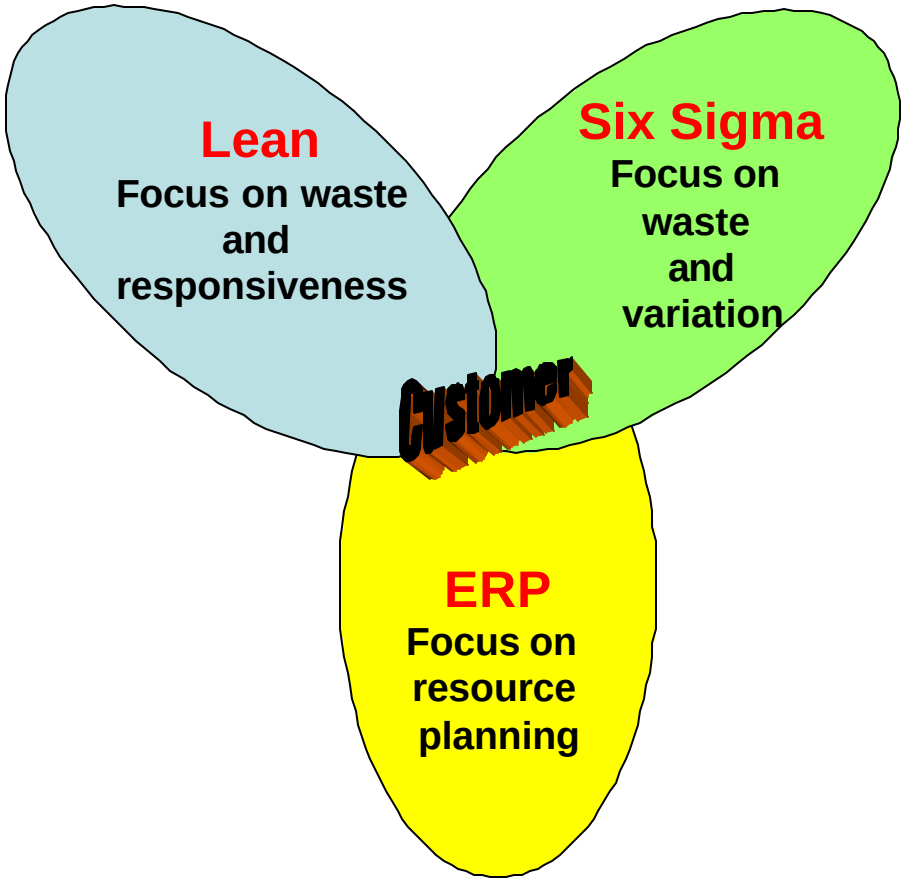
Productivity Centers International

4490 Monitor Rock Lane
Colorado Springs, CO
80904 USA

Phone (719) 685-5405
Fax (719) 685-5406
E-mail: was.pci@att.net

A Lean look at ERP



How we perceive ERP and Lean, and the nature of our business, both affect our beliefs whether or not the two technologies belong together.

Personal Perspective

Three problems hinder understanding of how Lean and Enterprise Resource Planning (ERP) fit together – terminology, history, and our own experience.

Terminology

A buzzword, or fuzzword, occurs when the term becomes disassociated from its content. In the planning world, we have progressed (or regressed) from "mrp" to MRP, to MRPII, to ERP. I predict the next buzzword in this vein will be ERM (enterprise resource management)!

In the execution world there are even more buzzwords. In the beginning we had the Toyota Production System, but then added Stockless Production, Zero Inventories, Short Cycle, Continuous Flow, Customized, Synchronous, Just-in-Time, Demand Flow, Agile, and Lean – to name just a few. A few years ago the dominant name was Just-in-Time; today it is Lean.

And in the problem-solving world, we have gone from Zero Defects, to Total Quality Control, Total Quality Commitment, Total Quality Management, Total Quality Leadership, Continuous Quality Improvement, and now to Six Sigma – which mathematically is very close to Zero Defects.

