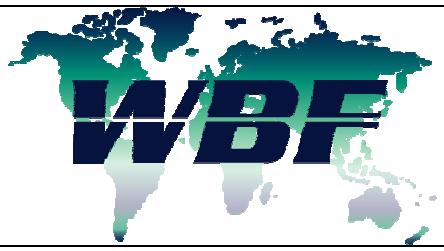
Presented at the
WBF
North American Conference
Atlanta, GA
March 5-8, 2006



195 Wekiva Springs Road, Suite 200
Longwood, FL 32779-2552
+1.407.774.5764
Fax: +1.407.774.6751
E-mail: info@wbf.org
www.wbf.org

ISA95 Business Case Evolves Through Applications and Methodologies

Charlie Gifford
Sr. Solutions Architect-Lean
Performance Mgt
GE Fanuc Automation Americas
630 Angela Drive, PO Box 4424
Hailey, ID 83333
USA
O: (208) 788-5434; C: (208) 309-0990
F: (208) 788-5690
charlie.gifford@ge.com

Paresh Dalwalla
President
OpteBiz Inc.
1330 West Laskey Road
Toledo, OH 43612
USA
O: (419) 476 4520; C: (216) 337-7438
pdalwalla@optebiz.com

KEY WORDS

ANSI/ISA95, MES Business Case, B2MML, Production Management, System Life Cycle Cost, Software Integration Methods, Manufacturing Schema, Manufacturing Data Modeling

ABSTRACT

Business-to-manufacturing (B2M) data exchange applications and system life cycle methods are being developed from ANSI/ISA95, Enterprise-Control System Integration Standard, to adapt and optimize manufacturing in the 21st Century "Pull" marketplace. The MESA/ISA95 Best Practices Working Group shall publish an annual ISA Technical Report to document these evolving applications and methods with an explanation of ISA95 business case. The business case centers on:

1) Lowering life cycle cost of B2M interfaces and manufacturing operations applications

2) Constructing the flexible Manufacturing Application Framework (MAF) to optimize B2M interoperability and production (capability) flexibility through B2M functional segregation for optimized production workflow

The standard practically addresses today's B2M language (terminology and schema) requirement for an application-to-framework (A2F) data exchange using Service Oriented Architectures (SOA). Utilizing ISA95 schema foundation, applications, methods, and business cases are established through a structured MAF consisting of 1) work flow function organization, 2) transformation best practices for operations applications and 3) their transactional interfaces. The ISA95 business case is demonstrated by:

1) Enabling application of Lean practices of standard work and value streaming

2) Enabling developing B2M functional segregation methods to correctly position operational tasks within ERP, SCM and MES systems to optimize single piece work flow and supply chain flexibility.

3) Structuring a lifecycle management framework to lower system TCO (total cost of ownership) and execute MAF flexibility in response to market change

The MAF utilizes ISA95 Part 3 Activity Models to explain influence of different system configuration on workflow, life cycle cost, flexibility, and change management.

PAPER

Recognizing a Historical Inflection Point in World Industry and Markets

Beginning in 1995, the Instrumentation, Systems, and Automation Society (ISA) and the World Batch Forum (WBF) developed the ANSI/ISA95, Enterprise-to-Control Integration, and the Business-to-manufacturing markup language (B2MML) standards. These standards are intended as the foundation for standardized best practices for information exchange between plant systems and plant-to-business systems. Over the last 10 years, manufacturing operations management (MOM) solutions evolved to enable the distributed supply chain networks for 21st Century markets. ISA95-based MOM applications and methods are recognized as the foundation for configurable, interoperable software tools to integrate interoperable data in readily useful forms to extended enterprise systems. This paper assumes the reader is familiar with ISA95 and B2MML and so will focus on best practices and business cases and will not provide a standards overview.

Goal of the ISA95/MESA Best Practices Technical Report

The annual ISA95/MESA Best Practices Technical Report shall explain how ISA95, Enterprise-Control Integration Standard, is applied to lower total cost of ownership (TCO) of manufacturing operations management (MOM) systems and their enterprise and plant interfaces. ISA95 Best Practices propose a three-legged MAF containing:

1. Tools: ISA95 methods and technical applications characterize, support, and adapt production workflow processes
2. Training/Staffing: Define system roles and skill sets for personnel for MOM processes
3. Delivery: A defined transformation and lifecycle management process for MOM

The ultimate goal of the ISA95/MESA Best Practices Working Group is to explain "how to" apply, migrate to, and maintain a single data definition across Level 3 functions and interfaces, the Manufacturing Operations Management (MOM) domain, and their Level 4 domain enterprise interfaces. By utilizing developing ISA95 methodology and technical applications, the TCO for manufacturing IT architectures as well as manufacturing and supply chain operational costs are dramatically reduced. The annual ISA95 Best Practices Technical Report consists of a series of related "how to" white papers described in the context of ISA95 models, definitions, and data flows and the Level 3 interfaces between Level 4 enterprise functions and Level 2 shop floor systems.

