The (Dynamic On-Demand Supply Chain) DODSC:

By Gregory L. Schlegel and Richard C. Smith

In an article in *Supply Chain Management Review's* March 2005 issue, titled "The Next Stage of Supply Chain Excellence," we presented the Dynamic On-Demand Supply Chain (DODSC) concept with supporting detail, initial user testimonials and some examples that outlined the multiple benefits of our approach.[1] In that article, we described the competitive landscape that is driving most companies to identify ways to accelerate supply chain value propositions. In this current article we expand on our approach by presenting compelling work that demonstrates the value of an on-demand, lean-pull supply chain. And, we focus on one compelling case study that outlines key supply chain advantages from the application of this model.

Our DODSC approach consists of four "platform" principles:

First, geared around process improvement, we advocate *Lean, Six Sigma and the Theory of Constraints (TOC)*. These methods, frequently combined within a continuous improvement charter and sometimes called "TLS", provide methods for locating a bottleneck, eliminating non-value-added waste, accelerating all process speeds and constantly taking a very data-driven, statistical process control approach to reducing process variability.

Second, *World Class Supply Chain Management*. This involves end-to-end horizontal thinking throughout the supply chain. It also includes extending the supply chain to suppliers and customers, contract manufacturers and other communities of practice. World-class also entails enhanced supply chain visibility, agility and profitable response.

Gregory L. Schlegel (schlegel01@earthlink.net) *is vice president of business development at SherTrack LLC, adjunct professor of supply chain management at Lehigh University and a past president of APICS. Richard C. Smith* (richard.smith@valeocon.com) *is an executive advisor with Valeocon Consulting and former partner at PricewaterhouseCoopers.*

Third, *On Demand Technology*. Technology innovation and leveraging new technology to differentiate the organization are part of the on-demand platform. This principle involves remaining focused on leveraging technology to drive bottom line results, through responsiveness, flexibility and resiliency.

Finally, *Change Management*. Our approach advocates tightly wrapping the tenets of DODSC with an integrated change management strategy. This strategy achieves and sustains continuous improvement throughout the organization, facilitated by exceptional communications, alignment of goals, short-term wins and sustained gains.

As we mentioned in our initial article, the elements of DODSC that involved lean/Six Sigma and theory of constraints, supply chain best practices, on-demand technology and change management have been around for some time. (See Exhibit 1) However, to our knowledge, they have not been leveraged simultaneously. Further, as several of the testimonials in our initial article from subject experts at IBM, Dow, AMR Research, and academia explained, the thought of integrating these established methodologies, best practices and new protocols in a systematic way during the supply chain journey could easily eclipse existing benefits derived to date by other methods.

In this article, we use an example from Bayer Material Science LLC, to show how use of the DODSC concept dramatically transformed a slow-moving supply chain process into an agile, flexible and profitably responsive entity. This transformation has resulted in reduced lead times, improved capacity utilization, improved working capital and a reduction in production costs.

Bayer and Lean-Six Sigma

Bayer MaterialScience (BMS), which is part of the worldwide Bayer company, is among the world's largest polymer companies. Its business activities are focused on the manufacturing of high-tech polymer materials and the development of innovative solutions to problems

A Practical Application

A Dynamic On-Demand Supply Chain (DODSC) combines proven techniques like lean and Six Sigma with innovative technology to drive sustained supply chain improvements. The case study presented here shows the DODSC concept in action. The results have been impressive: reduced lead times, lower production costs, and higher service levels.

