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**

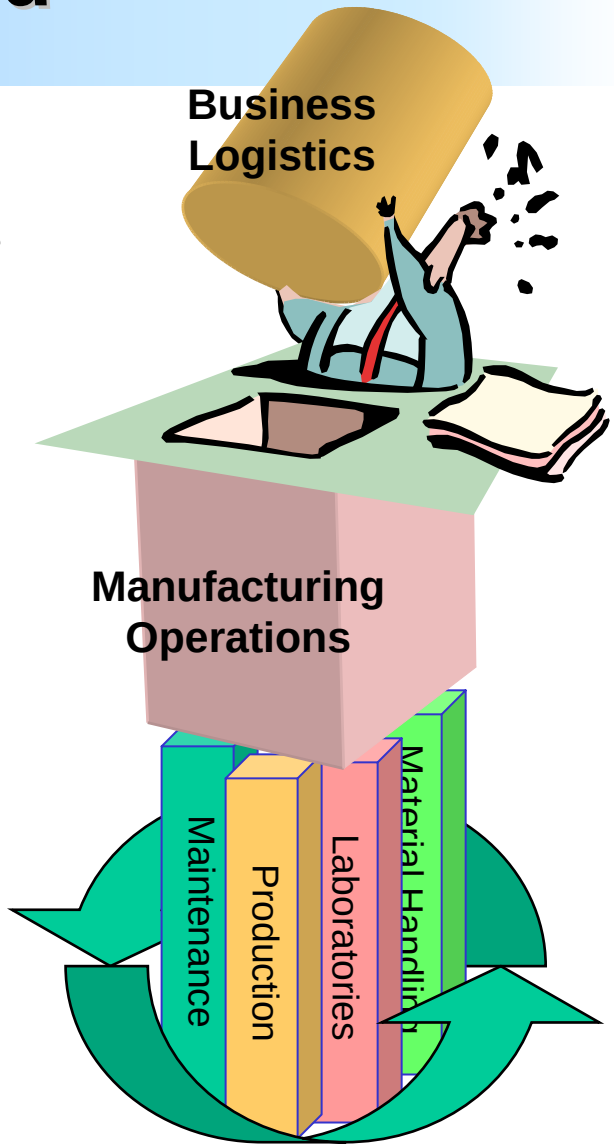
- **ANSI/ISA 95.01-2000** “Enterprise - Control System Integration – Part 1: Models and Terminology”
- **ANSI-ISA 95.02-2001** “Enterprise - Control System Integration – Part 2: Object Attributes”
- **ANSI/ISA 95.03-2005** “Enterprise - Control System Integration – Part 3: Models of Manufacturing Operations”
- **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

