Lean Planning and Execution Software: Extending Lean Thinking Across the Enterprise

by Colin Masson and Simon Jacobson

A flurry of mergers and acquisitions that feature some of the premier names in software and lean consulting—JCIT, Microsoft, SAP, and Siemens—highlight the growing demand for applications to support enterprise-wide replication of lean best practices across increasingly complex and volatile manufacturing environments.

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Many companies seem to have lost sight of one of the core tenets of lean: putting the customer first.

The
Bottom
Line

Executive Summary

Despite strong advances in features and capabilities, supporting lean manufacturing through enterprise-class software is not growing at the pace one would expect. Although lean concepts have made their way into the mindset of many corporations, it has remained relatively plant centric, even line centric.

This Report analyzes interviews with more than 20 technology providers of lean planning and execution applications and more than 45 companies currently practicing lean manufacturing techniques. From our research, we conclude the following:

- Although lean manufacturing practices are fairly widespread, particularly in operator-paced line flow and job-shop environments, the penetration of enterprise-class lean software is still low.

- Most plant-centric implementations focus on applying lean principles first, and then grudgingly on making sparse and selective use of software.

- Companies with complex configuration requirements use software earlier in their lean journeys than their repetitive flow brethren.

- Differentiation across lean software packages is primarily based on lean philosophy: the Toyota Production System (TPS) or demand flow technology (DFT) and the industry focus of technology providers.

- During the software selection process, incumbent software providers, particularly ERP or MES suppliers, have the inside track because of their customers' desires to leverage as much as possible from existing IT investments. There is also the need for integration with sales and operations planning (S&OP) processes and order-promising systems.

Vendors featured in this Report:

Cincom
Dassault Systemes
DemandPoint
eBECS/Microsoft
Epicor
Glovia
IFS
Infor
Invistics
Lawson
Oracle
QAD
SAP
SAP's FactoryLogic
SoftBrands
SupplyWorks
Synchrono
UGS/Siemens
Ultriva (eBots)

Enterprise-class software penetration is still low

In a 2006 AMR Research survey of 208 manufacturers, 43% of respondents claimed to use lean manufacturing practices, but few have deployed these practices widely across multiple sites. Deployments using software to support these practices are even less common.

Despite the fact we reviewed over 20 lean planning and execution software packages for this Report, most vendors had user counts that barely exceeded 50 sites. The low penetration of enterprise-class software is confirmed by related AMR Research studies on lean manufacturing, which show that, among lean practitioners, there is high usage of homegrown tools with PC-based ones, such as Microsoft Visio for value stream mapping and Microsoft Excel for takt time and kanban sizing calculations. However, there is very limited use of commercial lean software applications and even less integration to ERP systems.

While our recent IT spending survey shows 15% of companies said the application of lean practices across the organization was the single most important business initiative affecting IT investment decisions, our interviews indicate companies have been slow to adopt the broad range of functionality offered by lean software providers. This is also a result of the relatively small number of vendors delivering lean software applications, with even fewer showing profitable growth.

Plant-centric implementations focus on lean principles first

Most manufacturers we interviewed confine their lean projects to a single plant, often right down to a production line or product area. This plant and production-line centricity runs contrary to the enterprise and value chain focus that is the mainstay philosophy of ERP implementations, supply chain investments, and the burgeoning demand for a predictable manufacturing response across global supply networks. This myopic plant/line focus challenges companies trying to make the business case for their lean IT investments. As they begin to roll out lean manufacturing techniques across additional lines and plants, they've continued to use their spreadsheets and whiteboard approaches to their implementation.

This trend can and should be reversed. While companies we interviewed realized 40% to 50% inventory savings with their manual lean processes, the most mature lean practitioners admit technology is needed to scale beyond a single line or plant, sustain the advantages already in place, and provide enterprise visibility to inventory and job status. Lean manufacturing can be enhanced with data accuracy and visibility as well as the quick problem resolution of software applications.

In addition, the benefits of lean principles are realized when companies reach outside the plant to the extended supply chain. Visibility to downstream data from the customer and the signals out to suppliers will be critical to attaining a perfect order.

Companies lose sight of core principle of lean

Consistent with our previous lean research, we are again staggered to find only a handful of companies surveyed for this Report measure their customer service levels before and after their lean implementations. The first core tenet of lean is to deliver what customers want at the price they are willing to pay, and then manage processes to deliver product on time and to those specifications. Out of the 40 companies surveyed, those in a capable-to-order (CTO) or available-to-order (ATO) environment are more likely to measure the impact on customer service. One industrial products manufacturer highlighted its success in reducing the time from when an order hit the system to when it was scheduled on the shop floor: from 18 hours to 9 minutes. Only two standard assembly companies performed any measure of customer service or customer satisfaction.
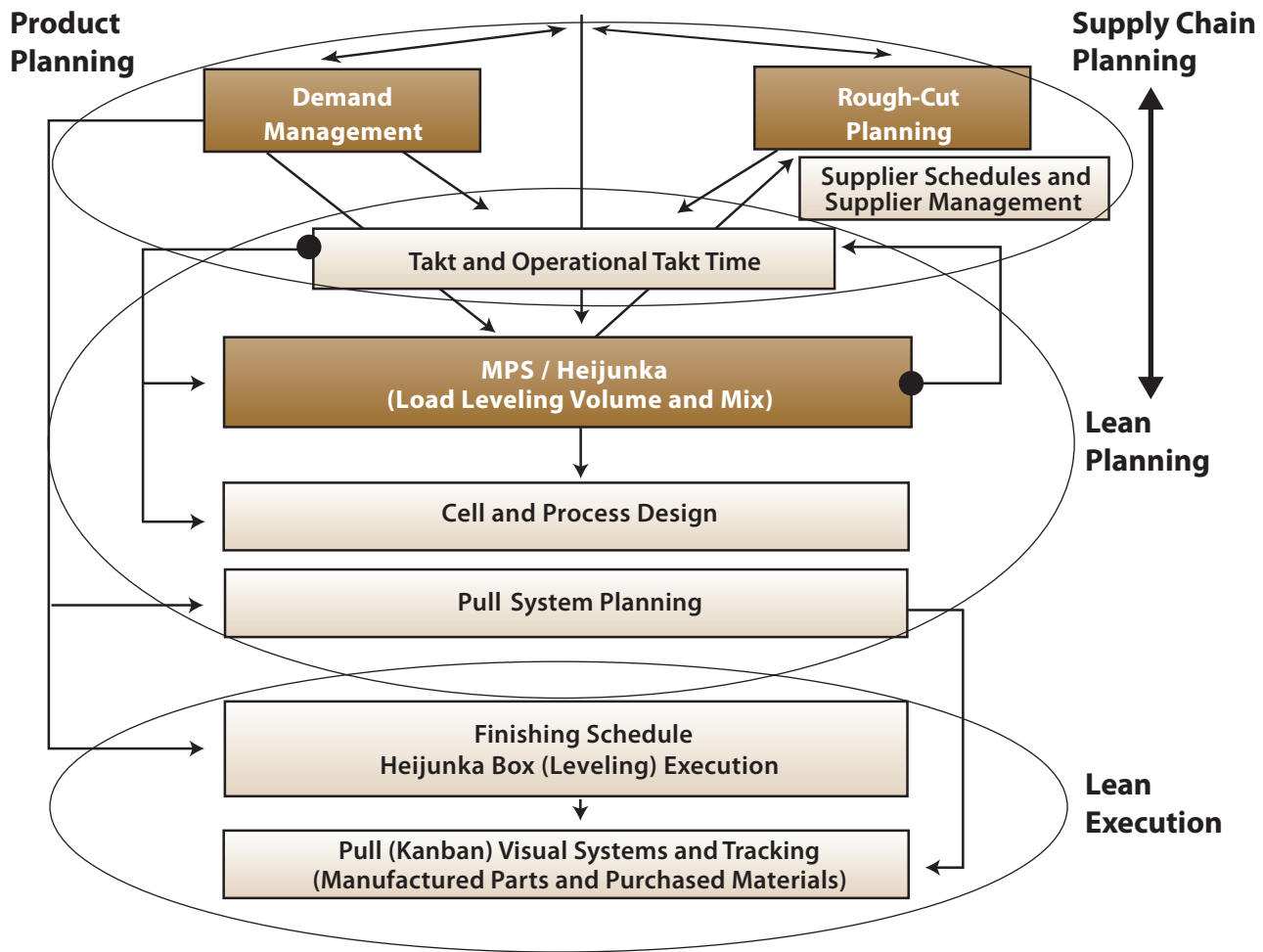
Yes, lean brings a set of work-in-process and manufacturing principles into play, but it's not confined to heijunka, kanban, and takt-time calculations. Lean is a philosophy grounded in delivering what customers want, when they want it, and at a price they will pay through the constant and relentless elimination of waste. Success of lean is measured against these core tenets, and any tool, whether inside or outside the traditional lean toolbox, should be evaluated on how it supports these tenets within the given environment. Until companies make the leap to tools and applications that take a systemic approach to tying together the demand-to-delivery value stream, there will only be pockets of results.

