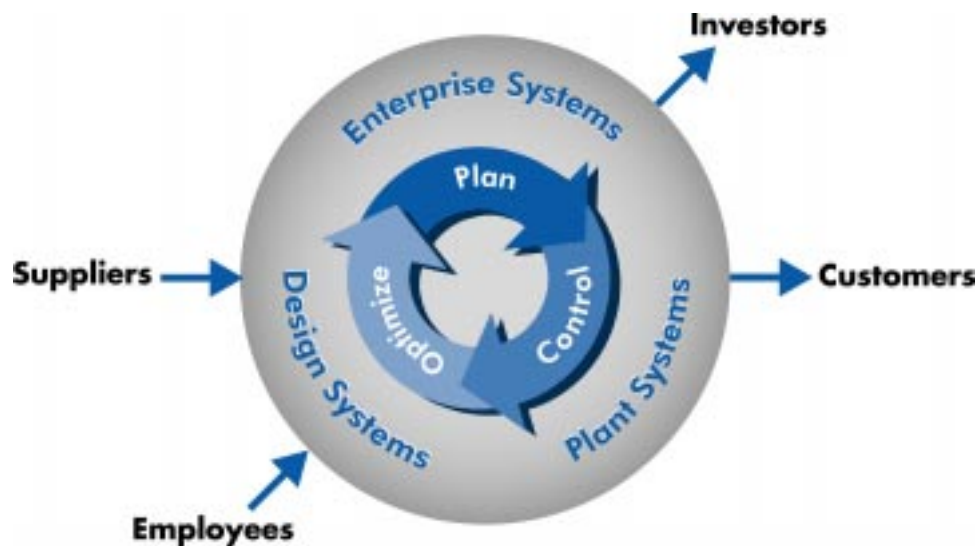




Enterprise Integration Strategies for the eBusiness Era

eBusiness Takes Industry to New Heights	3
eBusiness Success Requires a Unified, Optimized Approach	8
ARC's Unified Model Positions Manufacturers for the eBusiness Era.....	9
Integration Opportunities Are Everywhere	12
Enterprise Systems Must Reflect eBusiness Philosophy	15
Design Integration Efforts Must Extend to the Plant Floor.....	18
Plant Systems Hold a Wealth of Information	21
Plan, Control, and Optimize on a Global Basis.....	22
eBusiness Technology Enablers	23
Find the Right Partners.....	28
Enterprise Integration Is Worth the Effort.....	29



ARC's Unified Enterprise Model Positions Manufacturers for the eBusiness Era

1. Global reach
2. Lowest cost
3. Increased speed & flexibility
4. Superior customer responsiveness
5. Enhanced customer partnership
6. Instant access to the latest information from around the world

eBusiness Provides the Ultimate Competitive Advantage

eBusiness Takes Industry to New Heights

Manufacturers today are faced with an onslaught of internal and external pressures that escalate the uncertainty surrounding strategic decision-making. One of the most prominent pressures is exerted by newly-empowered customers who can readily access information on competitive features, promotions, and comparisons via the Internet. These customers want easy to use, low cost products that are delivered as quickly as possible and at continually lower cost.

Modern investors pose an even greater challenge for manufacturers: they want you to make them rich. Quarterly earnings reports, daily stock prices, and periodic analyst reports for public companies exacerbate the pressure from vocal investors intent on maximizing their ROI. If you don't fulfill their expectations they are prepared to dump your stock, drive down your stock price, and potentially make you vulnerable to takeover. For a manufacturer, this translates into relentless pressure to make and market better products at lower cost and with a faster turnaround.

Make me happy!



Make me rich!

- Make it:**
- ♦ what I want
 - ♦ now
 - ♦ better
 - ♦ easy to use
 - ♦ green
 - ♦ perfect
 - ♦ for less

**Today's Customers and Investors
Are Very Demanding**

Enter the eBusiness Era

In response to these unrelenting business pressures, manufacturers are increasingly adopting eBusiness strategies. An eBusiness strategy is designed to exploit the limitless potential inherent in Internet technologies and the World Wide Web in order to achieve competitive advantage. Numerous examples of the eBusiness phenomenon are already evident in the success of companies ranging from Amazon.com to Dell Computer, but the industrial market is just beginning to appreciate the potential impact of this powerful technology. Manufacturers' ability to successfully execute an eBusiness strategy will be a key determinant of success in the Internet-dominated new millennium.

Proliferation of open Internet standards makes low cost technology accessible to all players, but successful execution of an eBusiness strategy will require more than just developing a web site or posting an on-line catalog. Ability to strategically exploit Web technologies to improve the core eBusiness metrics of customer responsiveness, service, and cost are the keys to success in this new competitive environment.

Customer responsiveness, service, and cost are the key metrics in the eBusiness environment.

eBusiness: The Ultimate Competitive Advantage

Companies pursuing eBusiness strategies are creating a new paradigm in manufacturing. This strategy allows firms to instantaneously react to shift-

With an eBusiness Strategy You Can:

1. React quickly to market opportunities
2. Adjust prices & production schedules as market dynamics dictate
3. Quickly diagnose and resolve customer or channel issues
4. Push information instantly to all involved parties

ing customer preferences or competitive maneuvers by adjusting production schedules on short notice. Prices can be changed quickly to respond to changing market demands or competitive moves. Updates are instantaneously available to employees, the supply chain, the distribution channel, and customers via the Internet-based delivery system. New product roll-outs can be accomplished in only a fraction of the time, allowing companies to beat competitors to market while reducing their own time to market and the cost of introducing a

new product. All of these factors come together under the eBusiness umbrella to deliver the ultimate competitive advantage.

eBusiness Extends Global Reach, Lowers Cost of Doing Business

eBusiness represents the lowest-cost means of doing business both now and in the new millennium. As an enabler to globalization, eBusiness represents a marked departure from pre-Internet globalization strategies that cost billions of dollars and took years to execute. Rather than emphasizing strategically located manufacturing and marketing facilities to achieve globalization, an eBusiness strategy allows manufacturers to market products all over the world from a single location and provide a continuous 24 x 7 market presence. In this scenario, even the smallest operations are capable of achieving a global market presence.

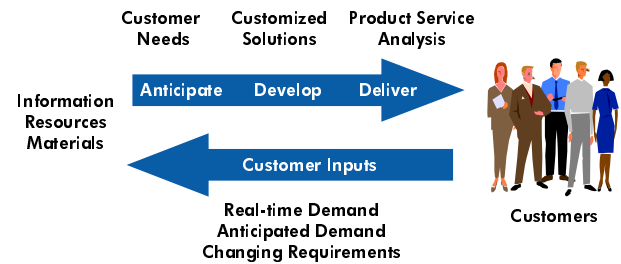
As evidenced in the personal computer business, one of the early adopters of an eBusiness strategy, a successfully executed eBusiness strategy can also markedly improve cash flow. Customers pay for PCs ordered via the Web from companies like Dell Computer before the PC is even assembled. Once the order is received, the PC is assembled to the customer's specification and then shipped. With this approach, the PC manufacturer has received payment before incurring any variable costs associated with making the PC, plus they maintain a minimum level of inventory for which they have up to 30 days to pay. The associated Web-based order-taking, order tracking, customer profiling, and numerous other actions represent little to no variable cost to the manufacturer.

A Customer-Centric Philosophy Is at the Core of eBusiness

An eBusiness strategy is a primary enabler behind customer responsiveness, an essential characteristic of successful competition in the new millennium. To win and keep customers you need to be highly responsive to customer needs. This is true not only for what the customer needs today, but also for what products or services they may need tomorrow to achieve and maintain competitive advantage. In the eBusiness era it is necessary to work closely with your customers so you can understand what they will need tomorrow. This translates to more than just delivering the product to the customer, it entails helping the customer get the most out of your product.

A key advantage of an eBusiness strategy is the ability to use the Internet to become more customer-centric and ultimately more successful. Even the simplest components of an eBusiness strategy such as a browser-based interface will make it easier for your customers as well as your employees, supply chain, channel participants, and others to access and convey information important to marketing, service, and overall customer responsiveness.