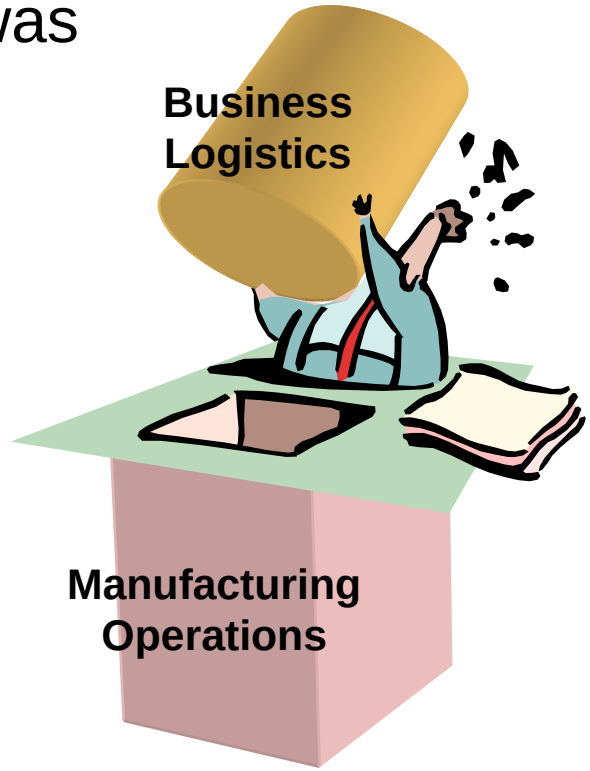


Three Main Area

- 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

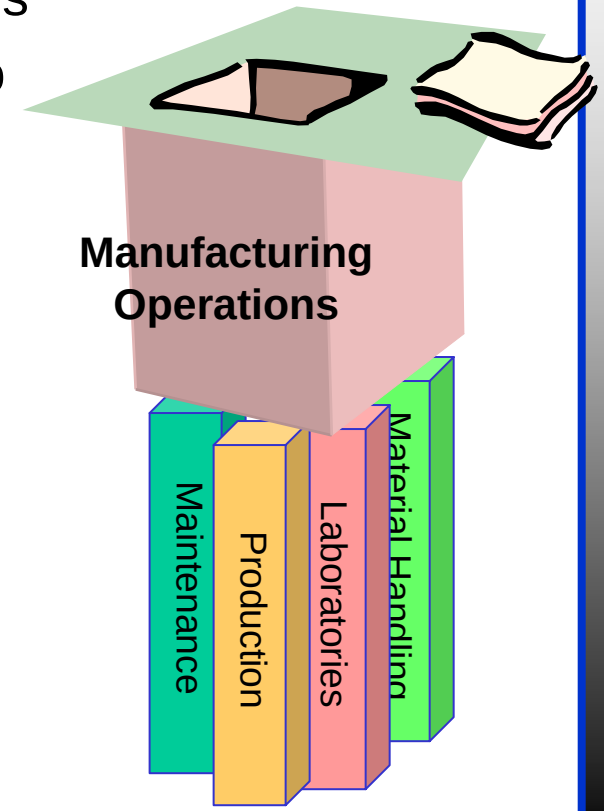
Why was ISA 95 Developed, Part 1,2,5

- 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
  - ...



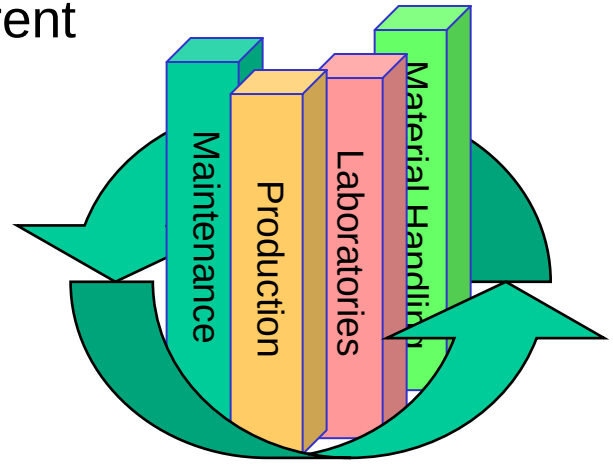
Why was ISA 95 Developed, Part 3

- 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

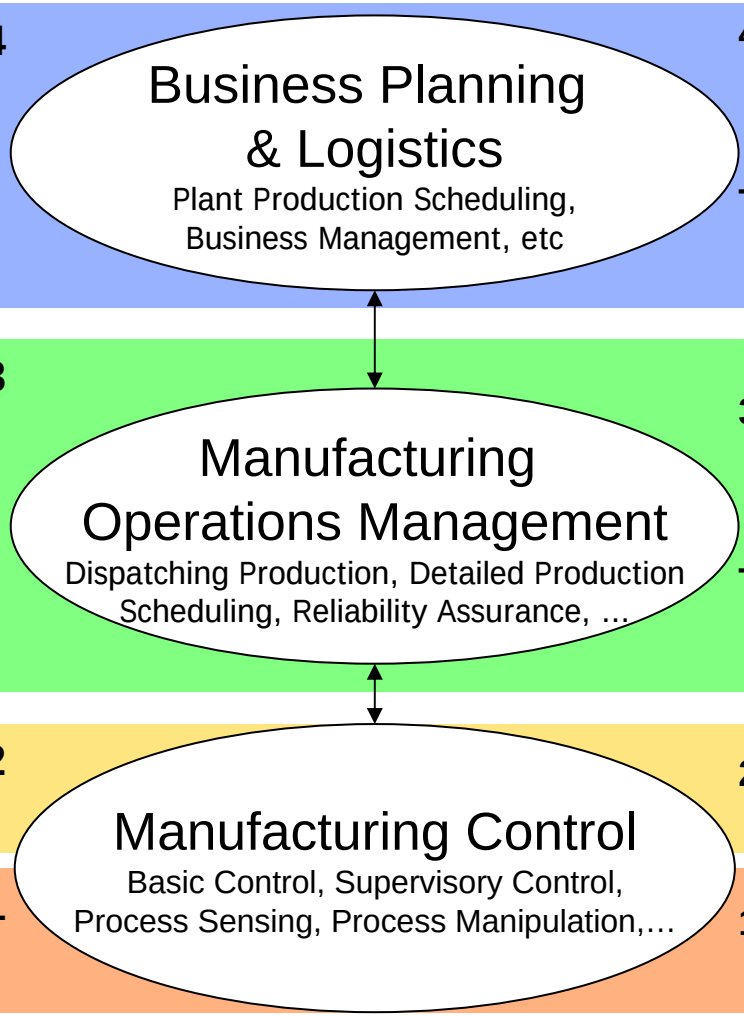
- Key Business Drivers
  - Key business drivers are the areas of performance that are most critical to an organization's success
- Available To Promise
  - Requires detailed knowledge of available capacity
- Reduced Cycle Time
  - Major performance indicator with a direct impact on corporate profitability
- 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



4 - Establishing the basic plant schedule - production, material use, delivery, and shipping. Determining inventory levels.