Manufacturing Trends Relevant to the Role of ISA95

The 21st Century manufacturing model is ALL ABOUT FLEXIBILTY of production capabilities within globally distributed supply chain networks or Demand-Driven Supply Networks (*DDSNs* as described by AMR Research). Manufacturing markets are rapidly changing and driven by global competitive trends which make production flexibility a critical path component of supply chain collaboration. This coordinated data exchange across global supply chains and internal enterprise groups is just a part of the ISA-95 business case. Current industry discussions are focused on production's actual role in e-commerce, product development, supply chain planning and replenishment, or logistics. For any 21st Century manufacturer to be competitive, actual manufacturing operations activities must be highly

interactive in supply chain and enterprise processes for effective collaboration and competition. This is the domain of collaborative and flexible MOM system architectures. This paper explains the business cases for using evolving ISA95 methods to effectively design, implement, change and optimize the MOM business processes and supporting MOM system architectures within the larger DDSN model. Each vertical industry is being influenced by their unique combination of the following global business drivers for flexible manufacturing:

Global Business Drivers for Flexible Manufacturing

#1. Increased Globalization: global markets with distributed sources of supply, production and distribution facilities

#2. Increased customer diversity: culturally and geographically

#3. Increased access to competitive data

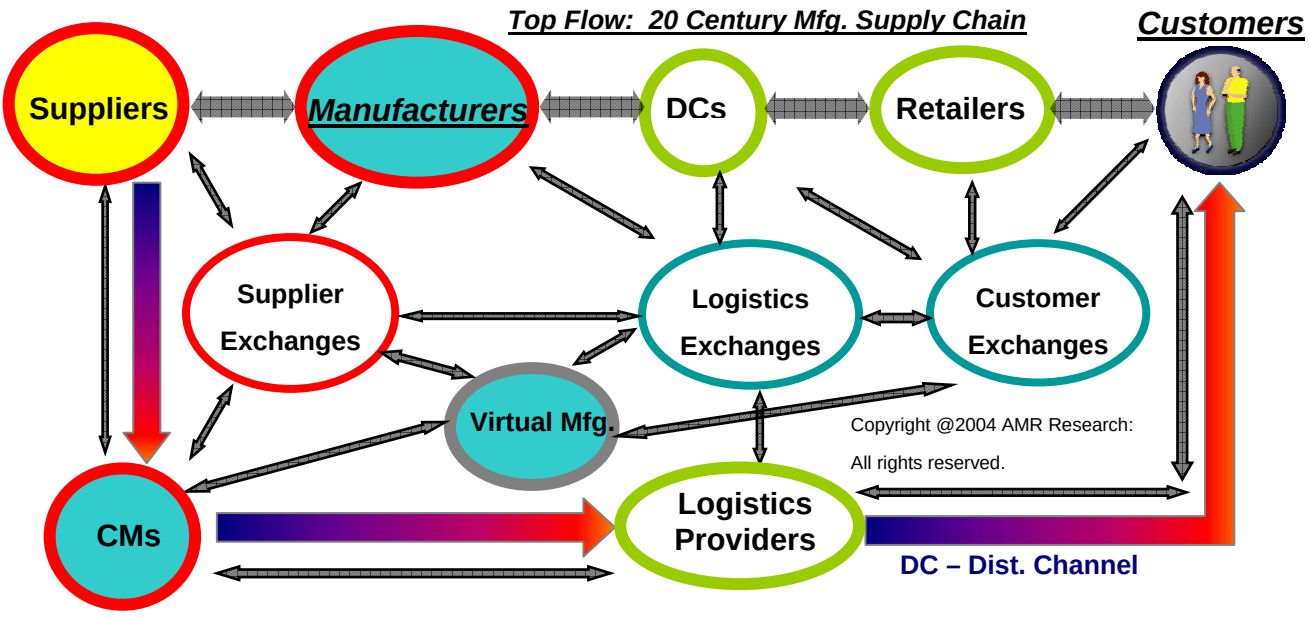
#4. Increased level of expected value

#5. Increased outsourcing of production and logistics operations

#6. Increased pace of new product introductions

#7. Increased product quality @ lower cost

Align Mfg. Capabilities to 21st Century Challenges Mandates Change…
Figure 1



Today's competitive environment requires new business models that accommodate changing geographic presence, cost base, product array, use of new materials and technologies, and relationships with customers, suppliers, and other trading partners.

The other side of the challenge includes organizational issues and aligning the goals and objectives of the different players in the organization as the company designs their 21st Century business model.

Manufacturers that adopt a standardized approach to understanding, implementing and deriving benefits from MOM applications should be able to accelerate the transformation to a successful implementation as well as increasing satisfaction levels of users.

The B2M integration of operational systems requires unique skills to accelerate the B2M transformation. A thorough understanding of the following is essential:

- Operational processes and workflows
- Real-time controls and automation systems
- Information technology systems
- Knowledge of standards that encompass all the levels of information flow
- Lean manufacturing and 6 Sigma methods

The current MOM skills sets available in the market place are often segregated across the above knowledge items by different levels; team members must become more broad-based to successfully integrate MOM architectures horizontally as well as vertically across the different levels.

