



# **The integrated chemical enterprise**

**Forging the link between  
business and process**

*'One trend we've been seeing clearly for some time now is that the chemical plant has very much changed its position. It used to stand by itself [but now] is part of the overall supply chain, and Step 1 in state-of-the-art is that all of the plants in a chemical enterprise will be connected. Over the next five years you will see two dynamics driving the shape of the chemical plant, and both of these relate to integration.'*

*—SAP's Udo Edelmann, former global director of chemical and pharmaceutical industries, from CP's December '98 cover story on "Imagining the plant of the future."*

In December '98, *Chemical Processing* peered into its crystal ball, hoping for a glimpse of things to come in the year 2003. As the vapors parted in the orb, the editors divined signs that integration of business and process systems would bring quantum improvement to operating performance and would enhance competitive advantage.

Now, a year later, CP examines the industry's progress toward that vision of integration.

And the staff also turns its gaze to what may happen in the year 2000 as chemical companies endeavor to recoup the \$20 billion a year they've been spending on Enterprise Resource Planning (ERP) systems, which in most cases have fallen short of expectations.

"While integrating the plant and business systems is the current hype," said Roddey Martin of AMR Research, "most manufacturers are using ad hoc,

point-to-point integration to hook plant systems into the business."

So what integration approaches will allow companies to recoup their sizable investments in ERP systems? And how will integration affect you and your work?

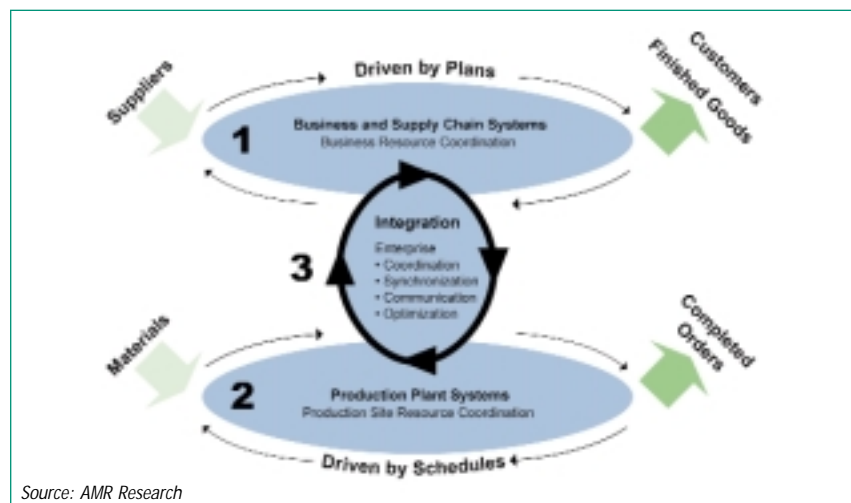
### Linking business and process

But, wait. What is "integration" anyway?

Integration coordinates the business and supply chain systems with production plant systems (Fig. 1). Integration improves coordination, synchronization, communication and optimization between the transaction-based business systems driven by plans and the time-based plant production and control systems driven by schedules.

AMR's Martin identifies eight styles of integration (Fig. 2). In Style 8, the ultimate goal for any of the process industries, the process model of the

Fig. 1. Integration coordinates dissimilar systems



plant is tightly integrated with the business model. But that does not exist today. Instead, Styles 4 and 5 dominate the chemical industry—Style 4 in continuous processes and Style 5 in batch processes.

In the petrochemical and chemical sectors, Style 4—“Process data collection and plant-floor communication”—uses Process Information Management Systems (PIMS) as the nucleus of the Manufacturing Execution Systems (MES).

In the pharmaceutical and other batch-oriented sectors, Style 5, “Functional data collection and coordination,” uses packaged MES applications to drive functional execution of production orders from ERP using standard operating procedures or batch recipes. Plant data is collected about quality, and material is automatically reported to ERP.

Style 7—“Business & plant coordination”—is a variation of Style 5 but is not necessarily a step up from it. Style 7 is an emerging trend where model-based plant systems, such as MES, are integrated with ERP production requests for tighter real-time connections between the plant and the business.