Time Frame
Months, weeks, days, shifts

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

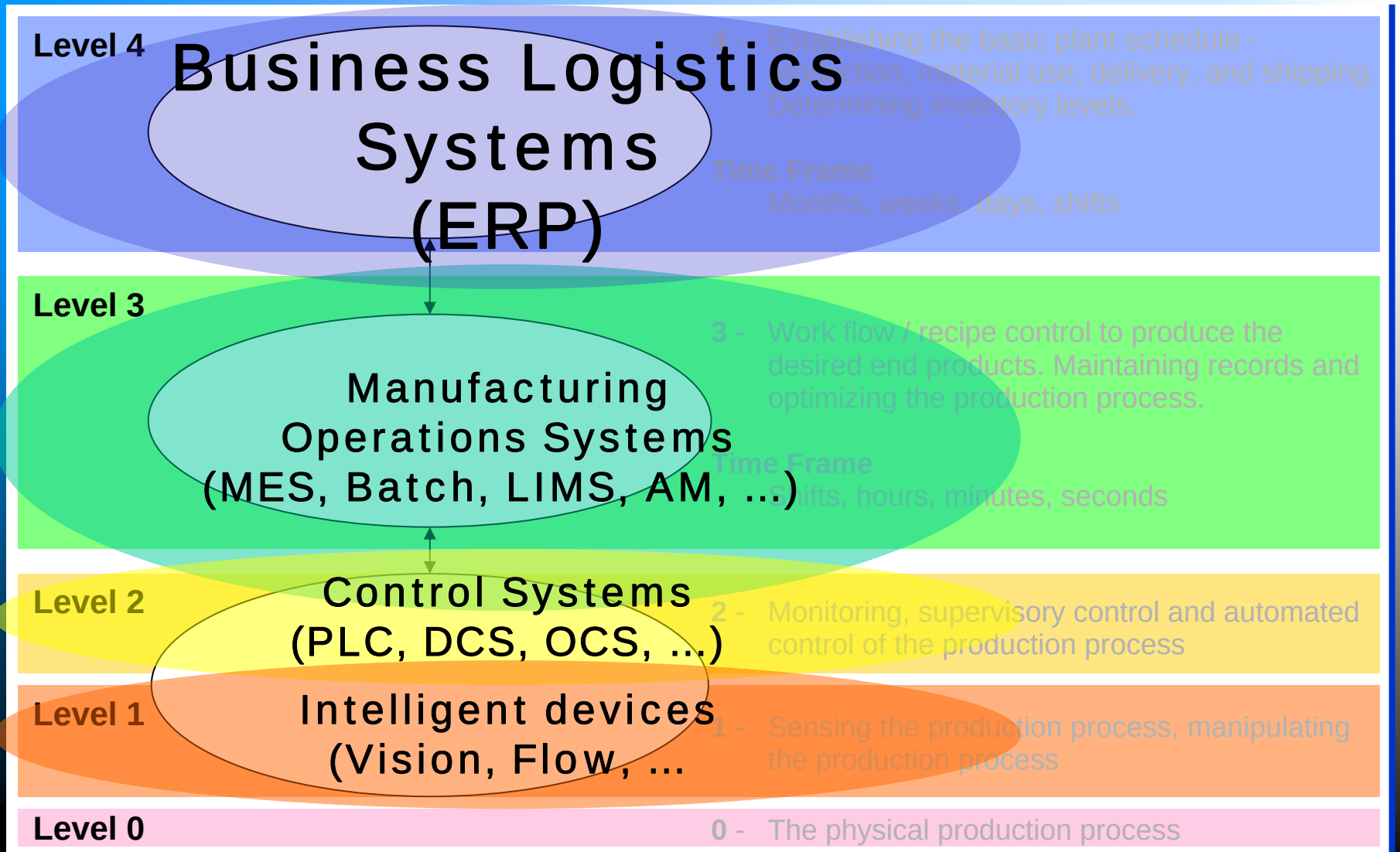
Time Frame
Shifts, hours, minutes, seconds

2 - Monitoring, supervisory control and automated control of the production process