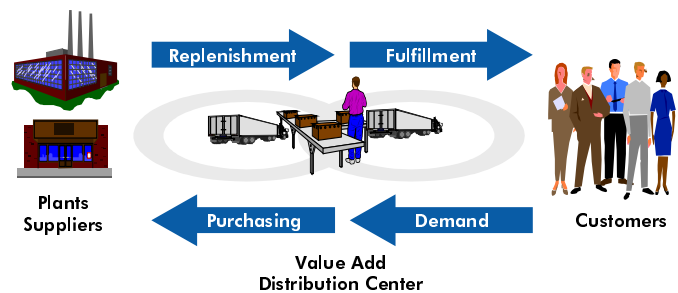
Use of a Web-based strategy allows you to learn more about your customers through registration profiles, documented buying behavior, and analysis of overall web site usage patterns. Knowledge of exactly what your customers want can be used to anticipate demand and offer them the right products at the right time and at the right price. Information on new products, programs, and other activities can be pushed instantaneously to customers who best fit the target profile.



The Customer Is King in the eBusiness Era

Make to Order Capabilities Are Mandatory in the eBusiness Era

Many manufacturers who have invested millions of dollars in Enterprise Resource Planning (ERP) and Supply Chain Management (SCM) systems continue to employ make-to-stock manufacturing strategies, but the demand for profitability has virtually eliminated this luxury. Today's consumers expect more product options and greater flexibility in product configurations. The customer-centric manufacturer must be able to



eBusiness Execution Emphasizes Optimal Order Fulfillment Strategies

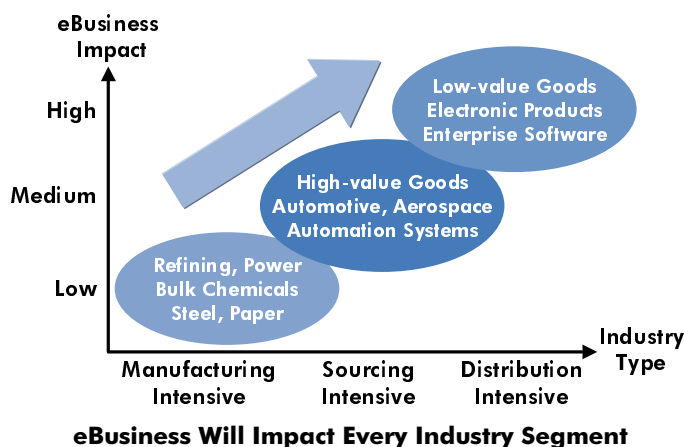
meet these market expectations while quickly responding to changes in customer preferences. Demand-based operations require not only multipurpose, modular facilities that have the flexibility to produce many different products with the same equipment, but also flexible software for making rapid changes as market conditions warrant.

Top Priorities	Business-to-Business	Business-to-Consumer	Consumer-to-Consumer
Lowest Price		1	2
Service	1		
Product Quality	3		
Quick Delivery		3	3
Convenience		2	1
Customized Products	2		

Many eBusiness Models Are Emerging

production, and delivery must be tightly coupled in order to convey when the product will be delivered.

A key determinant of success in the make-to-order environment is the ability to set manufacturing schedules directly from customer orders. This activity requires extensive integration of WIP, order tracking, and other functions with supply chain and delivery mechanisms, but it can also significantly lower costs associated with product lifecycle management, inventory, and the supply chain while improving overall Return on Assets (ROA).



No Industry Is Immune from eBusiness Impact

The eBusiness reach extends across all industries, including manufacturing, finance, retail, healthcare, and others. As a result, numerous eBusiness models are emerging to reflect the differing applications. Priorities such as price, service, and convenience vary markedly between the models, reflecting the different emphasis in each type of relationship. In their current form, most eBusiness models reflect some type of Business-to-Business or Business-

to-Consumer relationship, but even in these categories the model can vary widely. For example, large, global customers are likely to emphasize global service & support while smaller firms may value local support above all else. If you are selling to consumers, lowest price is likely to be a dominant characteristic.

Within manufacturing, the impact of eBusiness will vary significantly by vertical market. For example, distribution intensive industries such as electronic products are already deeply involved in eBusiness. On the other end of the spectrum, eBusiness will have less of an impact on manufacturing intensive vertical markets such as refining, bulk chemicals, and steel.

eBusiness Challenges:

1. Delivery of customized products & solutions
2. More frequent, smaller, faster shipments
3. More flexible, optimized production facilities
4. Effective information management
5. Transaction security
6. Change in corporate culture
7. Winning & keeping customers
8. Customer responsiveness

eBusiness Era Poses Its Own Challenges

The Internet represents both a competitive threat and a technology enabler for today's manufacturer as it makes the business climate more volatile and competitive. Companies reliant on a make-to-stock strategy will need to move to more flexible, optimized plants in order to accommodate the more frequent, smaller, and faster shipments and customized products and solutions that typify eBusiness. This migration will have multiple significant payoffs as manufacturers are able to adopt a make-to-order production strategy.

The shift in these and other operating procedures will result in a significant cultural change for virtually all manufacturers. An eBusiness philosophy relies on a dynamic, customer-centric environment that encourages change and risk-taking but leaves no room for errors

Winning and keeping customers will remain one of the most significant challenges for manufacturers in the eBusiness era. As most if not all manufacturers move to an eBusiness focus, competitors will use their implementation of this strategy as a differentiator and a means of luring customers from competitors. Transaction security is also paramount, since one slip could easily mean lost accounts. This is evident in the experience of other industry segments, such as financial, that have already experienced the impact of these security issues.

eBusiness Success Requires a Unified, Optimized Approach

Manufacturers must prepare for competition in the eBusiness era by forming a unified, optimized enterprise that enables you to meet escalating customer demands, withstand competitive onslaughts, and generate the continued increases in earnings and revenues mandated by investors. In the 1990s

Benefits of a Unified Enterprise:

- Improved customer responsiveness
- Improved competitive agility
- Improved supply chain performance
- Improved production performance
- Optimized enterprise performance

manufacturers responded to these pressures by remaking themselves into Lean, Agile, Global enterprises that focused on core competencies. Manufacturers must now add to these initiatives a unified, optimized enterprise perspective that enables successful competition in the eBusiness environment of the new millennium.

The numerous potential benefits fueling the drive toward a unified, integrated enterprise are compelling enough to warrant the effort. Along with the ability to position manufacturers to compete effectively in the eBusiness era, adoption of a unified, integrated enterprise optimization perspective will:

1. Allow you to capitalize on shifts in market preferences by decreasing your time to market and enabling delivery of the right product to the right place at the right time.
2. Enable you to make products to order and implement integrated order fulfillment and just-in-time inventory systems, thereby reducing the cost and impact of reduced product lifecycles and long inventory turns.
3. Enable the most cost-effective management of product, plant, and process lifecycles, including better appreciation and management of the total cost of ownership (TCO) of a product, plant, automated system, or process.
4. Make best practices and standardized optimal processes easily accessible to all facilities throughout the enterprise. This includes retention and distribution of the numerous and often localized knowledge bases surrounding a product, plant, and/or process.
5. Improve understanding of the dynamic relationships between different enterprise entities, the positive and negative impacts their activities may

have on one another, and the potentially costly gaps inherent in the existing infrastructure.

6. Maximize realized benefits, Return On Investment (ROI), and Return On Assets (ROA) of all incorporated systems including enterprise, design, and plant floor. This includes optimal scheduling of production and maintenance activities throughout the global enterprise as well as maximum asset utilization.
7. Improve supply chain performance and demand management while easing the incorporation of new acquisitions, suppliers, or customers into your allied business enterprise.

