Demand Activated Manufacturing Architecture (DAMA) Model for Supply Chain Collaboration

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ABSTRACT

The Demand Activated Manufacturing Architecture (DAMA) project during the last five years of work with the U.S. Integrated Textile Complex (retail, apparel, textile, and fiber sectors) has developed an inter-enterprise architecture and collaborative model for supply chains. This model will enable improved collaborative business across any supply chain. The DAMA Model for Supply Chain Collaboration is a high-level model for collaboration to achieve Demand Activated Manufacturing.

The five major elements of the architecture to support collaboration are 1) activity or process, 2) information, 3) application, 4) data, and 5) infrastructure. These five elements are tied to the application of the DAMA architecture to three phases of collaboration – prepare, pilot, and scale. There are six collaborative activities that may be employed in this model: 1) Develop Business Planning Agreements, 2) Define Products, 3) Forecast and Plan Capacity Commitments, 4) Schedule Product and Product Delivery, 5) Expedite Production and Delivery Exceptions, and 6) Populate Supply Chain Utility. The Supply Chain Utility is a set of applications implemented to support collaborative product definition, forecast visibility, planning, scheduling, and execution. The DAMA architecture and model will be presented along with the process for implementing this DAMA model.

INTRODUCTION

A collaborative environment is one in which people can work together, sharing information, and knowledge. Our research has been dedicated to developing streamlined manufacturing supply chains in the textile industry, and enabling that supply chain with collaborative software environments.

INFORMATON ARCHITECTURE

Architecture is an overloaded term, and can have many interpretations. An architecture, which is a style and method of design and construction, can be applied to any system, or group of interrelated, interacting, interdependent constituents that are functionally related. These functionally related constituents can best be analyzed and understood by evaluating the process, and letting that process drive the development of technical solutions to support the process.

We have defined a supply chain information architecture that includes five elements.

- Activity: The activity(s) or processes involved in the accomplishment of a goal.
- Information: The derived knowledge from the application of data that supports the process.
- Application: The transformation of data into information.
- Data: The detailed facts required providing information to support the activity.
- Infrastructure: The underlying technical, business, and social foundations that support the process.

In developing this architecture for a collaborative supply chain environment, we addressed these elements from the top-down. Lessons learned from many software development efforts have proven time and again that technology driven solutions are difficult to implement due to a lack of user buy-in, often resulting in software that does not get used.

APPLICATION OF THE DAMA ARCHITECTURE TO A BUSINESS DRIVEN SOLUTION

The technology-driven approach was the main thrust of DAMA through 1997. However, it met with limited success. In 1997 in conjunction with DAMA leadership, the focus changed to pursuing a top down or business-driven approach (see Figure 1).

This approach focused on four areas, or business requirements, necessary for the move to a collaborative approach:

- the knowledge of industry culture and business practices,
- the development of maps of industry process models of information flow,

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- the construction of collaboration frameworks for business practices, and
- the deployment of architecture-based information systems to support this collaboration

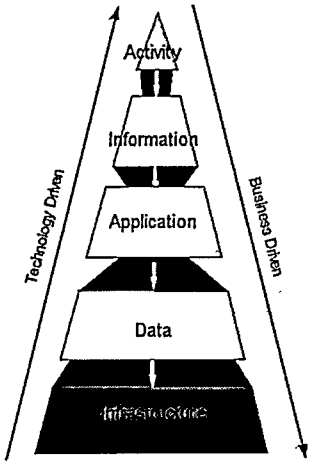

Figure 1 Business Driven Five Level Architecture

There were three key findings from our research on the textile industry that support these requirements. First is the conclusion that the one *necessary* piece for the movement to collaboration is culture change, that is, changes in the values and attitudes that motivate behavior. Once the decision is made to modify corporate value structures and associated activities to support collaborative relationships, maps of information flows within the supply chain, collaborative business frameworks, and architecture-based information systems will facilitate the change. The second finding is that the primary target for an agile company is the consumer or end user of the product – *no matter where that company is in the supply chain.* The third is that there is an evolutionary path that companies follow as they move toward a true collaborative environment. This path takes them from a focus on internal processes and systems to a global view of the supply chain.