1 - Sensing the production process, manipulating the production process

0 - The physical production process

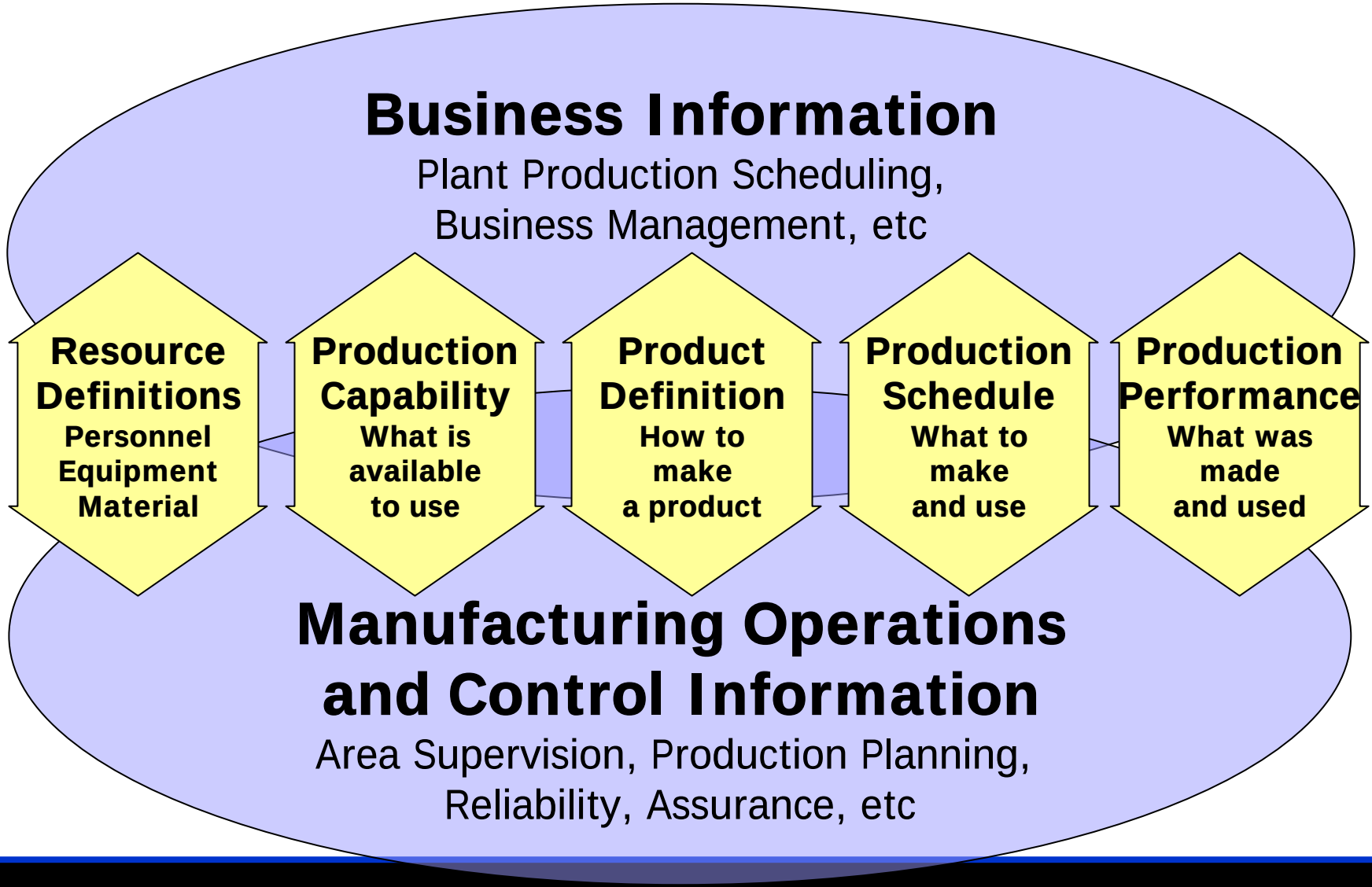
ISA 95 Corresponds to Applications



Manufacturing Operations and Control

- 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

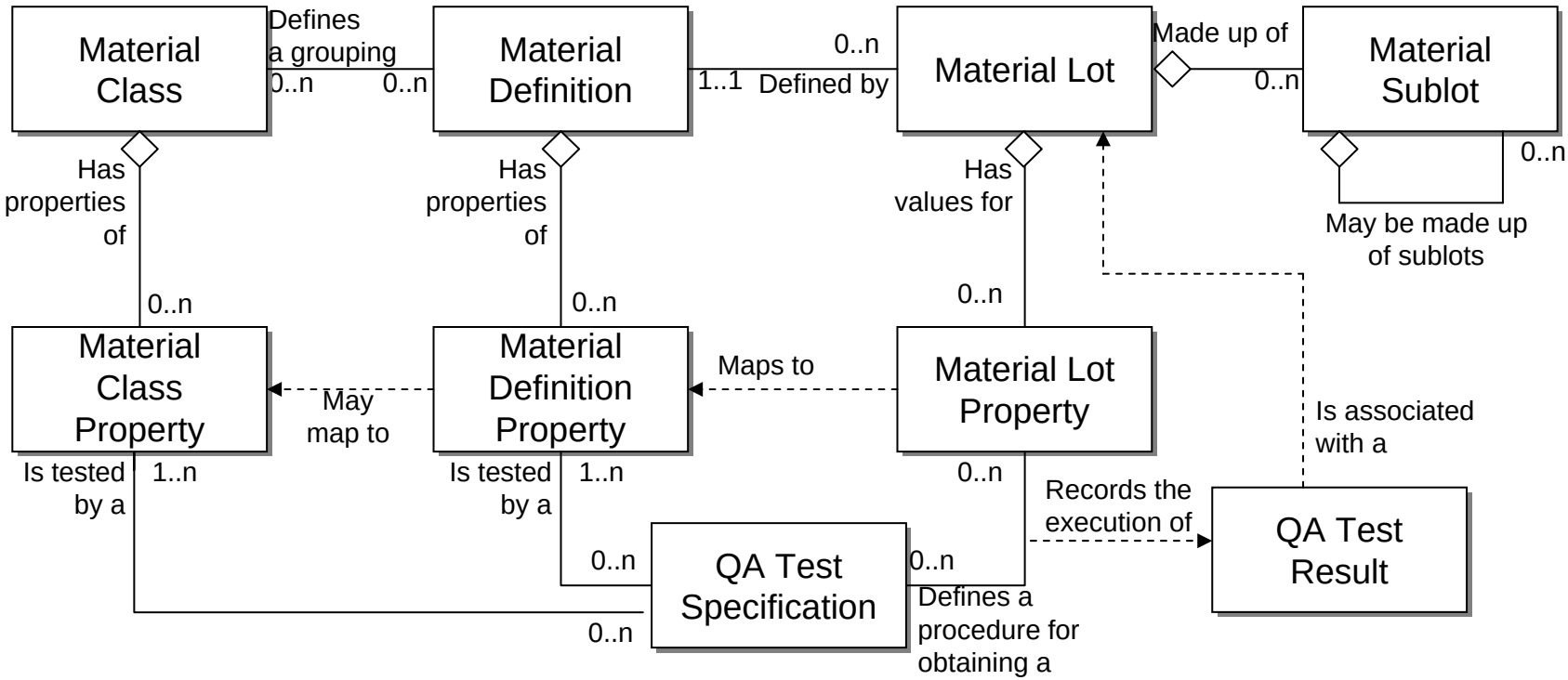


ISA 95 Defines Formal Data Models