Why all of these terms? Because people like to position their new term to be first in a new or redefined category, to capture attention in the market place, to promote their new term as bigger and better, and even to exclude and demote earlier terms. All of these terms complicate understanding. To me MRP and JIT have always embraced the full scope of activity that ERP and Lean employ today. To others, MRP and JIT have been demoted to a more narrow scope. Today we have crossed the line of common sense -- there are so many acronyms for essentially the same thing that it is almost healthy. Now we are forced to look into the content to see if only the name has changed or if there is really a fundamental difference. Now I just tell clients that I don't care what you call it, just adopt the Nike slogan – "just do it! ©"

History

In the 1960's ERP started becoming popular (it was called Manufacturing Resource Planning or MRP back then). Manufacturing was typically

arranged in functional job shops and production was in economic order quantity batches. MRP helped us manage the complexity.

Lean started to become a manufacturing strategy for some companies in North America in the 1980's (it was called Just-in-Time or JIT back then). Leading companies began to adopt Lean principles by converting job shops to faster flowing assembly lines and cells. Before then, virtually all Western companies were batch producers. All had significant amounts of waste around to allow them to compensate for unresolved problems. Although in the 1920's Ford pioneered much of what we know as Lean today, few North American companies followed his practices until they were forced to compete with others using the Ford and Toyota Production System techniques.

Today, some comparing ERP and Lean are quick to point out that MRP is designed for batch environments. However, just because MRP was born in the days of batch and job shops, does not necessarily preclude it from being useful in a Lean environment. And, just because Lean was introduced in higher volume, lower variety environments, does not mean it does not apply to other environments as well.

Own Experience

Finally, our own experience can limit our ability to see other possibilities. Early in my manufacturing career, I thought twenty products a day was high volume. Since then I have met people making volumes that are orders of magnitude higher. Some people make many products out of a few components or ingredients, while others make a few products out of many items.

One client had a firm order backlog of more than a year; yet some complained of too many changes. Of course some changes did occur, but their order product backlog was longer than the entire life cycles of many of the products I was used to at Hewlett-Packard.

Everything is relative. Every environment seems to have its advantages and disadvantages. Some of us are in environments that make planning and/or execution easier than others, but there are no simple environments. Those that started simple soon find many competitors, who complicate things once again!

Identifying the factors that most affect Lean and ERP is essential if we want to understand how they can help us satisfy our customers and other stakeholders.

To build a house, which is the most important tool, a hammer or a saw? Of course, they are both needed. But we need to know when each tool is applicable, and when it is not, to build the house quickly, efficiently, and

safely. Keep your focus on the house; avoid useless debates about whether a hammer or saw is best! With respect to ERP and Lean, keep your focus on the customer; avoid becoming emotionally involved in defending one tool over another.