Style 6, “Production capacity coordination,” is Style 5 taken to a higher level with tighter integration at the scheduling level through an Advance Planning & Scheduling (APS) component. Better integration between the production order process and the production scheduling process ensures that scheduling is more accurate and more current. APS looks at the whole supply chain and tries to optimize it.

Regarding Style 6, AMR’s Leif Erikson observed that “suppliers are selling integrated advanced planning and scheduling modules for scheduling your complete supply chain integrated with your manufacturing processes. But very few people are doing it now. They just don’t have the business bandwidth for doing it yet. They may be sold applications that can do it, but they end up implementing subsets of the main system for supply chain management. Most people today are

in Styles 4 or 5. Some people are at the point of Style 6 but not in a truly integrated sense. The products for Style 7 are relatively new, so nobody is really doing that yet and Style 8 is where we want to be in the future.”

So the fully integrated chemical enterprise of the future, represented by Style 8, uses emerging applications to link the business process model to the MES model to form a common process information structure for plant and business information flow.

Over the next several years many companies will likely replace their ad

hoc integration approaches with Style 8 systems to streamline global business coordination. Globalization and ongoing mergers, acquisitions and divestitures provide additional incentives for standardized integration between plants and enterprise systems.

need plug-and-play components, is an integrated system,” he said. “So in order to get an integrated system you have to follow the upper curve [of Fig. 3]. Ultimately users want to be at the plant model to business model represented by Style 8.”

In a related discussion about AMR’s report called “Creative Destruction Visits the Automation Industry,” Erikson pointed out that “traditional automation” is becoming a commodity business. “As automation suppliers are facing up to the reality of declining revenues,” he said, “the automation vendors must find a way to stand out from the pack. Currently, they overlap

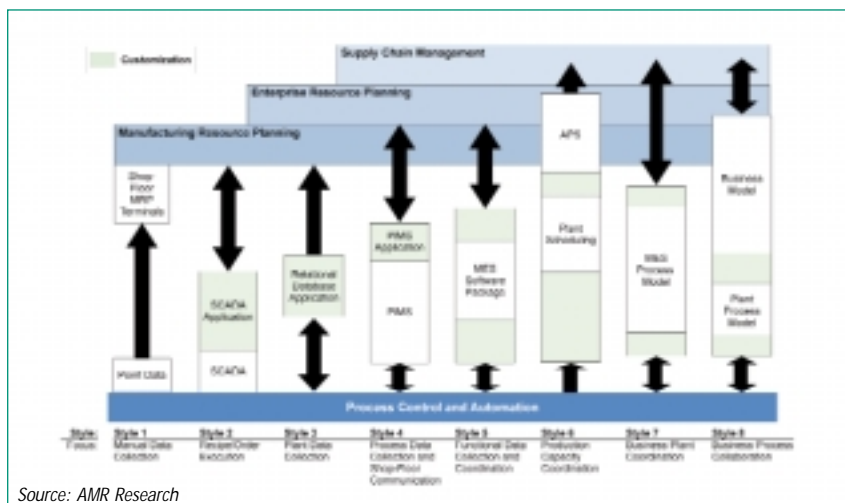
*Some companies are using software that allow input of data directly to the ERP layer, totally bypassing MES.*

So, what technology trends are emerging at the business–plant interface?

### Commodity components

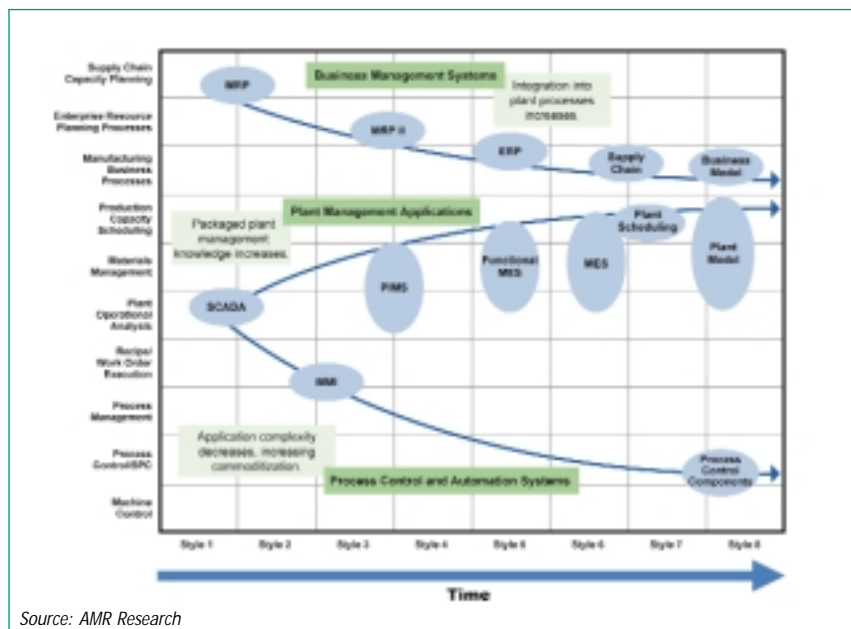
AMR’s Martin said that in the last year “as the push to tighten the connection between the plant and the business gained momentum, companies are realizing that fragmented point-to-point integration of systems spread

