Collaborative Production Management:
Maintaining Capabilities in a Shifting Environment

Eric C. Cosman
Manufacturing IT Consultant
<table>
<thead>
<tr>
<th>Advanced Materials</th>
<th>Agricultural Sciences</th>
<th>Performance Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Electronic &amp; Functional Materials</strong></td>
<td><strong>Coatings &amp; Infrastructure Solutions</strong></td>
<td><strong>Agricultural Sciences</strong></td>
</tr>
</tbody>
</table>
| - Dow Electronic Materials  
  - Semiconductor Tech  
  - Interconnect Tech  
  - Display Technologies  
  - Growth Technologies  
  - Functional Materials  
  - Dow Wolff Cellulosics  
  - Dow Home & Personal Care  
  - Dow Microbial Control  
  - Performance Additives  
  - JV: Dow Corning | - Dow Building & Construction  
  - Dow Building Solutions  
  - Dow Construction Chemicals  
  - Dow Solar Solutions  
  - Dow Coating Materials  
  - Architectural Coatings  
  - Industrial Coatings  
  - Dow Water & Process Solutions  
  - Performance Monomers  
  - JV: Dow Corning | - Dow AgroSciences  
  - Agricultural Chemicals  
  - Seeds, Traits, & Oils  
  - AgroFresh |
| **Performance Plastics** | **Feedstocks & Energy** | **Performance Materials** |
| - Polyethylene  
  - Plastics Licensing & Catalyst  
  - Dow Packaging & Converting  
  - Dow Elastomers  
  - Dow Electrical & Telecommunications  
  - JV: EQUIATE  
  - JV: Equipolymers  
  - JV: The Kuwait Olefins Company K.S.C.  
  - JV: SCG-Dow  
  - JV: Univation Technologies | - Chlor-Alkali/Chlor-Vinyl  
  - Energy  
  - Ethylene Oxide/Ethylene Glycol  
  - JV: EQUIATE  
  - JV: MEGlobal | - Epoxy  
  - Oxygenated Solvents  
  - Polyurethanes  
  - Polyglycols, Surfactants and Fluids  
  - Dow Haltermann  
  - SAFECHEM  
  - JV: BASF Dow HPPO B.V.  
  - JV: Saudi Acrylic Monomers Company LLC (SAMCO)  
  - JV: SCG-Dow |
| **Performance Materials** | **Feedstocks & Energy** | **Performance Materials** |
| - Hydrocarbons (Olefins, Aromatics, Aromatic Derivatives)  
  - JV: Compañía Mega  
  - JV: SCG-Dow  
  - JV: The Kuwait Olefins Company K.S.C.
The Request...

- Address the current state of ISA level 3 application (multi-vendor, level on integration, ability to visualize all the information necessary to maximize production efficiency and effectiveness;
  - what business issues the current installed base presents or does not solve?
  - What are you planning to do to address this?
  - Where you are?
  - How did you get there?
  - What you are doing about it?
Where we’ve been…

- “Shop Floor to Top Floor”, c. 1990
- Built on custom applications and (then) current infrastructure and commercial solutions
- Tightly integrated with a proprietary control system
- Still in use today
  - Hundreds of installations

If you know us, you’ve heard this story
**Scenario 1** - to be avoided.

- **Enterprise Systems**
- **MES/ICS**
  - Factory X
  - Factory Y
  - Factory ..
- **Application X**
- **Application Y**

**Scenario 2** - the goal.

- **Enterprise Systems**
  - XML Adapter (as required)
- **MES/ICS**
  - System X
    - Factory X
  - System Y
    - Factory Y
  - System ..
    - Factory ..
- **ICS**
- **Application**
- **OPC**
As seen by a system architect...

