Engelhard Deploys Integrated FactorySuite™ Applications For Automating Plant Floor Operations, Linking to Corporate MRP

MIAMI, FLORIDA—It sounds a bit like Rodney Dangerfield to put it this way, but millions of people literally walk all over Engelhard Corporation’s specialized paper products every day. The difference between the comedian and the company is that Engelhard does get respect.

Engelhard HexCore L.P.—a subsidiary of Engelhard Corporation, the number 425 company on the Fortune magazine listing of the 500 largest corporations—is one of the world’s leading producers of aramid paper-based honeycomb core products used widely in the manufacture of aircraft, boats, air conditioner rotors and sports equipment. These core products are popular with the aircraft industry because they provide excellent structural capabilities for interior cabin construction yet are light in weight. They are very useful in commercial and industrial air conditioning systems because they are an efficient way to achieve high-level latent heat removal properties that make A/C systems more efficient and solve problems with indoor air quality.

Growing demand for the specialty honeycomb products was the trigger for the launch of a massive program at the Engelhard facility here in Miami to completely retool plant floor information systems and to provide a real-time link between production applications and the corporate information systems (IS) operations. Earl Truman, honeycomb production process team leader, started the quest with a visit to the APICS trade show in Orlando, Florida, in the fall of 1995, armed with a “wish list” of software capabilities he sought for implementing the project. At that show, he created a short list of potential vendors and proceeded over the next 12 months to select a software vendor and a system integrator who understood manufacturing processes, then to develop a program proposal for winning corporate budget approval.

The Engelhard project staff completed the first phase in May of 1997, only six months after starting development work.
Engineer Vince Fuillerat. When Truman went off as the emissary to the APICS show in October of 1995 to look for software solutions, the wish list included these sought-after capabilities:

- tracking of work-in-process inventory
- migration from labor tracking collection systems that provided 24-hour old data, at best, to on-line, real-time data collection and tracking
- automation of manufacturing information data collection and updates to the existing MRP II system
- provide a mechanism for changing work priorities for scheduling and dispatch
- provide on-line display of safety and work instructions at any step of the process
- provide a reporting system for supporting these functions
- provide a single database repository for all production history, including operating conditions, labor history records and other critical operating parameters
- replace an obsolete bar code system for which hardware and software were no longer supported
- move recording of all process parameters from manual entry on shop orders to on-line data collection in a centralized database (with replacement of chart recorders as the next step)
- provide immediate update of work instructions on the shop floor as changes are made
- and provide easy retrieval of process data.

"ISE and Wonderware had created an application demo for the APICS show booth that showed the real-time linking of plant floor operations, including WIP tracking to MRP systems," Truman explained. "They
dropment tools from Wonderware® Corporation of Irvine, Calif., to create systems for PC-based control of production machinery; for supervisory control and data acquisition (SCADA) of production workstations; for work-in-process (WIP) tracking of all manufacturing processes; for creating a real-time relational database of production information; and for providing real-time links to the corporate manufacturing resource planning (MRP) and financial systems that run on an AS/400 located at corporate headquarters in the northeastern U.S.

In just the first three months of operation, the new systems have generated some amazing results: productivity has more than doubled in some areas and scrap costs have been reduced by more than 80 per cent. As good a return on investment as that is, it didn't come without a lot of hard work, continual redefining of objectives, and re-engineering of procedures and processes over the course of the first year.

**Good Project Definition**

A good project starts with good planning, but planning must be flexible to accommodate change. The original intent of the project was to replace an outdated bar code system and eliminate the use of paper forms in manufacturing operations. The company had been using a paper shop ticket for tracking each honeycomb block from start to finish— a fanfold form that literally could be as much as 6-8 feet in length, depending on the product being made. All production data was entered manually and was linked to a bar code ID for each block of honeycomb produced.

As the development team progressed with their plans they saw the possibilities of adding more and more functionality— so they did. The team included Truman, as project leader; Paul Draghi, site director; Robert Agramonte, network coordinator; and Project
showed me simplicity with great functionality—automatically doing receipt of incoming materials, mixing and delivery of materials, dispatch lists, work instructions, real-time data collection on the process, and more. This was intriguing enough but in addition, I felt that the staff at ISE, who would be our system integrators, had the knowledge that we needed to put this system in. We had the vision of what we wanted to do and Don Den Uyl and his staff at ISE had the technical capabilities to bring it to life.”

