About the Author

Michael McClellan has over 30 years of experience serving and managing manufacturing enterprises. He has held a number of positions in general management, marketing and engineering, including President and CEO for a multi-division equipment systems supplier. In 1984 he and a group of associates founded Integrated Production Systems, a company that pioneered the use of computer systems to manage and track production events on the plant floor. His first book, *Applying Manufacturing Execution Systems*, defines manufacturing execution systems and explains the reasoning and history behind them. He is a frequent speaker at companies and manufacturing conferences, has presented a number of papers on plant information systems, and holds one patent. He has recently completed a new book, *Collaborative Manufacturing: Using Real-time Information to Support the Supply Chain*.

He currently lives in Washington state and is President of Collaboration Synergies Inc., an advisory company providing consulting services in the area of collaborative manufacturing system development and implementation, plant floor information systems and manufacturing execution systems.

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The Collaborative Era

This is the collaborative era. The era when trust is in and adversarial contingencies are out. The era when real facts and shared information are the foundation for business decisions and business relationships. The era when estimates or assumptions are regarded as guesses. The era when working together with shared and confirmed information is the norm, not the exception. The era when supply chains compete against supply chains, a major change beyond company against company.

Collaborative manufacturing can be a totally different way of doing business. There are many facets to this idea, but the most significant is the change of business buy and sell roles: from adversarial relationships to cooperative and then collaborative arrangements, based on identified elements of mutual interest and trust. Collaboration is a concept where participants contribute something for the betterment of the whole. In doing so, the relationship changes from traditional business rules to those based on mutual trust; these are enhanced by performance and contribution.

The process begins with steps that identify and set out the objectives of the arrangement. The second phase establishes the requirements, responsibilities, and methods of each partner in meeting the determined objectives. The third phase is the ensuring of compliance or the confirmation of facts based on absolute truth. This is the most vulnerable point of the process, where trust alone can bridge the gap between partners.

Trust is gained through confirmed compliance using on-line real-time information. In the case of product design, on-line information is basic to the process of tracking and recording each event and contribution throughout a product’s entire lifecycle. In the production environment trust is ensured through generation and presentation of real-time information from the plant floor production process that confirms agreed-on planned events and product compliance processes. Assumptions, paper transmittals or promises will not suffice, as any misinformation will detract from the fundamental element of trust, the foundation of the collaboration agreement. Actual information gained through process visibility is the only data source that confirms truth. There is no substitute.
Collaborative Manufacturing Components

There are three major components to this idea. The overriding piece is the Enterprise Resource Planning (ERP) system where overall management of corporate planning begins. Included are the processes of corporate inventory management and forecasts, financial objectives, manufacturing requirements, and the general focal point of information technology.

A fully integrated ERP system is the core management tool of most major companies today. This tool is the primary method to keep everyone within the company on the same sheet of music by presenting business information in a consistent and formal way using one integrated database and information presentations as defined by highest management. Modern corporations function much like the human body with the ERP system as the brain that provides sensory sensation recognition and response. Functions are continuously occurring in response to the cadence set by the brain whether that is a rapid heart beat rate or tactile response to a hot stove. In the business sense the ERP sets the company-wide pace. The ERP system drives the business plan, monitors concurrence to objectives, and is sensitive to significant events.

The one seemingly universal condition of any manufacturing business is the concept of the supply chain, an interlinking system of suppliers, manufacturers and customers. The second major leg of collaborative manufacturing is the supply chain, in its broadest sense and in all its permutations: upstream and downstream to and including the end customer.

Charles Poirier provides these definitions in his book, E-Supply Chain.

**Supply Chain:** Those core business processes that create and deliver a product or service, from concept through development and manufacturing or conversion, into a market for consumption.