East meets west: lean planning and execution

In our view of lean manufacturing tools, we break them down into two primary categories: lean planning and lean execution. Figure 1 depicts a future-state blending of traditional ERP systems and practices with modern lean planning and execution activities. It reflects how many of today's leading manufacturers want to leverage their ERP investments to accommodate the needs for demand visibility and supplier integration while scaling their lean manufacturing practices.

In this state, value streams have been restructured and simplified, shared processes disentangled, equipment dedicated to a single value stream, and all parts and processes handled by flow or pull mechanisms. Traditional material planning also has been eliminated for lean manufactured items, and supplier projections are done from rough-cut planning techniques.

Product Planning

Supply Chain Planning

Demand Management

Rough-Cut Planning

Supplier Schedules and Supplier Management

Takt and Operational Takt Time

MPS / Heijunka
(Load Leveling Volume and Mix)

Lean Planning

Cell and Process Design

Pull System Planning

Finishing Schedule
Heijunka Box (Leveling) Execution

Lean Execution

Pull (Kanban) Visual Systems and Tracking
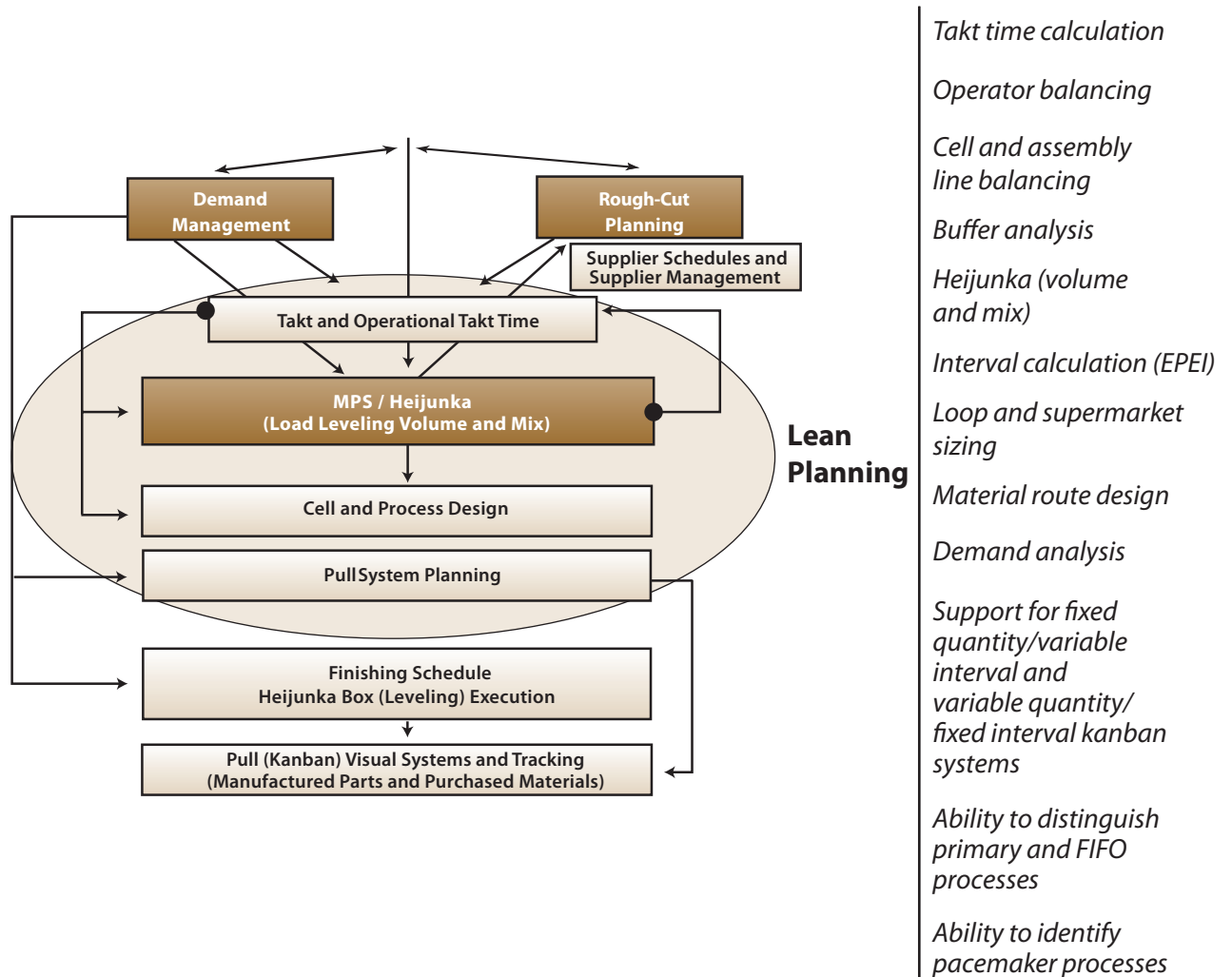(Manufactured Parts and Purchased Materials)

Source: AMR Research, 2007

Definitions

Lean planning is the set of activities and applications that analyzes product design for lean manufacturing demand inflows, with an eye toward calculating required takt times, interval calculations, balancing lines, leveling load, synchronizing raw material procurement, managing inventory buffers, and setting overall inventory levels. These activities do not handle the actual manufacturing execution.

