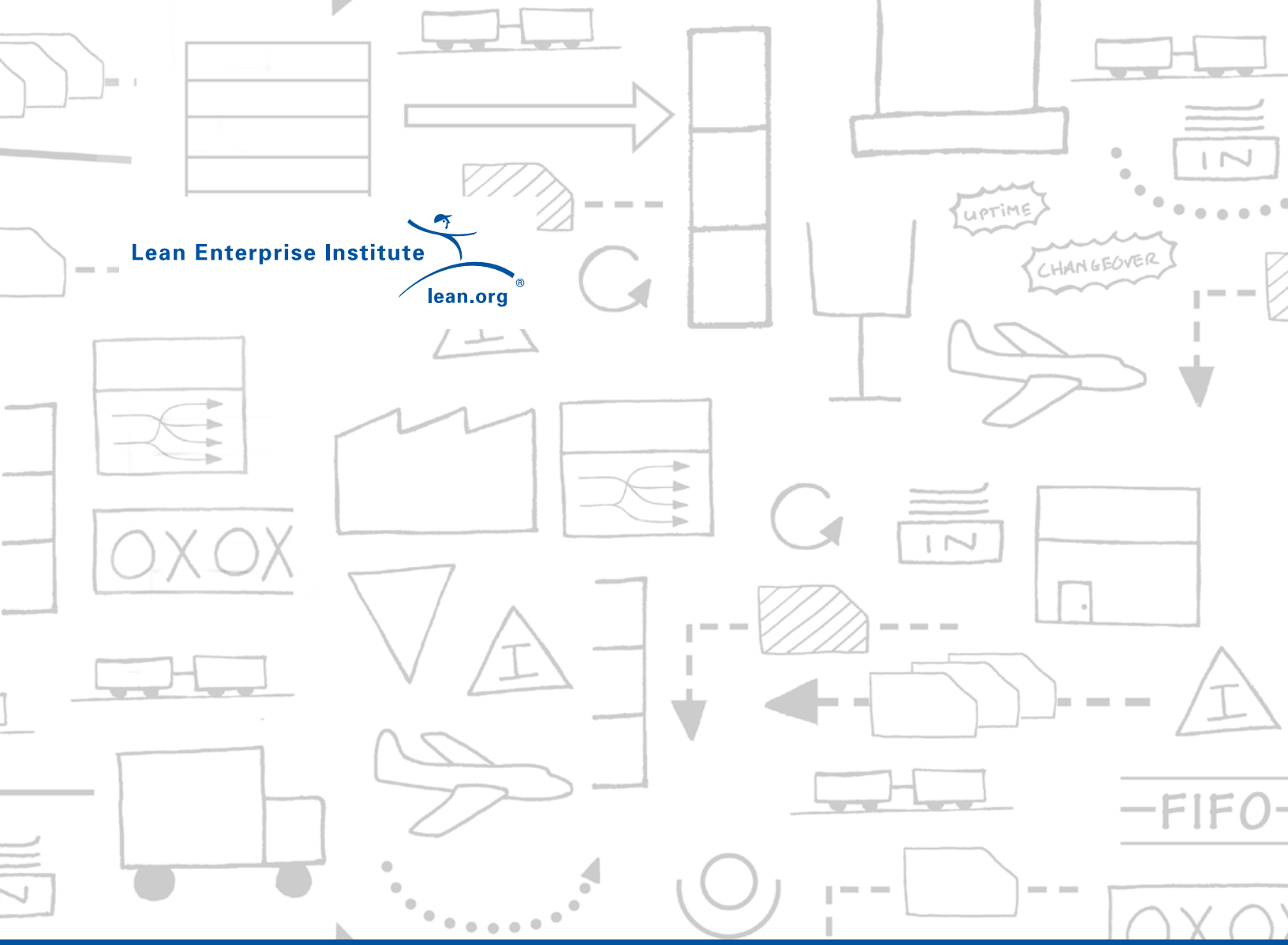

Insights on Why, When, and How Value-Stream Mapping is a Vital Part of Continuous Improvement

A selection of the most-read Lean Posts *offers the information leaders need to maximize the benefit of using this powerful lean practice.*

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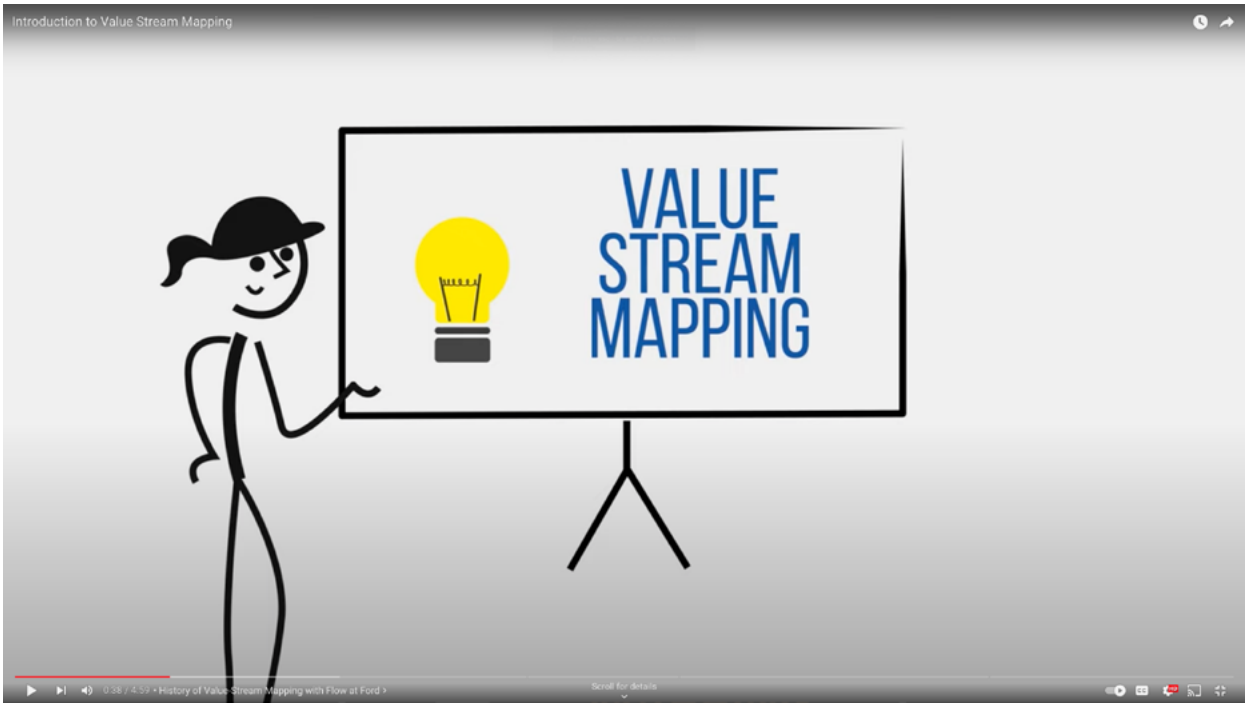
Jim Womack Explains the Origins — and Value — of Value-Stream Mapping

This brief video offers a quick overview of how and why this essential practice helps lean practitioners see and improve their work processes. (Read the lightly edited transcripted below.)

By James (Jim) Womack, PhD



Hi, I'm Jim Womack, president of the Lean Enterprise Institute. I wanted to welcome you to this value-stream mapping workshop and share with you a little background of where this came from and why I think it's so terribly important. The ideas that you're going to learn about are not new. In fact, they were mostly invented by Henry Ford in the early 20th century. In 1913, at Highland park, he opened a car plant for the Model T, which actually used all of the ideas that we now talk about in the context of value-stream mapping.

Ford Invents Flow Production

Ford had grown up in a world where you put processes in different places, and the product went to the process. Things moved all around. They didn't go very quickly. So, lots of big batches, lots of stopping and starting. And at Highland Park, Henry Ford had a fundamentally revolutionary idea: Why don't we line up the activities in process sequence so that the product goes smoothly from beginning to end?

Now we know about the assembly line. That's really not the great breakthrough that Ford made. Though, that's a wonderful breakthrough. But what Ford made his breakthrough in, more importantly, was in the actual fabrication steps: casting, machining, painting, welding — where he lined up all kinds of technologies that didn't normally then, and don't normally now, live together, into one continuous sequence to create flow. And he talked about flow. He called his system flow production back in the early days.