Fig. 2. Eight styles of integration



Source: AMR Research

Fig. 3. Technology trends at the business-plant interface



and compete for shrinking markets.” Looking at it another way, Erikson paraphrased his son’s favorite game: “Last one to break away from the pack is out of the manufacturing automation business.”

**Has ERP paid off?**

What would you do if, upon purchasing a house, you discovered that the closing costs were four times the price of the house?

No kidding!

That analogy to ERP investments came up in a roundtable discussion with representatives of the newly formed “Owner/Operators Forum.” One respondent immediately said, “Yes, that’s probably true. But would we do it again? ABSOLUTELY! Because it’s giving us the competitive advantage for the future.”

In CP’s late September advisory board meeting, board member Earl Beaver of Practical Sustainability took a different view. “I don’t think companies do it as a competitive advantage,” he said, “because virtually everyone is going to it. So, you’re not going to have the edge. But if you didn’t do it and everybody else did, it puts you at a competitive disadvantage.”

CP’s board member William Smith,

Eli Lilly’s executive director of global manufacturing, said he hasn’t lost faith. “If you think you’re installing a software system,” he said, “it’s going to be a real shock and it’s going to be very expensive. If you think you’re figuring out a different way to run the business, then you have a different mind set. For example, our company is going to go to a global common chart of accounts which doesn’t exist today in our company. The problem isn’t how to start up the software system—it’s how are you going to get 162 affiliates to agree to a common global chart of

accounts to run the financial system? That’s where most of the money is being spent. Actually starting up SAP is a small piece of it after you’ve had everybody agree to it—the same with purchasing systems and the rest of it. I don’t think, at this point, we’ve felt it’s costing us two or three or four times what we thought. It is an expensive installation but we still think we have a positive business case.”

**ERP movers and shakers**

A “typical” chemical company with annual sales exceeding \$1 billion invests about 3% of total revenues in IT, and the enterprise applications budget is about 25% of that, said Hal Stebbins, solutions executive for IBM’s Global Chemical and Petroleum Industry.

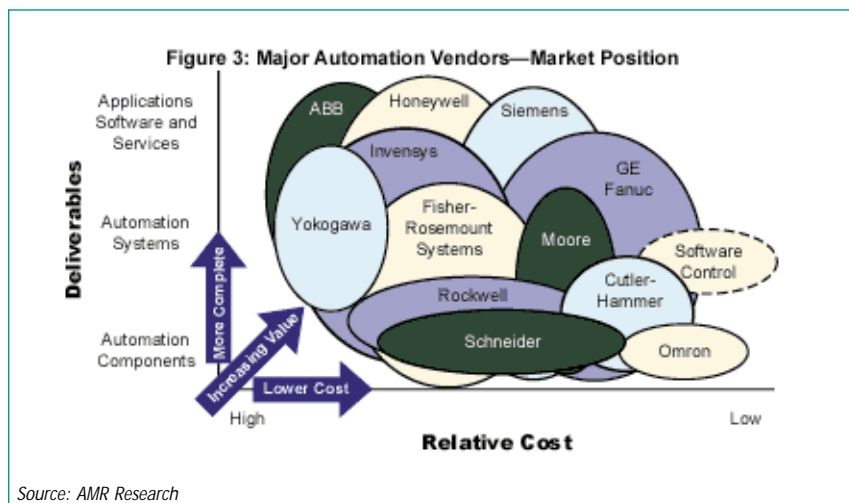
Projecting from those figures, a \$5 billion firm would spend \$150 million on IT and \$40 million for enterprise applications. Of that \$40 million, approximately \$16 million would be allocated to ERP systems.