DDSNs Create the Interactive 21st Century Manufacturing Model

To effectively compete in 21st Century markets, companies are creating improved tangible value by *accurately* matching products and value-add services to each customer's need within hours rather than weeks. Timing is key to profitability now. This *value* objective is not new, but maturing capabilities of web technologies (integrated into application software) have provided the interactive tools for the required collaborative and interoperable communication. In conjunction, ISA95 is defining MOM data structures and exchanges (definitions) that can be utilized to construct the MOM web services and Services Oriented Architectures (SOA) for MOM solutions. Operations management data and transaction definition in ISA95 Parts 3-6 are the basis of SOA for manufacturing (SOAm) or a Manufacturing Services Architecture (MSA). These ISA95 Parts are establishing the real-time basis to quantify cycle time, cost and resource elements of workflow for production, maintenance, inventory and quality. As seen below in Figure 5, ISA95 Part 3 Hypothetical B2M Interface Chart, B2M data flows and metrics are defined in terms of 4 B2M categories of information *(activity definition, activity capability, activity schedule, activity performance)* for 4 primary plant activity models shown. These data elements are required for scheduling and planning order fulfillment across DDSNs. In 2005, the ISA95 Committee and the Supply Chain Council formed the ISA95/SCOR Alignment Working Group which mapped data flows between the Supply Chain Operations Reference (SCOR) Model and ISA95 Part 3 Activity Models. This is foundation for aligning the development of the two standards as ISA95 Parts 4-6 are composed over the next 3-5 years. This combined work enables the rapid evolution of MSA and DDSN architectures.

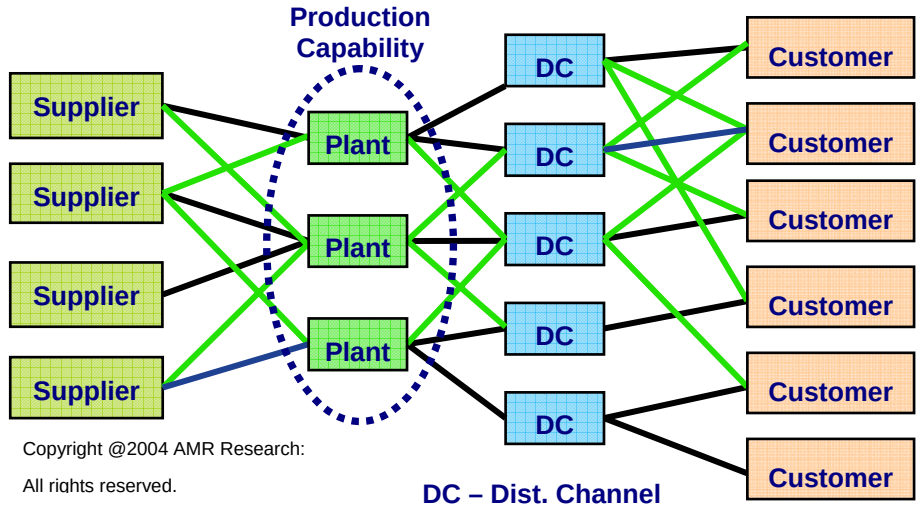
SOA Components: Over the last 15 years, integration technology has evolves from data to process level capabilities with SOAs being the merger of business process management and the enterprise services bus. SOA surrounds Web services containing the business process rules with various technologies to manage, orchestrate and choreograph Web services into an executable business model.

Core SOA services include:

1. Services Registry
2. Enterprise Services Bus
3. Web Services Management
4. Web Services Security & Identity Management
5. Web services development and programming tools

The business justification for ISA95-based MSA within interactive MOM solutions is reinforced by "contract manufacturers" (CM). The necessary practice of outsourcing production to CMs is driven by global markets in growing economies such as India, China and Eastern Europe across all industries. The result is low cost competition for North American and European suppliers due to lower labor and operating costs. Also, outsourcing has accelerated adoption of the DDSNs model where consumer demand for a single product order is now met by evaluating competing supply chain paths. Basically, the order fulfillment path is now determined by evaluating real-time supply chain cost to customer demand for on-time delivery at a specific quality level. Order commitments are made based on this algorithm.

Business Evolves into Configurable Demand-driven Supply Chains…
Figure 2



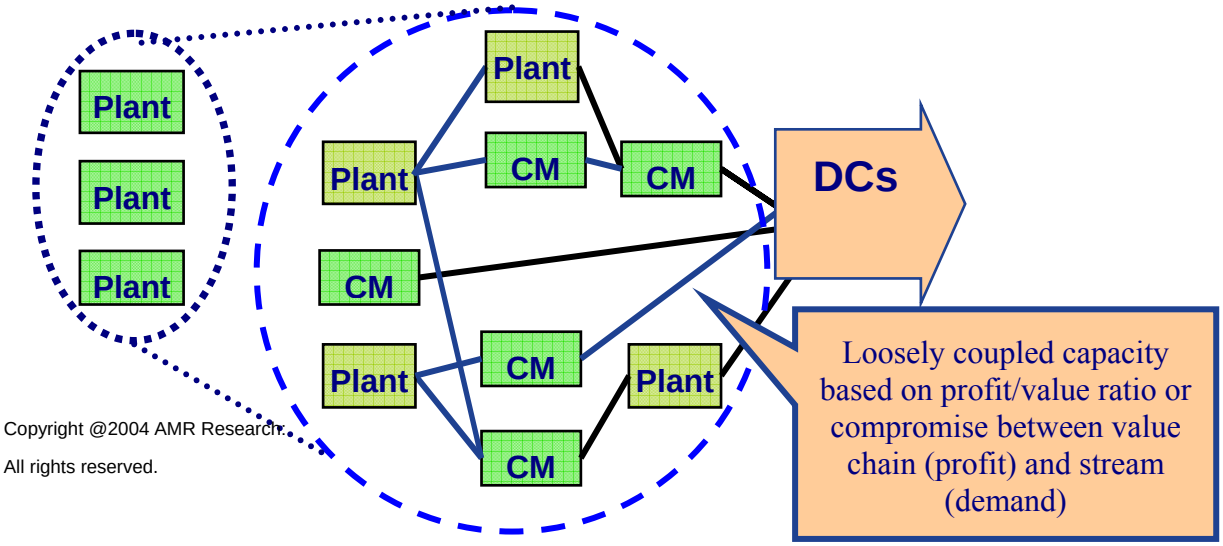
Original equipment manufacturers (OEMs), such as IBM, GE and HP, previously known for building a variety of products are now known for their market-leading product designs and their ability to market and sell them by managing their DDSNs through CM partners and internal production. MSA-based MOM solutions provide the means to OEMs to identify available materials and resources (capacity) across competing supply chains in a "lead time vs. price" form for immediate prototyping to market demand (i.e., Design for Supply, DFS). The more real-time the supply chain management, the larger profit margin due to order accuracy.