The problem was that he just had one product, the Model T, that came with no options and came in one color. And as long as that's all he had to make, it was very easy to introduce continuous, smooth flow. As time went on, the

industry had a wide variety of products, lots of options, lots of colors, and customer demand went up and down and up and down, and gradually Ford and other manufacturers abandoned the original flow ideas, which were rediscovered after the second world war by Toyota.

Ohno Advances Flow Production

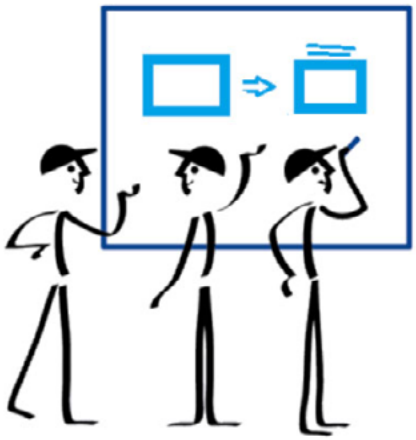
Taiichi Ohno, the fellow who put the Toyota production system together, always said, "I learned everything I know from Henry Ford, except I found a way," said Ono, "to do it with high variety and low volume. Ford can only do it with low variety and high volume." So, how to create flow in a steady pull of the customer, a voice of the customer all the way through the production system, with high variety, low volume — that was the real challenge. And that's what Toyota found out how to do.

Toyota people use the method that you're going to hear about: value-stream mapping. To them, it's just natural; it's like breathing. For us, because we've not used this language, it seems a bit strange. The idea is to take a product family *(Find the definition on page 17.)* and write down all the steps, from start to finish, for either a component or the whole product.

Using VSM to Achieve Flow

You could draw a map all the way from raw material to the customer, but let's be practical and just start at the plant level. Write down all of those steps and ask a very simple question: Which of these are waste? It turns out that most of the steps were waste. And which actually creates value that the customer would be willing to pay for?

Then when you've written down those steps, you need to write down the information flow. You've got steps, physical steps, going across the bottom of the map. You've got information flow across the top of the map. You put that together. And, when you've done that, you have a complete map. Then you ask some very simple questions: Which of the steps can we get rid of? And of the steps that remain, how can we do them in a continuous flow, so the product goes smoothly and only — only — when the customer wants it, at the pull of the customer?



Learning to See

So this is a method for drawing yourself a map so you can see that. As we say, so you can learn how to see. So many managers, good managers, hardworking managers, and workers — hardworking workers — are, in fact, blind. They're looking at all the wrong things. They're looking at the machine. They're looking at the organization. They're looking at the plant, the facility, the walls — we need to learn how to look at the product. The customer is only interested in the product.

This is the tool that permits you to do that. It's a tool that you need to learn, that all of your coworkers need to learn — no point in learning a language that only you can speak. The whole point of a language is everybody speaks it.

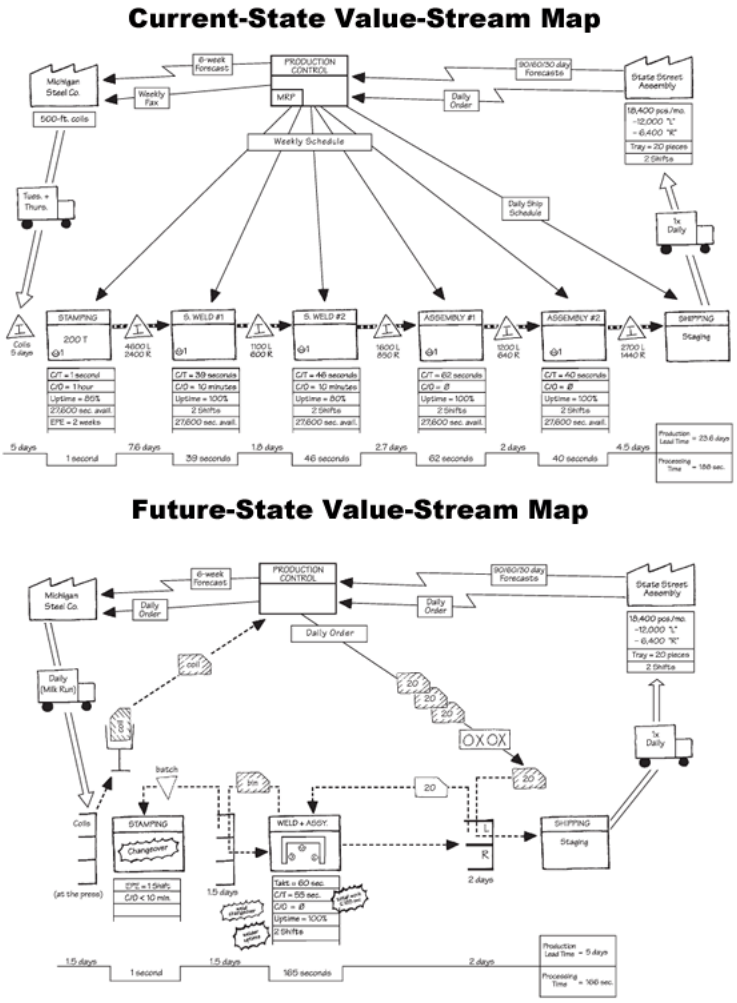
So this is the start; this is a course that will get you going, your first course in this new language. I guarantee it will change your life. It'll change your business. If we all do it, it'll change the world. So let's get started. ■

Understanding the Fundamentals of Value-Stream Mapping

This overview explains the essential elements of this powerful lean practice.

By Lean Leaper

Too often, lean practitioners begin value-stream mapping without fully understanding what it is, why it is a vital part of a lean transformation — and even some basics as to what information is gathered and presented with the practice. So, here is a primer on what you need to know to leverage VSM to chart your lean journey.



The current-state map enables everyone involved in the value stream to visualize a shared understanding of how each step in the process delivers value to the customer, including the material and information, and identify areas of improvement. The future-state map similarly creates a shared understanding of how the process will work once the team makes improvements, serving as a roadmap of improvements.

What is Value-Stream Mapping?

Value-stream mapping (VSM) is a fundamental lean practice that involves diagraming a value stream, which includes all the actions (value-creating and nonvalue-creating) needed to move a product or service from raw material to the customer, including the material and information flow. Lean practitioners use the process and the resulting map to identify and eliminate waste.

Toyota developed the practice and tool (which it calls a material and information flow diagram) as a critical part of the Toyota Production System.

Value-stream mapping typically begins with a team creating a current-state map by capturing the actual condition of a value stream's material and information flow.

Subsequently, the team draws a future-state map, a target image of how the material and information should flow through the value stream. Repeatedly doing the value-stream mapping process is the simplest and best way to teach yourself and your colleagues how to see value-adding versus nonvalue-adding process elements.

Most commonly used in lean manufacturing, value-stream mapping has been proven effective in any industry.

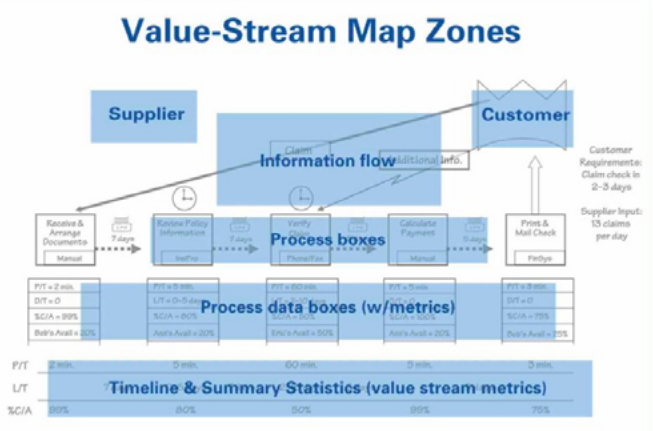
Why Value-Stream Mapping is an Essential Lean Practice

The main intention of current state mapping is to try to understand the dock-to-dock, or start-to-finish, flow, not to draw a perfectly accurate depiction. The primary reason for future-state mapping is to visualize the vision of the

improved value stream. So value-stream mapping:

- helps you visualize more than just the single-process level, enabling you to see the flow of work across all the processes.
- helps you see more than waste in your value stream, including the sources of waste.
- provides a common language for talking about a process.
- makes the decisions about flow apparent so that you can discuss them. Otherwise, many decisions happen just by default.
- forms the basis of an implementation plan, a blueprint for improvement, helping you design how the whole "door-to-door" flow should operate. Imagine trying to build a house without a blueprint!
- shows the linkage between material flow and information flow. No other tool does this.