Figure 2: Lean planning capabilities

Takt time calculation

Operator balancing

Cell and assembly line balancing

Buffer analysis

Heijunka (volume and mix)

Interval calculation (EPEI)

Loop and supermarket sizing

Material route design

Demand analysis

Support for fixed quantity/variable interval and variable quantity/ fixed interval kanban systems

Ability to distinguish primary and FIFO processes

Ability to identify pacemaker processes
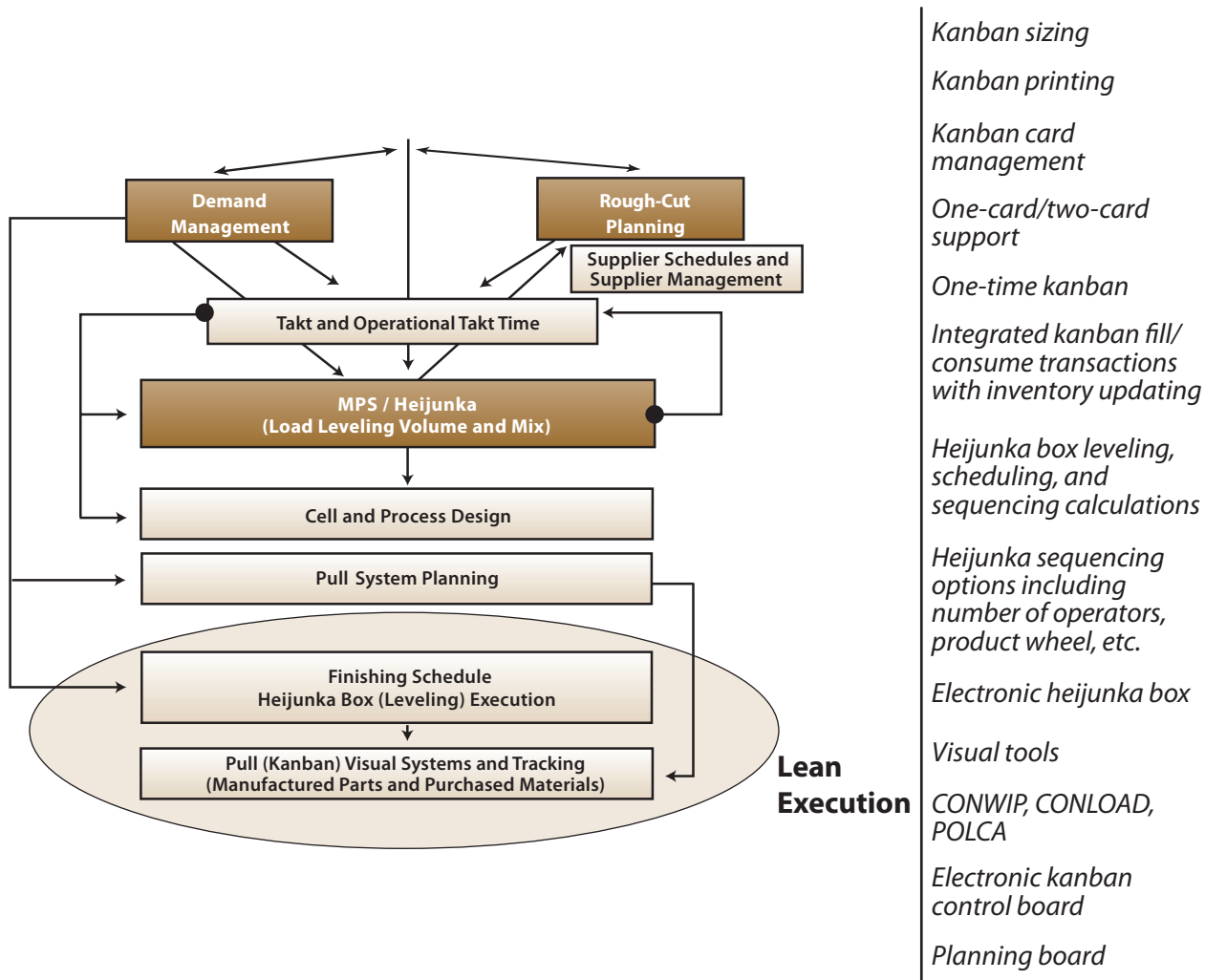
Source: AMR Research, 2007

Lean execution controls the physical activities of the shop floor and component supplier signaling. The techniques include kanban replenishment and management, rapid replenishment, and CONLOAD (constant load) workflow regulation. It also covers the detail scheduling of production activities through heijunka sequencing, workflow prioritization, and electronic displays. Some systems will carry the kanban activities out to electronic integration with component suppliers as well.

Figure 3: Lean execution capabilities

Kanban sizing

Kanban printing

Kanban card management

One-card/two-card support

One-time kanban

Integrated kanban fill/consume transactions with inventory updating

Heijunka box leveling, scheduling, and sequencing calculations

Heijunka sequencing options including number of operators, product wheel, etc.

Electronic heijunka box

Visual tools

CONWIP, CONLOAD, POLCA

Electronic kanban control board

Planning board

Source: AMR Research, 2007

Before selecting your vendor, select your lean philosophy

The core tenets of lean thinking have been extensively documented, and the vendors featured in this Report will pass an initial checklist that screens for coverage of core lean planning and scheduling functionality. In the early stages of adoption, though, there's little evidence that manufacturers have the patience to labor through feature and functionality bakeoffs.

One factor that clearly drove not only the design of these vendors' packages but also the selection by users was an underlying lean philosophy. The two most common design approaches are based on TPS and DFT.

TPS

The Toyota Production System emerged in the 1950s. It organizes all jobs around human motion and creates an efficient production sequence without any *Muda*, or waste. It consists of three elements: takt time, working sequence, and standard in-process stock.

One of the foundations of TPS is just in time (JIT), which refers to the manufacturing and conveyance of only what is needed, when it is needed, and in the amount needed. JIT is built upon three basic principles: the pull system, continuous flow processing, and predictable cycle times. Work organized in this way is called *standardized work*. It's very successful in high-volume standardized products, but faces challenges in many of today's scenarios of high product mix, shared production asset, and volatile demand.

DFT

In the 1980s, John Costanza of **JCIT International** turned DFT from a black art into a science, developing implementation steps, mathematically based tools for simulation, and design production processes to achieve balanced and flexible processes. Based on a flow-manufacturing technology with an emphasis on simultaneous engineering techniques, responsiveness, and speed to market for delivering high-quality products on demand, it has found a home with manufacturers that, by necessity, must deliver products with a high amount of configurability and shorter runs.

In DFT, production lines and cells are established for multiple products, and optimized families of products and aggregated demand are scheduled for a production line that supports a family of products. DFT also uncouples the planning and procurement of materials, making it independent of production schedules. As a strategy, DFT considers all supporting organizations, such as IT, engineering, procurement, and quality, as part of the manufacturing value stream. DFT also places emphasis on training, certifying, and compensating employees to facilitate flexibility, quality, and continuous improvement. JCIT has been consulted by many of the ERP vendors and manufacturers interviewed for this Report.

The limitations of TPS

What happens when you try and apply the typical TPS lean approach to high product mix, shared production assets, and volatile demand scenarios? Here's a small sampling:

- Kanban cards and heijunka boards become unmanageable when there are hundreds or thousands of products and components.
- Machines and cells can't be dedicated to single products. Product flow has to be managed through complex factories, competing for resources with moving bottlenecks.
- More complex pull-scheduling techniques, such as generic kanban, CONWIP (constant work in process), CONLOAD, drum-buffer-rope (DBR), or POLCA, need to be implemented to avoid starvation of moving bottlenecks while still driving down inventory levels despite demand variability.
- Calculating raw material, work in process, finished goods inventories, and production lot sizes can no longer be based on simple rules of thumb and experimental design. They need to use operations research techniques that simulate shared assets, flow paths through these assets, and regularly recalculate target inventories based on volatile demand.
- Similarly, capacity utilization isn't a simple rule-of-thumb calculation using takt times. Capacity utilization and bottleneck locations in high-product-mix scenarios are sensitive to variability in equipment processing times, downtimes, setup times, and product demand. By modeling the exponentially damaging effect of variability on cycle times at higher capacity levels, high-mix lean techniques can also calculate the sources of variability that should be attacked first without compromising customer-service levels with guesswork.