As OEMs evolve their MSA practices, they build a tighter relationship with key suppliers and CMs to:

- Provide forecasted demand from all customers and sales channels
- Require real-time production records and visibility to the OEM customer from ISA95-based MOM solutions

Production Capability Configured REAL-TIME: Evaluate Customer Value/OTD to Production Path and Profit Margin…

Figure 3



To address global competition, 21st Century manufacturers are rapidly adopting several types of corporate software systems to transform to their global business model: Enterprise Resource Planning (ERP), Supply Chain Management/Execution (SCM and SCE), Customer Relationship Management (CRM), Design Collaboration tools, Product Lifecycle Management (PLM), others. These extended enterprise systems were supposed to be designed to exchange information outward to customers and suppliers in near real time. Results over the last 10 years have been poor to fair since these tools were not designed for a DDSN global market. For some companies, these early generation systems provided quick benefit by reducing the time and costs of interacting with their 20th Century linear supply chain partners; however, most have not achieved predicted benefit due to lack of actual production data integrity (response and accuracy). For the next generation ERP+ system to support the complex (non-linear) global DDSN model, an ISA95 methodology for data exchange is being developed to map data and transactions between workflows of a distributed supply chain and production. With inaccurate or "too coarse" production data being the major limitation of the Y2K corporate business systems, a similar major issue is a lack of common defined metrics or schema across supply chain and production operations. ISA95 methods solve these limitations for system interoperability. These will be further explained as part of the 95 business justification.

ISA95 Blends SOA Approach into Manufacturing Operations Management

The ISA-95 standards address the interface or exchange of data between the extended enterprise systems (sales, planning, scheduling, and procurement) and the following Part 3 Activity Models of MOM (and example MOM systems):

- Production Management Operations (aka: product tracking/tracing, manufacturing execution, manufacturing intelligence portals, finite capacity / detailed scheduling, work order management, production sequencing, batch execution, recipe management, others)
- Maintenance Management Operations (aka: asset management, computerized maintenance management, preventative maintenance, MRO, others)
- Quality Test Management Operations (statistical process control, statistical quality control, laboratory information management, corrective and preventative action (CAPA), material review board (MRB), others)
- Inventory Management Operations (MRP tracking of plant-side raw material, work-in-process, and finished goods, others)

With an ISA95 foundation for MSA to be contained in Parts 3-6,

- **ISA 95.00.03** "…-Part 3: Activity Models of MOM"
- **ISA 95.00.04 (Draft)** "…-Part 4: Object Models & Attributes of MOM"
- **ISA 95.00.05 (Draft)** "…-Part 5: Business to Mfg Transactions"
- **ISA 95.00.06 (Proposed)** "…-Part 6: MOM Transactions"

the MSA concept brings all the above MOM operations of a manufacturing business into alignment to intelligently respond to market forces. Currently, corporations are attempting to identify MSA practices to publish and distribute customer demands across the supply chain. Once all suppliers in company's DDSN are able to align on market demand, products are then rapidly and accurately developed for new markets while maintaining high margins. The combination of a DDSN model being driven by an ISA95 MAF allows a manufacturer to capture large market share or even create markets due their ability to rapidly adapt their collaborative production resources to real time market demand.

"Post-Part 6 B2MML" Required to Meet MSA Requirement and End User Demand

B2MML Version 3 is based on the 1st approved, untested versions of ANSI/IEC/ISO/ISA95 Parts 1 and 2 in 2000-2002:
2000: ANSI/ISA-95.00.01, Enterprise-Control System Integration Part 1: Models and Terminology
2002: IEC/ISO 62264-1: …Part 1: Models and Terminology
2001: ISA/ANSI-95.00.02: …Part 2: Data Structures and Attributes
2002: IEC/ISO 62264-2: …Part 2: Data Structures and Attributes

In the current 5-year review of the 1st versions, many changes are being proposed due to end user "lessons learned" in applying the standards and schema applications (not be addressed in this paper). However, of important note, B2MML Ver. 3 is a special case of manufacturing environments and the B2M interface instance as opposed to a general case. This is illustrated in the following Figure 4: Simplified Workflow Complexity Matrix and Figure 5: Part 3 Hypothetical B2M Interface Chart. B2MML Ver. 3 is based on an academic definition at the Level 3 / 4 interface described in Parts 1 and 2

where all MOM functions are plant side systems. B2MML schema has not yet evolved (and not be able to evolve since schema must follow the approved standard) to address a more wide range of real world B2M interfaces where many MOM functions are within centralized corporate applications. With recent release of Part 3 and the eventual completion of Part 4, 5 and 6, B2MML is evolving to adequately address Level 3 MOM data and work flows for majority of hybrid manufacturing environments.