Understanding the 4 Value-Stream Map Zones



Generally, value-stream maps show specific types of information in a standardized way. So, the information flow is in the first row or line. The process steps are in the second, with process data boxes (metrics) immediately below each step. And the timeline and summary statistics — the value stream's key process indicator (KPI) data at the bottom.

Information flow tells each process what to make or do next and when to do it.

Process boxes depict the steps of product or service delivery in a value stream. Because drawing a box for every process step would make the map unwieldy, use the process box to indicate one area of material flow. The process box stops wherever processes are disconnected, stopping the material flow.

Process data boxes detail essential information and metrics about each step, including:

- *Cycle Time (C/T) or Processing Time (P/T)* – the time an operator requires to complete all the work elements before repeating them.
- *Downtime (D/T)* – production time lost due to planned or unplanned stoppages.
- *Uptime* – the percent of the time a machine is available for production.
- *Changeover Time (C/O)* – the time required to set up a machine to make a different product or part number.
- *% Complete and Accurate (%C/A)* – the percent of product completed with perfect quality in a process step.
- *Availability* – the time a process operates over a single shift, often measured in seconds.

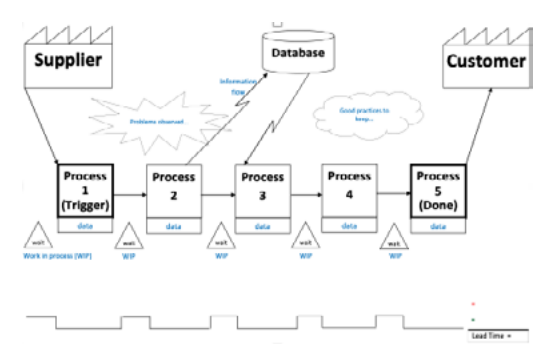
Timeline & Summary Statistics (Value-Stream Metrics) record a summary of the metrics.

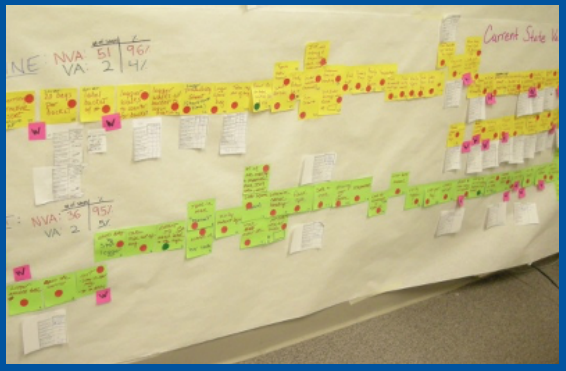
- *Lead Time (L/T)* – the time it takes one piece to move through a process or a value stream from start to finish.

How Value-Stream Mapping Differs from Process Mapping

When you want to "see" and improve the big picture — all the process steps needed to deliver a product or service from customer order or raw materials to delivery, value-stream mapping helps prioritize where efforts will yield overall improvement. Alternatively, when you want to improve a specific process or operation within the value stream, process mapping enables a detailed look at each step, allowing you to determine specific, targeted improvements. In other words, value-stream mapping is about improving the entire value stream, not just the parts, while process

Comparing Value-Stream and Process Mapping



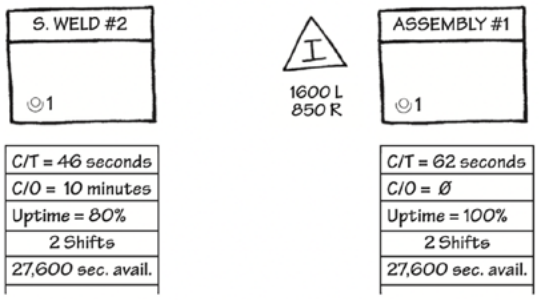


	Value-Stream Mapping (VSM)	Process Mapping
What	• Shows the 'big picture' • Visualizes system flow from the customer's perspective • Depicts how all processes are linked • Includes both the material and information flow	• Focuses on a single step or operation • Visualizes the operation from the worker's perspective • Depicts the series of tasks needed to complete an operation • Includes every action, in detail, of every task
Why	• To optimize processes to improve the entire value stream, which avoids the risk of improving a process to the detriment of the value stream. • To identify where to start and prioritize improvements	• To tactically improve a specific operation
When	• Early in problem investigation	• When you need to analyze a specific point of concern within the value stream • When creating standardized work

mapping is about improving a specific process within a value stream.

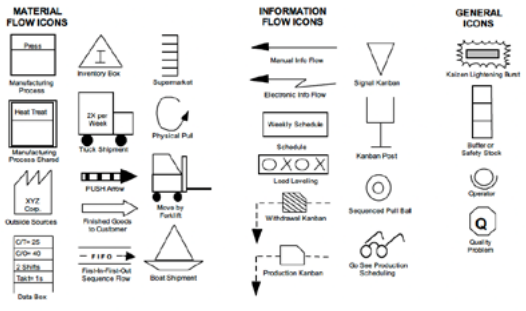
A Closer Look at Process Data

An example of process data boxes in a value stream map shows the type of detail that value-stream mapping captures.



Value-Stream Mapping Icons

Using standardized icons, such as those shown below, for each action depicted on a value-stream map ensures that everyone can "read" them. Download these value-stream mapping icons.



6 Guidelines for Moving Toward a Lean Value Stream

Once you're ready to use value-stream mapping to continuously improve your value streams, follow this advice from the authors of *Learning to See*, the workbook that introduced value-stream mapping to thousands of people around the world.

By Mike Rother and John Shook

Though, by definition, it's impossible to achieve a lean value stream — because lean thinking and practice aim for perfection, a goal with a constantly shifting future state — value-stream mapping can keep you on the path of continuous improvement. Specifically, the mapping process and resulting map help identify and eliminate waste in any value stream because every lean value stream features common characteristics. So, whether your organization is in the manufacturing, construction, food service, or another industry, or you oversee administrative functions such as accounting and finance, HR, and IT, the following guidelines ensure you continuously improve your value stream.

1. Produce to your takt time	"Takt time" is how often you should produce one part or product — or complete one task to deliver a service — based on the sales rate. Consequently, it is a proxy for customer demand.
2. Develop continuous flow wherever possible	Continuous flow refers to having each step in the production process complete one part of the product or service and immediately pass it to the next step without delay or creating in-process inventory between steps.
3. Use supermarkets to control production where continuous flow does not extend upstream	In the spots of the value stream where continuous flow is impossible and batching is necessary, resist the temptation to schedule these processes via an independent scheduling function. Instead, control their production by linking them to their downstream customers through a supermarket-based pull system. A supermarket is where a predetermined amount of standard inventory is stored, usually adjacent to the supplying process.
4. Try to send the customer schedule only to one production process	By using supermarket pull systems, you will typically need to schedule only one point in the value stream. This point is called the pacemaker process because how you control production at this process sets the pace of production for all upstream processes.

5. Distribute the production of different products evenly over a set time at the pacemaker process, thus leveling the production mix

Most assembly departments probably find it easier to schedule long runs of one product type to avoid changeovers. However, this approach creates serious problems for the rest of the value stream and customers, such as:

- Increases the lead time from order to delivery
- Swells in-process inventories

The more you level the product mix (aka "heijunka") at the pacemaker process, the more quickly you will be able to respond to different customer requirements while holding less inventory.

6. Create an "initial pull" by releasing and withdrawing small, consistent increments of work at the pacemaker process, thus leveling the production volume

Too many companies release large batches of work to the shop floor processes, which causes several problems, such as:

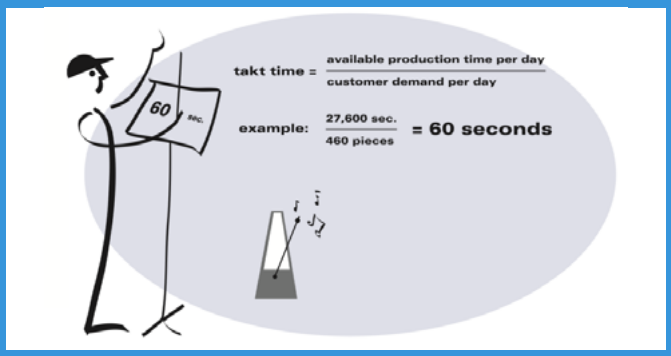
- There is no sense of "takt" or pull from the customer to which the value stream can respond.
- Responding to changes in customer demand becomes very complicated.
- The state of production becomes difficult to monitor.