An eBusiness Strategy Requires a Unified, Optimized Enterprise

1. Business transactions span multiple systems
2. Mergers & acquisitions create duplicate processes
3. Integration will boost the ROI of standalone systems
4. Decision support information is distributed in numerous locations
5. The latest information must be available when and where it is needed
6. A unified architecture is essential for web-enabled make to order manufacturing
7. A unified, optimized architecture maximizes customer responsiveness

Ability to execute the eBusiness vision requires migrating from individually optimized functional units that are currently the norm in most manufacturing operations to a truly unified, optimized, responsive enterprise where units become dependent on one another. Integration of currently standalone functional entities such as enterprise, design, and plant floor systems is the key enabler behind achieving true enterprise optimization, and integration forms the core of ARC's Unified Enterprise Model.

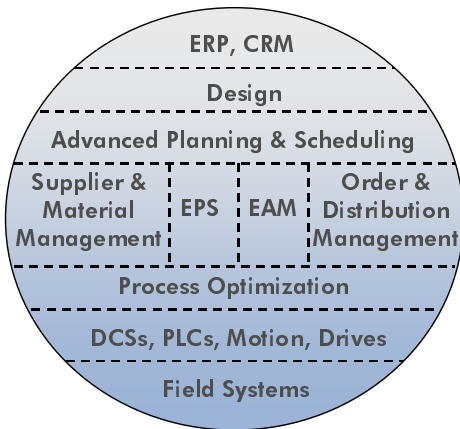
ARC's Unified Model Positions Manufacturers for the eBusiness Era

ARC believes it is time for manufacturers to go beyond repackaging of traditional enterprise hierarchies and toward a unified, optimized enterprise model that is the enabling platform for eBusiness. ARC developed the Unified Enterprise Model to convey our vision of the optimized enterprise, its key components, and the ongoing, cycling processes associated with it. While conceptually simple, ARC's Unified Enterprise Model establishes a sound framework for a unified enterprise and points the way toward integration of enterprise components.

Today's business pressures and the looming eBusiness era demand open, integrated architectures and continuous optimization throughout the enterprise. Integration of key enterprise elements, plus the ability to plan,

control, and optimize these elements for the good of the greater enterprise, are hallmarks of the Unified Enterprise Model. Functional components of the Unified Enterprise Model include:

- Enterprise applications, including ERP, Supply Chain, Customer Relationship Management (CRM), Enterprise Production Software (EPS), Enterprise Asset Management Systems (EAM/CMMS), and others.



**Numerous Applications Must Work Together
Flawlessly to Optimize Enterprise Performance**

- Design applications, including CAD/CAM, Facility and Product Data Management (PDM), and other components of Digital Manufacturing.

- Plant floor automation applications, including logic, motion, and process control and plant floor specialty systems such as Laboratory Information Management (LIMS) and safety systems.

By definition, the Unified Enterprise Model embodies the universe of enterprise activities. Each subsystem, whether enterprise applications, design engineering, or plant floor automation, inherently contains a variety of activities that are specific to its functional area and that must be coordinated at the level of individual applications. A unified enterprise approach provides the incremental ability to plan, control, and optimize the enterprise as a whole as well as the discrete systems that operate within it. This enterprise-wide plan/control/optimize capability extends into areas such as business process, lifecycle management, and material and product flow where an integrated management approach is crucial.

While these core components must be managed to operate in concert, ability to extend the enterprise to include integration with customers, the supply chain, and the distributor/wholesaler/retailer channel are critical determinants of future success. It is difficult to be successful if your suppliers or dealers are not successful as well. It is also impossible to tell your customers when they will be receiving their products if you don't know when your suppliers will be delivering the raw materials and/or parts assemblies. ARC's Unified Enterprise Model therefore extends beyond the standalone enterprise to encompass both the supply chain and demand management. Ultimate participants in the unified enterprise include:

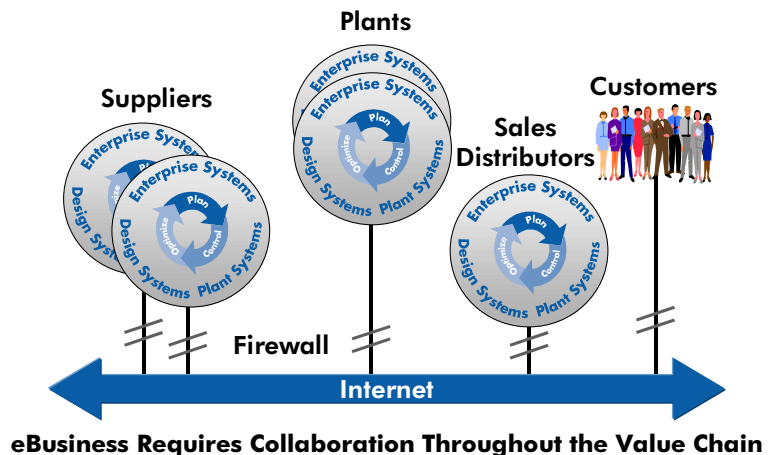
While these core components must be managed to operate in concert, ability to extend the enterprise to include integration with customers, the supply chain, and the distributor/wholesaler/retailer channel are critical determinants of future success. It is difficult to be successful if your suppliers or dealers are not successful as well. It is also impossible to tell your customers when they will be receiving their products if you don't know when your suppliers will be delivering the raw materials and/or parts assemblies. ARC's Unified Enterprise Model therefore extends beyond the standalone enterprise to encompass both the supply chain and demand management. Ultimate participants in the unified enterprise include:

- All internal operatives, including executive and middle management, marketing and sales, finance, plant managers, manufacturing and/or process engineers, operators, and maintenance personnel.
- Supply chain participants, including Tier 1 through 4 suppliers, outsourcing partners, and others.
- Distributors, wholesalers, and retailers.
- End customers.

Global Optimization Is the Path to Success

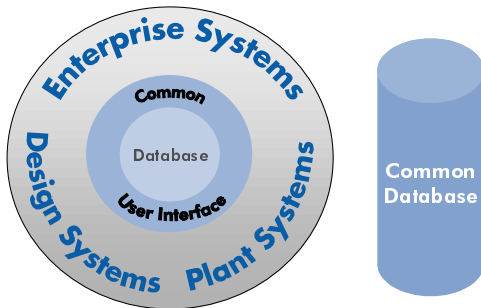
ARC's Unified Enterprise Model recognizes that availability of the right data in the right place at the right time and in the right format is a crucial enabler behind customer responsiveness and optimal order fulfillment. Enterprise integration is the path to achieving both this universal data accessibility and the ability to use it to plan, control, and optimize manufacturing operations. These capabilities are vital to not only deploying an eBusiness strategy, but also to executing it in the most cost-effective, streamlined fashion.

Current reliance on a variety of loosely coupled or independent systems for enterprise, design engineering, and plant floor automation is accompanied by a scenario where important business information is distributed throughout the enterprise in separate databases, data vaults, historians, and other containers. Proliferation of these standalone systems and sub-systems throughout the enterprise typically results in widespread data redundancy, an IT coordination nightmare, and sub-optimal use of knowledge assets. The unified, optimized enterprise eliminates this redundancy, striving for a common, unduplicated data set that is globally available to all stakeholders. This data integration will position companies for the unforeseen market and technological challenges that lie ahead, while simultaneously improving performance relative to both internal and external metrics.



Global Information Access Is Crucial

The Unified Enterprise Model ensures that product and/or process knowledge currently resident in numerous locations is accessible throughout the



**Plant Floor, Design, and Business Information
Must be Seamlessly Integrated**

organization. Use of a common infrastructure in areas such as user interface, computing platforms, and communication networks are key strategies for implementing the efficient global data access that is characteristic of the unified enterprise. Many organizations are already moving in this direction with their adoption of common web browsers, database and computing platforms, networks, and other infrastructure components that are used throughout the enterprise.

This integrated approach minimizes resource duplication and leads to a less costly IT infrastructure as common hardware, network, software, and knowledge resources are shared throughout the enterprise. Ability to view the entire order fulfillment process through a common user interface ensures that the most up-to-date information is used in decision-making and minimizes the time required to locate information or train employees in a new functional area.