MODEL FOR SUPPLY CHAIN COLLABORATION

Understand As-Is Model Before Proceeding To A To-Be Model

In order for DAMA to understand the complete supply chain, it was necessary to understand the "As-Is" information model of the textile industry today. Typically, a textile supply chain consists of several manufacturers, each representing a sector of the industry; i.e. fiber, textile, apparel (sewn products) and retail. Information is passed between sectors in the form of Electronic Data Interchange (EDI) transactions, and typically each sector is customer focused (fiber focuses on the textile customer), rather than consumer focused (all sectors focus on consumer demand). A model of the industry was documented that shows the flow of information between these sectors, and is represented in Figure 2.

TO-BE Model for Supply Chain Collaboration

In order for all members of the supply chain to respond to consumer demand, a new collaborative paradigm is required. This new paradigm will provide supply chain visibility to critical information for all members of the supply chain. The DAMA Model for Supply Chain Collaboration has been developed to show how all sectors of the supply chain would participate collaboratively in the major business. This model suggests that retail, apparel, textile and fiber companies within a particular supply chain share information and collaboratively make decisions about forecasting, planning, scheduling, product delivery and expediting orders. This model is documented in the Integration Definition Function Modeling (IDEF0) format, designed to model the decisions, actions, and activities of an organization or system. The number in parenthesis identifies EDI transactions.

The DAMA Model for Supply Chain Collaboration is a high-level model for collaboration to achieve Demand Activated Manufacturing as shown in Figure 3. There are six collaborative activities that may be employed in this model:

1. Develop Business Planning Agreements
2. Define Products
3. Forecast and Plan Capacity Commitments
4. Schedule Product and Product Delivery
5. Expedite Production and Delivery Exceptions.
6. Populate Supply Chain Utility

For each of the first five collaborative activities, the trading partners must populate the Supply Chain Utility, the sixth activity in this model. The Supply Chain Utility is a set of applications implemented to support collaborative product definition, forecast visibility, planning, scheduling, and execution.

This model assumes a collaborative supply chain, with multiple trading partners, working collaboratively to meet consumer demand. Trust must exist between all trading partners, and technical data security must be implemented. Working together, the trading partners share information about their products, manufacturing capabilities, allocations of capacity to the partnership, and day-to-day operational status.