Establishing a consistent, level production pace creates a predictable production flow. Consequently, this allows management to see problems more easily and take corrective action faster.

A good place to start is to regularly release only a small, consistent amount of production instruction (usually between 5 to 60 minutes worth) at the pacemaker process while simultaneously taking away an equal amount of finished goods. We call this practice a paced withdrawal. And the pitch is the consistent increment of work.

We calculate the pitch based on the pack-out quantity (the number of parts one finished-goods container holds) or a multiple or fraction of that quantity. For example, if your takt time is 30 seconds and your pack-out quantity is 20 pieces, your pitch is ten minutes (30 seconds x 20 pieces = 600 seconds or 10 minutes). In other words, every 10 minutes: a) give the pacemaker process instruction to produce one pack quantity and b) take away one finished pitch quantity.

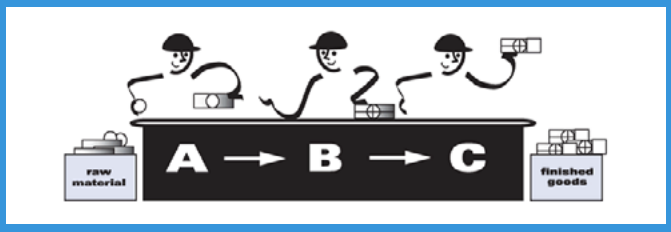
Takt Time



Takt time is a calculation of the available production time divided by customer demand.

For example, if a widget factory operates 480 minutes per day and customers demand 240 widgets per day, the takt time is two minutes. Similarly, if customers want two new products per month, the takt time is two weeks. The purpose is to precisely match production with demand. So takt time provides the heartbeat of a lean production system.

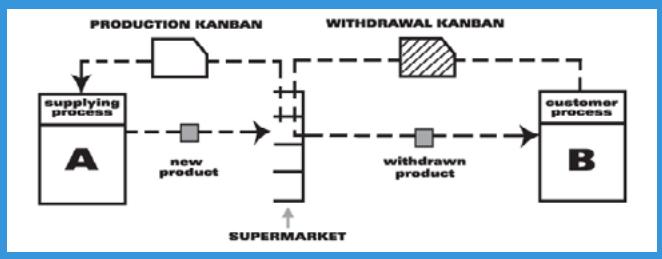
Takt was first used as a production management tool in the German aircraft industry in the 1930s. (Takt is German for a precise interval of time, such as a musical meter.) It was the interval at which aircraft were moved ahead to the next production station. The concept was widely utilized within Toyota in the 1950s and was in widespread use throughout the Toyota supply base by the late 1960s. Toyota typically reviews the takt for a process every month, with a tweaking review every 10 days.



Continuous Flow

Producing and moving one item at a time (or a small and consistent batch of items) through a series of processing steps as continuously as possible, with each step making just what is requested by the next step.

Continuous flow can be achieved in many ways ranging, ranging from moving assembly lines to manual cells. It also is called *one-piece flow, single-piece flow, and make one, move one.*

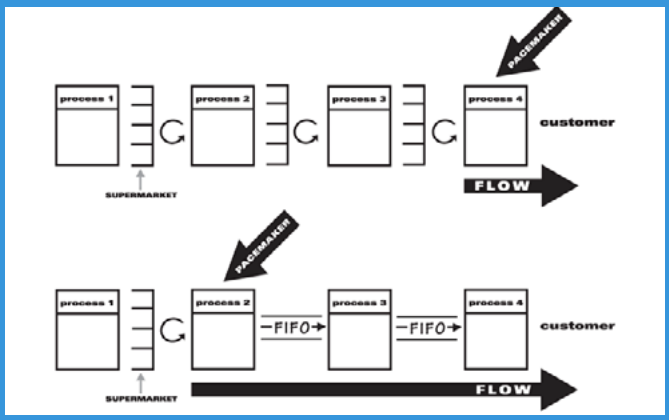


Supermarket

The location where a predetermined standard inventory is kept to supply downstream processes.

Supermarkets ordinarily are located near the supplying process to help that process see customer usage and requirements. Each item in a supermarket has a specific location from which a material handler withdraws products in the precise amounts needed by a downstream process. As an item is removed, a signal to make more (such as a kanban card or an empty bin) is taken by the material handler to the supplying process.

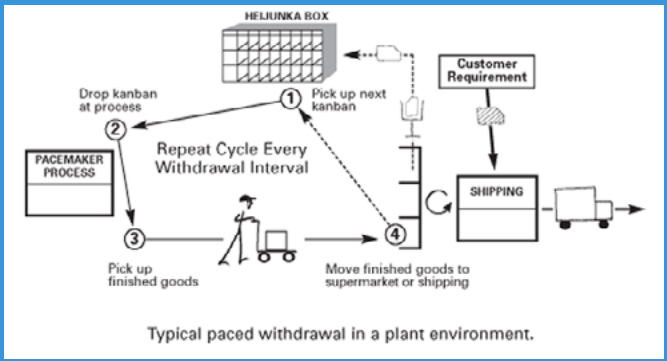
Toyota installed its first supermarket in 1953 in the machine shop of its main plant in Toyota City. Toyota executive Taiichi Ohno took the idea for the supermarket from photos of American supermarkets showing goods arrayed on shelves by specific location for withdrawal by customers.



Pacemaker Process

Any process along a value stream that sets the pace for the entire stream. (The pacemaker process should not be confused with a bottleneck process, which necessarily constrains downstream processes due to a lack of capacity.)

The pacemaker process usually is near the customer end of the value stream, often the final assembly cell. However, if products flow from an upstream process to the end of the stream in a FIFO sequence, the pacemaker may be at this upstream process.



Typical paced withdrawal in a plant environment.

Paced Withdrawal

The practice of releasing production instructions to work areas and withdrawing completed product from work areas at a fixed, frequent pace. This practice can be used as a means of linking material flows with information flow.

In the illustration above, the material handler circulates through the entire route every 20 minutes. The handler begins by withdrawing production instructions (production kanban) from a heijunka box, then delivers the kanban to a production process where they are the signal to produce goods.

Next, the handler picks up finished products from the production process and takes these to the supermarket. There the handler picks up production kanban from the collection box, takes these to the heijunka box for insertion in the box, and withdraws the next increment of production kanban from the appropriate column in the box as the cycle starts again.

Paced withdrawal serves to prevent overproduction and quickly alerts managers—in this case, in less than 20 minutes—if there is a production problem.

Pack-Out Quantity

The number of items a customer (whether internal in a facility or external) wants packed in a container for conveyance and shipping. Note that a pallet or skid of the product may consist of several containers.

Pitch

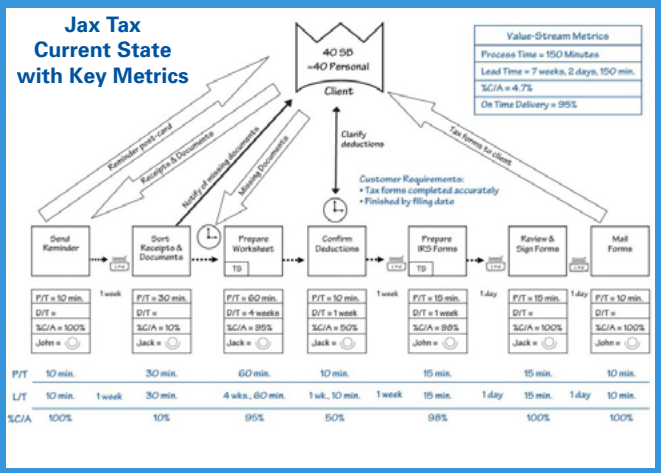
The amount of time needed in a production area to make one container of products.