**Supply Chain Management:** Refers to the methods, systems, and leadership that continuously improve an organization’s integrated processes for product and service design, sales forecasting, purchasing, inventory management, manufacturing or production, order management, logistics, distribution, and customer satisfaction.
The third major leg is the specific information necessary to keep all parts of the supply chain properly oiled with clean, timely, and correct data. There are many sources of information necessary to build closer relationships but centermost is the necessity for real-time/on-line plant floor and logistics information. The full array of the production management system infrastructure must be available to give openness and real-time/on-line shared information.

- It takes an enormous amount of data to run a business and, once existing, using the data elsewhere is relatively easy. A short list of data sources would include access to production planning, inventory management information, quality assurance measurements, schedule revisions, material location, engineering change order management, production variances, statistical process control, and engineering change orders. In most cases the sources exist and are already being used within production management systems up and down the supply chain.

- With every one in the supply chain working with consistent, current, and synchronized information, contingencies can be more effectively managed.

- Supply chain to supply chain competition is here and will grow in the future. Each partner can benefit through collaboration and the full effect is synergistic.

Real-time information from the many production facilities within the supply chain is largely underutilized. As the idea of collaboration within the supply chain gains adoption, the need for truly accurate, reliable information will be the key. With customer service as a primary competitive element of the supply chain, it is not enough to rely on estimates or contingency planning. Only actual information from on-line sources will suffice.
Collaboration Strategies

There are at least four forms of collaborative strategies currently being applied to support manufacturing companies. Informal collaborative alliances have been around a long time as some companies have intentionally built closer relationships with their suppliers and customers as a normal part of supply chain management. Collaborative manufacturing is simply an extension of that process with some new possibilities that have come available only recently due to technological advances and evolving market forces.

- Information technology allows information to be shared in near real-time. Regardless of whether the tool is the fax, the Internet, or integrated computer technology, the ability to transfer data between interested parties removes any reason to not be informed.
- The increasing emphasis on mass customization requires manufacturers to have production systems built to support production agility that responds to small lot sizes and individualized customer requirements.
- The possibility of synchronized inventories across the supply chain network is an idea with great economic potential. The tools are here and some companies are making significant progress.
- Product design done through collaborative efforts of supply chain partners has been very cost effective.

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Collaborative Manufacturing is to automate, link, complement, or support business processes across departmental, plant, enterprise, or supply chain boundaries.

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Product Lifecycle Management

The practice of sharing and collaborating on product design using supply chain partners has emerged as a significant management tool, especially in industries using outside contract manufacturing facilities and those with multiple design engineering input locations. Included in this category is real-time information sharing on product tracking and product genealogy throughout the life of the product. This data could include the following: complete product design history from initial concept to product disposal; quality assurance data; use and repair information throughout the useful life of the product to disposal or recycle.

Synchronized Inventories and Production

The intent in these applications is to synchronize inventories across supply chain partners. This means removing the inventory buffers that most companies put in place to protect their ability to provide products to customers when unanticipated adverse events impact the production plan. Another major factor is basing production plans on a demand forecast that is shared between supply chain partners as much as is practical and useful. Within this view is the growing requirement of mass customization to meet individual customer desires. Inventory management is a crucial element in accomplishing individualized unit production without a major adverse cost impact, and the key to inventory management is to produce to actual demand, not anticipated or forecast demand.
Distribution Order Fulfillment—CPFR®

The most successful implementation of collaboration to date appears to be Collaborative Planning, Forecasting, and Replenishment®, a model developed by the Voluntary Interindustry Commerce Standards Association. The CPFR® standard guidelines have been implemented by a number of companies building on earlier models of vendor managed inventory (VMI), an idea that has been very successfully implemented in retailing industries. Their success and the guidelines that have been published are very important but are only a part of the process envisioned in this book as the CPFR® model stops with order affirmation. The inclusion of the CPFR® model plus collaborative relationships across the extended manufacturing enterprise, the use of real-time process information, and the concept of a virtual inventory provide a broader view of the opportunities of collaboration in manufacturing.