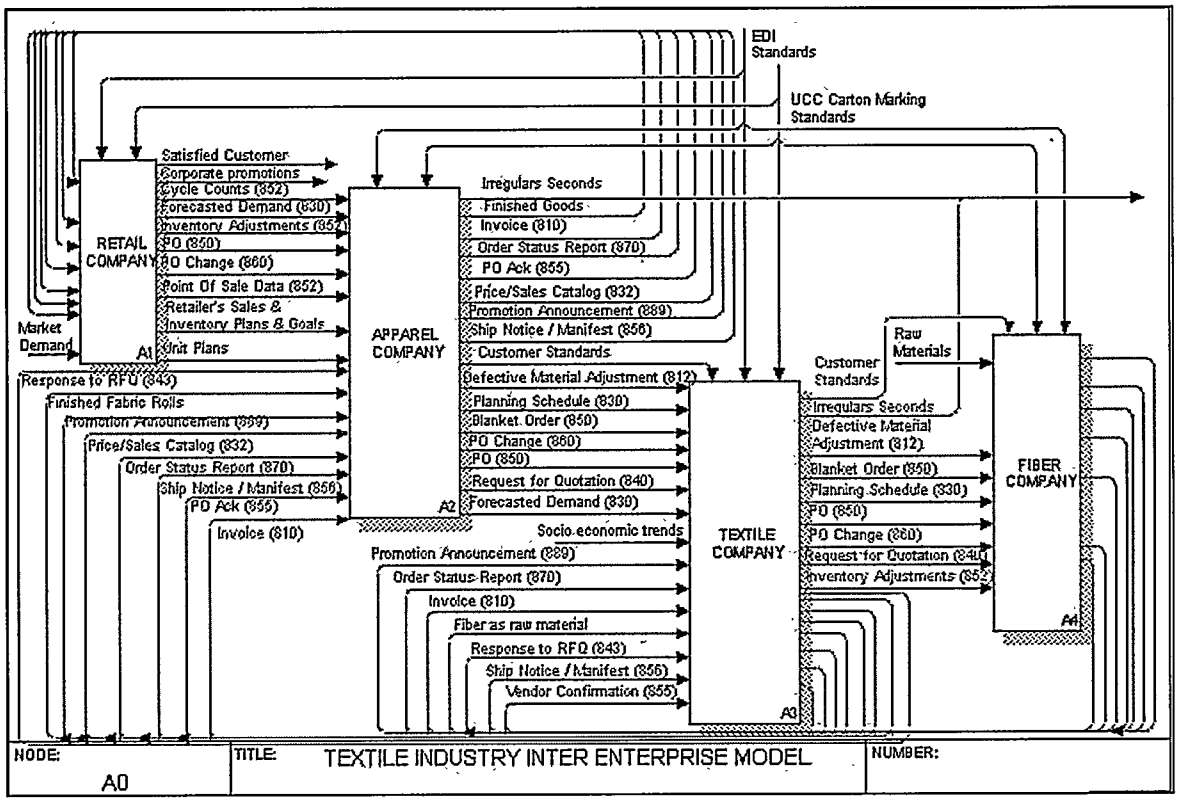

Figure 2. Textile Industry "AS-IS" Model

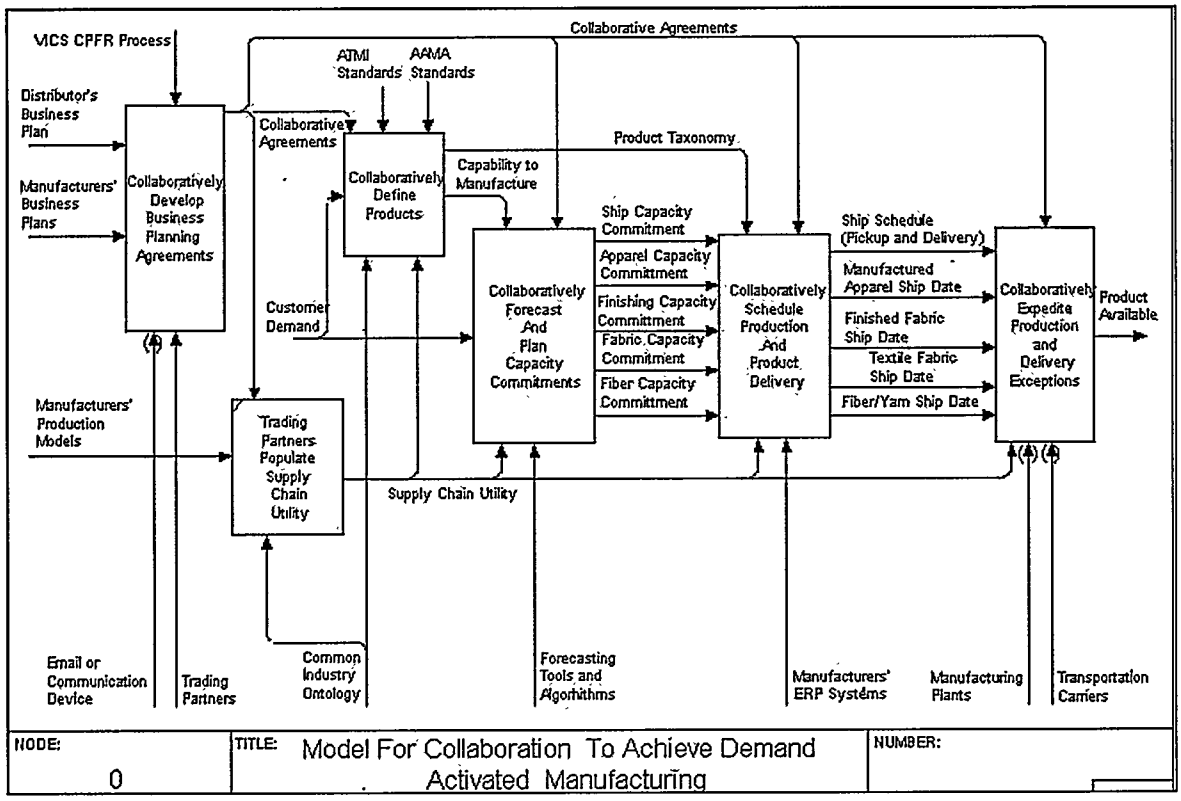

Figure 3. "TO-BE" Model for Supply Chain Collaboration

PROCESS FOR EXECUTING THE DAMA MODEL

The business process for executing the DAMA Model for Supply Chain Collaboration is consumer focused and incorporates all members of the supply chain. This business process involves ten major activities, illustrated in Figure 4.

1. Develop Business Planning Agreements
2. Populate Supply Chain Utility
3. Define products
4. Collaborate on Exceptions for Product Definition
5. Forecast and plan Capacity Commitments
6. Collaborate On Forecast Or Capacity To Meet Forecast Exceptions
7. Schedule Production and Product Delivery
8. Collaborate Product Ship Date Exceptions
9. Expedite Production and Delivery
10. Execute Delivery.

Partners Prepare to Collaborate and Define Products

1. Develop Business Planning Agreements

Successfully implementing this model requires the trading partners first complete the process of Collaboratively Develop Business Planning Agreements. The Voluntary Interindustry Commerce Standards (VICS) Collaborative Planning, Forecasting and Replenishment (CPFR) guidelines thoroughly describe what is required in the business planning agreements. (VICS, 1998) Where the DAMA collaborative supply chain diverges from current CPFR is in the addition of trading partners from all manufacturing sectors of the supply chain.

It is important that each company accesses their own strategy, and goals to ensure that these are incorporated in the partnership agreements. The goal is to arrive at a win-win situation for all players. This requires sharing of some risk and rewards, in addition to sharing common goals.

2. Populate Supply Chain Utility

The DAMA Model for Supply Chain Collaboration includes a process where the trading partners populate a Supply Chain Utility. This Supply Chain Utility is envisioned to be a collaborative software system that should support product definition, supply chain planning, supply chain visibility, and select, secure data sharing. The initial population of the utility would require each trading partner provide initial information in the following areas:

- manufacturing (lead times, process times, and transport times),
- capacity allocation to the partnership,
- manufacturing capability (product lines, bill of material for products, product specifications and boundary constraints), and
- exception criteria.

In order for the Supply Chain Utility to be successful, an ontology, or common vocabulary, must be established. The ontology is a set of formal definitions of the information being shared. (www.ontology.org, 2000) In the textile industry, much of the ontology information can be provided by organizations such as American Textile Manufacturers' Institute (ATMI) Voluntary Standards.

Populating the supply chain utility is an on-going process. Weekly or daily updates of data might include goods available to promise, reduction in capacity or capabilities, or changes in lead times in a process.

3. Define products

The concept of collaboratively defining products in a supply chain requires increased supply chain visibility of all partners to the product lines in each sector. The process begins with customer (consumer) demand. The partnership collaborates to develop products to meet demand. Once the product is developed, a product definition is provided to each member in the chain.

Products for orders are defined using the data that is loaded in the supply chain utility. The utility can determine if the product is available; otherwise, the utility will determine the lead-time required to produce the product. From this information, the product definition order is generated.

4. Collaborate on Exceptions for Product Definition

If a particular product attribute is not available, an exception is generated. Resolution and/or collaboration of the exception may involve phone calls, email, or on-line interaction. Resolution may require adding a product or manufacturing capability by changing the product mix or outsourcing to a third party supplier who is not a member of this collaborative partnership.