The formal program changed from merely being a paperless manufacturing system to what Engelhard now calls the Advanced Integrated Manufacturing System (AIMS). This took advantage of multiple modules from the Wonderware FactorySuite to integrate plant-wide functionality for HMI, WIP, database, PC-based machine control and remote data viewing. In addition, it provided an easy to use but high performance real-time link with the company’s BPCS MRP system.

“This gave us what we felt was a foundation for the ‘factory of the future,’ but even more importantly, it allowed us to turn production techniques that had been an art into a science, into a methodology that provided tremendous repeatability and consistency in our product output,” Truman said. “We began configuring plant floor applications in late 1996 and the system was brought on stream in May of this year.”

**Turning Art Into Science**

The process of making honeycomb structural products is a complex one that in the past had been almost the exclusive province of several skilled technicians. These operators maintained their own process notebooks on each block as they made it, so they could replicate the particular product recipe from one batch to the next. But as more product types were added to meet new customer needs, the complexity of the “art” became overwhelming. Although the basic process steps were quite similar, requirements for honeycomb to be used in desiccant air conditioning rotors were vastly different from those required for interior structures aboard aircraft.

Rolls of aramid paper feed the rotogravure printer that applies adhesive on the paper in patterns that will result in a customer-specified hexagonal honeycomb cell size. The paper is cut into sheets and stacked in layers, often thousands of sheets thick, before being cured under pressure and high temperature in a large dielectric press, which functions much like a huge microwave oven. The resulting block of paper is then pulled open and the areas where the adhesive pattern holds the layers together form the proper size and pattern of honeycomb cells.

“The blocks then go into a pre-cure oven that sets the ‘memory’ in the paper so that each block will maintain the intended block dimensions and cell size,” Truman said. “The production line divides at this point and the structural and other products continue their processing with separate finishing operations. Blocks intended for aircraft structural use are coated with resins to attain the desired density, which along with the aramid paper controls the strength of the product. Some light densities might be used in stow bins and side walls, for instance, while heavier ones would be used for aircraft flooring. The structural honeycomb blocks are sliced into thicknesses specified by the customer order, as downloaded from the BPCS MRP-II system.

“The air conditioning components are sliced to the required thickness, then cut into circular shapes for small to medium sized rotors, or into pie-shaped wedges that can be placed within circular aluminum frames to create larger size rotors,” he added. “The rotors that will be used to dry the moisture from the air are then coated with a proprietary desiccant. Rotors that will be used as heat exchangers aren’t coated.
“Our goal with the AIMS system was to take all production from what had been an informal system, an ‘art’ if you will, to a formal one, a science,” Truman said. “The intent was that every time we put a block through this process, we would know exactly what it takes to produce it. We would know how to drive the equipment more efficiently, would automate all data collection from the process, provide information to operators so output volume and quality would be predictable, and that we would meet or exceed customer specifications with near-100% reliability and operator safety.”

Integrating Multiple Applications

The Engelhard production systems were oriented toward manual control of multiple application steps, with production data generated via bar code readers, by handwritten notations or via chart recorders. The collection of labor and materials data was not real-time, and data was forwarded to the MRP system in batches, also not in real-time. Collection and retrieval of operating conditions were done manually on shop travelers or oven charts.

All of this has changed with the implementation of the new systems. There are 15 nodes each of Wonderware InTouch™ HM1 software and Wonderware InTrack™ WIP tracking software running on PCs spread throughout the plant. Operators can now automatically download customer orders for starting production and can monitor honeycomb block production as it progresses through the plant, from workstation to workstation. One of those initial PCs, located adjacent to the dielectric press, is also running the first node of Wonderware’s InControl™ PC-based machine control software. It functions as the programmable logic control (PLC) system for the press. In addition, the quality lab uses a workstation to access on-line production data and for attaching results from QC sample tests.