Most plants are hybrid environments from dock (raw materials) to dock (finished goods packaging) with a mix of work order types for customer orders 80% MTS (Make-To-Stock), 10% MTO (Make-To-Order), 10% ETO (Engineer-To-Order) and more of a mix for WIP work cell orders (50% MTS, 35% MTO, 15% ETO/rework). The B2M interface line ("B2M" Line in Figure 5) is determined by the MOM applications required at the plant floor to address the complexity of work order mix and its associated workflow business rules. As evolving global markets drive manufacturers to rapidly adjust their work order mix based on market demand and drivers (example: towards a higher percentage of MTO and ETO, B2M functional segregation of MOM applications and the representative B2M interface line are determined by the MOM architecture that optimizes production single piece flow, profit margin, and throughput. Basically, profit margin drives the MOM architecture. A manufacturer's ability to rapidly adapt their MOM architecture to new market conditions determines the level success in their global markets. This proposed ISA95 methodology is Step 3.5 in the MAF best practices methodology outlined later in the paper.

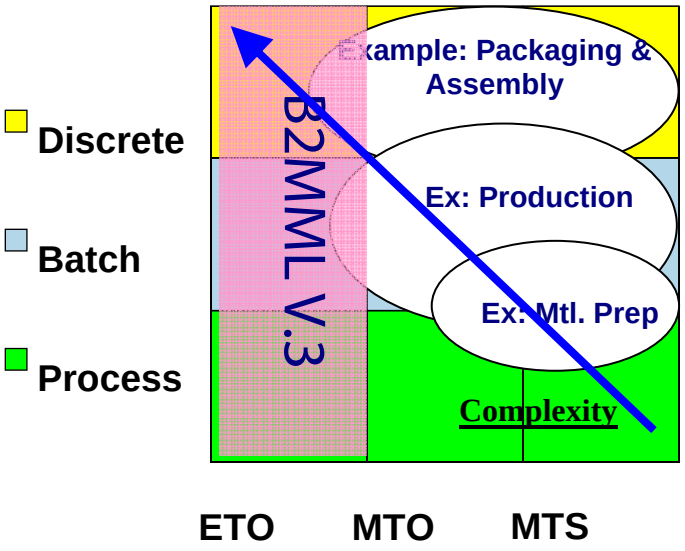
"Simplified" Work Flow Complexity Matrix
Figure 4

Production Types

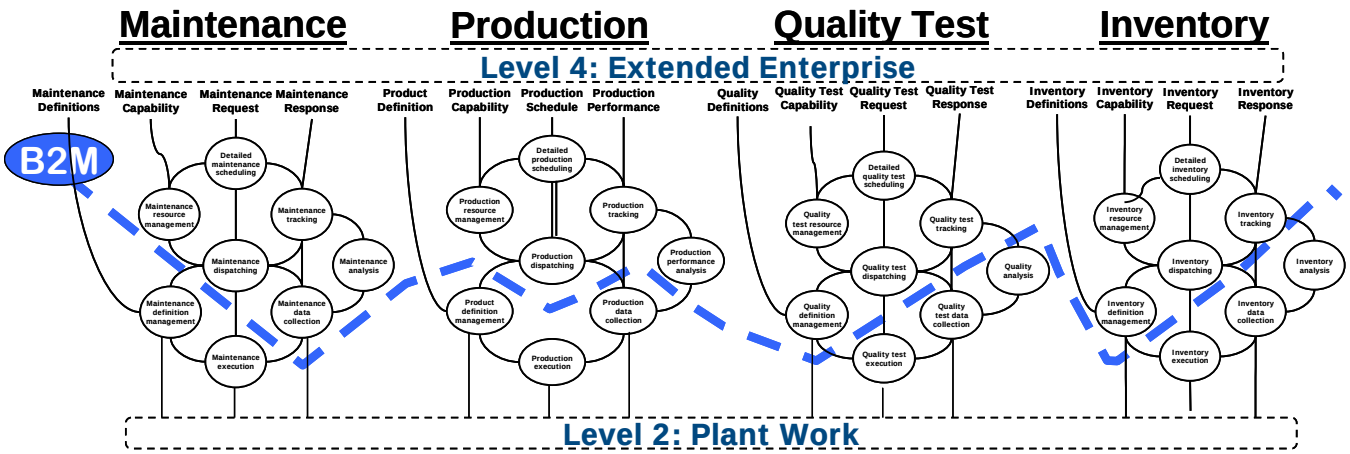
- Discrete Manufacturing
- Batch Processing
- Continuous Processing

Work Order Types

- Engineer-to-Order (ETO)
- Make-to-Order (MTO)
- Make-to-Stock (MTS)
- 9 Primary Combinations (with many hybrids)
- Each have a specific set of business processes and rules
- Complexity Contributors: Product, Legacy, Speed, Volume, Co. Size, Compliance, SKU Count, others



ISA95 Part 3 Hypothetical B2M Interface Chart:
Real World B2M Interfaces Exist Within/Between MOM Activity Model Functions
Figure 5



Once industry has agreed upon the "Post- Part 6 version" of B2MML, the ISA95 body of work (schema, standards, applications, and methods) will adequately model the majority of the Level 3 MOM use cases, data flows, transactions, business processes and metric (interface, KPI, and operational) construction. Based on this MOM use case modeling, vendors will roll out their collaborative libraries of MSA web services that end users essentially need for global DDSN architectures. At this point (2008-10), the ISA95 methodology for construction of the MAF will coalesce and mature into a proven supply chain management system required for the DDSN implementation. This paper and ISA95 Technical Report, 1st Edition 2006, proposes the working methodologies to drive toward these goals over the next few years. Software vendors and MOM literature are moving to this important inflection point for the next 3-5 years to meet the 21st Century manufacturing model requirement. As of 2006, the ISA95 body of work needs accelerating to limit the scale and variation of implemented beta B2MML interfaces and MOM applications. Many early innovative adopters are struggling with how to apply and extend B2MML Ver. 3 to address their hybrid environments and are taking their best guess where the ISA95 body of work will direct software vendors in the future.