Manufacturing Enterprise Collaboration

Sometimes it simply makes good sense to share information. This too is collaboration. As our information systems applications have matured we have developed large silos of information that have provided more information and in most cases better resulting data. Unfortunately we have constructed walls around and between business processes. These walls exist between departments within companies and between supply chain network partners in spite of the best intentions. Another opportunity for manufacturing enterprise collaboration is to link companies and facilities that have come together through acquisition or merger. Although there might be a quick connection at the planning system level, the real-time information from the plant floor may be necessary to support business processes.

In manufacturing enterprise collaboration systems the idea is to simply share information because it better supports the common everyday business processes that people work with as a matter of course. Historical efforts to tie systems together through tight integration has been very expensive, unreliable, time consuming to develop, and difficult to change once in place. Collaborative manufacturing methods use these systems as network nodes that are linked to retrieve or exchange information that can be interpreted and passed to interested parties and/or other systems.

One example is to link quality assurance data from within the manufacturing execution system with a supply chain event management system to monitor yield information and broadcast results to internal or external recipients. An additional step might be to provide that information to the planning and scheduling system for an automatic response to the actual yield quantity and to revise the schedule accordingly. To extend this further we might inform downstream partners of the quality assurance data, the resulting yield, the revised schedule, and current shipment information as developed in the logistics management system. One more step might be to advise the Supply Chain Event Management System of the new priority enhanced schedule by using a logic requiring notification by the MES if the revised schedule for the order does not begin on the date specified.
At least two categories of collaboration are aimed specifically at supply chain inventory management. A fundamental part of the ideas behind both synchronized inventories and CPFR® collaboration is an intense focus on manufacturing products to an actual demand as opposed to a forecast demand. Although any production environment other than a build-to-order method will have some degree of an estimate, the idea is to eliminate as much of the guesswork as possible and to use time buffers, not inventory buffers, to address any discrepancy. This is best accomplished through a scheduling system that integrates each node of the supply chain into a single schedule and provides actual demand information to each participant. This approach requires complete visibility and accuracy of production events and processes, and is a part of the trust equation that is so important to successful collaboration.

**Deployment**

Strategic deployment of collaborative manufacturing formally addresses at least two issues within the supply chain.

- A modern company can have a global supply chain of suppliers, factories, logistics, distribution centers, and customers. This many entities with their myriad of functions will encounter normal dynamics that cause incidental performance failure. Integrating links must exist within the supply chain so performance failures can be recognized early and proactively, thereby mitigating their impact.
- The second strategic view is the use of core competencies within the extended enterprise to gain a competitive advantage. This can begin with product development or product lifecycle management technologies and continue through the production and distribution processes of each member of the extended enterprise network. The collaborative advantage benefits the entire supply chain network and rises to the level of supply chains in competition with other supply chains.

Collaboration can be a very effective and successful business strategy but it is not easy or simple and will require some new thinking, openness and trust. Using new names to identify old processes is not enough. The most significant ingredient is trust between the partners but there are more considerations.

- Trust is the fundamental building block of collaboration. Each partner must be able to share information without fear of being taken advantage of. This includes such sensitive information as product design, cost information, and occasional performance deficiencies.
- Only accurate, timely, available, and real-time information gives everyone the ability to react in the interest of the supply chain network.
- The purposes and objectives for collaboration should be consistent and mutually aligned among all partners across the supply chain.
- There should be high visibility and accuracy of all data sources. Assumptions are unreliable and therefore unacceptable. Only accurate information allows trust.
- The old cliché still applies: A chain is only as strong as its weakest link. Reliability is a key factor in collaborative network performance and there is no substitute.
- To obtain reliability there must be a consistent allocation and commitment of resources.
- The ability to make delivery promises must be based on sound data and resource allocation.
- All partners must buy into the ideas, methods and objectives.
- There must be a simple, well-defined data transfer methodology.
- There must be consistent and shared performance benchmarking standards that are measured and shared on a regular basis.
- Companies in a supply chain can hardly work at opposing ends. They must work together as an aligned...
team; they must collaborate.