While both have their adherents and demonstrated strong performance in their respective implementations, Figure 4 shows where each has its stronger fit to manufacturing scenarios. For users selecting software for lean manufacturing, this will be one of the key criteria for their decisions.

Figure 4: Product and process attributes drive lean philosophy
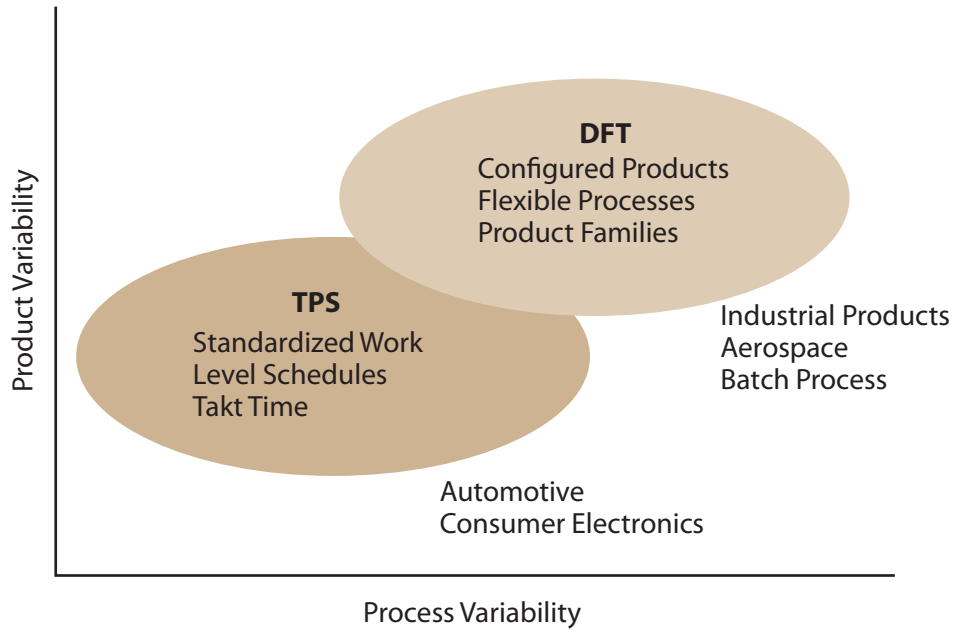
Source: AMR Research, 2007

While several vendors have tried to weave the two philosophies together in their packages, most vendors line up squarely behind one. This is reflected clearly in the industries in which they've been successful.

Table 1: Supported manufacturing styles and ERP integration

Vendor	Native ERP or Add-On	Product Supported	Manufacturing Style Support
Cincom	Add-on only to Cincom Control	Cincom only	ATO/CTO/ETO/MTO, Discrete
Dassault Systemes	Best-of-breed add-on—more specific to CAD/PDM applications	DELMIA, CATIA	Discrete
DemandPoint	Best-of-breed add-on	Infor MAPICS, Microsoft Dynamics AX, Oracle JDE, SAP	MTO/MTS
eBECS/Microsoft	ERP-based (now owned by Microsoft)	Microsoft Dynamics AX	Discrete
Epicor	ERP-based	Standalone	Discrete, ETO, some BTO
Glovia	ERP	Glovia ERP	Discrete, BTO
IFS	ERP	IFS Applications	Discrete, ETO
Infor	ERP	Infor ERP LX, Infor ERP LN, Infor ERP XA, Infor ERP SyteLine, Infor ERP VISUAL, Infor ERP Adage	MTS/Process/HVR, MTO/MTS, MTO, Process
Invistics	Best-of-breed add-on	SAP	High mix, process
Lawson	ERP	M3	MTO/MTS
Oracle	ERP	JD Edwards EnterpriseOne, Oracle (E-Business Suite), Oracle OPM	MTO, high-volume repetitive MTS/MTO/CTO, ETO, repetitive, process
QAD	ERP	QAD MFG/Pro	Discrete, repetitive
SAP	ERP Best-of-breed add-on	SAP ERP, All-in-One	Low-mix discrete
SAP's FactoryLogic (xLPO)	Best-of-breed add-on	SAP ERP, All-in-One, QAD	High-volume/low-mix discrete

Source: AMR Research, 2007

Table 1: Supported manufacturing styles and ERP integration (continued)

Vendor	Native ERP or Add-On	Product Supported	Manufacturing Style Support
SoftBrands	ERP, Best-of-breed add-on	FourthShift Edition for SAP, Business One, DemandStream	Discrete, repetitive
SupplyWorks (now part of Consoma)	Add-on	Infor MAPICS	Discrete
Synchrono	Best-of-breed add-on	SAP, Infor ERP Syteline & VISUAL, Epicor, Microsoft, Axapta, Great Plains, Oracle, JD Edwards EnterpriseOne & E-Business Suite, Best Software	ATO/CTO/ETO/MTO, discrete
UGS/Siemens	Add-on (PLM focus)	Teamcenter	Discrete
Ultriva (eBots)	Best-of-breed add-on	Oracle, SAP, Microsoft AX, PRMS, Infor MAPICS	Discrete

Source: AMR Research, 2007

The technique may be industry oriented, but lean delivers

After interviewing a great number of end users, we found that industry and product complexity played a big factor in the popularity of one technique over the other. Still, it was clear that, despite the differences, users of both philosophies have achieved successes. Through the interviews and case studies, we found the following examples:

- One automotive supplier that applied TPS reduced finished goods inventories by 40%, while simultaneously reducing labor costs through overtime reduction by 12%. Throughput increased by 17%.

- An industrial machinery maker that adopted DFT saw a 23% reduction in inventory, while also increasing manufacturing output by more than 30%. The inventory turns for this configured product manufacturer increased from 6.2 to 10 turns annually.

TPS and DFT have their roots in different industries. Along with the support for their preferred lean philosophies, vendors have targeted their marketing and development efforts in those industries. To overcome the resistance to lean software, the vendors featured in this Report had to deliver differentiated industry functionality. For example, as vendors succeeded in selling into an industry, they developed deeper functionality to meet the requirements of that industry. For example, the engineer-to-order (ETO) focus of A&D requires tight integration of configuration and scheduling, whereas the repetitive manufacturing processes of automotive parts suppliers are better served by the automatic communication of kanban signals to their suppliers.

No matter how much functionality is available, the majority of standard assembly users are primarily concerned with the kanban capabilities and some scheduling—often easily treated as standalone requirements. The good news is that, especially at the execution level, lean software is seen as contributing positively to the sharing and scaling of lean thinking across the enterprises interviewed for this Report. Users often claim excellent savings from the software's ability to highlight deviations from takt times, identify the need for kanban resizing and management, enable automated supplier kanban communication management monitoring, and provide real-time visibility of kanban replenishment.

One of the key user issues is software usability, especially in the kanban management and reporting area. It's a concern that seems to reinforce the spreadsheet usage that is dominant in many early-stage lean implementations. While many of the ERP vendors now offer comparable functionality to best-of-breed applications, the complexity of their user interfaces and higher configuration and deployment costs were frequently cited as reasons for sacrificing integration benefits.