- 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
  - ISO/IEC 19501-1, Information Technology—Unified Modeling Language (UML)—Part 1: Specification
- 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



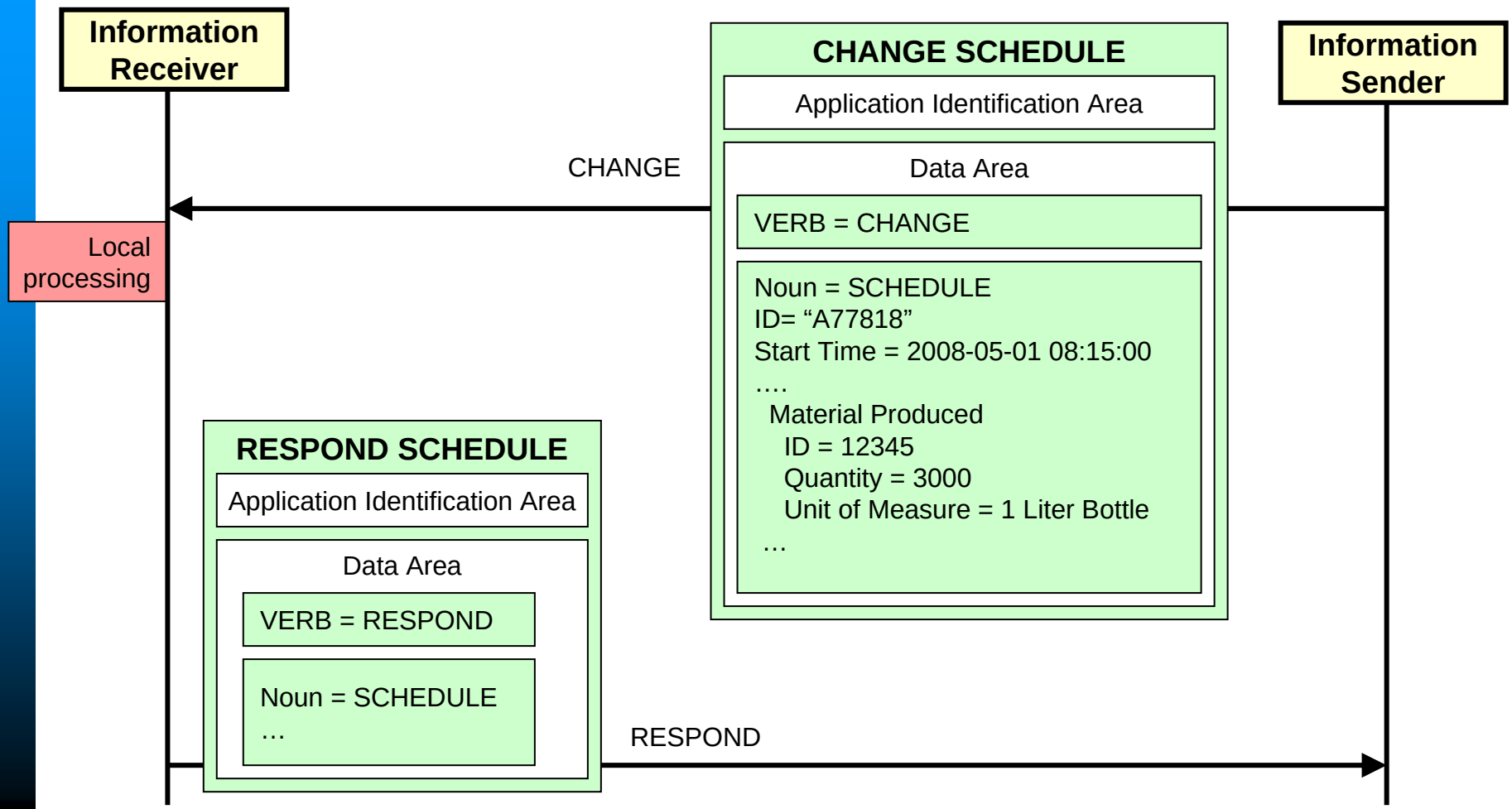
A B2MML Example – Material Lot

```
<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>
```