Stebbins said he sees the ERP market growing to \$50 billion in the year 2000, encompassing a broad base of manufacturing in addition to chemicals and petroleum.

Stebbins pointed to seven tangible benefits of ERP from a survey of 62 companies by Benchmarking Partners:

- 1. Improved visibility of information, 57%;

Fig. 4. Major automation vendors—market position



- 2. Better financial management, 55%;
- 3. Integration, 46%;
- 4. Improved processes, 39%;
- 5. Increased customer responsiveness, 33%;
- 6. Improved inventory, 32%;
- 7. Headcount reductions, 32%.

Stebbins concurred with the vision of a more fully integrated chemical enterprise in the future and pinpointed four business challenges:

- To fully leverage the extended supply-chain management to the production operations;
- To optimize operating margin in manufacturing through yields,

to shake out?

While SAP has the lion's share of the market (about 40%), Stebbins pointed to the AMR '99 MARS Report for a broad perspective of the market (Table 1).

### Emerging trends

The dominant chemical industry ERP provider is SAP. Fig. 5 illustrates how SAP's R/3 system includes ERP and MES. The interface between MES and Control is through products such as MM (materials management), PP-PI (production planning—process industries), PFS (process flow scheduler), PM (plant maintenance) or QM (quality management). Those products

*In the year 2003, expect fewer people in plants—but more challenging work for those who remain.*

cycle-time, on-spec through-out based on business decisions;

- To improve asset management through the synchronization of planning, execution and control;
- To provide enterprise-wide, process-wide visibility of the critical operating information.

So who are the primary ERP players and how is the market likely

are designed with the assumption that MES operations will be in effect because they are in that layer.

Fig. 5 illustrates three layers. The ERP suppliers are driving functionality down into the MES layer. Likewise, the control suppliers are doing the same thing from the bottom up. Many people predict the MES layer will eventually disappear.

Table 1. Industry shares

|            | Chemical and petroleum (%) | Pharmaceutical and biotech (%) |
|------------|----------------------------|--------------------------------|
| SAP        | 43                         | 36                             |
| Oracle     | 11                         |                                |
| PeopleSoft | 6                          | 6                              |
| SSA        | 6                          | 11                             |
| JD Edwards | 5                          | 10                             |
| QAD        |                            | 7                              |
| Others     | 29                         | 30                             |

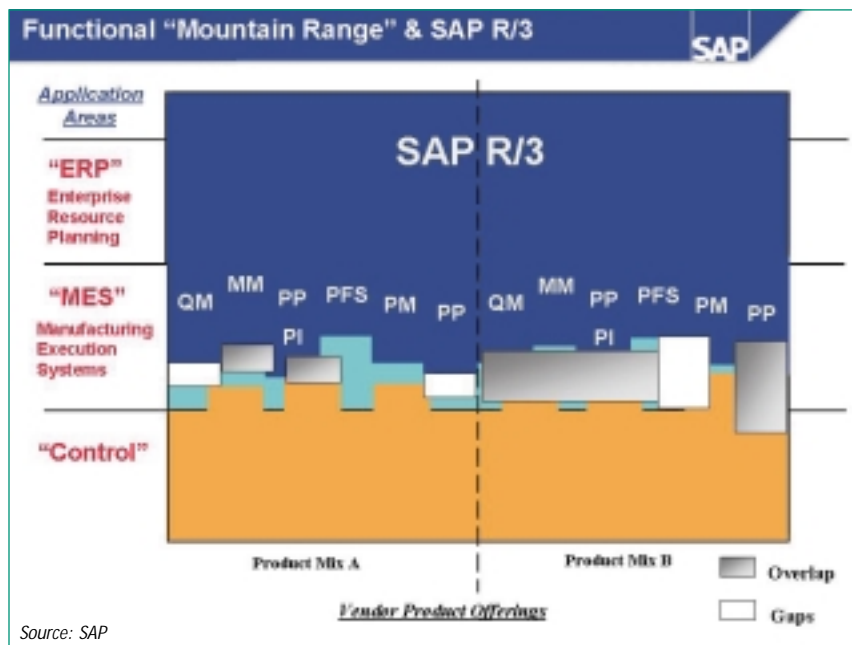
The importance of linking ERP to the plant floor (control room) to leverage the full benefit is captured in a statement by SAP AG's former global director of chemical and pharmaceutical industries, Udo Edelmann, "If you install SAP for traditional ERP functionality but not linking to your plants, you leave about 40% to 60% of the benefits on the table."