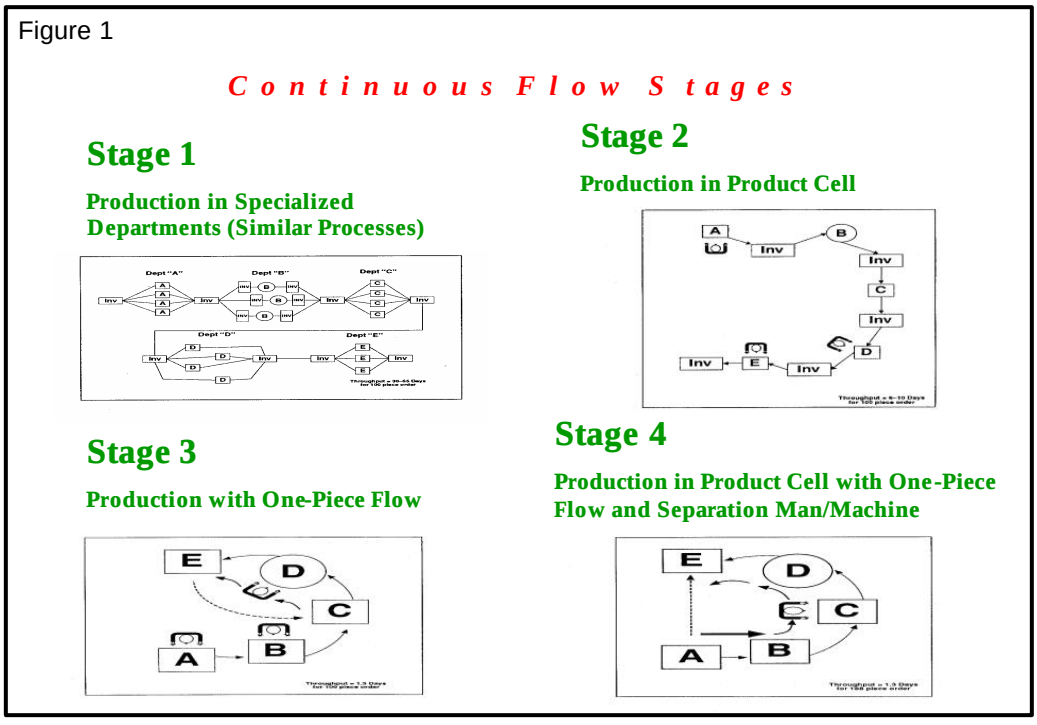
Business Factors

Three factors directly affect our planning and execution strategies – type of manufacturing flow, shape of the bills of material, and variation in demand.

Flow

Some factories have functional layouts, others have assembly lines, and still others have cells. Professors Wheelright and Hayes use the term "disconnected flow" to refer to job shops, and "connected flow" to refer to assembly lines. There are many variations between a tightly connected and completely disconnected flow, besides those show in Figure 1. The type of manufacturing flow we use affects planning and execution and therefore how ERP and Lean work together.

Figure 1

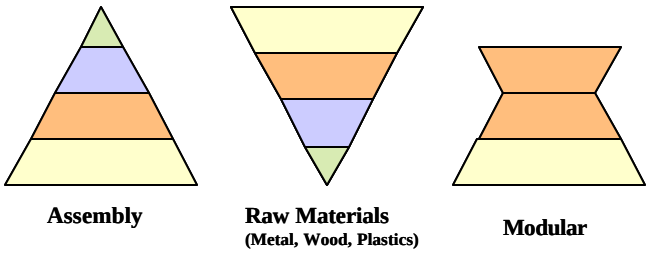


Bills of Material

Earlier we mentioned that some people make many products out of a few components or ingredients, while others make a few products out of many items. The difference between these two situations is reflected in the bills of material. See Figure 2.

Figure 2

Bills of Material Shapes



Assembly | **Raw Materials** (Metal, Wood, Plastics) | **Modular**

BOM shapes can also affect the organization (e.g., by product, by process, by customer, by geography)

When an organization has many components and many end items, a logical strategy is to develop modular products to shorten lead-times, improve flexibility, and minimize cost.

Demand

Finally, variation in demand affects our ability to plan and execute. The more end item variety we have, the more item-to-item variation we will experience. The more components we have in any end item, the more careful we need to be to ensure that we are not missing one item that prevents completion and shipment of the product. If we have both end item variety and many components, we have an even more difficult environment for planning and execution. Figure 3 shows strategies to manage, or compensate, for the variation in demand. Use of inventory

Figure 3

Coping with Fluctuating Demand

Strategy	Tactics	Waste
Reduce variation	•Smooth demand (pull, kanban, small lots, level order ship dates) Design for modularity & postponement (minimize impact of variety) •Reduce process variation	Low Low for new products Low
Vary inventory	•Store capacity as inventory (not an option for service processes)	High
Vary capacity	•Flex people (overtime,temps, seasonal) •Flex equipment (relocate, have excess) •Subcontract peak capacity requirements	Depends (often high) Low Depends (often high)
Vary customer lead-time	•Use order backlog to smooth fluctuations	Low (until you begin to lose orders, then very high)

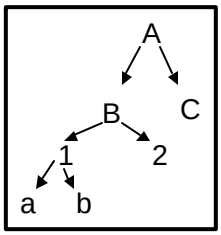
Two choices: We must reduce variation or respond to it.

may help in some cases, but it is an expensive and wasteful approach. Other strategies are less wasteful.