A B2MML Example Production Capability

```
<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>
    </EquipmentCapability>
  </ProductionCapability>
```

ISA 95 Part 5 - Transactions



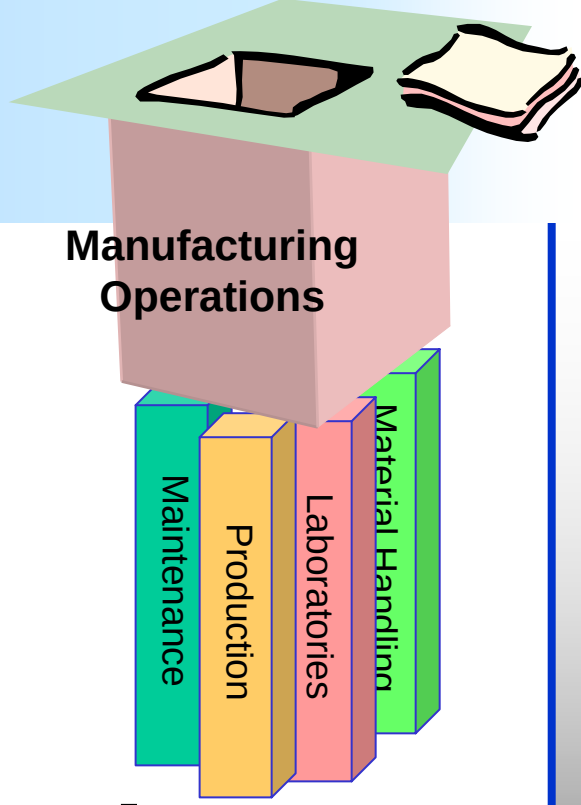
ISA 95 Part 1, 2, 6 Benefits

- 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

Industrial Interoperability Compliance Institute
(a forum in ASCI)