Recent and emerging standards will be key to successful integration. All control system suppliers are using Microsoft standards. For example, companies like Fisher-Rosemount Systems and Intellution are using Microsoft standards that allow data input directly to the ERP layer, totally bypassing MES. Unlike those companies that are bypassing MES, companies like Yokogawa are providing the MES layer. Other companies, such as Hewlett Packard and Moore Process Automation Solutions, are using middleware technology to provide plug-in software to integrate to ERP systems.

The OPC Foundation has announced the formation of the OLE for Process Control (OPC) Extensible Markup Language (XML) Working Group. The new group will eventually publish a specification for an XML schema for Microsoft's newly released BizTalk framework. XML will expose the OPC data to any application that supports the BizTalk framework. Incorporating XML in the OPC standard allows applications to access data that has traditionally been isolated in databases in the plant.

Microsoft's DNA (digital network applications) for Manufacturing framework is a roadmap for ISV's, software vendors and customers. It gives them a standardized way to look

Fig. 5. Integration of ERP with control



at how they integrate applications. So OPC allows integration at the control level; DNA helps that integration move up to the ERP system; and Biztalk helps move the integration out to customers and suppliers.

Another emerging trend is the role the Web and e-commerce/e-business will have in the integrated chemical enterprise.

"If you can't integrate to the plant floor [control room]," said Scott Fawcett, Microsoft's manager of global manufacturing and energy industry,

"e-commerce won't work."

### The future of work

Advances brought about by integration aren't always technical. They're also social and cultural. All plants in a company's supply chain will be connected, including global integration with suppliers and customers.

Peering into the crystal ball for the year 2003, Microsoft's Fawcett sees new ways of doing business and performing your work, including:

- Common communications on the

Web;

- e-commerce as the way of doing business;
- Increased use of service companies and outsourcing;
- Smaller gap between supply and demand;
- Fewer people working in the plants—but more challenging and demanding work for those who remain.

*By Peter J. Knox, editor-in-chief and associate publisher*

## Integrating from the bottom up

Joining business and process from the control room to the board room

One way of linking business and process is from the bottom up. Here's a look at some experts' views of integration, mostly in their own words, gathered from phone interviews, trade show speeches and scholarly tracts.

Hewlett Packard, in a white paper called "Putting You in Control," said manufacturers and utilities face accelerating waves of change. The pressure of Y2K compliance is "cleaning" legacy systems, the paper said, noting that Microsoft owns the desktop and is claiming a share of servers. SAP prevails in the rush of ERP implementations, according to the paper, and the Internet brings everyday users unprecedented access to information.

Those thoughts from HP were echoed in a talk with Wendy K. Strauss of the Batch Solutions Business Team at Moore Process Automation Solutions in Spring House, PA. "The

need for integration in chemical production facilities will continue to grow," she said, adding that the first wave of ERP implementation was driven by Y2K and concentrated on financial and accounting functions. "As we move into the new millennium," she said, "more and more companies will start focusing IT projects on plant level activities and control system integration."

Some, like Paul Gruhn of Moore Automation, are maintaining a sense of humor in the face of change. "What? IT controlling safety issues and safety systems? Not in MY plant!" joked Gruhn, who's also co-author of "Safety Shutdown Systems" (ISA Press, 1998). "The idea of a safety system owned or installed by the IT folks is an absolute impossibility," he continued.

Jim Parshall of Eli Lilly Co., co-author of "Applying S88: Batch Control

from a User's Perspective" (ISA Press, 1999, described the conflict this way: "For some reason, engineering and IS/IT always seem to fight like cats and dogs. If your organization is really progressive and you have some form of production execution system, such as an MES software package, the IT folks may very well own that system. Your system may need to talk to their system and vice versa."