Oracle and SAP are already addressing their configurability and usability issues with targeted manufacturing investments. Examples include Oracle's new configurable MES Workstation and Supervisor Workbench in the Oracle EBS Release 12, as well as SAP's acquisition of **Lighthammer** and FactoryLogic. But for now, the pure plays have both a usability and cost-of-deployment advantage.

Lean practitioners with build-to-order (BTO) or ETO requirements are more likely to adopt software earlier in their lean journeys. Because of the high number of product configurations in their product families, complexity in their bills of materials (BOMs), and routing through shared resources, manufacturers of medical device, industrial, and A&D products have been more apt to turn to providers of DFT for help with constraint-based planning and scheduling along with the use of configurators in the execution of their lean operations.

Table 2: Preferred lean philosophy and industry references

TPS		
	SupplyWorks	Automotive
	eBECS/Microsoft	Automotive, High-Tech
	SAP's FactoryLogic	Automotive
	IFS	Automotive, Aerospace, Capital Equip
	Infor (ERP VISUAL, ERP SyteLine)	Automotive
	Lawson	Complex Discrete, Automotive, Capital Equipment, Furniture
	QAD	Automotive, Electronics, Medical
	Ultriva (eBots)	Electronics, Automotive, Heavy Equipment

DFT		
	Cincom	Complex, Industrial Products
	Glovia	Complex
	Epicor	A&D, Industrial Products, Electronics
	Infor (ERP LN, ERP XA)	Automotive, A&D, Industrial Equipment
	Invistics*	Pharma, CPG, Specialty Chem, Metals
	Oracle—JD Edwards EnterpriseOne	High-Tech, Medical Devices, Industrial,
	Oracle—E-Business Suite	High-Tech, Medical Devices, Architectural Products, Automotive, Complex, Industrial Products, Capital Equipment
	DemandPoint	Automotive, Industrial Equipment, High-Tech, Medical
	SAP	Industrial Equipment, Electronics, A&D
	SoftBrands	Industrial Equipment, Electronics, Automotive
	Synchrono*	Capital Equipment, Industrial, High-Tech, A&D, Metals
	UGS/Siemens	Heavy Equipment, A&D

Also implements "Factory Physics" techniques.

Source: AMR Research, 2007

Incumbent ERP software providers have the inside track

Few of the lean practitioners interviewed had conducted rigorous software selection processes, although many started with their incumbent ERP providers. If the providers offer credible applications, the scales are heavily tipped in their favor, with best-of-breed vendors facing an uphill battle.

However, best-of-breed vendors still have lots to offer. They are more likely to be selected by companies that have multiple ERP systems or if the ERP vendor of record does not have significant lean planning and execution functionality. As mentioned earlier, other factors likely to derail the incumbent ERP provider are poorly designed user interfaces for shop-floor users, high cost of deployment, and the ever-present manufacturing operations requirement for onsite planning and execution systems to run independently of corporate ERP systems.
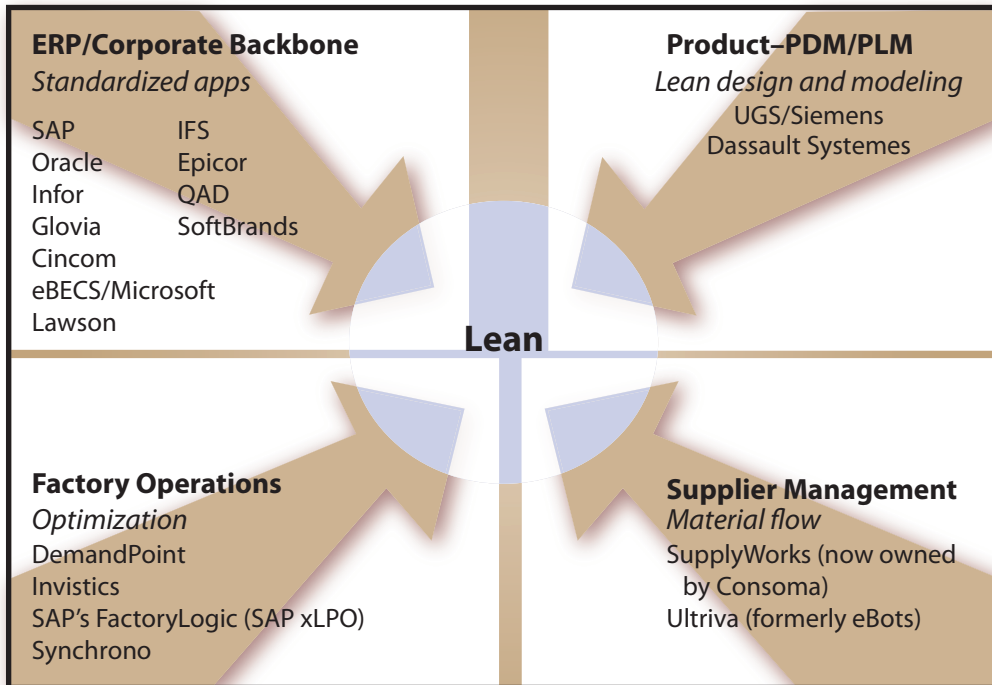
Many ERP vendors are still struggling to deliver intuitive, low-complexity support for work-orderless production. If lean initiatives are outpacing ERP deployments, best-of-breed vendors are seriously evaluated. In this scenario, industry experience and referenceability are given heavy weighting in the software selection process in addition to functionality, ease of use, and cost of deployment. This is where best-of-breed players have the chance to shine.

Existing IT environment is a big influence

From our interviews with manufacturers and win-loss analysis discussions with vendors, existing IT environments clearly influence the software selection process.

Manufacturers with aging ERP systems wedded to push philosophies have little option but to turn to specialty applications and add-on products. This is especially true for lean execution, where these manufacturers selected add-ons that deal with supplier and kanban issues from vendors such as Ultriva (eBots), SupplyWorks, or SAP's FactoryLogic. Others that need to resolve both complex product and line design issues opt for tools provided by their product lifecycle management (PLM) vendors, such as UGS/Siemens or Dassault.

Figure 5: Coming at lean from very different directions

ERP/Corporate Backbone	**Product–PDM/PLM**
Standardized apps	*Lean design and modeling*
SAP IFS	UGS/Siemens
Oracle Epicor	Dassault Systemes
Infor QAD	
Glovia SoftBrands	
Cincom	
eBECS/Microsoft	
Lawson	
	Lean	
Factory Operations	**Supplier Management**
Optimization	*Material flow*
DemandPoint	SupplyWorks (now owned
Invistics	by Consoma)
SAP's FactoryLogic (SAP xLPO)	Ultriva (formerly eBots)
Synchrono	

Source: AMR Research, 2007

Vendors providing more comprehensive design, cycle-time optimization, and lean execution capabilities, including SAP's FactoryLogic, Invistics, Synchrono, and DemandPoint, are managing to overcome these hurdles, with nimbler, easier to use, factory-level applications:

- The FactoryLogic acquisition gives SAP some new options for supporting lean initiatives at the plant level in traditional high-volume repetitive environments (the product is now offered as xApp for Lean Planning and Operations, or SAP xLPO).

- Invistics is pioneering lean thinking in batch process environments, such as specialty chemicals and pharmaceuticals.