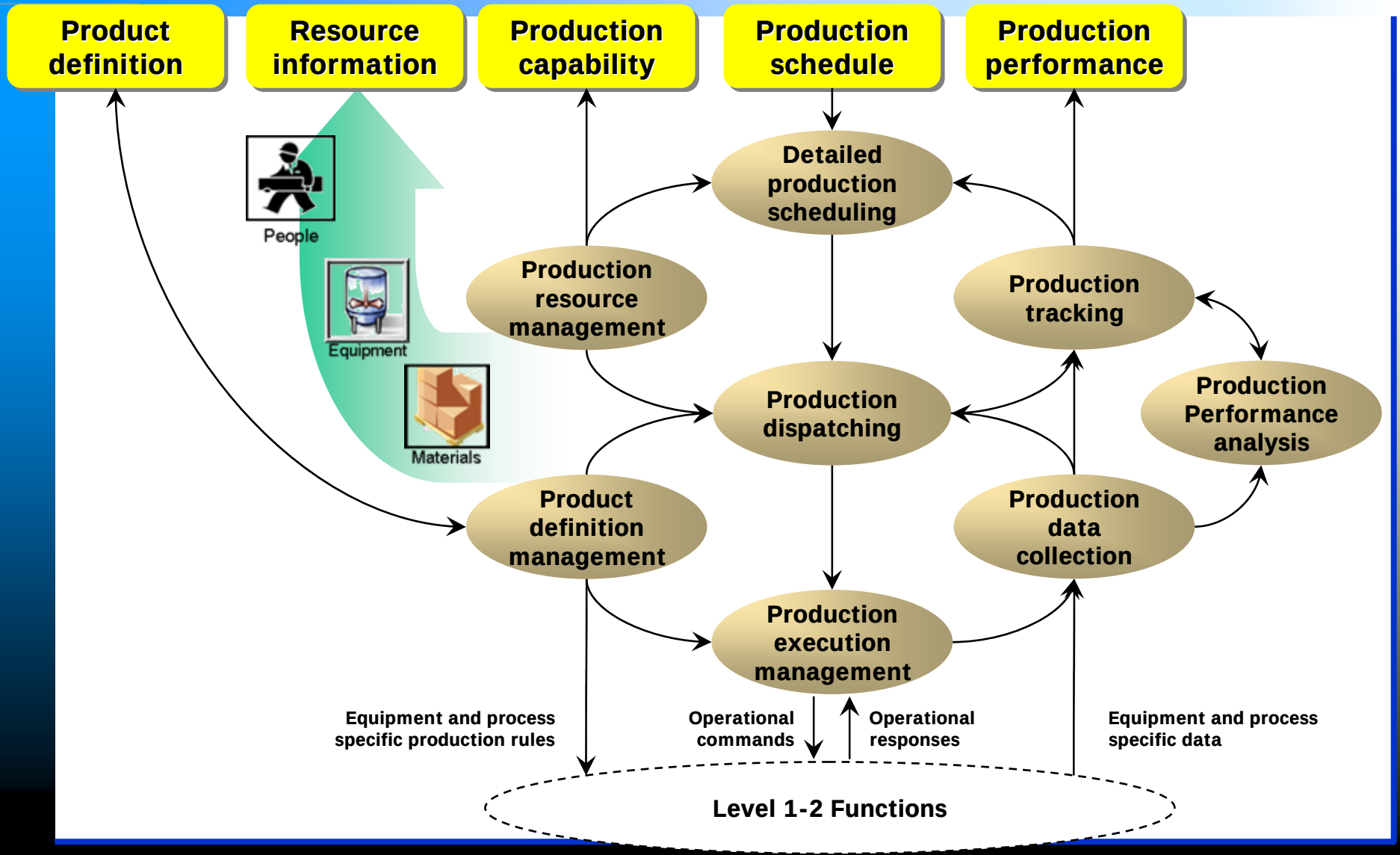
Models of Manufacturing Operations

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



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

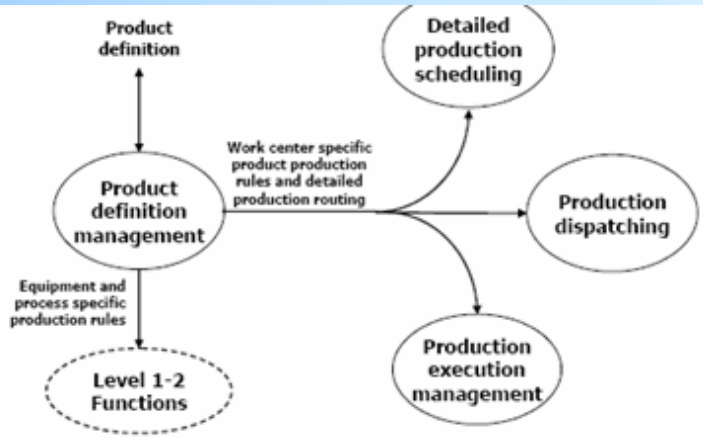


Figure 10 - Product definition management activity model interfaces

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 (CASE), recipe management systems, Computer-Aided Process Engineering (CAPE), and Electronic Work Instructions (EWIs).