Enterprise-wide integration typically relies on a variety of industry standards that propagate a common knowledge base and reduce the need to reinvent the wheel when new demands are placed on the system. Migration to an integrated approach will also boost the ROI of acquired systems in all functional areas as integrated data sets and infrastructures are used to optimize all types of processes.

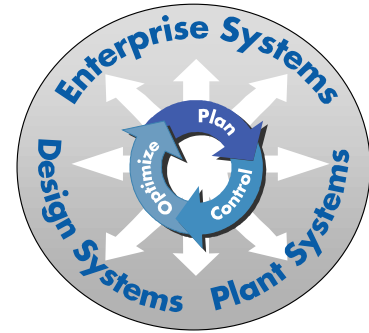
Integration Opportunities Are Everywhere

Expansion of the enterprise definition to include the supply chain, distribution channels, end customers, and other participants is driving the move to a more comprehensive approach to integration. Internal integration efforts, currently typified by the often-painful effort to integrate ERP and production systems, are driven by the need to enable the sensor-to-boardroom perspective necessary to be a responsive enterprise. External integration requirements extend from the supply chain to demand management, encom-

passing suppliers as well as distributors, wholesalers, retailers, and finally the end customer.

Integration Reduces Supply Chain Waste

The need for supply chain management is well-documented in the manufacturing sector, but a recent ARC user survey found that Supply Chain Planning (SCP) implementations are not producing anywhere near their full value because of poor integration with ERP, legacy production and logistics systems, and plant automation systems. Without real-time connections, robust available-to-promise (ATP) capabilities that allow manufacturers to take customer calls and tell a potential customer the earliest date any order can be reliably fulfilled are out of the question. Ability to achieve this key order fulfillment capability relies on robust enterprise integration.



The Unified Enterprise Requires Integration Among All Business Elements

Most companies currently have a lot of slack in their supply chain. This slack must be removed in order to execute most efficiently in the eBusiness era. Order management systems must be closely coupled with the advanced planning & scheduling (APS) system to provide quick response to the customer. The APS system will then communicate to the EPS system to make sure that the order is shipped to the customer on time.

Effective Outsourcing Requires Integration

In the automotive industry, outsourcing is entering the next stage of evolution as automotive suppliers move to outsource entire sub-assemblies, such as dashboards and seats, and ultimately have the supplier install those outsourced components on the assembly line. In another area, automotive manufacturers such as Chrysler and Ford are extending their digital manufacturing infrastructures to include their supplier base. An integrated, optimized approach encompasses the universe of the allied enterprise and is the best means of coordinating the outsourcing of these and a myriad of other activities.

Demand Management Requires Integrated Approach

Enterprise integration is also necessary to leverage the increasing interaction with the demand side of customer-centric business transactions. While close customer relationships have typified business transactions within many industries since day one, escalating use of information technology and

particularly the Internet is generating a constant flow of valuable customer data. Customer-centric manufacturers are using that information to develop new, enhanced, and even customized products that enhance their competitive advantage.

Ability to respond to customer-driven windows of market opportunity requires coordination of activities throughout the enterprise.

Ability to respond to customer-driven windows of market opportunity requires coordination of activities throughout the enterprise. Customer information must be gathered and synthesized and new products developed and produced in the least possible amount of time. Both internal operations and the manufacturer's supply chain must be able to react in concert to new customer demands. This requires both vertical integration with internal enterprise, design, and plant systems as well as horizontal integration of supply chain and demand management.

Enterprise-wide integration will be a key determinant of a manufacturer's ability to execute in these market conditions, particularly regarding the minimized time-to-market necessary to achieve competitive advantage. Reduced time-to market will result in increased margins for the successful competitor as less cost will be incurred in the shorter product development and launch process. Competitors unable to execute in this environment will be forced into a reactive mode typified by late-to-market products, short unprofitable product lifecycles, and higher inventory costs.

No One System or Supplier Can Do It All

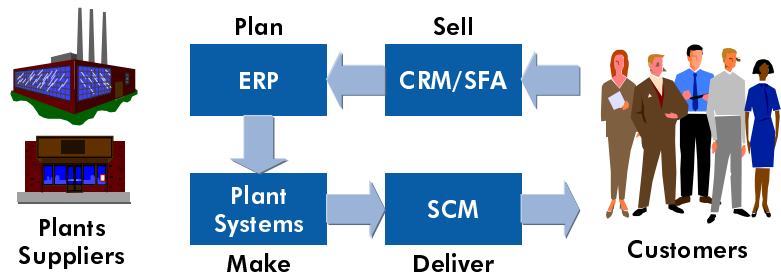
Recognition that no one application, system, or platform can meet all the requirements of a modern manufacturing enterprise is a fundamental precept behind ARC's emphasis on integration as a means of attaining a unified, optimized enterprise. Even the highly successful Digital Manufacturing initiatives in some discrete manufacturing industries, which employ design engineering environments as cost-saving common end-to-end platforms for product design and process configuration, see integration with both enterprise and automation systems as their next step.

While no one platform can meet the needs of the entire enterprise, nor can any single supplier.

While no one platform can meet the needs of the entire enterprise, nor can any single supplier. In recognition of that reality even the most dominant players in all facets of manufacturing automation have formalized partnering programs to plug their functional gaps.

Enterprise Systems Must Reflect eBusiness Philosophy

Over the past decade or so organizations have increasingly focused on managing and optimizing cross-functional business practices at the enterprise level. In response, application software suppliers introduced enterprise software suites, of which Enterprise Resource Planning (ERP) is the broadest example. Other examples of enterprise applications include Supply Chain Planning and Execution, Enterprise Production Systems (EPS), and Enterprise Asset Management (EAM/CMMS).



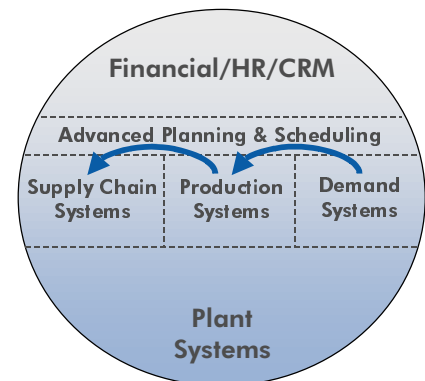
Today's ERP Systems Contain Too Much Inertia

In spite of the monumental efforts of both suppliers and users, enterprise systems have fallen largely short of expectations. Lack of integration with design, plant floor, and other systems is fueling a double-digit shortfall in ROI for enterprise systems relative to expected benefits.

ERP systems as they stand now contain too much inertia and are too slow to respond, two highly undesirable characteristics in the eBusiness era of customer responsiveness. These sophisticated, transaction-based systems typically take several years to install and are inherently slow to change. In the eBusiness era, the lack of integration between ERP and plant systems will make it difficult if not impossible to tell customers when their orders will be shipped.

Most enterprise systems are a portfolio of loosely connected modules or applications. This leaves users with the highly resource-consuming task of integrating incremental modules, such as financials or distribution, as well as coupling ERP with other enterprise applications. Enterprise software suppliers themselves have had to devote a large portion of their resources to providing and updating basic interfaces with other systems. Given this landscape, it's no surprise that Enterprise Application Integration (EAI) is one of the fastest-growing segments within the enterprise space.