The formula for pitch is:

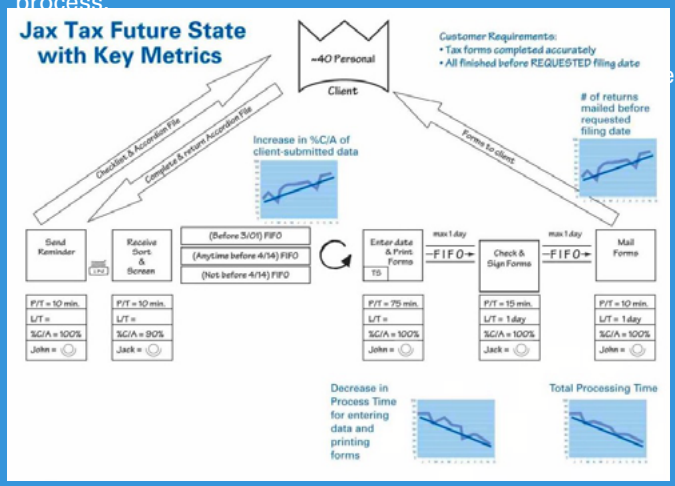
takt time x pack-out quantity = pitch

For example, if takt time (available production time per day divided by customer demand per day) is one minute and the pack-out quantity is 20, then: 1 minute x 20 pieces = pitch of 20 minutes.

Pitch, in conjunction with the use of a heijunka box and material handling based on paced withdrawal, helps set the takt image (the visual signal) and pace of a facility or process.



Current-State Value-Stream Map with Metrics



Future-State Value-Stream Map with Metrics

10 Tips for Getting the Most Value from Value-Stream Mapping

Before you map your value stream, review and keep in mind these tips for ensuring your organization reaps the performance gains it can deliver — including improvements in performance and teamwork.

By Judy Worth

Most organizations see only a tiny amount of the potential benefits of a value stream improvement effort built around a mapping exercise. Such an exercise can be a powerful organizational development tool as well as one for improving value-stream performance on quality, efficiency, and safety. However, before you embark on such an endeavor, here are 10 key things to keep in mind:

1. Pick Processes (Value Streams) That Matter

In other words, select value streams (or value-stream segments) that link to your strategic plan, annual goals, balanced scorecard performance, etc. Doing this means you must be clear about your customers, what they require from these value streams (not programs) by which you deliver value to them, and how well those streams are currently performing. Publicly funded companies may also have other stakeholders to consider as well. Picking value streams that impact organizational performance will help justify the time and effort required to map well and improve the work.

2. Start With a Win — For the People Doing the Work

Lean management is full of paradoxes, and here is one. Sometimes you may need to select a value stream for improvement based on the potential impact on your employees. Choosing to map and improve a value stream to benefit employees is especially important when people are just learning the lean improvement methodology. For example, it's not by accident that CEO Paul O'Neill started his turnaround at Alcoa with a focus on employee safety. Once he demonstrated that commitment, he got full cooperation for other improvement efforts from the union and workers on the front lines. Likewise, starting with a value stream to reduce high employee dissatisfaction or undesired turnover builds support for future improvement efforts.

3. Be Clear About Scope — And Don't Creep!

We all want to end world hunger and achieve world peace — but without focus, we won't achieve anything. Most high-level value streams are really more like value rivers. Sorting out the major contributing streams and identifying those that need to be improved to impact organizational performance increases the value of your mapping and improvement efforts. And determining up front where the value stream starts and stops and what is in and out of scope for people doing improvement work prevents a lot of wandering in the wilderness. Address these and other issues before you start a mapping exercise in the form of a Value Proposition or Team Charter.

4. Get the Right People on the Bus

Involve the value-creators — the people closest to the work process you'd like to improve (at whatever level that work is performed) and in all the critical processes involved in developing the map(s), defining problems, and crafting solutions. See together, learn together, act together, and improve together. And, wherever possible, ensure to include suppliers and customers, not just doers. If you have to map with a small group, make sure you socialize their draft products with the value creators for the value stream. Keep a regular communication link to all levels of the organization.

5. Go and See How It's Really Done!

Supplement spreadsheet data with direct observation and interviews at the gemba. You'll be amazed at the things you learn that never appear on spreadsheets.

6. Eat the Elephant One Bite at a Time — but Plan to Eat It All — or at Least As Much as You Need

As you begin your improvement effort, try to get action teams involved in rapid learning cycles within two to three weeks after concluding a mapping exercise. Craft quick wins and 30-, 60-, and 90-day plans for implementation, but think about a future state that is 18 to 24 months out. In other words, nest those short-term improvement efforts in the context of a longer-range vision. That way, people have some sense of where they're headed, and you have insurance against doing improvement work that optimizes some portions of the value stream but sub-optimizes others.

7. Count, Count, Count — But Count the Right Things

Before you start, be clear about the "vital signs" for your value stream — the few key metrics that tell you whether the value-stream performance is healthy — and the key few metrics for the individual processes that make up that value stream.

Be sure to measure things that are meaningful to the people doing the work, allowing them to see the improvement and how their work links back to the higher-level organizational goals and metrics. Use existing information systems when you can, but you may need to measure manually when you are getting started. If so, keep your measurements simple. Otherwise, they won't get done — or done honestly.

8. Experiment Before You Implement

Insist on experimentation. Establish a ground rule that no "solution" gets implemented hasn't been tested to confirm that it will address the problem for which it was identified.

9. Don't Be Afraid to Take It Outside

Some of the most critical value stream redesigns involve working across functions and organizations. Indeed, here's where value-stream mapping comes into its own. Many organizations jump from a current state map to point kaizen improvement. However, when value-stream mapping cross-functional or cross-organizational value streams, ensure all key stakeholders agree on the key problems that need to be solved and reach a consensus on the future-state vision (in the form of a map). Agreement on a vision that eliminates or addresses those problems turns value-stream mapping into a powerful tool for system-level problem-solving.

10. Make It Fun! (Or at Least Not Painful)

I've already alluded to the importance of engaging people in improvement activities that are personally meaningful to them. However, we've seen many of our client organizations get downright creative regarding engaging staff members in the socialization of maps and improvement plans and involving them in rapid learning experiments. Such efforts include:

- communicating updates at shift-change spaghetti suppers or casino nights
- using unique themes (often involving sports) for obeya boards and board meetings
- posting pictures of employees involved in the work
- providing recognition for people who have gone above and beyond in the improvement efforts.

My all-time favorite still is a communication-board series with a movie theme for a general radiology workflow. It used "Playing Now" for the improvement effort underway, "Coming Attractions" for scheduled workflows to be improved, and "Critic's Corner" for staff member comments about experiments and problems.

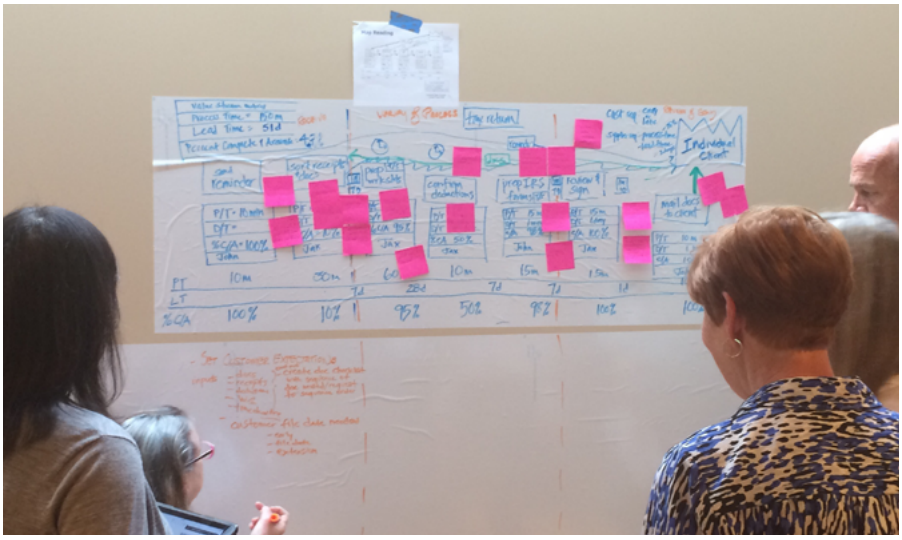
Ultimately, value-stream maps can tell a story — and tell it effectively. But a well-planned and executed value-stream mapping exercise that engages the right people and involves appropriate follow-up can change that story in ways that make a real difference for the long haul — in value-stream performance and teamwork. ■

Keep It Simple: Value-Stream Mapping at the Gemba

A veteran lean coach shares a story showing that even simple and quick value-stream mapping can be hugely helpful when you include the people doing the work in the mapping process.

