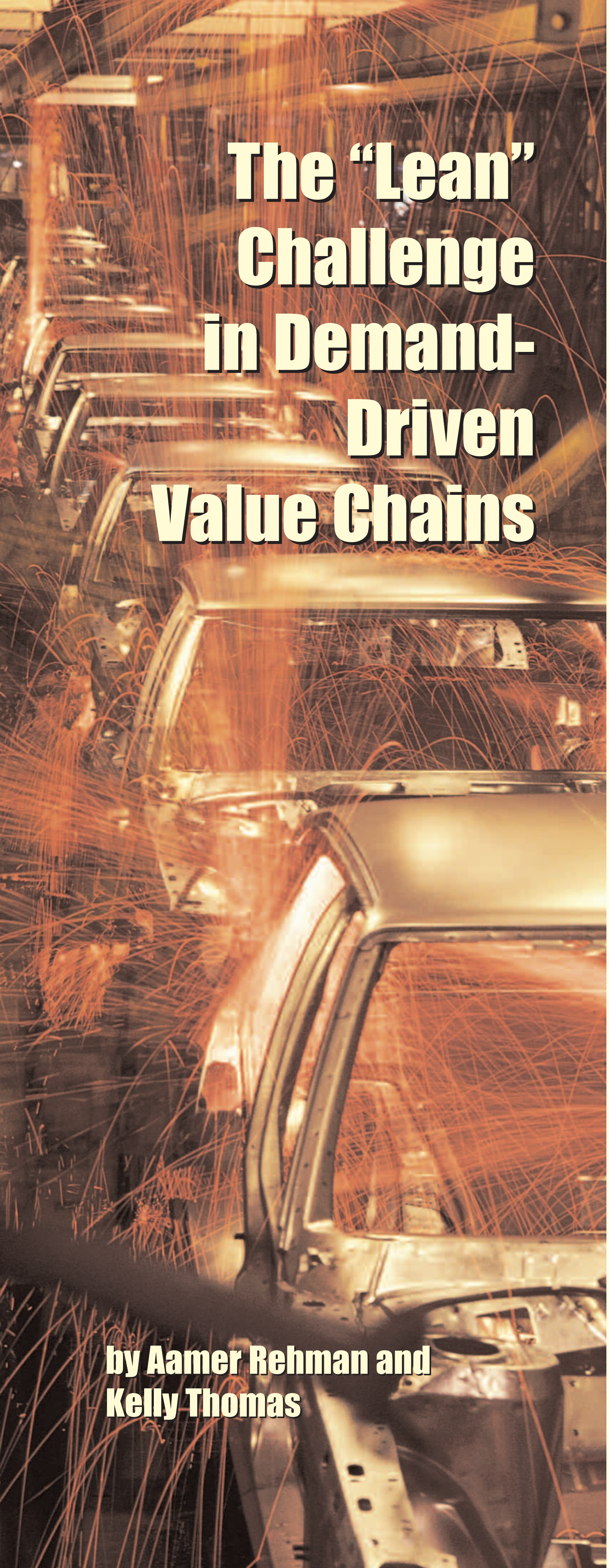

The "Lean" Challenge in Demand-Driven Value Chains

by Aamer Rehman and Kelly Thomas

Material pull must be driven by capacity signals from down-stream in addition to inventory-replenishment signals.

A May 2007 *USA Today* article entitled "Toyota's Success Pleases Proponents of 'Lean'" may have left some readers confused. On one hand, it attributes Toyota's success to lean manufacturing. On the other hand, it quotes survey results from management consulting firm Bain & Company stating that just 19 percent of companies that have tried lean are happy with the results. While the key concepts surrounding lean have existed for more than 40 years, the bottom-line savings and operational performance—in terms of inventory turns or order-fulfillment performance—have been below target, especially in environments beyond simple make-to-replenish.

Still, the concepts of lean manufacturing are fundamentally sound and pragmatic, and there is significant interest among industry professionals to use lean manufacturing to realize demand-driven order fulfillment. What is standing in the way of better results? Recent trends have contributed to a sense of skepticism about the adaptability of lean techniques, eroding adoption of the principles across all industry sectors.

One of these trends is mixed-mode manufacturing, where elements of build to order, engineer to order, and assemble to order can be applied to support an ever-increasing product portfolio and fluctuating demand profile. This operational model is more complex than the simple make-to-replenish model, and lean practitioners are having a hard time adapting the principles to it.

Another complicating factor is the extended enterprise or value chain, where value-added activities are extending beyond a company's four walls. In this case, the material-control techniques using the traditional manual/visual methods are no longer sufficient to synchronize material flow. More and more companies are calling for an electronic pull mechanism to adapt to the visibility, speed and flexibility required.

The other key factor for slow adoption of lean is the lack of knowledge and process discipline to enable a closed-loop continuous improvement, or kaizen, culture. [Kaizen is a Japanese term for creating continuous improvement; it focuses on quality, communication, teamwork and a willingness to adapt to change.] This kind of culture is critical to realizing a quick plan-do-check-act cycle for factory personnel.

But several obstacles to routinely achieving this iterative process present themselves in today's fast-moving, short-cycle manufacturing environment. There may be high employee turnover, eroding the knowledge base established over many years that fosters a systematic, "best-practice" approach to operations. Also, as manufacturing becomes less centralized and more distributed, it gets more difficult to sustain consistency across plants and practices. The solution is in standardization of both processes and systems. (Also see Interviews with GM's Adriana Karaboutis on page 12 and with reengineering guru James Champy on page 45.) A structured approach can eliminate maverick shop-floor behavior and channel shop-floor innovations so they can become cross-plant best practices.