- DemandPoint, the name of the new union between JCIT and Pelion Systems, provides an integrated application that takes value stream maps all the way through to lean execution in a wide range of discrete manufacturing environments. JCIT has the credentials to provide consulting and services to extend the Pelion Systems DFT factory optimization software to broader demand flow fulfillment.

- Synchrono has been evangelizing demand and supplier integration across multiple manufacturing facilities with software for adaptive order promising, manufacturing and supplier replenishment applications that enable pull, synchronization, and flow in environments where heijunka and kanbans struggle to cope.

Easy-to-use, low-cost, value stream mapping tools, like **GumshoeKI** eVSM, **iGrafix** tools, **Orlando Software Group's** (**OSGi**) LeanView, and **SigmaFlow** VSM, are gaining the most traction, but software deployments that support lean planning and execution are much more scarce.

Lean implementations still need many processes that reside in backbone systems. For example, TPS benefits from the level-loading capabilities of product family planning, master production scheduling (MPS), and backflushing that often is performed in ERP systems. Likewise, DFT implementations in ATO/CTO manufacturing typically benefit from tight integration with the product configurators, BOMs, and process definitions available in ERP.

IT's role in lean

The history of IT and lean is a rocky one. Lean advocates look at time spent interacting with computers as non-value added. Given the cumbersome interfaces of most ERP systems, they're right.

Some companies are already well along the path, but lean leaders have been avoiding IT. Companies should consider the following:

- As described in "East Meets West—Lean Manufacturing and ERP Are a Better Fit Than You Think," the traditional MRP logic will be used differently and, in the initial phases, much of it may be turned off or ignored.

- The process must be leaned out before it can be automated. Hold off from diving into the project until the team is ready. At that point, IT applications can help scale up the new process and reinforce it so that people don't slip into old habits.

- A key principle in lean is a visual workplace: workers can tell what to do based on what they see. For lean processes within the four walls of the factory, these can be simple tangible signals, bulletin boards, and so forth. To make a global supply chain visual, you need technology to make each site visible to the others.

Lessons learned from lean practitioners

Despite limited adoption of enterprise-class systems, it is clear that companies are reaping the benefits of lean manufacturing techniques. Lean practitioners have shared a few lessons:

- Many lean practitioners recommend that those embarking on their lean journeys start with lean education first. This includes observing things that work for other companies with similar manufacturing issues. Most existing practitioners are proud of their accomplishments. We found them eager to show others what they accomplished. This, however, did not include their competitors, reflecting their views that lean thinking is giving them a competitive advantage. But most are willing to share with noncompetitive companies that have similar manufacturing styles.

- A common theme expressed by many lean practitioners is the desire to learn and work out the lean mathematics, processes, and disciplines manually or on commonly available spreadsheet and graphics tools prior to implementing their knowledge in more sophisticated lean software. They've been taught by their lean sensei that they must avoid automating bad processes at all costs.

- Long-serving lean practitioners are finding they must implement technology to institutionalize their lean process knowledge to scale and meet demand for visibility from the rest of the enterprise, which wants to optimize its demand and supplier processes to take advantage of newfound manufacturing responsiveness. Several lean practitioners we talked to made observations that they were often locally optimizing manufacturing, but not for the business as a whole. One example was in the strategic sourcing of components and raw materials.

- Striving for incremental success, lean is a process of continuous improvement. As one user described it, "If you're striving for one piece flow, but it now takes you eight steps, then drive it to five, then three, and then one." In other words, don't wait until it's perfect. Execute, learn from your experience, and perform another kaizen event when you understand the next steps.

- 50% of users surveyed reiterated that the real key to a successful lean transformation is through people. To be successful with lean, your employees must be willing to adapt to change and embrace critical self evaluation. Many companies also credited the success of their lean projects to the buy-in and commitment from senior management. Beyond supporting the cultural change required to support lean thinking, changes in inventory and assets can appear to have a negative impact when measured through standard accounting practices. Executive buy-in helps overcome this hurdle when lean accounting practices haven't yet been implemented.

Conclusion

Despite limited adoption of enterprise-class systems, it is clear that lean thinking has taken root and is here to stay. We noted several key trends and heard numerous recommendations from the users of today's lean planning and execution software systems:

- ERP-based lean implementations will grow over time. Today many best-of-breed add-ons excel at their given lean focus, which works well for the highly focused surgical strikes of early-stage lean adopters. As time goes on, manufacturers will want to use more of the capabilities that reside in their ERP systems: order management, mixed-mode manufacturing, cascading planning, integrated financials, and corporate-wide analytic systems, most of which aren't part of specialty lean systems.

- Many manufacturers, seeing the productivity and financial performance improvements from isolated lean deployments, want to implement these systems on an enterprise-wide scale. However, disparate systems across corporate landscapes make this more difficult. Manufacturing service-oriented architecture (SOA) adoption is running ahead of enterprise SOA. This could be a tremendous opportunity for best-of breed vendors to deliver standardized, locally deployed lean planning and execution capabilities that can still be integrated to multiple ERP systems. With functionality, ease-of-use, and cost-of-ownership advantages, best-of-breed vendors still have lots of room to grow, particularly in manufacturers where lean initiatives are running ahead of ERP deployments and consolidation efforts.

- Ease of deployments and use remains a barrier to the adoption of lean software on the shop floor. These have long been the barriers to ERP penetrating manufacturing operations and displacing MES (see "ERP-Based Manufacturing: Challenging MES Assumptions." Lean techniques must deepen and broaden to allow lean thinking to deal with high product mix, shared assets, and variable demand. The real challenge, though, is to provide those additional capabilities while simultaneously reducing the overhead of potentially non-value-added transactions and improving usability for work-orderless production. ERP vendors that remain wedded to proprietary and complex transaction-oriented user interfaces are going to lose ground to innovators that hide the smart math behind intuitive, role-based graphical user interfaces. The vendors that manage to phase an implementation that starts with familiar spreadsheets and then gracefully migrates onto scalable applications that perform more regular, complex calculations and integrate with ERP-based demand and supplier processes will have a winner on their hands.

- There's still room for innovators, particularly those extending lean thinking to the underserved process industries, to link product and process design to lean planning and execution or provide much-needed analytical workbenches on top of real-time data collection.

Appendix A: Lean planning and execution vendors

Cincom

Cincom's lean focus is about bringing demand-driven tools to complex manufacturing environments. Cincom has long targeted manufacturing industries such as A&D, truck and heavy equipment, and industrial products. For its lean manufacturing, it uses a hybrid of demand flow for complex environments. The company's differentiator is an extension to the full ordering/configuring process beyond just lean manufacturing operations support. This is accomplished through a guided selling front end to improve demand shaping and sequencing into production. In the execution area, Cincom uses constraint-based sequenced manufacturing to create a level-loaded production plan, sequence them, and manage material flow and production execution.

Dassault Systemes

Addressing lean via the design and product side of manufacturing, Dassault provides its DELMIA toolkit for the lean manufacturer. It is the end result of several acquisitions that Dassault has made, beginning with **Deneb** for robotics simulation, **Delta** for process planning, and **SafeWorks** for ergonomics/human-machine interface planning. Of the three, the process planning module plays the largest role in assisting companies with their lean initiatives. This is primarily a modeling tool for companies with complex process development requirements, such as the A&D world. The Dassault production line modeling will help assess best process flows, automatically balance lines, and help identify wasteful steps.

DemandPoint (Pelion Systems and JCIT International)

Pelion Systems recently merged with the pioneer of DFT, JCIT International, and the combined entity is known as DemandPoint (for our analysis, see "DemandPoint: Lean Software and DFT Consulting Pioneers Merge").

