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Redefining Manufacturing Productivity

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Over the past 25 years, even while coping with an unprecedented pace of change, U.S. manufacturers have managed to maintain at least one constant: a solid, unbroken track record of productivity improvement. Vertically integrated enterprises have given way to virtual networks capable of taking advantage of trends such as cheap offshore production. Long, steady production runs have changed to short, demand-driven production bursts. Manageable bills of materials and product catalogues have exploded as the number of products and features has skyrocketed. Yet, through it all, U.S. manufacturers have remained at or near the top in driving productivity, at least as measured in the traditional terms of output per worker hour.

And it's a good thing, too. Without the breakthrough productivity gains that they have achieved in recent years, many U.S. manufacturers would not have been able to overcome an avalanche of rising costs for everything from raw materials to energy. Nor would U.S. consumers have enjoyed the steady supply of low-cost manufactured goods that has played a major role in stimulating economic growth.

"While it tends to be cyclical, the long-term rise in manufacturing productivity has resulted in a competitive advantage for U.S. manufacturers and an important boost for the economy, driving down inflation," says Dan Meckstroth, chief economist at the Manufacturers Alliance/MAPI, a manufacturing industry trade group. "It's really quite a success story."

But how much further can U.S. manufacturers push productivity gains? After more than two decades of continual and impressive improvements, are manufacturers finally beginning to see diminishing returns from the tools and techniques that have delivered world-beating productivity gains in the past? Or are the opportunities for boosting productivity as wide open as ever? In other words, how close to the productivity summit have U.S. manufacturers climbed?

The answer, experts say, is that manufacturers are nowhere near maxing out on potential productivity gains. But, in order to cash in on tomorrow's opportunities, manufacturers will need to shift their thinking about what constitutes meaningful productivity improvements and, in many cases, change their internal organizations and cultures in order to achieve them. There's still plenty of productivity headroom available to manufacturers, for example, who transform push-oriented supply chains into more agile, demand-driven supply networks. Similarly, although manufacturers have attempted over the past few years to apply lean and Six Sigma principles, most have only scratched the surface of what can be achieved, experts say. And most manufacturers have only begun to realize efficiency gains that are available from the integration of processes and systems that have historically been separate, such as manufacturing and supply chain.

"I don't think we are out of gas here by any stretch of imagination," says John Berra, president of Emerson Process Management. "In fact, we could be entering an era where the kind of productivity improvements we've seen in the past can be not only sustained but improved on."

That's saying a lot. Over the past 25 years, U.S. manufacturers have outdone most of the rest of the world when it comes to sheer output per worker hour. According to figures compiled by the U.S. Bureau of Labor Statistics, U.S. manufacturers between 1979 and 2005 generated productivity gains averaging 4.1% per year. That puts U.S. manufacturers behind only a handful of countries studied during that period.

And productivity improvement rates in the U.S. show no signs of slowing down. Between 2004 and 2005, output per worker hour among U.S. manufacturers climbed by 5.1%. The productivity growth rate among U.S. manufacturers continues to be about double the rate of the rest of the country's non-farm economy, says MAPI's Meckstroth. In fact, in the fourth quarter alone, productivity improvements helped U.S. manufacturers cut unit labor costs by 2.8% while meeting rising demand.

By helping to reduce overhead such as labor expenses, productivity gains have allowed manufacturers to remain a step ahead of operating costs that have been accelerating faster in the U.S. than in much of the rest of the world. According to a recent study by the National Association of Manufacturers, MAPI, and the Manufacturing

Institute, U.S. manufacturers face structural costs that, on average, are 31.7% higher than those faced by manufacturers in a group of nine major trading partners. That cost disadvantage, imposed by items such as taxes, employee benefits, legal costs, and energy prices, has grown from a 22.4% average just three years ago, the study found.