Two Technologies

Given the confusion over history, terminology, and personal experience, let's make sure we are on the same page regarding ERP and Lean before we go any further on how the two work together.

I have personally written, implemented, and used ERP systems, and have personally implemented and used Lean systems. Yet, I was not conscious of the fundamental difference in how I approached each technology until I had an intense discussion with a client of mine some years ago. He was extremely knowledgeable in ERP. He drew a multi-level bill of material using letters A, B, C, etc. on a board. He then asked me to explain how Lean would build this product. The first question I asked was what kind of product is it – metal, electronic, etc. He said it doesn't matter. After some frustration on both of our parts, the obvious became apparent. ERP tries to understand and model the current state, while Lean *begins* by trying to simplify the flow and shorten the lead-time. ERP asks how are things done, Lean asks how should things be done.



Back when ERP was called MRP, we used MRP to help us provide the right part, at the right price, in the right quantity, at the right quality, at the right time, to the right place. We were taught the Six Rights.

Back when Lean was called JIT, and still today, we say JIT/Lean is striving to procure and manufacture just what is needed, in just the required amount, and delivering it precisely where and when it is needed.

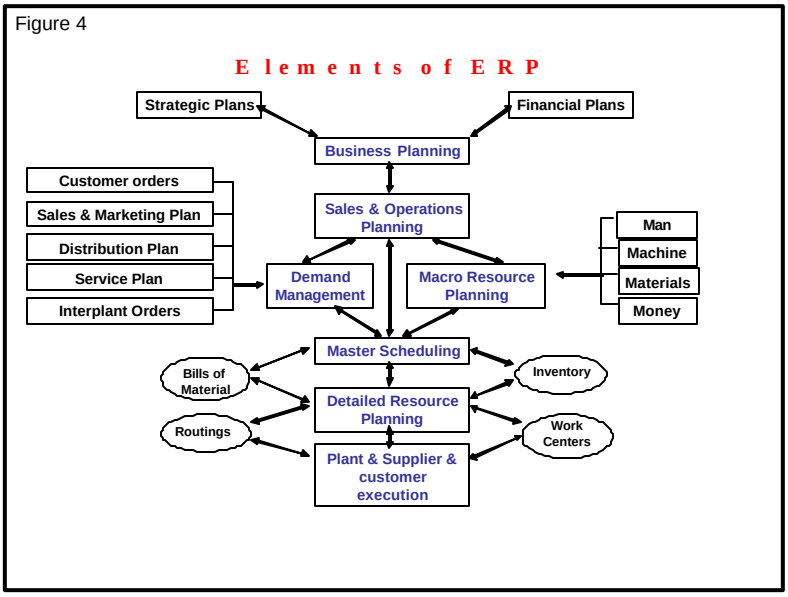
There is no significant difference in these two statements. What is different however, is how MRP/ERP and JIT/Lean try to help us achieve customer satisfaction.

As Figure 4 shows, ERP encompasses multiple elements, such as sales and operations planning, bill of material structuring, and inventory record accuracy.

MRP is a big calculator. Given information about what and when we want to make something, what it takes to make it, what we have on hand, and what we have on order and in production, we can calculate what we need to get.

MRP is very powerful, particularly when it comes to helping us figure out macro resource requirements and "what if" scenarios. In the early days, primarily due to computing limitations, re-planning was done on a monthly basis, then later on a weekly basis. Then, as computing power increased, we began net-change re-planning on a daily or even more frequent basis.

Figure 4



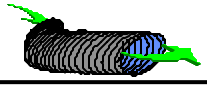
ERP modules are also available to track labor and material expenditures, and to level and control activities on the production floor. As ERP moved to the factory floor, it became quickly apparent that things change constantly and that monthly, weekly, or even daily updates were not sufficient. More frequent the updates required more transactions, more discipline, and more computing power. Then as Lean began to be implemented on the shop floor, lot sizes decreased significantly, ERP's transactions grew exponentially, and the ability of ERP to keep up decreased seriously.