DemandPoint has taken a different approach than many software firms in placing an emphasis on helping customers work toward a lean manufacturing operating system that addresses all the core tenets of lean thinking (define customer value, map the value stream, create flow, let the customer pull value, and pursue perfection). The modular nature of its offering reflects that approach: Factory Knowledgebase, Value Stream Mapping, Process Optimizer, Demand Manager, and Performance Manager, with Supply and Distribution Manager capabilities to extend lean benefits outside the factory. The company's approach has been validated by its nomination as a finalist in the 2007 PACE Awards, which recognize innovation in the automotive industry.

eBECS/Microsoft

eBECS was a value-added Microsoft partner, specializing in adding lean capabilities to the Axapta system, until its recent acquisition by Microsoft (see "Microsoft Dynamics Enters the Lean Market With eBECS Acquisition"). eBECS Lean Enterprise adds lean functionality to Microsoft Dynamics for discrete manufacturers. Their targets are manufacturers that need to upgrade ERP systems and, at the same time, introduce or support their lean initiatives. The product provides comprehensive lean functionality from simple use of kanbans to sophisticated lean accounting concepts. It supports a complete automotive capability.

Epicor

A vendor with numerous ERP packages in its stable, Epicor points to its Vantage product as its leading lean manufacturing suite. Vantage targets the midmarket manufacturer, but emphasizes the package's capabilities to help these manufacturers interact with their large customers. Vantage is a full-featured lean-enabled ERP system with some capabilities for ATO/CTO/ETO manufacturing. The product emphasizes ease of use and simple implementation along with workflow to support the unique needs of customers in industries such as A&D. The capabilities for electronic collaboration with partners focus on easy integration to suppliers, and the internal operations features include automated material flow that supports numerous types of kanbans. The product also includes CRM, supplier relationship management (SRM), advanced planning and scheduling (APS), PLM, and quality modules that will appeal to the smaller manufacturer looking for a full footprint system.

Glovia

Glovia's extensive ERP system is based on its long experience with complex and highly configured manufacturing environments. The product combines the ability to map demand accurately, with capabilities for smoothing, leveling, and scheduling it accordingly. It also features various operational capabilities, such as real-time pull and backflush, real-time data collection, and monitoring. Given its engineered product manufacturing heritage, Glovia also includes Engineering Change, Estimating, and Shop-Floor Data Collection modules to help manufacturers reduce setup and changeover cycle times and better execute total productive maintenance (TPM).

IFS

The IFS model aims at bringing lean into the ETO world. IFS's industry-focused systems combine ERP, enterprise asset management (EAM), and maintenance, repair, and overhaul (MRO). IFS characterizes its approach as a hybrid lean model, a system that allows manufacturers to mix rate-based and order-based production. It incorporates demand leveling, kanban planning and execution, vendor-managed inventory, repetitive production, and cellular manufacturing along with kaizen costing analysis, event management, integrated engineering change management, and corporate performance management dashboards.

Infor

Infor has multiple tools available in the lean manufacturing area. The company has several ERP-based offerings, including its ERP XA, ERP Visual, ERP LN, ERP LX, ERP Adage, and ERP SyteLine products. It also has an extended offering for automotive tier suppliers to better manage their supply management needs with its SupplyWEB product.

With the ERP XA product, Infor has a legacy of focus on world-class manufacturing based largely on lean principles. The company has also released ERP XA Lean Execution and Planning, its version of an MES specifically designed to support lean initiatives on the shop floor. This set of MES applications allows for the coexistence and simultaneous scheduling of kanban and traditional manufacturing orders within a factory.

The ERP Visual Easy Lean system provides similar capability, but targets the smaller manufacture-to-order (MTO) / make-to-stock (MTS) manufacturer. Infor has also developed a DBR software product that works with its Infor ERP Visual Enterprise product suite, which replaces the scheduling and capacity management modules within the Infor Visual system with DBR-specific functions and facilities.

Lastly, Infor also provides SupplyWEB to the automotive market. SupplyWEB is an ERP-independent, web-based supply chain application that enables two-way communication of procurement and performance-rating information between Tier 1 and Tier 2 suppliers and their suppliers.

Invistics

A specialty add-on player, Invistics has taken a scientific approach to solving very tough lean problems: high product mix and high supply and demand variability environments in batch process industries, such as pharma and specialty chemical manufacturers. Rather than just being a shop-floor-level lean execution application, the Invistics MachSix tools focus on solving problems in four key areas: inventory, cycle time, throughput, and customer service.

The MachSix modules follow the Six Sigma DMAIC methodology to define, measure, analyze, improve, and control these four lean metrics, resulting in reductions in work in process (WIP) and cycle times while simultaneously increasing throughput in highly variable shops. The MachSix Analyze and Improve modules use queuing models and a simulation engine to assist users in predicting future values of these four key metrics in various scenarios. The Control module can be configured to use a number of different methodologies to implement pull (e.g., kanban, generic kanban/CONWIP, or DBR), with sequencing capabilities unique to batch
process industries.

Lawson

Don't get confused when you see Lawson's name here. The company threw its hat in the manufacturing ring with the acquisition of **Intentia** in 2005. With Intentia, Lawson inherited the Movex product (now renamed M3), which supports three key manufacturing philosophies in what it refers to as the M3 market (make, move, and maintain): World-Class MRP II Manufacturing, Advanced Manufacturing, and Lean Manufacturing. The Lawson M3 application provides support for high-volume repetitive manufacturing with the execution and automatic sizing of various types of kanban, including triggering replenishment of calloffs against supplier orders. JIT calloff management can also be managed in more complex CTO environments, leveraging its product configurator and support for supply-in-line sequence.

Lawson extends lean support to hybrid manufacturing styles and volatile demand scenarios using Goldratt's Theory of Constraints (TOC) and DBR techniques in its planning and scheduling applications. The company takes TOC execution to the shop floor with applications for displaying schedules as well as an Operator Manufacturing Execution System. While Lawson doesn't offer a specific tool for value stream mapping, it promotes the use of its Business Process Reference Models, Business Process Design Tool for capturing, publishing and communicating processes, and its Enterprise Performance Management for supporting value analysis and continuous improvement dashboards. Underpinning all these capabilities is M3's support for TPM to keep materials flowing.

Oracle

Oracle has two ERP products for the lean manufacturer: **JD Edwards'** EnterpriseOne with Demand Flow Manufacturing and its 11i E-Business Suite (EBS) with Flow. Both products benefit from consulting with JCIT, but JD Edwards also acquired and leveraged the intellectual property of the former JCIT product in developing its Demand Flow Manufacturing capability. The EnterpriseOne product is targeted at smaller shops that are looking for a suite of lean applications and functionality.

Both JD Edwards' EnterpriseOne and Oracle's 11i EBS implementations of lean and flow-based manufacturing provide a broad footprint that includes a comprehensive lean feature set, including line design, sequencing, and kanban planning and execution. They also extend out to service management, supplier management, and manufacturing analytics. Oracle supports multiple manufacturing models on the same instance. It also supports mixed-mode operations with a keen focus on lean planning and execution in the Flow manufacturing model, but still provides the many advantages of a large footprint ERP backbone.

With EBS Release 12, Oracle has made significant strides in overcoming resistance to ERP deployment on the shop floor, with major configurability and usability enhancements with its MES Workstation and Supervisor Workbench (see "OpenWorld 2006: Oracle Overtly Challenges the MES Paradigm").