But the need to offset rising costs is not the only reason U.S. manufacturers are under pressure to keep the pedal to the metal on productivity gains. Since a painful recession from roughly 2000 to 2003 that forced many U.S. manufacturers to lay off workers and reduce capacity, the industry has enjoyed a recovery. And that recovery, for the first time in many years, has begun to put a squeeze on manufacturing capacity, forcing many manufacturers to refocus on getting more out of their plants and equipment. In fact, according to a recent MAPI report, the number of manufacturers operating at above 85% of capacity increased from 41.3% in June of this year to 50.8% in September.

"There's a lot of investment being applied to manufacturing right now after a long decline," says MAPI's Meckstroth. "Companies want to make sure they get the most out of those new investments."

The Productivity Equation

If the traditional definition of productivity is output per worker hour, most improvement efforts historically have been focused on the denominator in that equation: worker hours.

"Over the past 20 years, manufacturing plants were considered outside the domain of the business itself," says Peter Martin, vice president of strategic ventures at [Invensys](#) Process Systems. "Executives viewed plants as necessary evils, and they focused a lot of their productivity improvement activities on headcount reduction."

In the 1970s and 1980s, the investments in new plant floor automation and control systems were most often justified by headcount reductions. Productivity-focused technology investments were calculated primarily to reduce labor costs rather than streamline or reengineer core processes.

As a result, Martin says, "In the '70s and '80s, we saw huge reductions in the headcount of field and control room operators. In the '80s and '90s, the focus was on automating maintenance, and headcounts in maintenance departments plunged. And, in the '90s and 2000s," he says, "the focus has been on engineering. It's gotten to the point that many plants found themselves below the critical mass level in terms of headcount. So the focus on reducing headcount as a way to generate productivity is over."

Now, Martin says, manufacturers must shift their focus from the headcount denominator part of the productivity equation to the numerator: making sure the plant is operating at maximum efficiency, that assets are generating the greatest possible return on investment, and that companies are agile enough to recognize shifts in demand and to respond to them quickly.

In order to do that, experts say, manufacturers must leave behind the notion that the plant is a necessary evil, divorced from the rest of the business. Plant-level processes and systems must be integrated with the processes and systems of the extended enterprise such as sales, fulfillment, and procurement, so that business managers and manufacturing operators alike have better, up-to-date visibility into not just how well a machine or production line is operating in isolation, but how well it is contributing overall to profitability, return on assets, and production goals.

With that kind of integrated view, analysts say, the definition of productivity itself will change. Rather than fine-tuning operations so that they simply pump out the most widgets per hour, manufacturers will be able to optimize, for example, on profitability or the ability to respond quickly to changes in demand.

"The trick will be to be able to look at operating equipment efficiency in terms of, 'Did I operate in a way that maximizes returns on assets,'" says Robert Parker, vice president of research at Manufacturing Insights. "The only way to get that is to get visibility of the whole network of manufacturing assets and how they are operating together."

Recently, Parker and Manufacturing Insights issued a report predicting that over the next five years [progressive manufacturers](#) will begin to build what they call fulfillment execution systems (FES) that will marry traditional plant floor manufacturing execution systems with supply chain management systems. Built as composite applications on top of a service-oriented architecture, FES will allow manufacturers to manage materials procurement, production capacity, and outbound order fulfillment within a single, closed-loop system. Under such a system, when, for example, demand for a product spikes, production can be immediately adjusted, ensuring superior customer service, less unnecessary inventory, and more efficient supply chains. (For more on FES, see [sidebar](#).)

Similarly, manufacturers such as Dow Chemical Co., PPG Industries Inc., and Timken Co. are getting better at

tuning their productivity and profitability levels by more closely linking plant floor systems and information directly with sales and marketing and financial processes and systems. Those manufacturers are using an analytical tool from 10-year-old [Maxager Technology Inc.](#) that gives different functional constituencies within a manufacturing enterprise -- production, finance, sales and marketing -- common and consistent information about which products -- and which production lines -- are generating the greatest return-on-assets to the company.