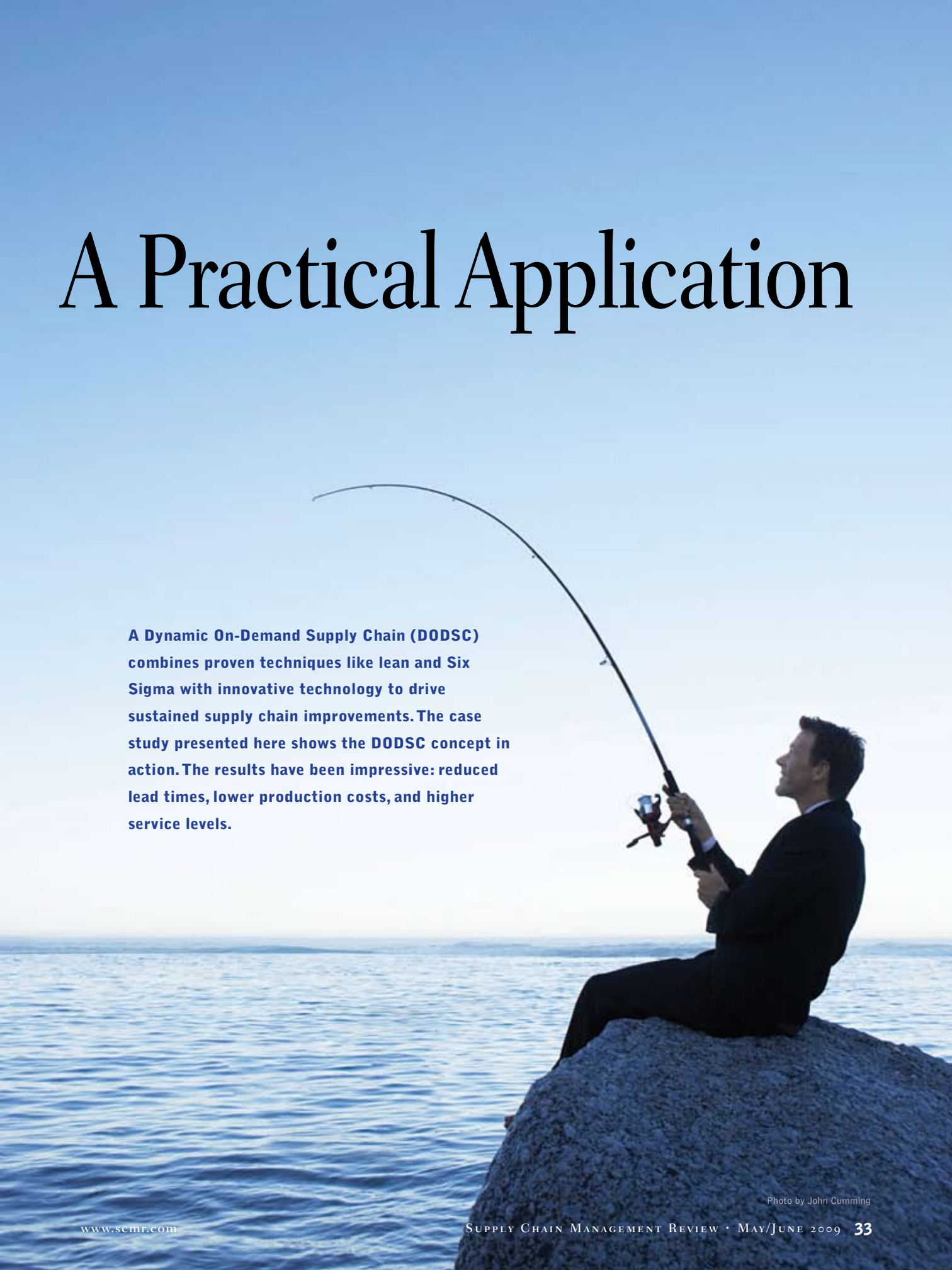
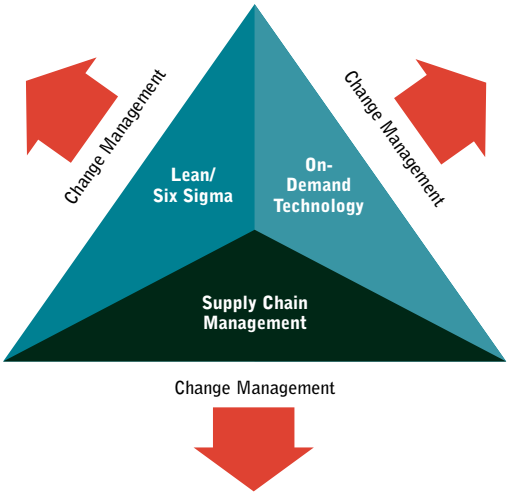


Photo by John Cumming

EXHIBIT 1

The Dynamic On-Demand Supply Chain



important to its customers. BMS has 30 production sites around the globe.