Manufacturers preparing to compete in the eBusiness era need to become production-centric, not ERP-centric. Rather than use the

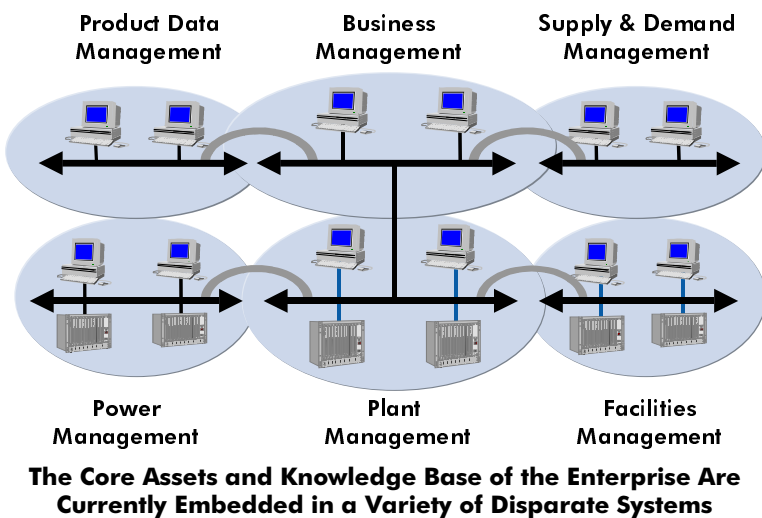


Dynamic Production Scheduling & Optimization Are Key Tools for the eBusiness Era

ERP system for production planning, manufacturers need to separate production planning from their ERP systems and adopt separate, real-time, production scheduling that is more suitable for competition in the eBusiness era.

Enterprise Systems Are a Key Repository for Corporate Assets

A key task requiring integration of enterprise systems is the ability to store, manage, and make available standard product and process models, such as recipes, that represent core assets of the company. Using the corporate enterprise system as the repository for product, process, and other data reduces



plant-by-plant duplication and enables standardization throughout the global entity. This standardization in turn leads to lower cost of production, improved quality, and typically faster turnaround. It also ensures that improvements are captured and available to the global enterprise. This last feature is important in light of the continuous product and process improvement that accompanies make-to-order manufacturing.

Management of batch recipes illustrates the necessity of this capability. If recipes are not portable, but instead buried deep within an individual plant's control system, then orders must be filled by specific plants. This severely limits the company's opportunity to transfer production to a more specialized or lower cost plant that may represent a more optimal approach. This portability through integration is also necessary to rapidly deploy new products and facilities throughout the global enterprise.

Enterprise systems must be tightly integrated with design engineering and plant systems, plus supply chain and demand management, to enable executives and empowered employees to respond with agility to changes in the business environment. Without this integration, it is impossible for a manager to make optimal decisions from the perspective of the corporation as a whole.

Integration with Design Systems Is Already Underway

Integration of enterprise systems with design engineering environments, particularly Product Data Management (PDM), can take many forms. One approach is to incorporate PDM as a module in ERP systems, the SAP approach, to the current trend toward alliances between enterprise and design engineering software suppliers. For example, software supplier MatrixOne just announced plans to integrate its web-based supply chain product development solutions with the SDRC I-DEAS Master Series mechanical CAD system used by Ford Motor and other discrete manufacturers.

The geometry contained in PDM data vaults currently necessitates that the databases remain largely separate. Integration of design and enterprise applications currently relies instead on custom data interfaces, as in the case of SAP's application-specific BAPI's, or standard web browsers. The MatrixOne-SDRC alliance is a recent example of using standard web browsers to access and manage design information via the enterprise application.

Plant Floor Data Types Represent Another Integration Challenge

Coordination of advanced business functions such as enterprise, plant floor, scheduling, and optimization with plant floor activities is not an easy task given the differences between the types of systems. The business system is more transaction oriented, working in time frames defined in minutes, hours, days, weeks, and even months, while the real-time control environment is typified by a large number of often unique processes, equipment, and systems that must react in milliseconds. Differences in data types and availability of enterprise systems, which require periodic maintenance, often drive users to an intermediate database between an enterprise system and the controls layer.

Plant floor integration dilemmas will be compounded as the intelligence of plant floor devices continues to increase exponentially. This will also be true as Windows CE and Java-based embedded systems proliferate in the factory. Data buried in all of these devices will be valuable for decision-making in numerous areas such as process optimization, maintenance, quality, etc. The constant stream of data generated by these smart

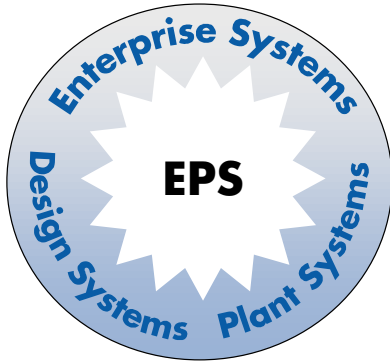
Gap	Business Systems	Plant Systems
Time	Months, weeks, days, hours	Seconds, milliseconds
Information	Transaction processing	Real-time, event-based
Execution	Planning & scheduling oriented	Control & engineering oriented
Cultural	Business processes	Chemical processes

Numerous Differences Exist Between Business & Plant Systems

devices and embedded systems must be managed and leveraged within the unified enterprise.

Enterprise Production Systems Can Help Unification

Enterprise Production Systems, or EPS, is playing an increasingly prominent role as a means of integrating enterprise systems with plant floor systems. EPS provides data handling functionality in areas such as process modeling and manufacturing execution, and, in the spirit of the Unified Enterprise Model, it is a tool that can be used to plan, control, and optimize plant operations.



**Enterprise Production Systems Can
Integrate Data Throughout the Enterprise**

Some EPS software provides a middleware-like integration capability through a plug-in framework that can be used to interface to other manufacturing software packages. This integration functionality is an important tool in a unified enterprise strategy and is often the basis for cost-justifying EPS purchases.

Design Integration Efforts Must Extend to the Plant Floor

In recent years automotive, aerospace, and other design engineering-driven industries have spent considerable energy establishing the integrated design engineering environments that typify Digital Manufacturing. Digital Manufacturing techniques, which first gained prominence in the aerospace industry on projects such as the Boeing 777 jetliner, enable concurrent computer-based design, simulation, and management of engineering product data and its associated manufacturing processes. Software integration is the consistent thread in these initiatives, which typically rely upon a common design engineering platform as their integration mechanism.

Chrysler's Digital Manufacturing Production System (DMAPS) uses the design engineering environment as a common end-to-end digital pipeline for data ranging from a 100% digitized depiction of a product to the automated assembly process required to manufacture it. As detailed at last year's ARC Advisory Group Automation Strategies Forum by Frank Ewasyshyn, Chrysler's Vice President of Advance Manufacturing Engineering, these digital

integration strategies enable numerous cost-savings. For example, by simulating both products and their manufacturing processes the company is able to eliminate the need for extensive prototyping. In the 1998 model year this approach saved Chrysler \$80 million and 8 months of development time on one vehicle platform alone.

Digital Manufacturing initiatives based on common design engineering platforms have yielded tremendous returns.

General Motors announced design integration plans of its own in the fall of last year. Familiar drivers behind this decision included the desire to achieve cost savings through decreased reliance on physical prototypes during the development and validation phases, reduced engineering changes, and shorter lead times during pre-production part & tooling phases. Number two automaker Ford Motor Company's digital infrastructure, C3P, is based on CAD/CAM/CAE software from SDRC. Visteon, Ford's automotive parts enterprise, announced its own plans to implement SDRC technology in 1998.

Automotive manufacturers have already extended their digital manufacturing infrastructures as a means of integrating their supplier base. Ford Motor Company, for example, has worked with SDRC to deliver pre-configured "solution seats" comprising both the software and training required to get authorized suppliers on board the Ford C3P infrastructure. Chrysler, on the other hand, requires architectural design firms to employ CATIA-based plant design software when designing new facilities.

Process Industries Pursue Design Integration

Process manufacturers are now beginning to pursue their own version of design integration in the form of integrated process and plant design. AspenTech, for example, has developed a relationship with Intergraph that integrates AspenTech's process design modeling expertise with Intergraph's prowess in plant design to form a product suite known as SmartSolutions for Front End Engineering Design (FEED). Similar to the common platform approach employed in discrete Digital Manufacturing techniques, the companies will use Aspen's Zyqad as a database infrastructure to link the design databases together. Process design software company Hyprotech has also jumped on the integration bandwagon by establishing an alliance with 3D process plant design software provider Cadcentre.

Process manufacturers are now beginning to pursue their own version of design integration in the form of integrated process and plant design.