In a trade show speech, Tom Archibald, vice president and director of global operations and manufacturing for Rohm and Haas Co., Philadelphia, said "process control systems must work with planning, inventory, data collection, and cost systems to optimize the process, as well as production scheduling, product cost, inventory, and distribution opportunities.

"Process parameters," Archibald

continued, "must be measured and continually optimized on-line for safer and more reliable operations. Mechanical reliability measurements must be taken to predict failures rather than to react to them or manage them. Tomorrow, all of our systems need to work together to predict and direct the outcome and optimize 'total' production cost, speed, and quality."

Donald Clark, director of refining and chemicals industry marketing at

*'For some reason, engineering and IS/IT always seem to fight like cats and dogs.'*  
—a chemical plant veteran

Phoenix-based Honeywell, told us "Chemical plants will begin to employ integration technologies to expand the operator's role, putting him or her in charge of the factors that affect not only the process but virtually all aspects of the business. The operator will be supported in that role by the tools and plant integration that will allow for broad information access and use. The vision of sensor to boardroom integration has been around a long time."

Competitive advantage occupies the thoughts of Mike N. Zaharna, P.E., president and CEO of ABB Automation in Wickliffe, OH. He wondered aloud whether anything on the horizon could give his competitors the edge but remained skeptical of some options. "If I am a plant manager, before I upgrade my system, I want to know whether there is anything on the horizon that if I do not have, but my competitor has, my competitive advantage is compromised...I don't want to buy a system through e-commerce in two seconds but still wait three months for delivery."

At ISA TECH99 in Philadelphia, ABB Automation introduced a human system interface (HSI) billed as a universal interface for all levels of the enterprise. It will serve as a single window interface for OLE for process control (OPC) compliant control systems, as well as Microsoft-compatible business

enterprise solutions. Open communications, engineering tools, asset optimization software and process specific applications span the enterprise. Users can base their production decisions on lots of application information.

Also announced at ISA was ABB's historian, which now integrates with software from Pavilion Technologies Inc. to provide intelligent analysis of historical data through neural network modeling. The distributed architecture

of the enterprise-wide historian allows for visualization, retrieval and storage that can turn data into useful information.

Denny Euers, vice president of systems business for Yokogawa Corp. of America, Newnan, GA, said his company's products are fully digital from the sensor to the boardroom. "Yokogawa can link our manufacturing execution systems (MES) and process control systems to any ERP system through industry standard protocols like OPC," Euers said. "We are a SAP R/3 implementation partner and offer a link for SAP."

Clark, of Honeywell, said that "to accomplish the goal of sensor to boardroom integration, Honeywell moved to cost-effective open systems that are based on common infrastructure technologies (e.g., Microsoft, Intel). Honeywell also began providing cost-effective fieldbus technologies."

David Nelson, vice president of product marketing at Intellution Inc. in Norwood, MA, said that, "with Intellution, manufacturers increase interoperability between systems. They are able to better manage their place in the supply chain by creating an electronic 'pipeline' that connects the plant systems and business systems with customers and suppliers. The results are increased collaboration, faster time to market with new products, reduced costs and waste, and smoother connec-

tivity between the plant floor, business systems and customers who are now empowered to interact directly with a manufacturer's systems."

OSI Software, maker of the LAN/WAN systems, has brought information from the plant floor to executive's desks, said Romie Shield, marketing manager. "Much of the company's development focus is on building more tools to support Internet and e-commerce-based applications," Shield said. "People from the boardroom to the guard shack know how to browse the Web and click on a link."

"The Internet and e-commerce is already impacting how chemicals are bought and sold," Shield continued. "Most people worry that the increased competition will only drive prices lower. I envision that if customers don't just see the inventory, but can also view the quality of the lots available, they will increase their bids for higher-quality product. OSI is also working on several other products to improve the flow of information."

Strauss of Moore Process Automation Solutions said her company is offering a module for one of its control systems that integrates the control system with enterprise applications. The user has the flexibility to plan the integration portion of the project according to the timing of enterprise application work. Moore uses the middleware technology to integrate the control systems to enterprise applications.