Industry collaboration is the real world challenge in order to lower TCO for integrated systems through focused dedicated effort. Accordingly, the end user's commitment to B2M Interoperability will remain speculative until this open standards work has been organized and accomplished. Industry analysts, vendors and end users are all looking to each other for leadership for this MOM standards effort. No clear leader has yet emerged as of this paper. A loosely coupled group of end users, vendors and consultants are proactively forming alignment working groups, but the progress is much slower than the market need.

The ISA95 Business Value:

Low Cost B2M Interfaces & Flexible Manufacturing Application Framework

Manufacturing data exchange applications and system life cycle methods are being developed from ISA95 Standards. ISA95 applications and methods are being globally applied by innovative manufacturers to adapt and optimize manufacturing for the 21st Century "Pull" markets.

The ISA95 business case is centered on:

1) Lowering the life cycle cost of B2M interfaces

2) Constructing the flexible manufacturing application framework (MAF) to optimize B2M interoperability and production (capability) flexibility through B2M functional segregation for optimized production workflow

The standard practically addresses the language (terminology and schema) requirement between operations and business systems for an application-to-framework (A2F) data exchange required for MSA. The business case is further established by providing organization and best practices to transform operations applications and their transactional interfaces into a flexible manufacturing framework. Through its B2M functional and object models and single XML schema hierarchy for B2M integration, ISAS95 transformation methods merge production workflows into the overall collaborative business process. The merger of ISA95 models, applications and methods to form the MAF is proposed by ISA95/MESA Best Practices Working Group in the annual ISA Technical Report. MAF defines data exchanges and metrics for integrating the production systems: 1) horizontally between MOM applications and 2) vertically between global DDSN / enterprise systems.

ISA95 business value and MAF are derived from two Classes of Best Practices to illustrate the high value of the MOM application development and lifecycle processes utilizing ISA95. Both classes of best practices are early in their lifecycle and are rapidly advancing due endorsement by the end user and vendor community such as SAP and Microsoft. These ISA95 best practices are being applied in isolated MOM projects by the most innovative manufacturers in the world, such as P&G, Dow, Arla Foods, Nestle, Dupont and BP. Wide spread use has not occurred due to the immature state of MOM solutions and SOA manufacturing technologies.

Class #1: ISA95 Technical Applications for Improving B2M Interface Interoperability

The ISA95 technical applications utilize:

1. B2MML schemas
2. ISA95 models from Parts 1-3,
3. Proposed Part 4 Level 3 MOM data flows and operations metrics
4. Part 5 B2M transactions
5. Proposed Part 6 MOM transactions
6. Other developing information technologies such as XML, web services, SOAs or data exchange frameworks for application interoperability

Class #2: ISA95 Transformation Methodology for Improving B2M Operations Interoperability

Class#2 describe a set of operations transformation methodologies that align with other current best practice for software development lifecycle such as good automation manufacturing practices (GAMP) or Microsoft Enterprise Framework (MEF) methods. These ISA95-based methods are intended to be

used to construct a MAF for optimizing B2M operations interoperability by providing MOM system architecture that are able to adapt to market change in the company's DDSNs.

This paper simply outlines and briefly describes the ISA95 Best Practices Classes that shall be described in detail in the white papers in the ISA95 Best Practices (BP) Technical Report, 1st Edition (Q3, 2006). As subsequent editions of the Technical Report are produced, each best practice and this business case explanation will be updated along with the addition of new best practices. This white paper introduces the evolving best practices and explains the high level business case through market need. In the ISA95 BP Technical Report, a business justification for each application and methods will be explained using the following 5 Steps:

1. Proposed ISA95 Best Practice
2. Identify prioritized Business Driver and Operational Benefits
3. Identify current state and the underlying forces (reasons for underperformance, stakeholders, resources, etc) behind the key driver (Quantification examples if possible)
4. Analyze example of capital expenditures, recurring costs and recurring savings
5. Example of an Net Present Value analysis

The ISA95 BP Technical Report utilizes a 6 Sigma structure to explain the construction of a MAF using Class #1 and #2 best practices. The 6 Sigma structure is abstraction of the following DMAIC process:

1. Define: Determine project objectives, scope, resources, constraints
2. Measure: Determine Critical-to-Quality (CTQs) tasks to production workflow. Obtain data to quantify process performance
3. Analyze: Analyze data to identify root causes of production workflows disruptions and defects
4. Improve: Intervene and change current MOM processes to improve performance through the ISA95 transformation to a single schema across MOM systems
5. Control: Implement a MAF or life cycle management framework to maintain workflow performance through analysis of market to production workflow and system architecture

In applying Class #1 Best Practices of ISA95 Technical Applications to Improve B2M Interface Interoperability, technical report white papers utilize ISA95 models to define best practice. These technical applications are the foundation for B2M and MOM interface interoperability by providing the data hierarchy and definition for interface construction. The ISA95 MAF is then able to be constructed through Class #2 methodologies.