By Dave LaHote

I remember a project where I helped facilitate problem-solving teams at a small manufacturing company. One group was developing scheduling software to help them schedule the production of samples. The problem was that they commonly had requests for product samples, which often caused problems when they added a sample order to the production process. As a result, the team had trouble meeting the sample required date and being on time in their regular production schedule, so they decided they needed to change their production scheduling software.



By now, you have probably already concluded that new software was not a problem but rather a solution. But, as a lean practitioner, you likely know that people often present their solution as the problem. So, for example, "the problem is that our current software doesn't allow us to properly schedule small sample runs."

I found the team in a conference room brainstorming ideas about how to schedule samples better. I asked them why their production process could not accommodate the interruption of a sample order. No answer. Then, I asked what the production process's steps were and where the sample order caused a problem in that process. After some discussion, it was clear that there were many differences in opinion.

Finally, I asked them why they were in a conference room arguing. I suggested we all go to the line and try to understand what was happening when they added a sample order to the schedule.

Go to the Gemba

As we walked the line, I had my notebook and pencil out. We walked each step and noted the work-in-process inventory (WIP). I timed and recorded the cycle time of each process step. We asked the workers how long the changeover from one product to another took. And we asked the workers about the problems they experienced when they needed to complete a sample order.

Getting a baseline understanding of the process took us about 20 minutes. When we finished, we had an old fashion process and material flow chart (today, more commonly called a value-stream map). But, most importantly, our discussion with the workers had pointed us to one process step that typically got behind when adding sample orders into the process.

Together as a team, we referenced the map to come to a shared understanding of how the process worked. Doing the math with the cycle times and changeover times we had on our map, it was easy to see how a sample order

that required extra time at one step of the process tended to starve the rest of the production line, causing regular production to fall behind.

Again, standing near the production line, we did the mathematical calculations and discovered that adding WIP at one process to buffer to the interruption caused by the sample order could keep the line running and on schedule. So the team decided to increase the WIP accordingly and experimented with some sample orders that afternoon to see if it worked.

As we were walking away from the line, one of the team members told me, "It usually take us two days just to do a value-stream map, but you just did one in 20 minutes." I explained that the purpose of a value-stream map is to create a shared understanding of a process. My observation of the team's discussion told me they didn't have this common understanding and were arguing based on opinions. Therefore, we needed to go and see and then draw what we saw so everyone would understand the problem similarly.

By the way, with a couple of check-and-adjust cycles, they got the WIP inventory at the right level so that samples no longer caused a problem at a total cost of $0. Moreover, the map-drawing process also revealed some underutilized equipment, which they used to achieve additional capacity — again, at no added cost. These results demonstrate how value-stream mapping can free up overlooked growth capacity, which is the real impact of lean thinking and practice.

Get Back to Basics

So, how are you creating value-stream maps? Are you spending days using fancy software to draw pretty maps suitable for lamination? Are you worried about whether you have used the correct symbols and recorded all the right information? Or are you drawing simple representations of how the processes link to create value? Are you drawing value-stream maps as a team to create the common understanding that leads to an agreement to implement a countermeasure as an experiment? And, are you doing mapping at the gemba by observation and discussing with the people who do the work?

I encourage you to use the powerful value-stream mapping process in its most basic form. Use a pencil and paper and work with your teams to collect as much information as you need to see and better understand your process steps and how material and information flow through those processes. So gather your team, get your pencil and pad, and go see to understand together. ■

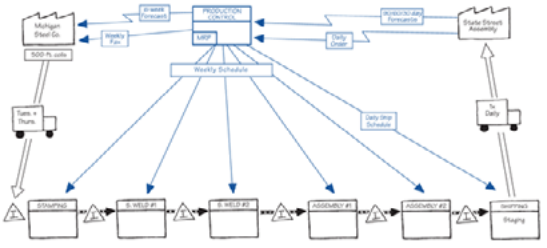
Information Flow

The movement of information on customer desires backward from the customer to the points where the information is needed to direct each operation *(see illustrations below)*.

In companies based on mass production principles, the flow of information usually takes parallel forms: Forecasts flowing back from company to company and facility to facility; schedules flowing back from company to company and facility to facility; daily (or weekly or hourly) shipping orders telling each facility what to ship on the next shipment; and expedited information countermanding forecasts, schedules, and shipping orders to adjust the production system to changing conditions.

Companies applying lean thinking try to simplify information flows by establishing a single scheduling point for production and instituting pull loops of information. These go upstream to the previous production point and from that point to the previous point — all the way to the earliest production point.

Current-State Information Flow in Mass Production

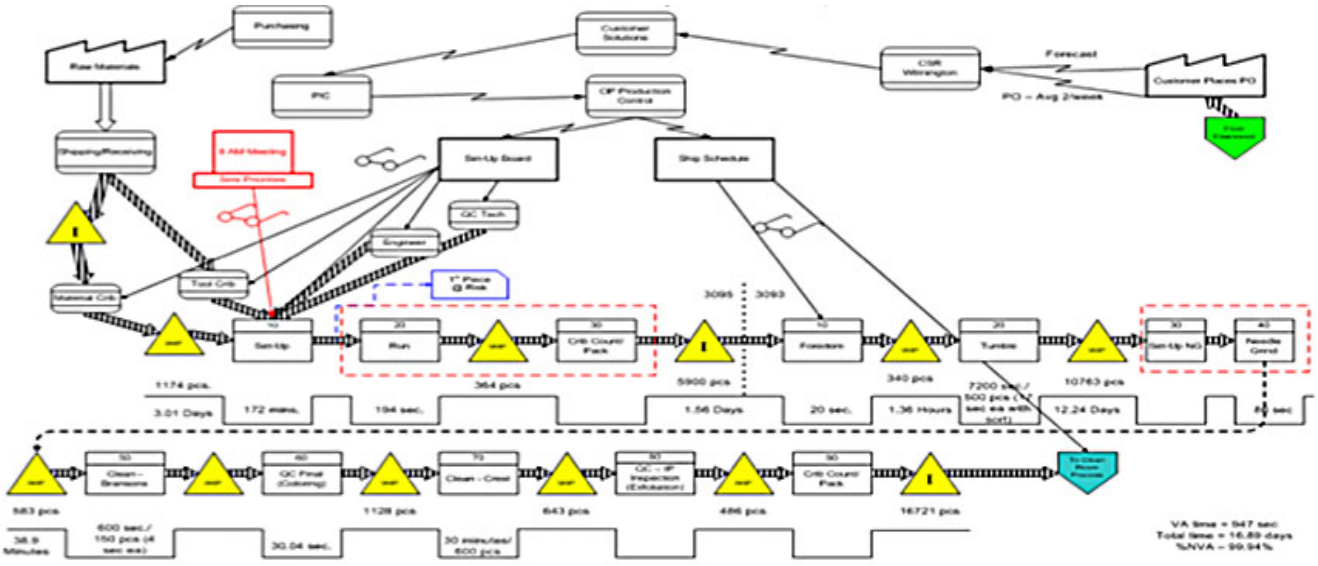


from the *Lean Lexicon 5th Edition*

Apples & Oranges: Value-Stream Mapping in a Low-Volume/High-Mix Environment

Here's how one LVHM company mapped its complex value streams — and discovered the path to next-level productivity that enabled it to transform the business for an entire range of products, from losing money to making a decent profit.

By Aaron Hunt



Making improvements using lean principles in a low volume/high mix (LVHM) manufacturing environment can be difficult, especially when determining where to start. However, some of the same tools used in traditional mass-production environments work equally well in a high-mix environment.

As the engineering manager for an LVHM organization in the medical device field, I found one of the keys to success was identifying groups of products by flow — especially during one project I worked on to fight long lead times and noncompetitive costs. In a sense, we stopped trying to compare apples to oranges and just looked at our products as if they were all the same. We would first work to identify all the products in a facility, department, or office and then define the flows. This task was probably the most time-consuming for us, as some facilities had as many as 4,000 products — some of which were only made once per year or less in quantities as low as five (excluding custom orders and prototypes).