In the white paper "Putting You in Control," HP said it invests in a middleware solution that reuses the plant systems users already have. With a sound SCADA and plant integration architecture, even a modern ERP system like SAP R/3 is just another client. HP's middleware product is part of the emerging market of "plant-to-enterprise" integration.

In August, while working with HP, Fisher-Rosemount said its Performance Solutions Div. will use HP production-integration software in its plant-information server process-automation architecture. The resulting process-automation solutions will give rise to

seamless plant-to-enterprise integration for process manufacturers in the chemical and pharmaceutical industries, the company said.

Jerry Brown, director of sales for the specialty chemical, pharmaceutical and food and beverage industries of Austin, TX-based Fisher Rosemount, said that “we have a very Microsoft-centric approach that is fundamental to the way we have designed and built our systems.

“Our vision,” Brown said, “is to provide a plant server for the rest of the enterprise. To do that, we have a broad concept of bringing information from the devices together with a plant information server. We do that through bus networks, principally fieldbus, so that we get a lot of data points to the actual physical running process in a process plant.

“Hence, we can interact and send information that might pertain to inventory levels and consumption that the ERP system might be interested in. We also can send up information about predictive maintenance and maintenance scheduling that might be used by, for example, the maintenance module in SAP that might trigger a maintenance alert.

“We use report-by-exception techniques and query-based responses as opposed to the old days of pulled systems with periodic scan times for fetching information from the devices and reading it up and sending it back down kind of a thing.”

Unlike HP, Fisher-Rosemount doesn't see middleware as the long-term answer. “We are definitely not going down the path of separate databases and software that lands in the middle to provide all this information—like a warehouse,” Brown said. “The whole idea of a central gathering point is almost like the mainframe analogy.

Frank Joop, plant design and engineering manager for Intergraph Process and Building Solutions, Huntsville, AL, agreed that Microsoft sets the standard and said that “Intergraph's vision is an IT environment, based on technologies, tools and standard architectures

from Microsoft as well as industry-standard data models.

“The goal,” he continued, “is to provide a step-change in productivity and lower total cost of ownership by integrating both technical and business systems, which includes integration of the instrumentation and control domains. This IT environment allows life-cycle engineering tasks to interact on an object level, and provides features such as once-only data entry, change notification and management, as well as global project execution. This

*‘The vision of sensor to boardroom integration has been around a long time.’  
—a software vendor*

system is data-centric architecture rather than a packaged product, per se. It's at once a development, integration and business partnering environment.”

A key aspect is its integration approach, a way for complementary software vendors to provide solutions for specific parts of the life cycle. Current partners include AspenTech, ICARUS, debis Systemhaus and ABB UTA.

Randy Reed of Advanced Manufacturing Solutions, The Foxboro Co., Foxboro, MA, said that “Foxboro can provide the integration needed to pass information from the production systems to the business systems. Depending upon the requirement, Foxboro offers a solution to share information to support better decision making in the business level, the manufacturing planning level and the production level.

“Using a flexible integration architecture and messaging technology,” Reed said, “one of our products allows disparate, heterogeneous applications to send transactions to a central location. From there, based upon a variety of possible events, applications can retrieve just the information that is of interest to them. This use of the publish-and-subscribe philosophy obviates the problems incurred by point-to-point solutions. For example, adding or subtracting

member applications does not upset existing enterprise relationships.”

Off-the-shelf connectors translate information to and from the solution. The connectors work for Foxboro and non-Foxboro production applications, as well as industry leading ERP systems, databases, and even emerging standards such as XMLOPC.

According to the company, benefits of this approach include flexible and scalable architecture; customer maintainable solutions; pre-structured connectors to speed implementation; and

robust integration based upon publish-and-subscribe transactions.

Bob Hlastala, sales engineer for Siemens Westinghouse Technical Services Inc., Information Technology, Alpharetta, GA, said that, “We offer hardware and software from the ground floor to the top of our customers needs. We have multiple products that are integrated to ERP systems, such as SAP. Some examples are document management systems, product data management systems, plant information systems, and security access systems. We developed our own integration to SAP for example. We developed the core integration and then customize it to fit the user's needs.

- For more information:  
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*By Brayton O. Paul, P.E., senior technical editor*