- Chain partners must reduce or eliminate the adversarial tone between themselves. Supply chain partners must be seen as departments of the extended enterprise with the common objective of enhanced supply chain performance.
- Utilizing effective information technologies toward the focused objective is a must.

**Tactical Applications**

Tactical applications of collaboration are unfolding rapidly. Applications can be simple or complex, between two departments or any number of companies, or across the broader extended enterprise. Some initiatives are easily recognized and allow quick implementation. Other initiatives are long range projects implemented through a team or teams of professionals over a period of years. Early projects aimed at obvious opportunities can be quickly brought on line with a very fast return on the investment. This is a starter list of tactical application ideas using collaboration tools for improvement.

- Initiate new product development efforts using a broader range of input and review from extended enterprise partners.
- Improve a product design for manufacturability using the full range of competencies within the supply chain network.
- Synchronize the inventory across the supply chain beginning with first tier suppliers.
- Provide schedule information to support producing to actual demand, not to an anticipated or assumed demand.
- Improve logistics cost across the supply chain network.
- Reduce the time to market for new product introduction.
- Reduce the manufacturing cycle time for designated partners.
- Develop a formula to measure overall supply chain cost and view tactical managerial initiative opportunities using that cost as the baseline.
- Initiate a benchmarking performance review of the supply chain network.
- Obtain maximum data input from all partners.
- Examine how collaboration might be used to more closely align production with distribution channels.

**Basic Elements**

Except in the simplest form, collaboration needs to have some foundation of formality. These guidelines are good thought starters.

**Alignment:** Collaborative manufacturing requires companies to have mutually aligned interests. Collaboration is not about coercion. It is about sharing information and objectives in a way that the total is greater than the sum of the parts. Alignment helps to ensure that the people understand the objectives and view the process alike.

**Dedication:** Dedication to the ideas and objectives is a fundamental requirement of collaboration at any level. Whether the exchange is between departments or between companies the commitment must be mutual and complete. Asset dedication, such as plant location or capacity set aside, is a part of the dedication. Collaboration cannot be business as usual.

**Visibility:** The primary thrust behind collaboration is to raise the visibility of current and near future condi-
tions within all partners of the supply chain. For all the partners across the supply chain, this includes visibility of production data, logistics information, quality assurance and yield data, product development and enhancement, engineering change order issues, customer reorder or order changes, work-in-process status, genealogy information, granular inventory information, etc. Decisions and commitment based on visible information develops trust and good business relations.

**Adaptability:** The supply chain network must respond to the combined requirements of the customer. Involvement in identifying and meeting those requirements necessitates a capability to adapt to new products, new ideas and other cultures quickly and completely.

**Accessibility:** Access to the data flowing within the collaborative system is a must. Some form of information systems integration between partners in the supply chain is absolutely crucial to ensure information is visible and consistent. The system must be able to support the objectives of the collaboration agreement.

**Glass Supply Chain:** The supply chain partners should seek to provide a full and open exposure to all partners. The ability to review and confirm events provides control over the process, something that is lacking with passive business cultures

**Engagement:** Collaboration is not a one-time thing or a business practice that you put in place and walk away from. Full engagement on a long-term basis is required to address marketplace and performance changes and to continue building an ever more successful alliance. Collaboration is a process, not an event.

**Production Information:** All manufacturing plants have some infrastructure to manage and measure their production. This may be a fully integrated manufacturing execution system, a stand-alone warehouse management system, a quality assurance system, a production scheduling system, a distributed process control system, a data collection system, a genealogy system, a supply chain execution system or any other combination of systems and methods

**On-line:** On-line real-time information is the source of data that is accurate, reliable, and available. There may be sources of production data that are not available electronically but that is the first option. Gathering data manually and entering it into the information system is not error free. Waiting for paper borne information is not reliable or fast enough

**Network:** The supply chain is made up of a network of interrelated companies and interrelated functions. The relationship may be only for a single product for a single node of the supply chain, but the responsibility as a link in the chain represents the commitment to the network. Collaboration is about all nodes being in step with each other through accurate information and access to other supply chain network partners.