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

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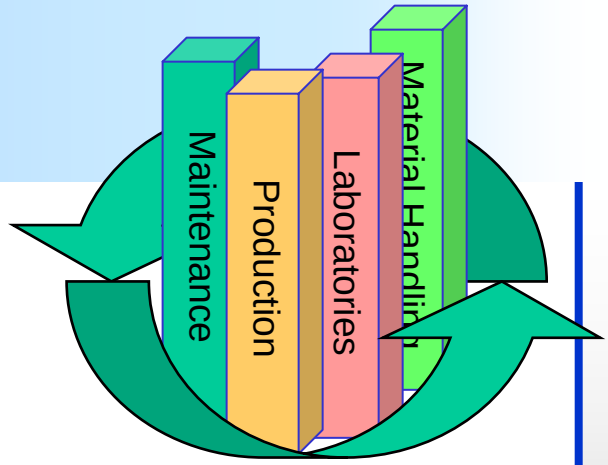
Benefits of ISA 95 Part 3

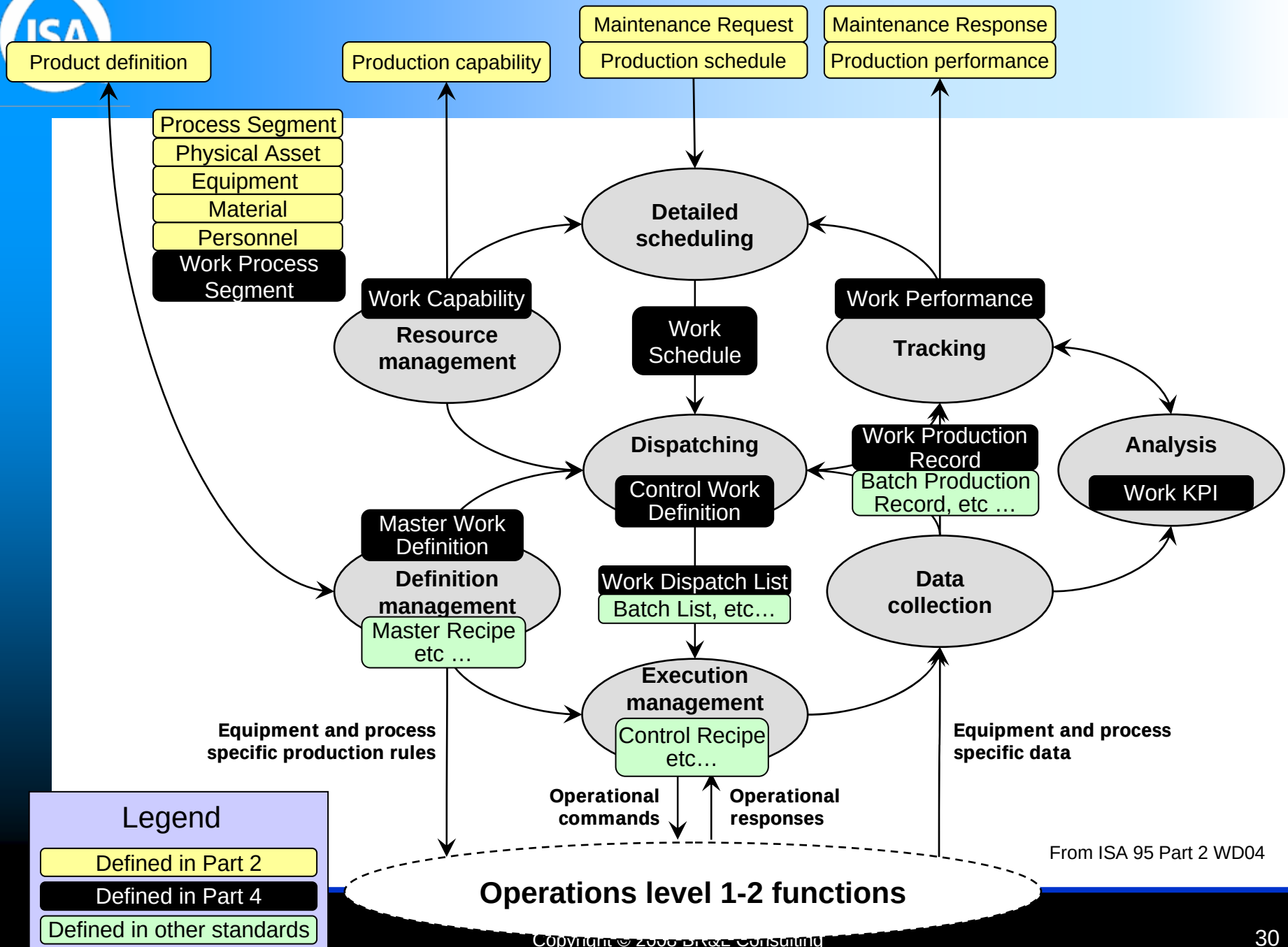
- Benefits to End Users
  - Significant reduction in time to determine MES requirements
  - Project time reduced from months to weeks
  - Possible to compare different vendor solutions
  - Possible to compare different facilities
- Benefits to Vendors
  - Standard language to use with customers
  - Quickly 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



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

Dennis Brandl