While, in the past, lean practitioners preached technology solutions as an obstacle to lean adoption, today they are calling for a combined process and technology deployment model that can address complex fulfillment challenges. Partly, this is because planning, scheduling and execution are converging, and the hierarchical levels among them are diminishing, due to the need for quick decision support in a lean environment. But there is also a dawning realization that it is hard to achieve return on investment and total cost of operations savings for lean plants using the solutions of the past.

There are three levers companies can use to adapt lean principles across the enterprise. One is the use of various material-control techniques adapted for multi-mode manufacturing. A second is the deployment of advanced technology solutions that provide standardized workflows and "what-if" exceptions management. A third is the application of lean process-transformation approaches offered by service providers. Such offerings address the training, design, deployment and roll out of new processes and systems, depending on where a company is in its journey to an evolved lean manufacturing model.

Before we explore these levers further, let's revisit some of the basic principles of kanban.

The kanban system

The kanban control system is probably the most well-known pull-type mechanism for multi-stage production systems. Pull-based production paces a factory to actual customer demand and keeps the factory floor synchronized through a set of real-time, pull (kanban) signals. The goal of pull-based production is to create a smooth material flow throughout the supply chain. This is achieved by flowing product in small batches (to reduce lot size), pacing the processes to Takt Time (the "drumbeat" that sets the production pace in the plant), to avoid overproduction, and replenishing according to signals originating from downstream operations.

This control discipline limits the amount of inventory to a fixed maximum for each manufacturing cell, where the maximum is equal to the number of kanbans circulating within the cell. That's where things get sticky. Unfortunately, a simple kanban control system does not perform well in environments dealing with high demand or process variability. For example, one would like to have a large number of kanbans at times of high demand to enable quick response. But one would like to have a small number of kanbans at times of low demand to reduce inventory costs, since the number of kanbans is equal to the target inventory of finished parts.

In reality, manufacturers need the flexibility to choose dynamically between large and small numbers of kanbans. But it is commonly accepted that kanban control does not work well when demand and flow of parts are highly variable, thereby making it impractical for production environments in the high tech and industrial sectors, in particular.

In environments with custom products, product-mix variations, seasonality or highly variable demand, simple kanban control is not sufficient. Fortunately, there are material-pull techniques other than kanban control that support the changing production landscape, but still adhere to the core principles of lean manufacturing. While proven, these techniques are more complex than traditional kanban control and therefore require sophisticated technology and process support.

In high-mix, low-volume, demand-driven environments, pacemaker-level planning and scheduling must take a number of factors into account. First, there is the need to

LEAN **CONTINUED** on Next Page . . .

schedule build-to-order, make-to-stock and assemble-to-order items on the same production resources. Then, there are the start-of-life and end-of-life issues associated with parts planning and ordering. Finally, a set of sequencing rules based on order configurations and changeover matrices for products must be established while still achieving mix and capacity leveling. In such complex situations, planners must be able to create "what-if" scenarios quickly to assess the impact of changes on inventory targets, product mix and capacity utilization before publishing a feasible level plan.

The new paradigm

In the old paradigm, the kanban signals keep all in-house and external operations synchronized with the pace-maker. These signals are consumption-based and initiate production of specific parts and quantities upstream to consuming operations. Such kanbans are well-suited for low mix and repetitive production.

In the new paradigm, production authorization is not only driven by inventory-replenishment signals, but also by capacity signals from downstream operations. The processes and systems must have the capability to adopt new techniques as the production model transitions to a mixed-mode manufacturing model. It must be able to apply a manual kanban approach when appropriate but ramp up to electronic material-control techniques when required.

These techniques have been developed over the past 10–15 years and include CONWIP (constant work-in-progress, to control the total inventory in the system), POLCA (paired-cell overlapping loops of cards with authorization, effective when there are capacity constraints) and hybrid CONWIP and kanban. An appropriate combination of these techniques can be used to synchronize upstream and downstream operations with the pacemaker schedule.

Technology requirements

The solutions required to deploy lean principles and at the same time react quickly to demand volatility in today's complex, demand-driven manufacturing environment must be able to:

- Handle hybrid make-to-stock, make-to-order, assemble-to-order and engineer-to-order fulfillment models using a single technology framework
- Support additional material-control techniques beyond traditional kanban control to manage high-variety and custom-engineered products for which dedicated flow lines and simple visual control methods are not practical
- Use a single application platform capable of addressing lean requirements during design, operate, sustain and improve phases of a lean program
- Standardize on a technology platform that can handle plant to plant variations in terms of business rules, user experience, reporting and integration with legacy systems
- Provide a closed-loop environment to drive structured kaizen improvements using real-time metrics on the shop floor
- Maintain the same level of simplicity, user control and visibility for which lean is known, while making the enterprise roll-out of a lean program possible

The i2 Lean Transformation Life-Cycle solution has been designed to meet these challenges. It offers a comprehensive set of capabilities that support design, deployment, operation and improvement phases of a lean-manufacturing program. The solution combines principles of the Toyota Production System, various material-control techniques, a flexible application platform, rich scheduling and execution capabilities, quick what-if scenario assessment capabilities and real-time metrics for driving kaizen improvements.

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The solution is compatible with lean manufacturing principles of level production, as well as with mix management, synchronized pull and Six Sigma's DMAIC (define, measure, analyze, improve and control) approach for continuous improvement and process control. In these ways, it can help companies operate in a hybrid mode to achieve the successful adoption of lean manufacturing across the extended enterprise.

In summary, i2 strongly believes that it is possible to employ lean principles across the extended enterprise if companies are willing and able to invest in a comprehensive methodology based on more sophisticated pull techniques and more advanced software solutions. If so, they can create a long-lasting lean transformation across their extended enterprises.

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