**Security:** There has been a lot of comment made about sharing information and visibility across the supply chain network but this is not about indiscriminate information access. Security is just as important here as in any other system.

**Scalability:** Initial collaborative arrangements are likely to grow. As early systems are being considered, design into your process the ability to increase traffic and the number of participants.

**Culture:** Collaboration is about bringing people closer together. Culture is a part of every group of people and must be a consideration in the process of collaboration development.

**Leadership:** There is an old axiom that business is not a democracy and that is no less true today. Collaboration may be closer to democracy but it is still business and it requires strong leadership, not just good cheerleading. It is a business strategy that must be led effectively by the supply chain host and accomplished with those qualified supply chain partners that share in the benefit.

**People:** Collaboration is a people-centric concept. Bringing people closer together with the proper supporting tools to bridge business process gaps is the essence of collaborative strategies. Business processes provide the framework, and information technology is the enabler but the applications must be people centric.
Considerations

Collaboration is a very good business strategy but there are certain issues that appear again and again in the available literature on this subject. The three impeding issues most often seen are these:

**Trust**—Much has been made about trust in this paper but this is consistent with successful collaboration implementations. Most current business is built on adversarial relationships between buyers and sellers. This adversarial relationship often exists within companies between plants or between departments. The first step in collaboration is to remove the adversarial environment and replace it with strong reliable information visibility and mutually aligned objectives.

Lack of trust is a major deterrent to collaboration. When companies do not trust each other, collaboration attempts fail. As a prerequisite, collaboration requires sharing more proprietary information than is currently shared. Only limited information is shared when there is lack of trust. Lack of trust was seen as critical issue between companies but also as an obstacle where there is lack of trust between divisions of the same company.

**Culture**—After trust, the next major hurdle appears to be culture. Culture is a significant factor in every business and combining cultures or trying to force mutually supportive relationships where only aggressive adversarial experiences are the norm, does not always work.

Collaboration, by design, brings people from different organizations together to work on common objectives. Each of the organizations in a collaborative partnership will have developed their own culture that is distinctive and unlikely to be easily modified. In some companies the culture allows people to arrive late but work well past the end of the normal workday. Some companies have a quiet soft-spoken demeanor where others may be loud and very forceful. Some may lean toward a very conservative position while others may be eager to push the boundaries.

Culture can be a barrier to cooperation and team building so it is important to recognize early on that attention must be paid to cultural issues and how this aspect of collaboration is to be managed. This should be a consideration in choosing collaboration partners and in staffing assignments. Organizational culture is not necessarily the Achilles heel of collaboration but it can be a serious issue if not adequately recognized for its possible impact.

**People Centric**—Collaboration is a people centric idea. Information technology is important as an enabler but is not the essence of the concept. Improved support for business processes to enhance people effectiveness is the objective. In today’s view collaboration is a strategic business tool that sees information as an underused corporate resource that could be better deployed to support business processes.
• View information and collaboration in the broadest sense across departmental, company, and extended enterprise boundaries.
• Examine business process gaps where decisions are based on poor or lacking information, assumptions, or information that is not current.
• View information as a corporate resource, not as departmental property. There is extensive information generated and accumulated each day that could enhance business processes if it were visible.
• Examine collaborative opportunities from the view of each group of users and information sources.
  • Internal users across the enterprise.
  • External suppliers and partners.
  • External customers
• Collaboration is not an all or nothing process. There should be incremental progress based on defining places of need and acceptance by the users.

**SUMMARY**

Collaborative manufacturing is a rapidly growing trend in business today. There are some who believe collaboration will provide a greater positive impact on business management than ERP. The implementation ideas range from formal contractual agreements between supply chain partners to informal ties between business processes. As is usually the case there are those companies at the leading edge and there are the naysayers who see only the negatives. Like so many other management tools collaboration must prove itself as a reliable idea that can deliver the bang for each investment dollar. So far the results seem very impressive.