In the early days of JIT, MRP supporters tried to defend MRP by saying it could calculate lot sizes of one. They said MRP could do JIT. Unfortunately, they missed a primary

Figure 5

Elements of Lean

- Show respect for people
- Focus on the Customer (Quality, Delivery, Cost)
- Reduce seven fundamental wastes
- Control with kanbans and use a pull process
- Produce to the takt time (strive for one piece flow)
- Reduce changeover times (equip., parts, people)
- Improve flexibility (equipment, design, people)
- Use visual controls
- Put parts, tools, instructions, support at point of use
- Use standard methods
- Build customer/supplier relationships (inside & out))
- Encourage continuous improvement at all levels, in all organizations, throughout the value stream.
- *Use "One less at a time…" to drive continuous improvement*



distinction between MRP and JIT. MRP is a mathematical model; JIT is a driver of behavior. MRP works with numbers, JIT works with people. Of course, some JIT'ers caused the MRP'ers to become defensive by saying MRP was no longer needed.

A well-run Lean system also includes multiple elements, as shown in Figure 5. The elements that most affect ERP are: kanban controls, pull systems, one piece flow and balancing to takt time, quick changeovers and smaller lot sizes, and visual controls.

Now that we have discussed problems hinder understanding, and factors that affect our strategies, let's objectively explore how Lean affects ERP, and how they both should affect our customers and stakeholders.

Affects of Lean on ERP

The lowest common denominators affecting the interaction of Lean and ERP are type of flow, shape of the bill of material, and predictability of demand. Table 1 shows eight basic combinations that can affect our ability to plan and execute. Of course, there are really infinite variations of these eight.

Table 1				
Scenario	**Flow**	**Bill of Material**	**Demand**	**Mfg Strategy**
1	Connected	Inverted	Predictable	BTO, BTS
2	Connected	Inverted	Unpredictable	BTO
3	Connected	Pyramid	Predictable	BTO
4	Connected	Pyramid	Unpredictable	BTO, ATO
5	Disconnected	Inverted	Predictable	BTS
6	Disconnected	Inverted	Unpredictable	BTO, ATO
7	Disconnected	Pyramid	Predictable	BTS, ATO
8	Disconnected	Pyramid	Unpredictable	ETO, BTO, BTS
	BTO = build to order			
	BTS = build to stock			
	ATO = assemble to order from stocked modules			
	ETO = engineer to order			

Note: Low volumes are often thought to be a factor, but further analysis will show that the dominant problem with lower volumes is unpredictability more than the volume itself.

Let's examine how Lean affects ERP in a few of these scenarios.

Scenario 1: Connected Flow, Inverted BOM, Consistent Demand

This is the dream environment -- for those in other categories (the grass is always greener on the other side). But organizations don't usually begin in this situation; they work to make it that way. Once I was giving a talk with the general manager of Toyota Auto Body (known as TABC at the time). I finished my portion and sat down. He went on to describe his 167 inventory turns. The person sitting next to me asked him how many suppliers he had, and he said eleven. At that response the person sitting next to me muttered "Well, I could be great too if I only had eleven suppliers!" Unfortunately, he missed the point. The point is how did TABC go from hundreds to a small but manageable number of excellent suppliers? People that have connected flows and consistent demand are not just lucky; they made it happen.

But, given that environment, how does it affect ERP?

As manufacturing simplifies, so does the re-planning process. Consistent demand allows for less frequent planning of resources -- weekly or monthly is adequate in most cases. Plans are expressed primarily in terms of production rates. Manufacturing is flexible and lead times are short, allowing build to order in many instances, or at least replenishment of stock when end customer deliveries must be within minutes or hours. An inverted bill of material, and short manufacturing lead times, allows purchasing to focus on only a few items and suppliers. Production rates do not vary significantly from day to day, but when changes do occur, people, equipment, and material resources are relatively flexible. This occurs through cross training, careful selection of right sized equipment, and design for manufacturability and flexibility. Suppliers have standing contracts. They plan to meet their customer's plan, but they only produce when they have an empty container (i.e., an empty kanban). Often this Lean value stream extends down through multiple tiers of suppliers. Flow is simplified, and so is resource planning at the macro level.

