance
- What was made and used
ISA 95 Defines Formal Data Models

- Data Models that represent exchanged information
  - Not an Enterprise Data Model
  - A way to represent information in a vendor independent method
- Defined in a UML notation
  - UML – Unified Modeling Language
- Implemented using WBF’s B2MML schemas
  - XML Schema Definition (xsd)
  - xsd published as a W3C recommendation in May 2001
Material Model

- Defines classes, material definitions, and instances
- Defines properties and values
- Defines QA Tests and results
<Material><MaterialLot>
  <ID> W89 </ID>
  <Description> A lot of material </Description>
  <MaterialDefinitionID> WXE908 </MaterialDefinitionID>
  <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>
<ProductionCapability>
  <ID>Area 54 : 2008-05-01</ID>
  <PublishedDate>2008-05-01</PublishedDate>
  <StartTime>8:00:00</StartTime>
  <EndTime>16:00:00</EndTime>
  <EquipmentCapability>
    <EquipmentID>"Production Line 2"</EquipmentID>
    <CapabilityType>"Available"</CapabilityType>
    <Reason>"Reduced rate due to maintenance"</Reason>
    <Quantity>
      <QuantityString>"200"</QuantityString>
      <DataType>"Int"</DataType>
      <UnitOfMeasure>"Boards Per Hour"</UnitOfMeasure>
    </Quantity>
  </EquipmentCapability>
</ProductionCapability>
ISA 95 Part 5 - Transactions

CHANGE SCHEDULE

Application Identification Area

Data Area

VERB = CHANGE

Noun = SCHEDULE
ID= “A77818”
Start Time = 2008-05-01 08:15:00

Material Produced
ID = 12345
Quantity = 3000
Unit of Measure = 1 Liter Bottle

RESPOND SCHEDULE

Application Identification Area

Data Area

VERB = RESPOND

Noun = SCHEDULE

Information Receiver

Local processing

CHANGE

RESPOND

Information Sender
• Benefits to End Users
  ► Integration projects went from over one year to under 6 weeks
  ► Success rate for projects went from less than 50% to over 90%

• Benefits to Vendors
  ► Integration costs reduced because of a standard format
  ► Less custom code to develop and support

• Benefits to System Integrators
  ► Standard tools and methods can be applied
  ► More opportunities for integration projects
Compliance with ISA 95 and B2MML

- A New Organization is starting to test compliance with B2MML messages
- Setup as an independent compliance test lab
- Will start certification processes in early 2009
Models of Manufacturing Operations

ISA 95 Part 3
ISA 95 – Requirements for MOM

• The ISA 95 Part 3 standard defines 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

• Tasks and activities are used as a map to identify MOM requirements
The Production Elements of ISA 95

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

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

- **Product definition management**
- **Production execution management**

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

**Level 1-2 Functions**
Activities and Tasks

- Part 3 lists tasks that occur in each activity
- It does not specify an architecture or organization
- Task list can be quickly converted into requirements
- Users identify which activities are to be supported
- Users identify which resources (equipment, personnel, material) are to be supported
- Users write requirements using ISA 95 terminology
A Template for MES Requirements

- Typical end user requirements document
- Used to compare different vendor's functionality and capabilities
- We finally have a vendor independent description of MES
- We finally have a common way to compare different facilities
Benefits of ISA 95 Part 3

• Benefits to End Users
  ► Significant reduction in time to determine MES requirements
  ► Project time reduced from months to weeks
  ► Possible to compare different vendor solutions
  ► Possible to compare different facilities

• Benefits to Vendors
  ► Standard language to use with customers
  ► Quickly demonstrate functions and problems solved

• Benefits to System Integrators
  ► Many more MOM projects
  ► Many more opportunities for integration projects
The Future

Object Models for Manufacturing

to Manufacturing Integration

Plans for Part 4 and Part 6
Operations level 1-2 functions

Legend
- Defined in Part 2
- Defined in Part 4
- Defined in other standards

From ISA 95 Part 2 WD04
Summary

• The ISA 95 has been a major success
  ► Reducing ERP-MES/MOM integration efforts by over 90%
  ► Improving integration project success from under 50% to over 90%
  ► Reducing early phases of MES/MOM projects by over 75%
  ► Helping revitalize the MES/MOM marketplace
  ► Increasing MES/MOM competition
  ► Helping improve manufacturing productivity
  ► Work done by volunteers
Thank you

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