Partners Collaborate on Forecast, Production Plan and Schedule

5. Forecast and Plan Capacity Commitments

The collaborative forecast was first defined by CPFR. In DAMA's model, one or several partners in the supply chain may develop the forecast. Once the forecast is developed, it is made visible to all members through the Supply Chain Utility. Each forecast must be reflective of the portion of the order that will be filled by each member in the partnership. The initial loading of the Supply Chain Utility will ensure that the correct proportions for an order are maintained. Based on the forecast received, each manufacturing member of the partnership should then provide a capacity commitment to the forecast for that specific product line.

As consumer demand and forecasts are generated, all members of the supply chain will have visibility to this information. The supply chain utility must have information about the allocation of a product (for example, the partnership agreement guarantees 50% of a product line to a manufacturer, who in turn guarantees 75% of that same line to their supplier). According to the estimated forecast, each supply chain member will commit a certain capacity to the product line in this collaborative agreement.

6. *Collaborate on forecast or Capacity to Meet Forecast Exceptions*

A forecast may exceed original capacity commitments or fall short of the commitments. When this exception occurs; the affected partners must collaborate and either seek third party sources for an increase in demand or share associated risk with a reduction in forecasts. The partnership agreements should provide guidelines for handling these exceptions to facilitate resolution.

7. *Schedule Production and Product Delivery*

The Supply Chain Utility will balance a final order commitment against initial capacity commitments. Using that information, in addition to manufacturing capability data, the utility will generate work orders for each manufacturer in the supply chain. Each manufacturer then processes these work orders individually.