Yet extensive detailed planning does occur – but not by traditional ERP systems. Traditional ERP systems tend to level the load for a period across shops by shifting batches – an environment that does not exist in the scenario we are describing here. Lean leveling occurs on each line to efficiently meet the takt time, whether the line is producing one or mixed models. Leveling also considers worker fatigue during the day. And, leveling occurs in the supply pipeline to avoid peaks and valleys in the transportation network and on any one supplier, or supplier's supplier.

Is ERP needed in this environment? Let's just say that macro planning is still needed but the need is simplified. ERP can certainly do the macro-planning job, and do it well, but so can other more simple systems.

Traditional ERP's do not perform the Lean line balance and supplier leveling tasks however; for that some specialized software is useful.

Scenario 8: Disconnected Flow, Pyramid BOM, Inconsistent Demand

Scenario 8 is on the opposite pole from Scenario 1. It has functional layouts, batch production, many parts going into one product, and inconsistent demand. This is where MRP/ERP was born and thrives.

One way to manage this situation is to adopt an engineer to order policy. Get the order, engineer the product, order the parts, and then build it. Of course, customers want delivery ever sooner, so even in this case, some planning for parts must usually be completed before the engineering is finished.

If competitive pressures will not allow you to engineer to order, then you must build to order (BTO) or build to stock (BTS), depending on your manufacturing and customer lead-times. In this BTO or BTS environment, Lean would try to connect the flows more tightly for sales, design, and manufacturing.

Sales should work to smooth shipping due dates, particularly where the variation is internally rather than externally caused. Month end spikes usually have internal causes, whereas holidays and seasons are external factors.

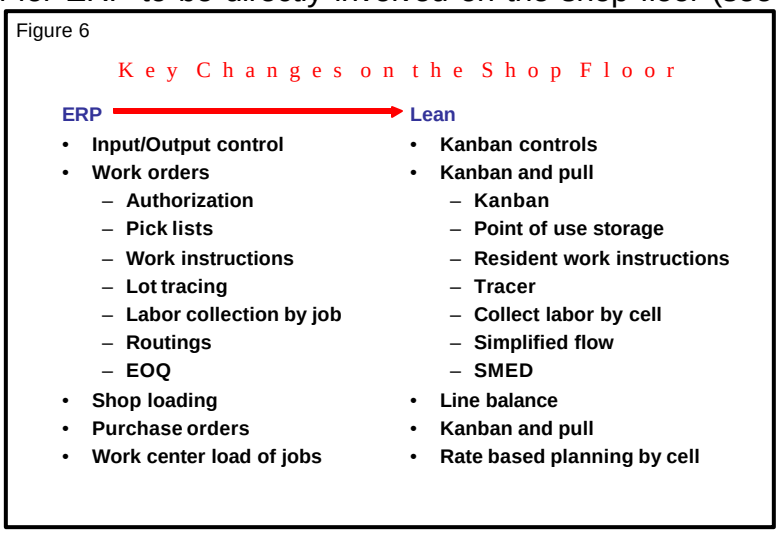
Design can work on modular designs, with fewer and more common parts that permit unique features to be installed late in the manufacturing process.

Manufacturing can work on quick changeovers, flexible resources, mixed model lines, etc. This can improve delivery predictability while shortening lead times.

Purchasing (i.e., supply chain management) can work with suppliers to improve responsiveness and replenish to kanban signals. Unique, long lead-time, expensive items are prime candidates that would benefit from improved flexibility and responsiveness. For starters, perhaps a supplier could build molded parts in a smaller batch and then finish them to order. Of course, implementing Lean throughout the value stream is a more difficult and longer lead-time task than just implementing Lean internally.

Early Lean changes by manufacturing should eliminate, or at least greatly reduce, the need for ERP to be directly involved on the shop floor (see Figure 6). The shop floor control module, or production activity control module, is an expensive ERP module to purchase and is transaction intensive module to operate. The use of kanbans with internal and external suppliers should eliminate the need for detailed supplier schedules. The use of generic kanbans will simplify the planning of material supply even more.