“We’re running the whole network on one NT server, but we’re going to upgrade that so we have dual redundant servers,” said Robert Agramonte, systems engineer. “We use a high speed Ethernet 100 Base T backbone on the factory floor. The server has 120 megabytes of RAM and the workstations are either 32 or 64 M B. Right now, only one PC has InControl, InTouch and InTrack all running on it, but we are planning on adding InControl instead of using PLCs to run the pre-cure ovens as well.

“We’ve used Microsoft®’s SQL Server 6.5 as our relational database, but we’re planning to convert to Wonderware’s IndustrialSQL Server™ as we add the next project, on the ovens,” Agramonte added. “We’ll be using an NT 4.0 server to host that real-time relational database. Our tagname database is only about 1,000 tags at the moment and we probably won’t exceed 2,000 tags for the whole factory once it’s done – but we are looking forward to the new capabilities that IndustrialSQL Server will provide because it will truly give us real-time data for use in all of our corporate applications, right up the line to the AS/400 system. Because it encapsulates a copy of SQL Server but adds extensions for high speed data collection and data compression, it still works like SQL Server but provides much higher throughput for handling real-time data from the plant floor.”
applies the adhesive to the paper, then to do the dielectric press, the curing ovens, the expanders, the sheeter/stackers, the saws, rotor fabrication and the quality lab. “We added the process data to close the loop and add new capabilities and then put our shop order data into the relational database,” Truman said. “We eliminated the bar code readers and replaced them with InTouch functions. We plan on getting rid of all the old paper chart recorders at some point. We can now track real-time data related to each shop order and, having the database, we can begin measuring performance parameters for each batch produced. What was the temperature and the time duration of a cure process? What were the temperature trends during the run? In the last 10 times the job was done, was there any different profile element that gave us different results? This ability to really examine the production steps in each batch allowed us to create standards that result in higher volume production with higher product quality and consistency from batch to batch.”

The combination of the HMI and WIP tracking systems has removed some serious roadblocks and produced dramatic increases in productivity, Draghi noted.

“The process now starts with the master dispatch list in the AS/400, which is based on the shop order priority and the customer due date,” Draghi said. “This is usually driven by operation start date and the routing file in the manufacturing system, but we now can do additional sorts to take advantage of efficiencies. For example, we can also do a match against our scheduling system to make sure a batch will have a clear path through the factory. And we can do a third sort for multiple similar product item numbers within the same priority sequences. We’ve set that feature up as a function key. Once the operator brings up a shop order and hits the F3 key, the system polls all other shop orders for similar blocks and adds them to the run. Once the dielectric press, for example, we can then run from one to five blocks high in the oven and achieve some good gains in productivity while maintaining product quality.

“If we download the shop order for a customer, it comes up right on the workstation screen, complete with products specifications for that order, detailed work instructions for what the operator has to do, the ‘recipe’ of oven parameters, special instructions for that item number or shop order, and safety instructions that caution him about any potential dangers,” Draghi added. “These lists of work and safety instructions must be followed and confirmed by operator inputs because we need to be able to certify to both our customer, the aircraft manufacturer, and/or the Federal Aviation Administration (FAA) that we followed those specific procedures. All of this information – the time starts, log-ons, labor hours, time on the job, and all the real-time process data on each batch – is stored in the SQL Server database according to shop order number and item number. We can routinely produce reports and analyse the data as we wish, and we also can more easily provide a complete product genealogy to the customer and regulatory agencies.”

The system developed by Den Uyl’s ISE team now provides a function-rich capability to monitor and analyse every step of production and be sure that every task falls within bounds.

“I can go into this system and analyze anything I need to, and this is a capability we’ve not had before,” Truman said. “For example, our operators used to have to manually calculate the amount of Aramid paper used in a particular product to be sure they’re within specifications. This is all automated now. If we need to, the system calculates the number of sheets of paper used which ultimately gives us length, thickness etc. It also records the temperature, humidity and other environmental data and factors that are needed for production evaluation. Not only is this data automatically stored in the database for that step in the process, but it also can be used for setup of downstream machines so they’re ready to run.”