Design Integration Efforts Must Extend Beyond Enterprise Apps

Integration of design systems with the rest of the enterprise will yield numerous advantages from an enterprise optimization perspective. In the spirit of ARC's Plan-Control-Optimize approach, discrete manufacturers are already using their digital pipelines to achieve continuous production improvement and provide continuous feedback to manufacturing engineering for input on subsequent programs. Integration with enterprise applications will allow manufacturers to improve time to market, inventory carrying costs, and other key business metrics as well as achieve potentially more efficient management of design approvals, changes, controlled documents, and other specifications.

	Enterprise	Design	Plant Floor
Culture	Business	Engineering	Manufacturing
Staff Training	Computers	Engineering	Manufacturing
Processes	Financial	Design	Machines
Data Types	Transactions	Geometry, documents	Real-time, event-driven
Integration Schemes	Common Database, Middleware, or Component-based	Common Database	Networks, moving towards component-based
Typical Computing Platform	UNIX & NT	UNIX, NT	Proprietary, UNIX, NT
Primary Users	Management	Engineers	Operators

Fundamental Differences Between Design, Enterprise, and Automation Environments Create Integration Hurdles

Extending the digital manufacturing infrastructure into the automation layer represents the next major integration challenge in this segment. Plant floor automation is subject to the same mandates driving the boom behind digital manufacturing, but to date this area represents another frontier on the path to the truly unified enterprise. Some design engineering-oriented manufacturers are taking the first steps toward addressing this rift by working with their plant floor automation suppliers in order to push the digital pipeline down even further and use it to generate control programs for plant floor systems.

Plant Systems Hold a Wealth of Information

In the long term view of a production-centric enterprise the value added during manufacturing is pivotal in determining whether the business is profitable or whether it fails. The data available in plant systems inherently contains patterns and relationships that can be used to optimize the value-add process. Access to this data and its derivations are critical to the business systems responsible for efficiently converting this added value into profit for the enterprise.

Plant systems include a myriad of sensors, devices, control systems, machine controls and supervisory software applications woven together with mostly proprietary networks, custom bridges, and device specific drivers. This is the plant systems legacy. This tier has been the focus of significant integration efforts in recent years, but the preponderance of proprietary, dedicated automation equipment makes it difficult to integrate the plant floor environment.

The data available in plant systems contains patterns and relationships that can be used to optimize the value-process.

Extend Enterprise & Design Infrastructures to Include Plant Systems

Extending the enterprise infrastructure to the automation layer is a major step on the path to enterprise unification. On the design side, some manufacturers are taking the first steps toward addressing the rift between design and automation systems by working with their plant floor automation suppliers to push the digital pipeline down even further and use it to generate control programs for plant floor systems. Efforts to integrate business systems currently come in a variety of flavors, with integration of ERP and plant floor automation systems the most prominent. ERP's long tentacles are also starting to extend to the plant floor.

Network Unification and Open Data Access Are Key

Many plants have thoughtfully evolved their automation schema based on core technology and supplier selections that represent the best choice for their situation. Therefore there is a foundation, albeit expensive and complex, for evolving into open and straightforward access to the plant data.

This evolution is commencing in four areas, with network unification over Ethernet as one. The others deal with open information access and include Microsoft's DCOM common component technology and the COM-based manufacturing-specific OPC (OLE for Process Control) interface. Fieldbus at the control network and field device levels is also in this category due to its use of both object and communications technology.

Plan, Control, and Optimize on a Global Basis

Success in the eBusiness era will in part be driven by the ability to optimize use of global resources – not one time or periodically, but continuously and instantaneously. To achieve true customer responsiveness and resource optimization, businesses must make maximum use of data and turn it into



The Plan, Control, Optimize Model Reflects the Need for Continuous Optimization of All Activities

useful information. In essence, all enterprise activities must in some way be planned, controlled, and optimized as distributed data that is easily accessible to all applications is fed back to fine-tune the process. The Plan, Control and Optimize (PCO) model offers a simplified process to optimize all enterprise and plant applications.

PCO can and should be applied to every phase of plant and enterprise operation. Enterprise, design, and plant systems must be continuously optimized to ensure agility, maximize profitability, and guarantee return on investment.

Efficient production networks must be able to quickly engineer and introduce new products or processes because continuous optimization will require subtle and complex incremental changes. World class value chain networks will incorporate the PCO methodology to continuously optimize the process design and new product introduction activities.

The Plan concept includes new product plans, long-range schedules, inventory data, current and recent production performance, and maintenance plans. Plans at the enterprise level may provide for partial production, transportation, storage, and final production at optimal sites based on market

conditions, contract requirements, tariff considerations, and plant utilization to achieve the most competitive product. As the model implies, the Plan concept uses input from the Optimize activities to fine-tune the process to the good of the enterprise.

Control involves implementing the continually-optimized production plan and producing product according to the directives inherent to the manufacturing process design. Monitoring, reporting, and maintenance functions related to production, measurements, data, and production and control equipment is also a function of the control domain. This data is then incorporated into the Optimization phase.

Optimization is the ongoing process of gathering and analyzing production data, assessing overall operations performance, and refining the operation. A related aspect is that of optimizing asset utilization based on optimizing maintenance of plant equipment. Sophisticated CMMS and Predictive Maintenance systems are of limited value if they cannot be effectively coordinated with the production schedules.

External factors, such as market conditions and competitive actions, are also incorporated in the Optimization activities. The output of this stage is used in both the Plan and Control activities, and often results in modifications to the plant or process based on production performance results.

Look to standardized optimization techniques to assist you with this task. You may choose a simple algorithm, a linear programming technique, or possibly a sophisticated constraints-based model. All of these possibilities recognize the need to go beyond just plan and control activities and into optimization.

eBusiness Technology Enablers

Market energy in enterprise, design, plant floor, and other key segments is highly focused on providing the tools and methodologies necessary to integrate these systems into a unified enterprise. In today's market, the integration emphasis lies at the interfaces, particularly user interfaces and data exchange mechanisms. Web browsers, component technology, middleware, and technologies such as Microsoft's XML/BizTalk are the current darlings in this realm.

Web Browsers Are the Window on the Enterprise

Similar to the "window on the process" capability provided by HMI software, Web browsers are the window on the enterprise.

In the 1980s and early 1990s, desire to have a software-based window on the manufacturing process spawned the market for Human-Machine-Interface (HMI) software that could provide this capability. In the late 1990s and into the next century we see this concept extending from a window on the process to a window on the entire enterprise. Standard web browsers such as Microsoft's Internet Explorer and Netscape's Navigator are already being employed to this end, providing a standard user interface that is increasingly common to automated systems throughout the enterprise. Internet technologies in general facilitate the global information distribution that is crucial to the unified enterprise.

Use of standard browser technology is a boon to manufacturers and a conundrum to software suppliers who traditionally relied on proprietary interfaces to lock in the customer. Standard browsers can be freely downloaded over the Internet, although some software suppliers ship their own versions with their applications. Leveraging web browser technology makes integration feasible for all plants, regardless of size. Facilities around the world can easily download standard or customized browsers from the Internet/Intranet and then use them to access orders, production schedules, common process models and other information via the corporate Intranet. Standard browsers are intuitive and easy to use, invoke little to no incremental training costs, and make it easier to shift personnel between systems.

Component Technology Is Key to Integration

Object-oriented technology and components play an important role in supporting the distributed architecture that Internet technology provides. A component-based architecture allows you to develop and deploy reusable objects and component libraries that save development time and resources. Object technologies enable you to achieve efficient models of the processes under control and make incremental improvements without having to reconfigure the entire system.

Benefits of Component Technology

1. Easy to configure & maintain
2. Reusable
3. Modular
4. Easily integrated across different applications and platforms
5. Knowledge of internal operation not required
6. Objects model real-life devices

Standard mechanisms for exchanging components between applications are the key to enterprise integration, so the question of which object exchange mechanism to use takes on huge significance. The ongoing battle between proponents of Microsoft's COM/DCOM and Java/CORBA is evidence of

this. Essentially invisible to users, component exchange mechanisms such as DCOM and CORBA specify standard interfaces that enable integration of diverse software and applications without the need for customized drivers or interfaces. Even suppliers such as SAP who previously relied on individual APIs to interface to third party software applications are realizing the benefits of the component approach, in their case in the form of the DCOM Component Connector, as a standard integration methodology.