Figure 6

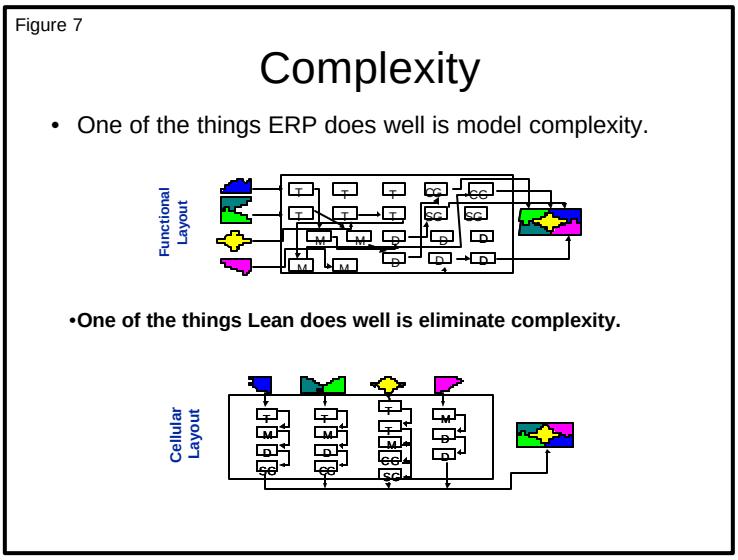


The more Lean principles we are able to adopt in this environment, the more simple the planning process becomes, and although it is not likely to ever be as straightforward as Scenario 1 we may be able to approach Scenario 4. It seems that ERP, or some form of it, will always be extremely useful for macro planning of resources and to explore "what if" scenarios. However, by even adopting a little Lean, the need for ERP's shop floor control module can be eliminated, or at least greatly reduced.

Scenarios 2 & 4: Connected Flow, any BOM, Inconsistent Demand

In these two scenarios, we have moved, at least partially, from batch to Lean practices (see Figure 7), that is, we have moved from Scenarios 6 and 8, to 2 and 4. The same changes in sales, design, manufacturing, and purchasing described for Scenario 8 should be applied here. It seems that ERP, or some form of it, will always be useful for macro planning of resources and particularly to explore "what if" scenarios in these environments.

Figure 7



Most disconnected flows can move to some degree of connected. Therefore, the most common scenarios should be 2, 3, and 4.

At this point the reader should be able to draw their own conclusions regarding how Lean and ERP relate in the other scenarios.

Should ERP and Lean co-exist?

Now for the big question: Should we use ERP in a Lean environment? Let's begin by posing two basic questions.

Figure 8

Seven Fundamental Wastes

- **Overproducing**
  - Queues, intermediate stores
- **Waiting**
  - Imbalanced flow & capacities
- **Transportation**
  - Layouts, part pathways
- **Planned Inventories**
  - Customer LT < manufacturing LT
- **Motion**
  - Lack of organization or method
- **Making defects**
  - process variation and complexity
- **Process itself**
  - No rationalization

Source: Toyota, Sandras JIT:MIH pg. 9

Should we eliminate waste in our processes (See Figure 8)? Of course, and since the purpose of Lean is to eliminate waste, we should practice Lean or at least something that helps us effectively eliminate waste.

Should we plan our resources to meet the conditions in the future? Of course; and since resource planning is the purpose of ERP, we should practice ERP or at least something that helps us effectively plan.

But, how much ERP do we need in a Lean environment? Recognize that Lean is an exception-based system. Operators that make a product, or drivers that move it, operate the kanban controlled Lean system themselves. Support people are needed only when things get out of control or parameters need to be reevaluated (e.g., contracts, kanban limits).

So, where we have tightly connected flows, simple bill of materials, and relatively consistent demand, Lean can control everything on the shop

floor and much of the flow in the supply pipeline. Macro (i.e., monthly and beyond) resource planning is still required, and that role falls to ERP or a simplified version of it.