BMS was encountering unacceptable levels of aged and slow-moving inventory across many of its business units. Furthermore, its compounding business wanted to significantly improve response time to customers to achieve competitive advantage. A project was commissioned to address dead and slow-moving inventory as well as related issues such as write downs, inventory space utilization, selling partial containers, and planning and scheduling. With these baseline goals established, BMS's Business Excellence Group assigned an experienced Six Sigma team to test several hypotheses and tackle these related problems.

Today's competitive landscape is driving most companies to seek to identify ways to accelerate supply chain value propositions.

Team Leader Rick Baxendell, a black belt and senior Six Sigma manager at BMS, realized that the company's manufacturing facilities with their complex interaction of constraints and operating processes would be very difficult to analyze using traditional approaches. Attempting to execute trial production runs in live operations to evaluate changes would be prohibitively expensive, time consuming and pose unacceptable risks to operations, Baxendell and his team acknowledged.

With that reality front and center, the Six Sigma team engaged with SherTrack LLC to leverage its innovative predictive manufacturing and digital modeling technology to develop new operating policies and processes to:

- Reduce customer lead times.
- Reduce dead and slow-moving inventory.
- Reduce production costs.
- Improve working capital.
- Enhance capacity utilization.

The idea to leverage digital modeling and discrete-event simulation with structured design-of-experiment (DOE) methodologies came mid-project, during the analyze phase of the Six Sigma Define, Measure, Analyze, Improve and Control (DMAIC) process. This approach created a more powerful evaluation model and allowed many diverse and complex manufacturing hypotheses to be tested in a "safe" modeling environment. The DOE enabled the selection of the optimal policies and set points to maximize business performance.

The Six Sigma DMAIC methodology is by far the most frequently used to evaluate and improve existing processes. The methodology normally includes a skill transfer through formation and facilitation of project teams and development of "black belts." This effort approximates the timing and placement of the "just in time" practices associated with inventory management. It's a structured approach that focuses on "real problems" directly related to the bottom line. It defines opportunities, measures performance, analyzes the opportunities, improves and then controls performance. (Exhibit 2 outlines the Six Sigma improvement process used.)

The methodology utilizes multiple tools and techniques, including rigorous statistical methods appropriate. Six Sigma DMAIC projects are normally four to six months in duration with an overall goal to sus-

EXHIBIT 2

Six Sigma Improvement Process: DMAIC

- Focuses on "real problems" directly related to the bottom-line
- Realizes results in 4-6 months
- Utilizes multiple tools and techniques including rigorous statistical methods when needed
- Sustains improvement over the long-term
- Disseminates improvement throughout the organization
- Acts as an agent of change

tain improvements over the long term. The methodology also strives to disseminate improvements throughout the entire organization and acts as an agent of change. (For additional insight on Six Sigma's DMAIC process improvement methodology, visit this Wikipedia link: http://en.wikipedia.org/wiki/Six_Sigma.)

Multivariate digital models are recognized as the methodology of choice for analyzing complex, non-linear systems. The analyze and improve phases of Six Sigma DMAIC are particularly challenged by the multivariate and nonlinear relationships in plants with multiple production lines and tens or hundreds of product items competing for limited capacity. SherTrack's digital models and discrete-event simulation provided sophisticated analytical tools for the BMS Six Sigma team during the analyze and improve phases. This enabled the team to effectively qualify and quantify the impacts of changing set points, policies and procedures in a complex manufacturing environment.

Laying the Groundwork

BMS subject matter experts teamed with the SherTrack Six Sigma Services group to build a realistic digital model of the complete order-to-fulfillment process. This included sales demand, scheduling and production along with inventory outcomes. The combined team built a working model of the complex compounding facility using historical demand streams and forecasts, scheduled and unscheduled downtime, planned and accounted-for production transitions, production rates, simulated random quality assurance failures and strict adherence to make-to-order and make-to-forecast policies.

Our digital model and simulator produced daily operating records that were virtually identical to those generated by the enterprise resource planning and manufacturing execution system systems in actual operations. This statistical model validation method—which includes running hundreds of daily production schedules from what actually happened, one day at a time and then comparing the model outcome against what actually happened at the facility—is called post analysis. For each new scenario/hypothesis, specific performance metrics were developed for each key performance indicator.

With this capability in hand, the DOE was constructed to extract statistically significant cause-and-effect relationships between selected discretionary policies and the resulting business performance. The team also conducted a regression-like analysis early in the process, and was able to assess the strength of the correlation of each factor and combination of factors on the output variables. Thus, using DOE, the team not only assessed the strength of the correlation between "X" variables, such as forecast accuracy and service levels, but also examined the effects of simultaneous changes in other "X" variables such as lead times, production lot sizes and policies of the manufacturing facility.