Traditionally, says Maxager CEO Michael Rothschild, production, finance, and sales and marketing functions have fine-tuned their processes based on different metrics. Production looks at units made per minute and cost. Finance looks at profit margins. But, without the ability to easily combine operational information -- cost, yield, and units per minute -- with financial data, manufacturers haven't really understood their ROA on a given product or production line, Rothschild says. A high-margin product, for example, may be so complicated and time-consuming to make that, on a per-minute basis, a lower-margin product that is easier to make turns out to deliver better ROA.

According to Rothschild, manufacturers that have used the Maxager tools to look at productivity in this way have increased their profits by between 3% and 5% of revenue.

Two-Way Street

But manufacturers should not limit their plant/enterprise integration efforts to pushing plant information up the organizational structure for management consumption and decision-making, experts say. Tomorrow's productivity gains will also come as a result of driving consolidated plant/enterprise information down to the manufacturing floor level, where operators can use it to make on-the-fly decisions.

Historically, notes Invensys's Martin, tools like balanced scorecards that combine information from various functional domains -- such as finance and manufacturing -- have been designed primarily for managers. Plant-level control systems, on the other hand, have been designed on a management-by-exception principle, whereby, "Unless there is an alarm, operators don't do anything," Martin says. "That's a waste. Operators are the people with the most potential to add to productivity. Yet we're telling them to read the sports page. What we really need to do is to bring the concept of the balanced scorecard down to the people who actually manage the process."

Besides allowing plant operators a freer hand to continually improve processes, systems such as Invensys's InFusion Enterprise Control System, which combines operational and financial information, will give all functions in the enterprise consistent metrics with which they can measure their own performance, Martin says. And that enhances cross-functional collaboration. Process manufacturers such as Dynegy Midstream Services that have begun to use InFusion to standardize on asset performance management metrics that combine financial and operational data have seen returns of 600% on their investment in the software in as little as eight weeks, Martin says.

While integrating the plant floor and extended enterprise will offer manufacturers promising ways to continue to drive productivity gains, cashing in on the potential won't be easy, experts warn. Technology to support such integration -- in the form of standards-based SOA architectures and composite applications -- is rapidly maturing. But the real challenge will grow out of the cultural changes required to increase collaboration among functional areas of the enterprise. Managers will need to learn to cede more control to plant operators, Martin says, and plant operators and engineers will need to become comfortable being measured and rewarded for their contributions to bottom-line financial results, not just plant-centric output.

"In order to maximize productivity and responsiveness, organizations in the future can't rely on vertically organized functional structures that typically take a long time to respond to the marketplace," says Dr. Fariborz Ghadar, director of the Center for Global Business Studies at Penn State University's Smeal College of Business. "They will need to evolve to a more matrixed organization where individual contributors are empowered to make decisions, and they are supported by consistent, accurate, real-time information."

To be sure, many manufacturers will continue to derive productivity improvements in the same way they have over the past 25 years, by automating and gaining new insights into existing processes. Shaw Industries, a Cartersville, GA, maker of carpets and other flooring, for example, is still in the process of replacing hard-wired programmable logic controllers in its 100 plants with modern PLCs all tied together with an IP Ethernet network.

On top of the new infrastructure, Shaw deployed [Rockwell Automation's](#) FactoryTalk data historian, RSBizWare production monitoring software, and RSView HMI software that allows managers and operators to analyze plant floor operations and fine tune them. The common infrastructure and operational insights have also allowed Shaw to begin to roll out common operating procedures across its plants, avoiding potential problems.

"It's made everything more consistent," says Shaw Industries' manager Gary Norwood. "We don't have the

occasional blow outs that we used to have, and that helps to improve productivity."