On the other hand, where we have very disconnected flows (i.e., traditional job shop layouts), complex pyramid shaped bills of material, and inconsistent demand, more frequent resource planning is needed. But by making even a few strides towards Lean, we can eliminate much if not all of the need for ERP on the shop floor.

We have long used the term Production Planning and Control. Today, in areas where it is implemented, Lean assumes the responsibility for control, whether that is on the shop floor or in the supply pipeline. And the more the design, sales, manufacturing and purchasing processes are simplified, the more the Planning process can be simplified as well – but not replaced.

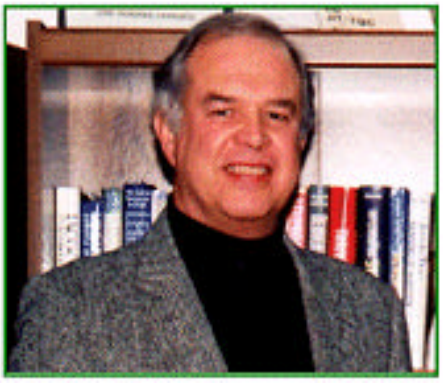
So, should we use ERP in a Lean environment? We should use the appropriate scale of ERP to match the degree to which Lean has simplified processes in manufacturing and other areas.

But most importantly, stay focused on the customer. They demand quality/reliability, delivery/responsiveness, and price/value. They don't care whether we use Lean, ERP, Six Sigma, or magic, as long as we can consistently provide what they need to be successful. Avoid becoming defensive regarding Lean, ERP, or any other technology – they are just tools. Keep focused on how you can help your customers be successful and on how you can continuously eliminate the seven fundamental wastes in your organization and throughout the value stream.

For additional information on this topic:

1. *Read the book Just in Time: Making it Happen,*
2. *Read the article "Dare to Control without Work Orders and Purchase Orders, " and visit*
3. *http://pciconsulting.home.att.net*

William A. Sandras, Jr.



Since founding **Productivity Centers International (PCI)** in 1985, **Bill Sandras** has provided his expertise to a wide-variety of manufacturing, engineering, health care, natural resource, transportation, distribution, administrative, and service organizations throughout the world. His **Rapid Breakthrough Events**© (RBE) are based on over 30 years of experience helping his customers safely and quickly convert their visions for change into reality. His "**one less at a time**©" process serves as a systemic driver of continuous improvement. Bill personally provides education, facilitation, implementation, and follow-up support to his customers.

Bill began his career with Continental Oil Co. as a computer systems / programmer analyst. He then worked for Hewlett-Packard (HP) for 16 years in various management positions. While at HP, Bill worked at two mature divisions and helped to start three new divisions including the ink jet printer division and engineering workstation division. These divisions manufactured high-volume/low-variety products, and complex low-volume/high variety products.

Bill led HP's first successful Enterprise Resource Planning and Lean/Six Sigma implementations (called MRP and JIT/TQC at the time). He and his team were the first to link Lean and ERP together. He also led product design, and then product marketing and support efforts for a small business ERP software package. Later as a senior manager, he championed three more ERP and two more Lean/Six Sigma implementations.

At HP, Bill managed production, manufacturing engineering, purchasing, planning, order entry, warehousing, shipping, transportation, software development, product marketing, product support, and information systems. Bill also introduced and managed the JIT/TQM worldwide education and consulting services for the Oliver Wight Companies for four years.

Bill holds a Bachelor of Science degree with dual majors in Production Management and Statistics, and a Master of Business Administration degree in Management Science from the University of Colorado. He passed the American Production and Inventory Control Society's certification exams at the highest level and was on their JIT certification test committee.

He wrote the how-to book titled Just-in-Time: Making it Happen -- required reading for Lean certification. He is on the Association for Manufacturing Excellence editorial board for their "Target" magazine, is on Industry Week magazine's Best Plant selection committee, has written many articles, and given numerous speeches throughout the world.

More information about Bill Sandras and the services PCI provides can be found at http://pciconsulting.home.att.net