Business Information

- Production Operations Management Information
- Maintenance Operations Management Information
- Quality Operations Management Information
- Inventory Operations Management Information

Manufacturing Operations Management Information
The reality...
The Familiar Hierarchy

Level 4

**Business Planning & Logistics**
Plant Production Scheduling, Operational Management, etc

Level 3

**Manufacturing Operations & Control**
Dispatching Production, Detailed Production Scheduling, Reliability Assurance, ...

Levels 2,1,0

- **Batch Control**
- **Continuous Control**
- **Discrete Control**
Levels in Motion...

ERP Migration

**Business Planning & Logistics**
Plant Production Scheduling, Operational Management, etc

ICS Migration(s)

**Manufacturing Operations & Control**
Dispatching Production, Detailed Production Scheduling, Reliability Assurance, ...

**Batch Control**

**Continuous Control**

**Discrete Control**

Different Drivers, Different Rates...
Looking for a Basis

What do we know ??
<table>
<thead>
<tr>
<th>Functionality</th>
<th>Business Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recipe Management</td>
<td>- Improves the ability to transport a recipe from one system to another</td>
</tr>
<tr>
<td></td>
<td>- Makes recipes more flexible and reusable</td>
</tr>
<tr>
<td></td>
<td>- Simplifies recipe validation</td>
</tr>
<tr>
<td></td>
<td>- Makes equipment control more flexible and reusable</td>
</tr>
<tr>
<td></td>
<td>- Lower first cost</td>
</tr>
<tr>
<td></td>
<td>- Improved long-term maintainability</td>
</tr>
<tr>
<td>New Material Introduction</td>
<td>Very fast product transformation from R&amp;D workbench into production</td>
</tr>
<tr>
<td>Segregation of Functionality</td>
<td>Reusability of objects/rules</td>
</tr>
<tr>
<td>Data Integration</td>
<td>Batch contextualization of data from multiple sources (e.g. LIMS, manual, process, customers, lab, etc.)</td>
</tr>
<tr>
<td>Workflow Engine</td>
<td>Coordination of shop floor activities and associated data flows (manual as well as automated)</td>
</tr>
<tr>
<td>SPC/SQC</td>
<td>High priority for business; document and improve product quality</td>
</tr>
<tr>
<td>Detailed Scheduling</td>
<td>Make to promise; rapid product delivery; increased asset utilization, operational equipment effectiveness(OEE)</td>
</tr>
<tr>
<td>Product Genealogy (Traceability)</td>
<td>Requirement for FDA approval, cGMP, customer requirement</td>
</tr>
<tr>
<td>ERP Connectivity</td>
<td>See data integration; data integrity, production flexibility and data efficiency, near real-time production cost estimate</td>
</tr>
<tr>
<td>Batch Reporting</td>
<td>Production data accessibility</td>
</tr>
<tr>
<td>Ad-hoc Reporting</td>
<td>Root cause analysis, Ability to quickly adapt to customer reporting requirements</td>
</tr>
</tbody>
</table>
Typical Capabilities

- Batch & Campaign Management
- SPC
- Compliance Monitoring
- Product Genealogy
- Order Execution
- Detailed Scheduling
- ICS
- MES
- ERP
- Shop floor
- Enterprise
- Network Independence
- Batch Reporting
- Recipe Management
Levels have a “thickness”
## Characterization by Process Type