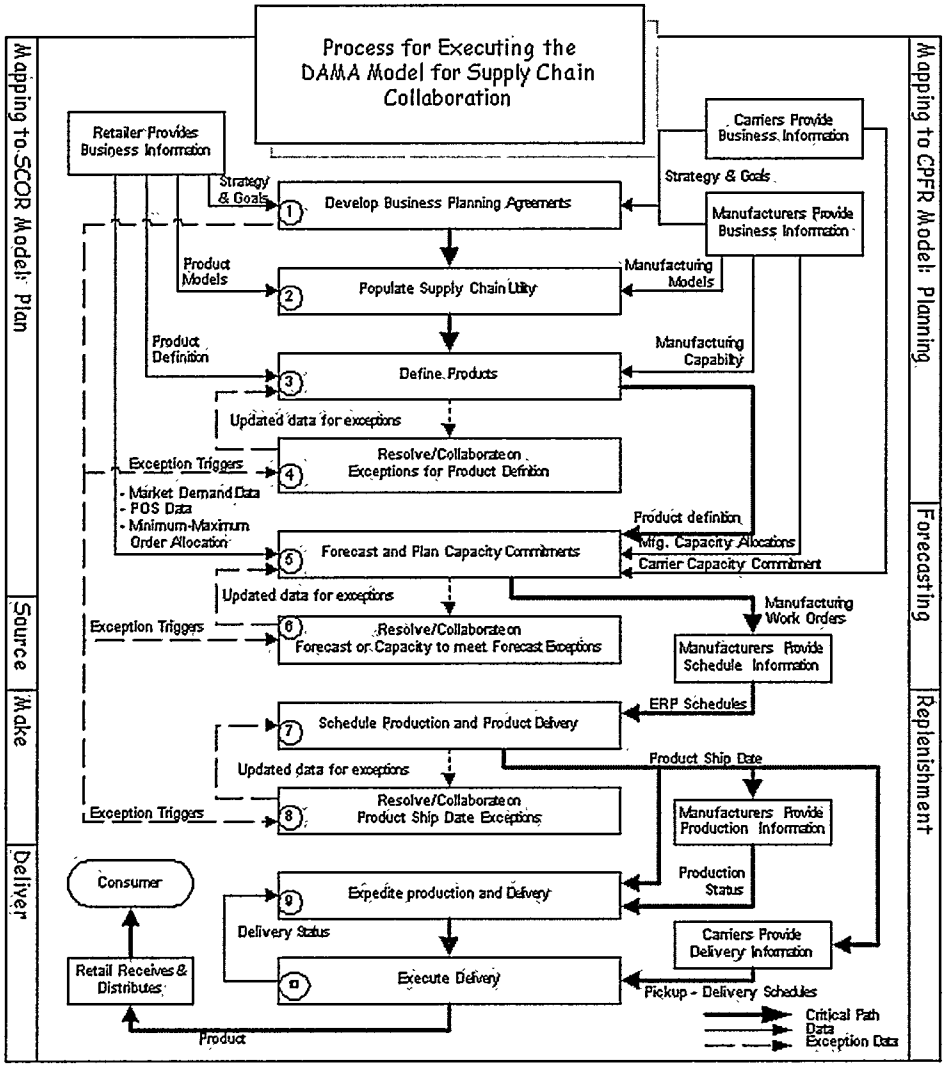

Figure 4. Process for Executing the DAMA Model

The supply chain utility, populated with base manufacturing capabilities and capacity commitments and updated with exception updates and firm orders, will generate work orders for each of the manufacturers and a shipment forecast for the carrier(s). Each company will then process the work order into their internal Enterprise Resource Planning (ERP) system generating a ship date for the product order. Ship dates that vary within a specified tolerance of the initial work orders and retail cancel date will generate exceptions.

8. Collaborate on Product Ship Date Exceptions

Resolving and/or collaborating on product ship date exceptions leads directly into the expedite production and delivery step. A late ship date on fiber would impact all customers along the supply chain. But the textile manufacturer might have yarn in inventory that was not previously entered into the supply chain utility (it may have been reserved for a customer outside of this trading partner agreement). The supply chain utility processes the updated data for exceptions.

Partners Collaborate to Expedite Production and Execute Delivery

9. Expedite Production and Delivery

Manufacturers' ship dates generated from the process of collaboratively scheduling production will be compared to delivery status provided by each manufacturer on a regular basis. If ship dates and delivery status for product are not meeting the agreed upon product ship dates, an exception will occur.

Most exceptions will only be made available to the trading partner who is initially impacted by the exception. For example, late shipment of greige goods would trigger an exception for the finishing plant. Resolution of that exception would either be expedited or negotiated with the appropriate trading partners.

Visibility to the supply chain product ship dates allows each member of the supply chain to expedite production and delivery as it relates to their position in the chain. Each member of the supply chain will be providing status updates for the delivery and production status of the product.

10. Execute Delivery

The carrier, who provides delivery status information, handles the execution of delivery. The supply chain utility determines if target ship-dates are being met.

SUMMARY

There are a number of initiatives that the DAMA project believes can provide the foundation to further develop and complete the DAMA model for collaboration:

- VICS CPFR (Collaborative Planning Forecasting and Replenishment),
- VICS CTM (Collaborative Transportation Management),
- SCC (Supply Chain Council) SCOR (Supply Chain Operations Reference model),
- ATMI (American Textile manufacturers' Institute) Voluntary Standards (i.e. Quality Characteristics, Codelists), and
- AAMA (American Apparel Manufacturers' Association) Guidelines.

The value of this model must be determined by industry. The DAMA model for collaboration needs both process and product information in an ontology that will support it. Such product information specific to the textile industry can be found in many of the voluntary standards and guidelines published by ATMI and AAMA.

Collaborative supply chains will not be successfully implemented overnight. It will require changes in business practices, and small-scale proof of concept pilots before they can be implemented successfully in a large-scale manner. The phases for collaboration provide a recommendation for progressing to a place of readiness to scale collaboration across the industry. The model for collaboration provides a recommended set of processes that could be implemented in a collaborative way and the industry standards groups such as ATMI, AAMA, and VICS provide a basic set of information that should be used to develop the industry ontology to support inter-enterprise collaboration.

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DAMA Project

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