Attempting to execute trial production runs in live operations to evaluate changes is prohibitively expensive, time consuming and poses unacceptable risks to operations.

A parametric model was then developed to enable further study. This model is a set of related mathematical equations in which alternative scenarios are defined by changing the assumed values of a set of fixed coefficients (parameters). Parametric statistical methods are mathematical procedures for statistical hypothesis testing. The technique assumes that the distributions of the variables being assessed belong to known parametrized families of probability distributions. The cross-functional team of BMS subject matter experts, black belts and outside consultants leveraged the strengths of the Six Sigma DMAIC process, digital modeling and discrete-event simulation, multiple-regression analysis and DOE techniques to test the interaction of over 44 different manufacturing hypotheses without inhibiting actual production.

In the analyze phase, the team:

- Captured the physical process, operating policies and decision rules in a single integrated digital model of the entire process.
- Correlated operating performance with historical baseline records.
- Enabled DOE techniques to determine feasible and optimal process capability, statistically significant cause-and-effect relationships and sensitivities.
- Evaluated and compared alternative process improvement scenarios.
- Used predictive modeling and predictive analytics as decision support for executing the process improvement activities.

The intent in presenting this case study is to demonstrate how DODSC can drive significant transformation in supply chain excellence. This approach is producing

rapid, profitable manufacturing response, using digital modeling and predictive manufacturing technology.

A Change in Thinking

As with all strategic process change initiatives, shifting to a rigorous model like DODSC requires that management address the change and organizational elements necessary to sustain the gains achieved. As we pointed out in our previous article, successfully dealing with the key change elements when introducing a new process initiative like DODSC is critical to success. These change elements are factors for both large scale interventions and tactical process initiatives in the supply chain.

The exemplars and early adopters are leveraging the DODSC concept to dramatically transform a slow moving supply chain process into a very agile, flexible and profitably responsive entity.

In this case study, the key change elements included communicating, gaining management alignment to support the DODSC initiative, obtaining short term wins to build momentum and sustaining the gains to drive more support and expand the DODSC process model. Let's look at how Bayer executed on these change elements;

Communication—The VP of continuous improvement championed the DODSC project and reached out to her management peers to ensure that they understood the benefits of this model. She organized a Six Sigma team, developed an official charter, and then communicated the charter throughout the organization. Effective communication during any significant change initiative is essential. Research from John Kotter's work[2] and others in the on-demand system user community over the years have emphasized the need to communicate directly to the folks in the process how their work will change as a result to new technology or structure.

Management Alignment—The continuous improvement VP developed a cross-functional team and enlisted the support of the director of operations, the marketing director, the VP of supply chain management and the VP of IT—all of whom were key partners in this process change. A working model was developed and the team members reached out across the organization to gain support for it. Both our consulting experience and recent change management research confirm that alignment among the management team is critical for successful implementation of new concepts such as DODSC.

Build Short-Term Wins—The Six Sigma team built digital models of their complex manufacturing environment and ran 44 different scenarios. The team then validated that the modeling outcomes were statistically significant and valid. The team next developed a safe environment to test the new scenarios. This lead to positive operational changes such as reducing lead time, reducing inventory, lowering production costs and improving service levels. These short-term wins provided the energy and confidence for the team to move forward. Again, John Kotter's work on effective transitions emphasizes the importance of building momentum for successful implementation of new approaches.

Sustaining the Gains—BMS has already implemented several operational and policy recommendations and has achieved many of the expected benefits. The company has leveraged the digital model and gained additional savings and market penetration. By establishing the right metrics, BMS will be able to track improvements and sustain these gains. Through this success, it will be able to drive this new process change in other parts the organization