<table>
<thead>
<tr>
<th>PROCESS</th>
<th>DISCRETE</th>
<th>MES / ICS</th>
<th>ERP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pharma/Spclty</td>
<td>Bulk/Basics</td>
<td>Simple</td>
<td>Intermediate</td>
</tr>
<tr>
<td>SCADA/PCS</td>
<td>SCADA/iCS</td>
<td>Some PLC’s</td>
<td>Some PLC’s</td>
</tr>
<tr>
<td>Equip Trains</td>
<td>Equip Trains</td>
<td>Machines/WC’s</td>
<td>Machines/WC’s</td>
</tr>
<tr>
<td>Flexible Connections</td>
<td>Fixed Connections</td>
<td>Fixed Connections</td>
<td>Production Lines</td>
</tr>
<tr>
<td>Large Recipes</td>
<td>Simple Recipes</td>
<td>Only Ingredients Change</td>
<td>100’s of Assemblies</td>
</tr>
<tr>
<td>Many Products</td>
<td>Simple Procedures</td>
<td>Few Products</td>
<td>Moderate No. Products</td>
</tr>
<tr>
<td>Complex Procedures</td>
<td>Simple Procedures</td>
<td>Simple Procedures</td>
<td>Simple Procedures</td>
</tr>
<tr>
<td>Compliance</td>
<td>Simple Routing</td>
<td>Fixed Routes</td>
<td>Simple Routing</td>
</tr>
<tr>
<td>Simple Recipes</td>
<td>Large No. Variables</td>
<td>Real-time Optimization</td>
<td>Large No. Variables</td>
</tr>
<tr>
<td>Simple Procedures</td>
<td>Simple Procedures</td>
<td>Simple Procedures</td>
<td>Simple Procedures</td>
</tr>
<tr>
<td>Simple Routing</td>
<td>Simple Procedures</td>
<td>Fixed Routes</td>
<td>Fixed Routes</td>
</tr>
<tr>
<td>Large No. Variables</td>
<td>Large No. Variables</td>
<td>Real-time Optimization</td>
<td>Real-time Optimization</td>
</tr>
<tr>
<td>Real-time Optimization</td>
<td>Real-time Optimization</td>
<td>Real-time Optimization</td>
<td>Real-time Optimization</td>
</tr>
</tbody>
</table>

### Integration
- PROCESS: M
- Bulk/Basics: M
- Simple: L
- Intermediate: H
- Complex: M – H

### Agility
- PROCESS: L – M
- Bulk/Basics: L – M
- Simple: L
- Intermediate: L – M
- Complex: M

### Visibility
- PROCESS: M - H
- Bulk/Basics: M – H
- Simple: L
- Intermediate: M
- Complex: H

### Complexity
- PROCESS: M
- Bulk/Basics: M – H
- Simple: L
- Intermediate: L – M
- Complex: H

### Compliance
- PROCESS: H
- Bulk/Basics: L – M
- Simple: L
- Intermediate: L - M
- Complex: M - H
Characterization by Business Type

- **Criteria include…**
  - Generic Business Drivers
  - Manufacturing Cost
  - Asset Capability
  - Operational Complexity
  - Product Introduction Frequency (new products / year)
  - Adaptability to Market & Demand Changes
  - “Time to Market” for new products
  - Production Flexibility
  - Production Transparency & Product Traceability
  - Access to and High Availability of Integrated Quality Data rapid customization of product quality & genealogy reporting)
  - Reliability of Product Delivery (make to promise)
  - Inventory
Program Approach

**Platform Selection**
- Specification of Functional components based on ISA-88/95
- Selection of Commercial off-the-shelf components & solutions
- Interoperability of components & solutions

**Develop Implementation Process**
- Project Model-Driven Execution
- User requirement specification Traceability Model
- Front-end Engineering Design (FEED) study
- Functional Requirement Specification
- Detailed Design Specification
- Factory Acceptance Test

**Collaboration Instantiation**
- Internal
  - Cross Functional
- External
  - Consultants
  - Multiple Vendor(s)
  - Main automation contractor
  - Systems Integrator
Program Coordination

- At all levels:
  - Sponsors
  - Steering Team
  - Management
  - Execution
- Common Architecture
- (Lots of) Communication

No magic here!
ISA95 FOR THE CONTINUOUS AND PROCESS INDUSTRIES

Interpreting and Applying the Standards in Specific Case Studies

Continuous Process Industries (CPI) Special Interest Group
Case Studies

- Different companies with different opportunities:
  - Migration Planning and Organizational Structure
  - Life Cycle Management
  - Automation Infrastructure Definition
  - Business Process Globalization
  - A New ‘Greenfield’ Plant