Step 1: Train Staff and Benchmark Technical Applications to Improve B2M Interface Interoperability *(Define)*

1.1. B2M Functional Model

1.2. B2M Interface Object Model and Attributes

1.3. B2M Markup Language (B2MML)

1.4. Part 3 MOM data flows mapped between SCOR data flows

1.5. Proposed Part 4 Level 3 MOM data flows and operations metrics

1.6. Part 5 B2M transactions

1.7. Proposed Part 6 MOM transactions

In applying the Class #2 Best Practices of ISA95 Transformation Methodologies to Improve B2M Operations Interoperability, technical report white paper will explain the step-by-step process to improve manufacturing operations interoperability through the adoption of a single schema system architecture that supports development of a MAF for system lifecycle management to 21st Century markets.

Step 2: Structured Mfg. Operations Assessment and Schema Migration Plan *(Define, Measure, Analyze)*

2.1. "As Is" MOM Assessment

2.2. "To Be" MOM Gap Analysis

2.3. Prioritized Criteria for Business Cases for MOM Applications

Typically, an organization will not transform to ISA95-based single schema MOM architecture in a short period of time. There is an established set of disparate of terminologies, work flows, data flows and applications that are utilized in running ongoing manufacturing operation and supply chain processes. A migration plan will involve the following steps:

Pre Migration step:

A good pre-migration step includes a study of operational and business drivers for a potential transformation. Since MOM covers a wide range of functions at the manufacturing level, the business drivers prioritized with regard to quickest and highest returns may assist in identifying systems:

- MOM related business drivers
- Priority of those business drivers
- Returns based on an NPV analysis
- Highest probability of success based on returns and current needs

The step, Prioritizes Criteria for Business Cases for MOM Applications, is required to assess the magnitude of investment and effort required in the transformation process. A sound approach includes an assessment of current MOM elements combined with a gap analysis derived from a comparison of the current MOM elements to the ISA95-based MOM elements.

Step 3: Accelerated MOM Transformation and Application Framework Implementation *(Analyze, Improve, Control)*

3.1. Establish a Project Plan Standard for MOM systems

3.2. Establish Standard Design Criteria for MOM Knowledge Mgt.

3.3. Establish Schema Standard for Enterprise and MOM System

3.4. Build MOM Flexible Manufacturing (Use Case/ Application) Framework

3.5. Analyze Functional Segregation between Enterprise and MOM Applications

3.6. Simplified Functional Requirement Process for MOM functions and Interfaces

3.7. Simplified Extended Enterprise Metric Construction Process

3.8. Simplified Event Management Construction Process

Step 4: Life Cycle Management of MOM Application and Interfaces *(Analyze, Improve, Control)*

4.1. Change Mgt Planning / Process using Flexible Manufacturing (Application) Framework

4.2. Simplified Workflow Analytic Development Process

4.3. Simplified Quality Analytic Development Process

4.4. Skill Set Mapping of Super Users, System and Data Owners, Functional Users, and Process Modelers

The biggest challenge faced by various systems and engineering departments is ensuring that the implemented MOM systems are well accepted and utilized by the user community within manufacturing operation. An effective change management plan with process expeditors developed as part of the best practices approach alleviate some of the risks associated with non acceptance. Educating the user community and stake holders about the benefits of MOM applications is an ongoing challenging cultural issue. ISA95 MOM architectures require collection of large amounts of data from both automated as well as manual sources. Manual sources of data are typically where questionable acceptance plays a significant role in application success. User acceptance depends on both a well defined workflow combined with ongoing validation of the benefits to individual user groups and stake holders.

Typically, manufacturing companies implement point solution MOM systems that are absolutely essential for short run requirements where the politics force a bypass of some elements of ISA95 Best Practices methodologies in order to ensure rapid deployment of the system. The table below highlights some differences in taking a short term project approach with the best practices. As noted earlier, the best approach may be to follow the best practices model with elimination of a few steps in order to achieve the rapid deployment for short term goals. Deviating from the best practice at the local project level may create a risk of non-standardized approach but could be minimized if the deviation is kept to minimal levels.

ISA95 Business Value: Holistic vs. Project Approach
Table 1

Elements	Generic Best Practices	Project Specific Best Practices
Business Drivers	• Standard business & operational metrics (enterprise wide as well as plant specific) • Definition of metrics	• Priority of resolving issues related to std metrics + any localized metrics • Based on urgency, need, returns, etc.
Assessment Standards	Function: Activity: Task: Dataflow based on S95 Models	• AS IS MOM Assessment • Target vs. Current Gap analysis
Implementation Standards	• Generic Project Plan • Generic Requirements Process • Standard Design Criteria for MOM • S95 based enterprise Schema Standards • Common Components • Boundaries between different levels	• Application specific project plan • Application Specific Requirements • Application specific schema • Common + Application Specific Components • Interfaces based on boundaries
Life Cycle Management Standards	• Change Mgt Planning / Process using Flexible Mfg. Application Framework • Simplified Work flow Analytic Development Process • Simplified Quality Analytic Development Process • Skill set Mapping of Super Users, owners, users, and process modelers	• Application specific maintenance process • Application validation of value delivered • Application specific change management process

ISA95 MAF Enables 21st Century Lean Manufacturing Renaissance

MSA best practices will provide companies with supply chain data and software technology to apply Lean manufacturing by balancing profit, quality and cost against each other for the On-Time Delivery (OTD) commitment decision:

- The value chain (lowest cost path to customer) to drive maximum profits,
- The value stream (value-added path to meet customer's expectation) to deliver quality products and services
- The cost of product throughout its life cycle

ISA95 describes the basis for Standard Work which is the foundation for Lean transformation and single piece/order flow. ISA95 functions, tasks, and data exchanges become the "Standard Work" component necessary to simplify and design an MSA for a Lean supply chain. MSA that are structured for single piece flow interacts with *SOA processes* across the distributed supply chain of supplier and customers to build global DDSNs. MOM solutions utilizing MSA allow appropriate organizations to make better decisions using timed, event-driven role-based data sets that are mapped into production work flow use cases characterized by ISA95 models and B2MML. Currently, manufacturers utilize a wide range of

Lean supply chain processes that only function correctly when accurate, real-time MOM information is available and accurately directed for MTO OTD supply chains:

- Defining customer value stream: Benchmarking and Fine-tuning production activities and quality into DDSN
- JIT transportation and distribution: Coordinating "Pull" logistics
- Value-added Engineering & Design: refining product characteristics to reduce waste
- MTO Sales and Marketing: Mapping customer specification and due dates into DDSN
- Procurement: JIT inventory levels for replenishment and fulfillment
- Operations: Proactively preventing equipment breakdowns with TPM and OEE methods

To optimize the 21st Century manufacturing enterprise, companies are recognizing that production workflow, use cases (transaction sequence), and data flows must be identified, characterized in an SOA, and optimized by utilizing Lean Manufacturing and/or Six-Sigma characterization techniques. As KPI and operations metrics with their cause/effect relationships (compromises) to production workflow are developed and built into systems, ISA-95 is the enabling tool for executing this functional design efficiently. Lean MOM applications transform previously optimized lean workflows as global markets demand change.

Lean MOM Examples

- "Standard Work", single schema product tracking, genealogy, and performance reporting
- Finite Capacity Scheduling with single piece flow "Theory of Constraints" for line balancing
- Utilization Management (OEE) with resource efficiency and benchmarking to drive cultural change
- SPC (online, at line, offline) and LIMS for quality and workflow statistical analysis
- Role-based manufacturing portals for interdepartmental communication of real-time situations with defined event management sequences (rules)

Conclusion

This 21st Century environment requires companies to evolve their 20th Century manufacturing business model, support systems, and existing organizational practices simply to survive. They need the ability to share data and information in a secure environment so that decisions are completed more rapidly and reliably, saving time and money.

Current Progress of MOM Applications and Methods are Highlighted by:

- Public MOM standards and methodologies being endorsed by end users and vendors
- Change in role of MOM solutions to being part of interactive global DDSN processes
- Vertical industry libraries of use cases and processes are being characterized using ISA95. Resulting MOM software tools applications are more configurable and less a custom extension. Vendors are developing large libraries of use cases with configurable components, XML schemas, and templates towards their MSA framework for configurable interoperability.
- B2MML interfaces require much less custom interface development due to ISA95-based libraries of configurable interfaces
- Recognition of skill set required for MOM implementations as a mixture of business process, IT and manufacturing process skills.
- ROI for MOM solution has been better quantified, explained, and accepted due a large increase in repeatable MOM application set at lower cost.
- Predictable lifecycle cost for MOM systems due to increase in tool functionality and dramatic reduction in custom programming of interfaces and applications.

ISA95-based MSA enables the flexible MAF of MOM systems to, first, analyzes and aggregates MOM data (capacity, capability, inventory, order and equipment scheduling) and then exchange data with ERP, APS and SCM systems and the DDSNs. Developing ISA-95 best practices will provide consistency and flexibility to an extended enterprise by working interactively in real-time within the supply chain to definitively determine the transformation rate to create new markets and move into them. This is 21st Century manufacturing. They enable decision making based on measurable and specific manufacturing constraints, abnormal conditions (alarms) and events. Flexible manufacturing is especially important since as the USA, Europe and the rest of the industrial world become more of a multilingual cultural melting pot. As mixing cultures, languages, foods and fashion drive higher demand for niche, and make-to-order products, manufacturers need responsive DDSNs and flexible plants to produce short, profitable production runs.

Acronym Glossary

A2F: application-to-framework
APS: advanced planning and scheduling
B2M: Business-to-manufacturing
B2MML: business to manufacturing markup language
CM: contract manufacturers
CRM: Customer Relationship Management
DDSN: Demand-Driven Supply Networks
DFM: Design for Manufacturability
DFS: Design for Supply
DFT: Design for Test
ERP: enterprise resource planning
ERP: Enterprise Resource Planning
ISA: Instrumentation, Systems, and Automation Society
JIT: just-in-time
KPI: key performance indicator
LIMS: laboratory information management system
MAF: manufacturing application framework
MES: manufacturing execution system
MOM: manufacturing operations management
MSA: Manufacturing Services Architecture
OEE: overall equipment effective
OEM: original equipment manufacturers
OTD: on-time-delivery
PLM: Product Lifecycle Management
ROI: return on investment
SCM/SCE: Supply Chain Management/Execution
SCM: supply chain management
SCOR: Supply Chain Operations Reference model
SOA: service oriented architectures
SOAm: SOA for manufacturing
SPC: statistical process control
TCO: total cost of ownership
TPM: total productive management
WBF: World Batch Forum
XML: extensible markup language