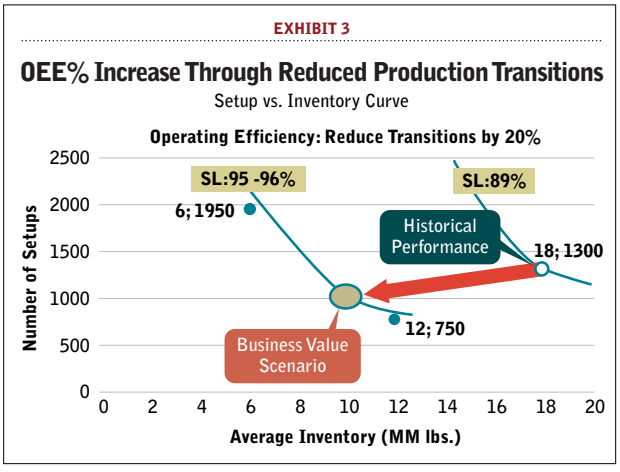
Lessons Learned

In this Six Sigma DMAIC continuous improvement project, the combination of design-of-experiment structured inputs for SherTrack's business process model demonstrated its value to the business with rapid, quantitative scenario simulation results. Hypotheses were tested and complex cause-and-effect relationships between project inputs, business and production processes and expected outcomes were explored. Assessing the experience, BMS team leader Baxendell commented: "This methodology provided the BMS project team with a robust decision making tool. The project team worked with the business leaders to find conditions that would improve service, delivery and other criteria. The methodology provided a basis for our supply chain improvements."

The lessons learned from this novel approach to evaluate manufacturing responsiveness were both revealing and compelling. The initial learning was that lead times could be reduced by up to 50 percent—an opportunity that the team suspected, but needed to be proven with further analyses, including sensitivity analysis and statistical curve fitting. The team confirmed that lead times could be reduced up to this amount, which would effectively support the new business plan of market penetration and share growth.

The next positive outcome to emerge was that service levels could be improved by 5-6 points. This was very well received by the team because it also supported the new business plan of top line revenue growth due to market penetration from shorter lead times to the customers. In conjunction with service improvements, the approach demonstrated that the BMS process could improve service levels while simultaneously reducing slow moving and working inventory by over 20 percent, thus improving working capital ratios.

EXHIBIT 3



From an operational perspective, the approach demonstrated that costly production setups could be reduced by about 20 percent. This improvement in overall equipment effectiveness (OEE)—allowing a reduction of 20 percent in production setups and therefore production costs, while improving service levels and reducing working inventory—was a huge breakthrough. On top of all these improvements, the approach provided a capacity utilization improvement of about 5 percent without capital equipment spending. (See Exhibit 3)

The team also gained tremendous insight into production issues that impact bottom line performance. Finally, the DMAIC / DOE and digital modeling methodology was rapid and compelling and more importantly, applicable to other plants.

Looking Forward

Bayer MaterialScience has already made positive changes to its supply chain and is evaluating further changes. Real world changes involve time and can often put money and customer relations at risk. This DOE/business process modeling approach, which took only 10 weeks to complete, coupled with the structured Six Sigma DMAIC process and enabled by SherTrack's digital modeling and discrete-event simulation, provided a good risk mitigation tool. The approach afforded BMS the opportunity to test complex manufacturing hypotheses within a "safe" environment. This benefits both BMS and its customers because the analysis executed within this statistically-oriented and structured environment provided the team with ample cause-and-effect impacts on the plant, BMS and its customers prior to committing funds, resources and time. It also minimized the risk to BMS customers and operations.

The exemplars and early adopters, such as Bayer, are leveraging the DODSC concept to dramatically transform a slow moving supply chain process into an agile, flexible and profitably responsive entity. The initial outcome, resulting in reduced lead times, improved service levels and capacity utilization, reduced working inventory and lower production costs clearly differentiates this novel approach from classic incremental improvement methods.

Companies such as Bayer and others, that are embracing the DODSC concept are leveraging the robust strengths of Lean/Six Sigma methodologies to drive process improvement by continuously being customer-focused and driving out variability in their processes. They are aligning their supply chain strategy with the business strategy utilizing best practices and becoming more demand-driven, agile, flexible and responsive. The exemplars are leveraging new on-demand technologies to become more dynamic and responsive, driving down IT cost-of-ownership. And finally, they are tightly wrapping these "platform principles" with solid change management techniques to achieve and sustain tremendous bottom line benefits, accelerate time to value, and extend the reach and advantages of this model.

Sources:

1 Gregory L. Schlegel, Richard C. Smith, "The Next Stage of Supply Chain Excellence," *Supply Chain Management Review,* March 2005.

2 John Kotter, *The Heart of Change*, Harvard Business School Press, 2002.