A common platform infrastructure is a key element of Microsoft's strategy of promoting interoperability between applications. COM is one of the strategic vehicles that provides that interoperability in Microsoft's Distributed Internet Applications (DNA) architecture. The COM-based OPC (OLE for Process Control) specification embodied in Microsoft's DNA for Manufacturing is winning broad-based support for use in communicating with both plant floor devices and, increasingly, enterprise systems. Microsoft is positioning DNA-M as an application integration infrastructure for use in manufacturing.

XML Is Gaining Momentum

XML, or eXtensible Markup Language, is gaining popularity as an integration mechanism for web-based applications. XML complements the familiar HTML, used to display web-based data, by acting as the delivery mechanism for conveying data between loosely-coupled applications on the Internet. For example, a plant floor application or script written in Visual Basic can write XML data to be viewed via a browser-based interface such as Netscape Navigator or Internet Explorer.

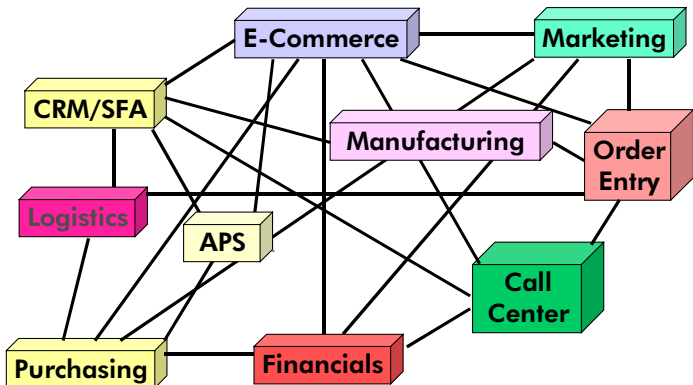
HTML is used to display static data over the Internet while XML is used to deliver dynamic data.

Software developers are already using XML as a standard means for delivering data between Internet-based applications. The non-profit Open Applications Group (OAG), formed by many of the leading enterprise software vendors, has released a full set of XML Document Type Definite (DTD) files that define interoperability APIs for Financials, Human Resources, Manufacturing, Logistics, and Supply Chain components.

XML & BizTalk Are Key to Microsoft's Strategy

Microsoft is incorporating XML as a key element of its DNA strategy for integrating web-based applications. Taking its place alongside COM as one of the company's key vehicles for application interoperability, XML and the associated BizTalk are squarely focused on the eCommerce arena.

Microsoft's recently announced BizTalk framework for eBusiness takes the concept a step further by providing a common XML-based software vocabulary designed to make it easier to publish content on the Internet. BizTalk defines XML-based business schemas in a number of enterprise arenas. Microsoft and SAP, for example, have already begun defining schemas for exchanging product catalog information and business documents between trading partners. BizTalk's library of standard business processes promises



Most Companies Today Employ Expensive Point-to-Point Integration Solutions.

to make it easier to conduct transactions, integrate applications, and exchange data. A BizTalk Server that provides BizTalk tools and services is promised shortly after release of the Windows 2000 operating system.

XML and BizTalk represent a loosely-coupled, non real-time scenario likely to be employed when serving plant floor or other data up to supervisory applications or when exchanging data between enterprise-level applications. While the jury is still out on

the BizTalk initiative, many of whose supporting products are still in development, it is vitally important to a company who was beaten to the important eBusiness table by competitors such as Sun and IBM.

SunConnect & IBM NCF Frameworks Target eBusiness

While Microsoft's BizTalk receives all the press, other competitors continue to market the eBusiness solutions they have offered for some time. Sun Microsystems and IBM both offer eBusiness frameworks. Neither was designed specifically for the manufacturing marketplace, but Sun is now turning their attention to this space in the form of their manufacturing.com initiative.

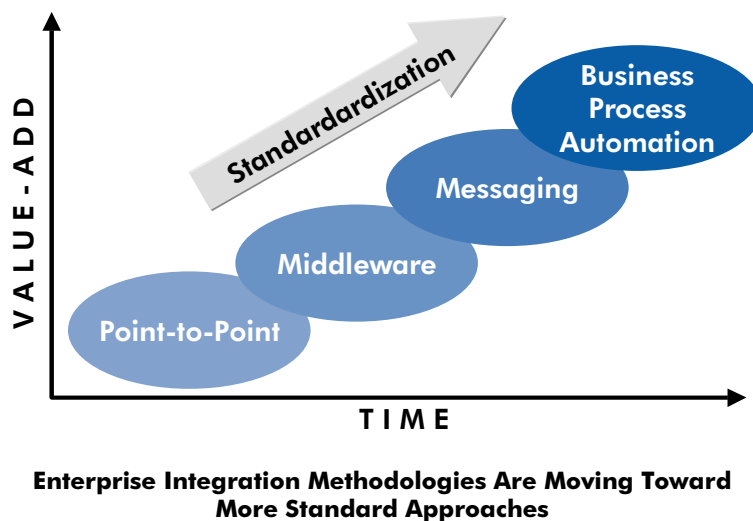
The Java-based SunConnect integration framework is designed to make it easier to deliver web-based information throughout the enterprise, including to customers, the distribution channel, and the supply chain. The platform-independent SunConnect model also provides highly transactional applications using Java and CORBA, which in turn enables tight integration with other platforms and environments.

Both SunConnect and IBM's NCF are based on open standards, specifically Enterprise JavaBeans (EJB) and CORBA. NCF runs on IBM platforms and

relies on EJB as a port to the Internet, but its runtime environment is tightly integrated with the IBM platform. NCF is not yet ported to Windows NT, but the company has plans for that migration.

Middleware Is an Interim Solution

Historically, manufacturers have relied on custom, point-to-point interfaces to link different applications. Over the past few years companies have started using middleware applications such as Enterprise Link from HP and BusinessBus from Compaq for this purpose. Unlike point to point solutions, the middleware approach can integrate a wide range of plant floor systems regardless of supplier, architecture or protocol, with enterprise applications. Middleware supports event handling, messaging, workflow transactions, systems management, and a form of database management. It synthesizes events on the plant floor as well as events coming from the ERP system.



The advantage of middleware is that it provides the integration necessary to interface plant data collection, mobile data collection, quality management systems, and other functions. However, middleware products need additional integration services to deliver a complete solution. According to users, the amount of supplier support required and support of chosen systems is what differentiates middleware products in their minds.

Although middleware-based integration solutions have been an appropriate choice to date, the messaging-oriented approach employed by Enterprise Application Integration (EAI) providers is gaining in popularity. ARC believes that this migration path will ultimately lead to business process automation and component-based integration as the integration methodolo-

gies of choice. Unlike the middleware platforms, component-based data exchange mechanisms are application independent. Support for the component approach continues to proliferate throughout industry. Once it is proven and secure, ARC believes this approach will be the integration technology of the future.

Find the Right Partners

In ARC's view, it is difficult if not impossible for manufacturers to keep pace with the rate of technological change. This is true even for suppliers, many of whom are encountering difficulty as they try to keep pace with the rate of technological innovation. Coupled with the emphasis on core competencies and "what business are we in," both suppliers and manufacturers are increasingly turning to partners to help them successfully implement new technologies.

A sound partnering relationship can be a key means of aligning your operations with the Unified Enterprise Model and the enabling integration it

Find The Best-in-Class Partners Who:

- Have experience implementing successful technology solutions
- Are committed to open systems
- Have worldwide support capabilities
- Understand your needs and objectives
- Have the expertise and resources necessary to help you achieve your objectives

embodies. In the most successful cases, the partner's workforce acts as an extension of your staff. Unlike project-based alliances that expire when the task is complete, these partnership relationships entail a deeper level of commitment and shared risk/reward from all involved parties. In return, the rewards can be tremendous.