We would then align the products by workflow. For example, in one manufacturing facility, we stopped grouping products by type, e.g., "hips," "knees," and "shoulders." Instead, we grouped them by process flows, e.g., "Lathe-Vertical Mill-Vertical Mill," or "Lathe-Mill/Turn-Mill," or "Laser Etch- Non-sterile Packaging – Labeling." The products might have been apples vs. oranges vs. pears in appearance, but if they all used the same flow, that was our starting point.

After grouping the products by workflow, we could start identifying the volume, takt time, and capacity required for each flow. Sometimes this meant grouping products A, C, and X together, even though they look nothing alike, and we traditionally considered them to be unrelated to each other. Grouping products by flow created smaller individualized value streams within the overall organizational value stream — some with 300 products, others with 50, and others with just one or two.

Once we understood this, we knew how many manufacturing "units" (e.g., machines, secondary processing, labor, etc.) we would need for each value stream. This information fed our capacity planning. Ultimately, our VSM looked something like the image above.

This overall strategic-planning work allows you to determine where to start value-stream mapping and what percentage of your business each flow represents.

> "we reduced the average changeover time within the critical value stream from 10 hours to 30 minutes. While that's not a single-minute changeover, it reduced wasted time between orders by 95%."

Then, more critically, you can leverage your map for strategic advantage by adding current margins and variance reporting (if you have the data) of the combined value stream and detail by each smaller product family within the stream. So, for example, you could start making intelligent choices on which VSM will probably yield more significant wins for the organization.

We added that data, which caused us to focus on one combined value stream representing several hundred products. As a result, we reduced the average changeover time within the critical value stream from 10 hours to 30 minutes. While that's not a single-minute changeover, it reduced wasted time between orders by 95%. And that reduction meant the difference between losing money and making a decent profit on the entire range of products.

We started seeing significant growth once we had defined and improved value streams representing 50% of our revenue using this strategy. We targeted one year for this initial part of the transformation after figuring out how many "events" we would need to get these changes done and get a large percentage of our staff involved in the cultural change. And things only got better from there. Once we improved value streams representing 80% of our revenue, the sky was the limit.

I challenge you to put aside some time to intentionally consider your organization's value streams — or your product families if you don't group products by value stream — and map your process flows. You might find hidden opportunities within your current assumptions, or you'll find a starting point for transforming your LVHM business. ■

Product Family

A product and its variants passing through similar processing steps and common equipment just prior to shipment to the customer. The significance of product families for lean thinkers is that they are the unit of analysis for value-stream maps, which are defined from the most downstream step just before the customer.

Note that product families can be defined from the standpoint of any customer along an extended value stream, ranging from the ultimate customer (the end consumer) to intermediate customers within the production process.

For example: In a power tools business, a product family might be defined as medium-sized electric drills utilizing a common chassis and passing through a common assembly cell as the last manufacturing step before shipment directly to end consumers.

Alternatively, the product family might be defined as the drive motor and its variants assembled in a common cell just prior to shipment to the drill manufacturer customer.

Or a product family might be defined as the drive motor stator and its variants going through a common manufacturing process just prior to shipment to the drive motor customer.

from the *Lean Lexicon 5th Edition*

Why Value-Stream Mapping is Essential to Product and Process Development

Learn about a proven way to help cross-functional teams clearly "see" their work and achieve their full potential.

By John Drogosz, PhD

In product development, a lot of people are working on the same data at the same time. And there are a lot of trade-offs in interfaces in the design work. When we don't have those things synchronized, a lot of times, we are working with unstable data. We start doing work and then have to rework it as we go through. And that causes more time on the project. But frankly, it also causes more frustration for the team members. No one likes to do work and have to rework it again.

> "… product development value-stream mapping has been a valuable technique to help teams see how they do their work and how it fits together. And as they see that, they also see opportunities to improve their work …"

So product development value-stream mapping has been a valuable technique to help teams see how they do their work and how it fits together. And as they see that, they also see opportunities to improve their work. It [VSM] was originally described by John Shook and Mike Rother in their book *Learning to See* many years ago, and the goal, whether you're designing a product, a service, or a process, you're trying to create new value for your customers.

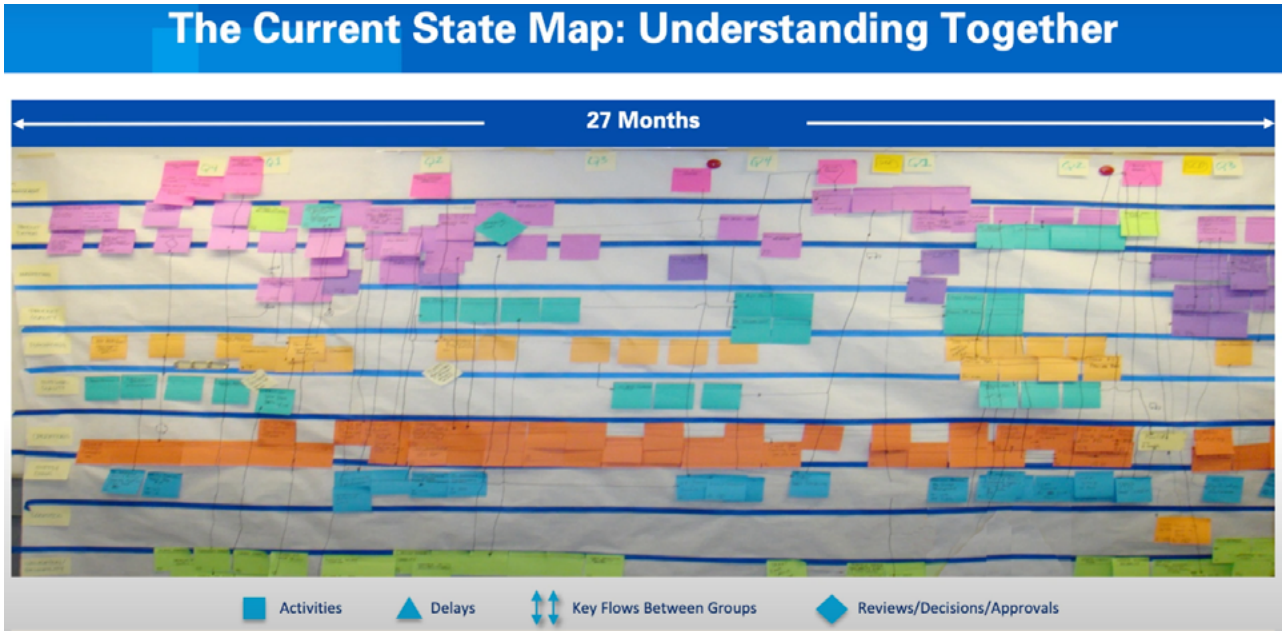
In that regard, the product development value-stream map helps us visualize where that value is being created and where we are being blocked from creating that value as a team and in our individual work.

So, the main components of product development value-stream mapping, starting with the current state: Where are we today? What's going on? And where are the challenges? And the future state: Where do we want to be in the future by eliminating some of those wastes and pain points? And then, to get there, the most important part is creating an action plan to move from that current state to the future state.

The Current-State Map

The current-state map is the starting point of the product development value-stream mapping process. Before it's possible to make any improvements, we all need a common understanding of how we're doing the work today. Then, as we start seeing how the work is being done, and we're sharing and comparing, we start seeing how it all fits together. And as we start seeing it coming together, we start understanding where the value is created.

As we always say, product development is a team sport. So, you will see multiple swim lanes on your value stream maps. Everybody needs to have a place to show their work. Each line represents a different person or group and how they contribute value to the particular product or service that is being delivered and designed.



As we look along the top, teams run to a timeline — because we need to understand what the team is doing, what kind of work they're doing, and when it's happening.

Time is a crucial element: We need to understand where that work is behind schedule. And usually, you need a pretty big piece of paper or a big wall because there's a much larger timescale. By comparison, in manufacturing, we use a stopwatch; in product development, we use a calendar for measurements. So the timescale and the number of actors are dramatically different.

On the map, the squares indicate processes. There are delay points as well, which are usually represented by triangles. And, of course, we have connections between the different groups.

In the product development value-stream maps, you will see a lot of interdependencies. And highlighting those interdependencies will help synchronize that work or see where it's not synchronized.