QAD

A long-time lean application provider, QAD has assembled a powerful set of lean manufacturing tools to create a strong position among automotive, electronics, and heavy equipment manufacturers. It has also achieved very good penetration in the Asia-Pacific region.

Delivered originally as an extension to its base MFG/Pro ERP system and now being delivered as part of the QAD Enterprise Applications 2007 suite, the company's lean manufacturing products provide complete functionality to establish and execute kanban processes, kanban loops, and supermarkets, with flexible planning calculations for internal operations as well as suppliers. The full set of lean applications also includes both JIT sequencing, production scheduling, an error-proofing application, and quality management functionality.

SAP

Prior to SAP's acquisition of FactoryLogic, SAP Business Suite was the delivery vehicle for its lean features. The fact that the functionality is an integral part of existing modules makes it a little more difficult to implement the applications into an existing ERP-supported manufacturing operation when it comes to lean projects, which is not surprising, actually, if one considers SAP's preeminent role as a backbone application. However, for new deployments, SAP does support many lean needs, such as takt-time calculations, kanban sizing and execution, supplier replenishment (using its web-based Supply Network Collaboration), and a heijunka scheduling board. The functionality also can be extended with **Tata Consultancy Services'** (**TCS**) RapidSigma xApp, using SAP xMII integration services, to support DMAIC requirements for Six Sigma initiatives—a big plus for many large shops that blend lean and Six Sigma thinking.

Critical to SAP's future lean applications is its acquisition of FactoryLogic (see "SAP Buys FactoryLogic, Gets Lean With Next Logical Step Into the Factory"). This not only enhances its lean planning and execution functionality, but when deployed in conjunction with SAP xMII, it allows SAP to support customer needs for locally deployable applications, decoupled from SAP ERP. One of the earliest lean add-on application players, SAP's FactoryLogic targets high-volume, low-mix manufacturers, primarily automotive, with a focus specifically on the planning and execution of lean. The product is appropriate for supply chains operating at very different paces and supporting a large company distributed environment with cascading planning groups. The product's focus is on supply-demand balancing and inventory management for final assembly, WIP, and in-bound processes. One of FactoryLogic's key strengths is its ability to recognize new demand patterns and dynamically adjust inventory levels and the production plan that is put in place.

SoftBrands

SoftBrands' lean offering, DemandStream, was designed to be integrated to existing ERP systems to smooth demand and fill the lean functionality gaps at the factory level. The company's key target customer is an early-stage adopter of lean that is just moving out of the paper and visual-only stage and is now seeing the need to automate to provide quicker response to demand at the shop-floor level and buffer calculations. The system handles line design, multiple kanban options, supermarkets, and cell support. It also can analyze work cell capacity, manage priorities, and sequencing. Through its heijunka scheduling, it balances and smooths production to satisfy uneven demand.

SupplyWorks (now owned by Consoma)

SupplyWorks' lean application focus is on automating the procurement and replenishment of direct materials for discrete manufacturers. The product, SupplyWorks MAX, is primarily a supplier kanban platform with integrated procurement/replenishment tools. The software works to automate communication and collaboration with suppliers, especially in response to fluctuations in customer demand, and optimize the flow of parts and materials in in-bound supply chains.

Intended to be integrated to existing ERP systems, SupplyWorks offers these tools as a web-based, on-demand service on a subscription basis. It has extensive experience supporting the manufacturing operations of large organizations.

Synchrono

Synchrono differentiates itself by integrating planning and execution flow through an adaptive closed-loop system that ties customer service (demand), planning, and scheduling directly to shop-floor execution. Synchrono's suite of patented demand-driven software orchestrates people, resources, and material in real time to keep variability under control. Synchrono focuses on the three main objectives of lean: elimination of waste, continuous synchronized product flow, and pulling to customer demand. Its approach creates a visible, predictable, manufacturing execution capability that allows for supply chain synchronization from the factory out.

In addition to standard lean planning and execution tools, Synchrono offers innovations to lean concepts, such as CONLOAD and simplified POLCA technology. These advanced lean concepts have been proven out by Synchrono's clients in a diverse range of discrete industries, such as capital equipment, metals, plastics, wood products, consumer products, and more. Recent extensions to Synchrono's Adaptive product suite include e-kanban and lean S&OP tools.

UGS/Siemens

Another design-side specialist, UGS has also expanded its coverage of the actual manufacturing process through its acquisition of **Tecnomatix**. It provides a suite of applications to help design and model lean manufacturing production lines. Beyond helping design for lean manufacturing, Tecnomatix brings what UGS characterizes as digital manufacturing: process design, simulation, optimization, and execution of lean manufacturing processes and related workflows. The system will calculate kanban sizes and takt times to help synchronize line design and operation. UGS was recently acquired by Siemens (see "Titans on the Move: Siemens Looks for First-Mover Advantage From UGS").

Ultriva (eBots)

The eBots Lean Execution System is a suite of three applications: Collaborative Electronic Kanban, Demand-Driven Scheduling, and Customer Demand Management. While a relatively new name in the enterprise application market, Ultriva has already signed up more than 70 customers. Its focus on supplier kanbans is one user initiative we see many firms attacking as part of their initial lean practice forays. Recognizing its role as an add-on, the company touts readily-available connectors for Oracle and SAP, which will be important for the many manufacturers standardizing on these backbones and the shops moving from manual and spreadsheet-based lean projects. The products are available as hosted or on demand, with monthly subscription pricing.

Appendix B: Related research

- "Enhancing Lean Manufacturing With Software Applications"

- "Take Lean Thinking to the Next Level With DDSN Thinking"

- "OpenWorld 2006: Oracle Overtly Challenges the MES Paradigm"

- "SAP Buys FactoryLogic, Gets Lean With Next Logical Step Into the Factory"

- "East Meets West—Lean Manufacturing and ERP Are a Better Fit Than You Think"

- "Demand-Driven Manufacturing: The (Potential) Rise of Lean"

- "Lean Value Stream Mapping Tools: The Vendor Landscape"

- "Microsoft Dynamics Enters the Lean Market With eBECS Acquisition"

- "DemandPoint: Lean Software and DFT Consulting Pioneers Merge"

- "Titans on the Move: Siemens Looks for First-Mover Advantage From UGS"

- "Case Study in Lean Thinking: Aligning People, Processes, and Technology at Lockheed Martin"

Notes

Acronyms and Initialisms

A&D	Aerospace and defense
APS	Advanced planning and scheduling
ATO	Available to order
BOM	Bill of materials
BTO	Build to order
CONLOAD	Constant load
CONWIP	Constant work in process
CRM	Customer relationship management
CTO	Capable to order
DBR	Drum-buffer-rope
DFT	Demand flow technology
DMAIC	Define, measure, analyze, improve, and control
EAM	Enterprise asset management
ERP	Enterprise resource planning
ETO	Engineer to order
JIT	Just in time
MES	Manufacturing execution system
MPS	Master production scheduling
MRO	Maintenance, repair, and overhaul
MRP	Materials requirements planning
MTO	Manufacture to order
MTS	Make to stock
PLM	Product lifecycle management
POLCA	Paired-cell overlapping loops of cards with authorization
S&OP	Sales and operations planning
SOA	Service-oriented architecture
SRM	Supplier relationship management
TOC	Theory of Constraints
TPM	Total productive maintenance
TPS	Toyota Production System
WIP	Work in process

MOHAWK
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