The spectrum of partnership possibilities is expanding as manufacturers pursue the types of alliances that make the most sense for them. At one end lies the \$100 million-plus agreements by Honeywell, Siemens, and ABB that span everything from equipment purchases to operation and maintenance of production facilities. At the other end lies smaller agreements for tasks such as motor maintenance. Another partnership axis is also emerging as technology providers like Microsoft inks more and more corporate agreements.

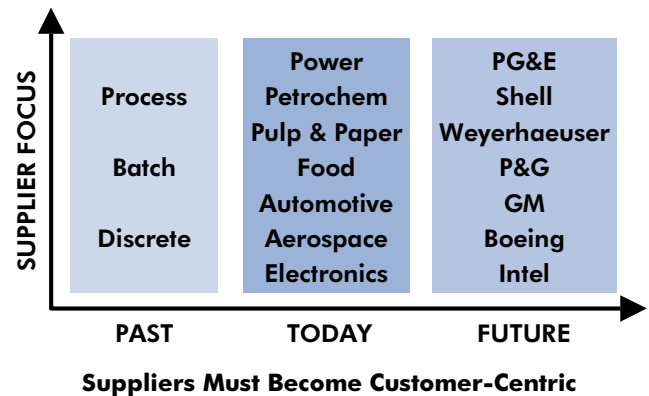
Match the Partner to the Requirements

It is vitally important to pursue partners who have successful experiences implementing technology solutions in the current and anticipated areas

where you would like to form alliances. Technologically, it is best to match up with partners who have both the right skill sets for your task and are committed to open systems. This open systems commitment is crucial if you look back at the rate of change experienced in only the recent past. After all, it was only a few short years ago that the Internet was an unexploited technology reliant on open systems to achieve its full potential.

Since the unified enterprise and the systems within it represent the means of achieving business objectives, it is imperative that your partners have a sound understanding of your business – and you theirs. This includes an understanding of the drivers behind both of your businesses, as well as a common understanding of each other's needs and objectives, where they come together, and where they diverge. Worldwide support capabilities are also necessary for manufacturers pursuing global unification.

Your partners form part of your unified enterprise, and as a customer you are part of theirs. It is therefore vitally important to take the time to select the right one for your operations and then move forward toward your commonly understood business objectives.



Enterprise Integration Is Worth the Effort

Enterprise integration will not be an easy task for any company. This type of wholesale integration is an ambitious undertaking that, like ERP implementations, could take several years and significant resources. Unlike ERP implementations, however, enterprise integration effectively positions a company for competition in the eBusiness era and enables it to respond to whatever business, competitive, or technological challenges may emerge.

Achieving management buy-in for an enterprise integration initiative will be a challenge for most manufacturers, as will managing cultural change. Technical challenges will also likely emerge as a result of the nature of the integration technology used and its applicability to existing systems. With integration as the current focus in the

Enterprise Integration Challenges

1. Achieving management buy-in
2. Lack of technical & financial resources
3. Technological difficulties
4. Diversity of applications
5. Cultural differences among various disciplines
6. Eliminating rigidity from integration approaches

manufacturing software world, integration-enabling technologies will represent a moving target in the near future. Ease of integrating a diverse stable of legacy applications will be another technological wildcard, particularly with older applications that are not object-based. Be sure to guard against information overload at the user level by taking a thoughtful, measured approach to ensuring that the right information is presented at the right time and in the right format.

Over the years our industry has seen numerous integration approaches that introduced tremendous rigidity, so when evaluating integration schemes it is important to ensure that your chosen techniques and methodologies are flexible enough to enable you to capitalize on future innovations. Standard component exchange mechanisms and other technologies will hopefully thwart this possibility in today's operations, but manufacturers must be vigilant about the flexibility of their integration schemes. This characteristic above all will position companies to absorb the as-yet-unknown technological evolutions of the next millennium.

Preparing the Way to Enterprise Integration

Manufacturers preparing a enterprise integration strategy must form and convey a sound understanding of the business issues involved. A sound,

Steps to Enterprise Integration

1. Understand the business issues
2. Build a solid business case
3. Prepare an Enterprise Integration plan
4. Get CEO's commitment
5. Get buy-in from all stakeholders
6. Prepare an IT technology policy for future investments that reflects unification strategy
7. Conduct comprehensive employee training
8. Work with the right partners

logical business case that appeals to the organization's objectives is necessary to sell the concept to management. Ability to get the CEO's commitment and buy-in from all stakeholders will significantly smooth the transition path, as will a detailed integration plan and an IT technology policy that institutionalizes in-house standards for use in future projects.

The path to enterprise integration, while technologically driven, contains a significant human element as well. Along with the need to manage

culture change, manufacturers must engage their partners and conduct comprehensive training so all involved parties share a common understanding. While these and the other steps involved require significant time and resources, the payoff from enterprise integration will return your investment several times over.

Analysts: Chantal Polsonetti, Steve Banker, Steve Clouter, Marcus Goncalves,
Greg Gorbach, Dick Hill, Vic Muschiano, Dave Woll

Editor: Andy Chatha

Acronym Reference: For a complete list of industry acronyms, refer to our web page at http://www.arcweb.com/arcsite/About_ARC/aboutARC.asp

API	Application Program Interface	HMI	Human Machine Interface
APS	Advanced Planning & Scheduling	IA	Industrial Automation
BPR	Business Process Reengineering	IT	Information Technology
CAD	Computer Aided Design	MRP	Materials Resource Planning
CCM	Customer Centric Manufacturing	OCS	Open Control System
CIO	Chief Information Officer	OLE	Object Linking & Embedding
CEMS	Continuous Emissions Monitoring System	OPC	OLE for Process Control
CIM	Computer Integrated Manufacturing	PAS	Process Automation System
CNC	Computer Numeric Control	PCM	Production-Centric Manufacturing
CORBA	Common Object Request Broker Architecture	PLC	Programmable Logic Controller
CRM	Customer Relationship Management	ROA	Return on Assets
DCOM	Distributed Component Object Model	ROI	Return on Investment
DNA	Distributed interNet Architecture	SCE	Supply Chain Execution
EAI	Enterprise Application Integration	SCP	Supply Chain Planning
EAM	Enterprise Asset Management	SFA	Sales Force Automation
EDI	Electronic Data Interchange	TCO	Total Cost of Ownership
EPS	Enterprise Production System	VAR	Value Added Reseller
		WMS	Warehouse Management System
		XML	eXtensible Markup Language
		Y2K	Year 2000

ARC is a leading international market analysis and consulting firm focused exclusively on enterprise applications and industrial automation. ARC provides strategic planning and technology assessment services to suppliers, solution providers, and manufacturing companies around the world. Founded in 1986, ARC has a proven reputation for delivering high quality, in-depth, and accurate information to its clients.

ARC Strategies is published monthly by ARC. All information in this report is proprietary to and copyrighted by ARC. No part of it may be reproduced without prior permission from ARC.

You can take advantage of ARC's extensive ongoing research plus experience of our staff members through our Advisory Services. ARC's Advisory Services are specifically designed for corporate executives responsible for developing automation strategies and enterprise applications for their organizations. For subscription information, please call, fax, or write to:

ARC Advisory Group, Three Allied Drive, Dedham, MA 02026 USA
Tel: 781-471-1000, Fax: 781-471-1100, Email: info@ARCweb.com
Visit our web page at ARCweb.com

ARC San Francisco, CA
650-373-2110

ARC Jacksonville, FL
904-273-4393

ARC Pittsburgh, PA
724-935-2442

ARC U.K.
+44 (0)1223-257744

ARC Germany
+49-211-3003-416

ARC Japan
+81-42-991-1685

ARC Australia
+61-2-4998-8196

ARC India
+91-80-530-5810

ARC Argentina
+54-1-639-7001



ARC Advisory Group

Three Allied Drive • Dedham, MA 02026 USA

Tel 781-471-1000 • Fax 781-471-1100 • Email info@ARCweb.com

www.ARCweb.com