One of the most sophisticated pieces of equipment in the plant is the dielectric oven, which incorporates a large 75 Kw oscillation tube to generate radio frequencies (RF) that cure the honeycomb blocks by heating them under pressure. “This machine is much more effective than a steam platen press for curing the blocks because it works much like a microwave oven – only the adhesives are cured, nothing else,” Draghi explained. “It heats the product more consistently throughout the block, rather than from the outside in, so there’s no danger of the product being over-cooked on the outside and under-cooked on the inside. Plus it allows us to handle more and larger blocks simultaneously – so we can do similar products from different shop orders at the same time. It also saves a lot of time, because the dielectric press can process a batch in about one hour, versus the 16 hours it would take for a typical steam platen press.”
The use of InControl on the same machine as the HMI and WIP applications makes setup of the dielectric press simpler to accomplish and more reliable to operate, Truman added.

“The operators simply load the blocks in the press, load the recipes according to the shop order, and input any extra information needed, such as whether multiple blocks will be processed at the same time,” Truman said. “They know what the current setpoints are, right on the workstation screen, so all they have to do is key in the new configuration data for that set of blocks and the system resets all the setpoints for the new configuration. Even if they’re doing as many as five blocks high, with a corresponding large increase in density, it will calculate what the new setpoints should be and set them up on the on-screen gauges. They’re ready to go.”

“Using InControl cost less than using a PLC to run the press, and it also gave us new capabilities that a PLC can’t provide,” Draghi noted. “We got tighter control of the process because process information is downloaded automatically as the operator clicks on a shop order with the mouse. Plus operators can make supervisory changes as necessary to override standard settings to accommodate special situations.”

“The dielectric press was probably the most technically challenging piece of equipment in our plant in terms of the types of data to be collected,” Draghi added. “In addition to the usual production information, we also have to collect things such as RF current and amperage data. We have to filter out the frequency of the RF generator itself. We figure if the system works this well in this application, then it’s probably going to work well in the next set of applications – on the ovens and sheeter/stackers – where we’re handling more traditional tasks like PID loops and ladder logic statements.”

**Aiming for the Future**

The new integrated automation systems have allowed the company to make great strides. “We’ve already replaced our manual planning activities on BPCS, and we’re readying systems to convert to a new MAX MRP II system,” Truman said. “We’ve automated our dispatch list. We’ve replaced our outdated bar code system. We’ve replaced all the big books of work instructions that had to be maintained on the shop floor. We’ve integrated laboratory QC testing with the production process. We’ve automated the certification process. We’ve achieved paperless engineering documentation and controls. And the results have been outstanding already.

“These systems are not only helping to make us more profitable, but they’re giving us technical capabilities that have let us leapfrog our competition,” he explained. “In addition, our productivity has gone from a production yield of 40% two years ago to more than 90% now. Scrap costs for product that was no good – either over-cooked or under-cooked in the cure process – have been reduced by more than 80%. And all of this was accomplished without specific efforts to do so. It’s been a generalized result just from putting in these automation systems and using these tools.”

In addition to completing the roll-out of systems to additional work areas in the plant, Truman foresees the addition of two more applications using FactorySuite tools. He would like to utilize the Scout™ remote viewing application to give the home offices in New Jersey the ability to monitor plant operations over the Internet. And he would like to add the flexible batch management functionality of the InBatch™ module to enhance the resin and IPA batch tasks for coating of structural honeycomb blocks and the ingredient batching and coating of desiccant rotors.

As the systems grow to include all production areas, perhaps the greatest challenge will be weaning the production staff from its paper trail, Truman commented. “We’re running the trial operation now and we’ll have the whole plant done by year-end. At that time, we’ll take away their security blanket,” he laughed. “People are used to seeing the information on screens already, but giving up their paper trail and working with data only on the PCs will be a big test.”

“Our vision is that we’ll now provide all of our batch production data to our customers on CD-ROM – they’ll literally be able to have an entire year’s worth of production information on just one CD instead of mountains of documentation,” he added. “So if somebody asks what the cure cycle was for the third dip here on Block #234567, they can simply pull out the data and print the results in a report. We think they’ll find it amazing, and that they’ll like it.”

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