As manufacturers like Shaw instrument more and more of their plant infrastructures using traditional or even wireless networks, they will be in a position to cash in on second-level productivity gains by using emerging predictive intelligence and visualization tools, predicts Emerson's Berra. Emerson's Smart Process family of products, for example, monitors real-time measurements coming from a plant's control system and can predict when a critical piece of equipment might be about to fail. Smart Process also includes tools that operators can use to model plant operations and pinpoint the causes of production problems. The ability to head off failures before they occur, Berra says, can help process manufacturers such as oil and gas producers cut into unplanned downtime, which can be as high as 7% of total operating time.

Manufacturers will also receive major productivity gains through the first-time automation of some increasingly important business processes. For example, manufacturers have historically under-spent on the automation of post-sales service and support processes such as warranty and field service management, says Kerstin Geiger, head of solutions management for discrete industries at SAP. Increasingly, however, wrapping finished goods with value-added services represents a high-margin business opportunity. In order to cash in on those opportunities, Geiger says, manufacturers will need to devote more energy and resources to automating post-sales service processes.

Lean Forward

Finally, experts say, most manufacturers are far from maxing out on the productivity gains that are available from properly implementing continuous improvement programs such as lean and Six Sigma. While such programs have been staples of manufacturing enterprises for years, many lean/Six Sigma initiatives have yet to live up to their full potential.

"I'd say only about 10% of the productivity gains achieved by manufacturers over the past few years have been directly due to lean/Six Sigma initiatives, so there's a lot of room for improvement," says Vince Buonomo, senior program manager at the Rochester Institute of Technology's Center for Integrated Manufacturing Studies. "Many lean/Six Sigma initiatives don't deliver nearly as much benefit as they should, for a number of reasons."

Many companies, Buonomo says, fail to create the culture necessary for the sustained execution of continuous improvement programs such as lean/Six Sigma. Many manufacturers, for example, lack the kind of top-level executive support that is necessary for lean/Six Sigma to take root and flourish, Buonomo says. Moreover, he says, many organizations attempt to take shortcuts, bypassing important lean steps such as value-stream mapping and 5S workplace organizing and cleaning.

"Managers skip these steps because they see them as unnecessary housekeeping," Buonomo says. "They think you can force change. You can't."

Besides making cultural changes and adhering more closely to the lean/Six Sigma programs, manufacturers can wring more productivity gains out of such continuous improvement initiatives by supporting them with the right technology.

"What will drive a lot of productivity going forward is the application of technology to lean programs," says Ralph Rio, research director at ARC Advisory Group. "That means things like electronic kanban for monitoring inventory status and sending signals to suppliers."

Historically, Rio says, many manufacturers have had a bias against deploying technology to support lean initiatives, in part because lean icons such as Toyota shied away from doing so. As manufacturers attempt to gain more productivity improvements from lean initiatives -- particularly by extending lean practices beyond the four walls of the plant floor and into the wider supply chain -- tools like electronic kanban make sense, Rio says.

"Technology that improves the process and allows people to continue to be involved is good," he says. "Even Toyota, at its plant in Tennessee, is beginning to use electronic kanban. The dam has been breached."

Even as manufacturers continue to deploy new technologies such as predictive intelligence and visualization tools and e-kanban, the macro impact on productivity won't be felt initially. Generally, says Penn State's Ghadar, it takes 10 years for important new technologies to translate into widespread productivity improvements.

"Much of the first-level productivity impact from things like financial software and video is still in the process of expressing itself," Ghadar says. "So the impact of current investments won't be seen for some time."

At the same time, Ghadar says, there's no guarantee that because U.S. manufacturers appear to be making the investments necessary to continue to improve productivity, they will stay ahead of the rest of the world.

Manufacturers in emerging countries such as China have at least one advantage in adopting new, productivity-boosting technology: They don't have to discard old technology to bring in the new.

Still, the good news is that there appears to be no foreseeable end to the opportunity to drive productivity.

"The sense that somehow we've reached the limit of driving productivity improvements is simply false," says Dennis Cocco, the founder and chief product strategist of manufacturing software provider Activplant Corp. "Really, we have only just started."



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