And the last shapes you will see are diamonds, which indicate when the development team must come together, share their knowledge, integrate their work, and make decisions. And these integration events are critical to product development because this is when we see where that value is coming together.

The map you see here *(above)* is from a company that designs and manufactures high-precision equipment. In their current state, they were taking 27 months to bring a product to market. The project team designing their next-generation product had the challenge of significantly reducing that time to meet their customers' needs and stay ahead of the competition. By visualizing their current state, the team was able to identify areas where they could improve the process and accelerate the time to market.

Seeing the 'Pain Points'

When you put together a current-state map, another thing that happens is you start seeing the pain points. Here are some pain points, or wastes, typically found when mapping the current state that stop teams from creating value. As we map, we also start understanding where those pain points are hiding, how big they are, and, most importantly, how they impact not just one person but the overall team.

Product development is not a one-person show. In many ways, the entire enterprise is interconnected to create that future value stream for the customer. So, we must have those different perspectives to understand the current state. And as we start getting those groups together, we also start getting, I think, a little more empathy on what each other needs. That empathy then allows us to work together to try and find solutions and help each other work more effectively.

The Future-State Map

The future-state is a vision of where we want to go with our product development system and is designed to bring out people's talent and help them create value in the most effective way possible. Coming back to the earlier example, the project team created their future state by incorporating some of the lean product and process development practices to address the pain points they identified in their current state. As a result, they were able to shorten their development time from 27 months to 15 months.

The future-state map is going to be different for each organization. Each organization has distinct value creation, different customers, and unique challenges. So, when we talk about what a good future state looks like, that's determined by the development team. However, in lean product and process development, we have a few guiding principles to help you as you start your journey. The concepts at a very high level and principles are fairly straightforward, but putting them into practice sometimes is very challenging.

By going through the future state, we create a scenario where people see that vision of how they apply those principles to attack the challenges and waste they have in their process — and, quite frankly, make it real. Some challenges are going to arise. Some surprises are going to happen. And you want to make sure that you pivot to adjust to those situations while staying true to your course. And that future state is a great anchoring point.

The Implementation Plan

As you're creating your future state, it doesn't answer all the questions. It gives you a direction. The implementation is where you test it out. We need to change the process toward the future state. There will be challenges along the road. You will need to do several learning cycles and run experiments. The future state, in many ways, is a hypothesis; it should be based on some reality and buy-in from the team. But it should be aggressive enough so that we challenge ourselves on how we can improve to deliver that value to our customers.

The other thing is the future state is not a one-and-done. So, as you start moving forward, you will probably see some opportunities to go to a future future state, and that's okay too. But as a team, you must have a good implementation plan that lines up and applies to the project that you're working on.

That's one of the things that's a little unique in terms of implementation for us in product development, we're designing the future product or service, and we're improving the way we do that process at the same time. So, in many ways, you're improving the railroad as the train goes down the track. And that's part of the improvement process, but it's imperative to have a good game plan because after you've created your future state, everybody's going back to work. So, we need to ensure we've got actions to improve built into our project plans.

> "… we're designing the future product or service, and we're improving the way we do that process at the same time. So, in many ways, you're improving the railroad as the train goes down the track."

Product development value-stream mapping is a universal technique. It can apply to almost any industry, whether a product, a service, hardware, or software. I've seen it applied to everything from very simple processes, like developing a squeegee, to very complex, like an aircraft carrier, and anything in between.

My sincerest hope is that you can use this methodology to get your teams talking to each other, see how their work fits into the big picture, and achieve a mutual understanding of how it fits together. And then see where we can help each other to eliminate those pain points or waste that get our way every day. So that, ultimately, we can free up our people's time to work on those important elements of creating value and addressing the challenges we have within our organizations and society at large. ■

Why You Need to Map the Extended Value Stream

This case study from the LEI workbook Seeing the Whole Value Stream shows how the practice can help businesses optimize their global sourcing strategy, creating win-win-win outcomes for everyone involved.

By Dan Jones

An invaluable use of extended value-stream mapping is to track the path of all of the essential parts that go into delivering a product to a customer, from raw material to delivery. The picture that emerges will show the consequences of the manufacturing and sourcing strategy that guided the design of the product and its supply system.

But, more importantly, an examination of the current-state system as a whole may reveal opportunities for rethinking the global configuration of the supply system for the next product generation, which is the point at which it is easiest to make a significant leap to an ideal-state configuration.

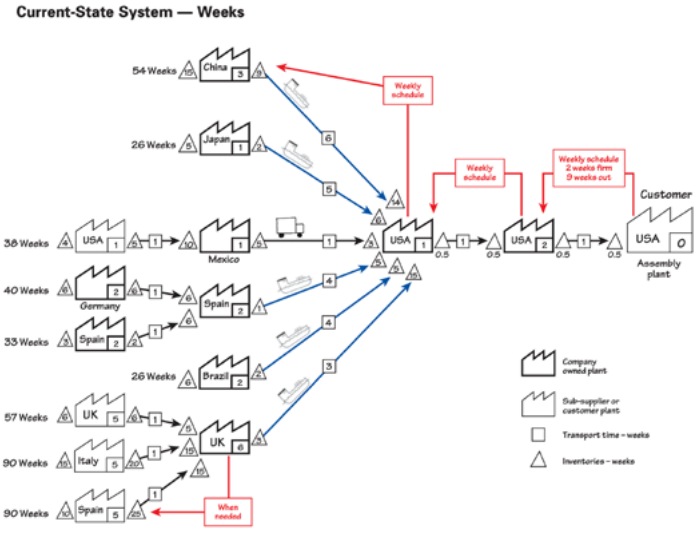
This case study expands the scope of value-stream analysis to all the value streams supplying materials for a complex component. The value streams include every supply system through and between each facility along each value stream. This entire system needs to be as lean as possible. The question that emerges once the lean practitioners complete this analysis and have improved the value streams is where, across the world, they should locate each facility. Answering that question was the key task of the ideal-state analysis presented for this value stream.

Seeing the System

When a global automotive supplier of a forged, machined, and assembled component delivered to an auto assembler in the U.S. began to design the next generation of its product, the firm took a fresh look at the supply system for all the key sub-components back to raw materials.

It assembled a cross-functional team from operations, procurement, supplier development, planning, and finance to collect the data and map each value stream in the current supply system using the methodology described in the *Seeing the Whole Value Stream* workbook. Then, they posted the maps on a big wall in their procurement department to analyze them. In this case, many of the facilities were part of the same corporation, so the cross-functional team was able to get most of the information they needed from internal suppliers.

The completed system-level map, which covered a whole wall, contained similar data boxes to the current-state maps for the product: recording processing time, raw materials, work-in-progress, finished goods, transport time, transport batch size, delivery schedule adherence, production batch size, changeover time, production interval, yield, parts per million, demand amplification, etc., for every activity.



Shortest lead time = 26 weeks. Longest lead time = 90 weeks.

Creating a System-Summary Map

It is easy to get lost in all this detail, so it is beneficial to summarize the system's main features in a system-summary map *(as shown above)*. The system-summary map illustrates the primary timelines (the amounts of raw materials, work-in-process, finished goods, and transportation time) needed for each of the extended value streams in the supply

system and the primary information flows that trigger these activities. Also included is a summation of the total lead time for each value stream.

Analyzing the Information

The conclusions they drew from the detailed analysis of each value stream on the wall and the system-summary map were:

- The critical parts for this product are made in 14 factories in nine countries on four continents and necessarily travel thousands of miles on their journey to the customer.
- It takes between 26 weeks (182 days) and 90 weeks (630 days) to perform the 10.5 hours of processing time to forge, machine, and assemble the part.
- The cost of all the inventories along the value stream totaled 9.5% of the total contract value. Once you have a delay, the customer builds this into their safety stock for the life of the program.
- The cost of special air freight to respond quickly to changes in demand from the customers was also 9.5% of the total contract value, while all the transport costs were 3.0%.
- A lot of top management time was spent responding to and sorting out issues and problems with the customer and distant suppliers, many of which were part of the group.
- Information flows are difficult to align across cultures, with different timings, languages, and information systems.
- Supply streams crossing currencies carry a much greater risk of windfall gains and losses.
- Long lead times also make it harder to introduce new product designs, accompanied by difficult discussions on who will bear the cost of obsolete stock in the pipeline.

These long lead times, extra shipping costs, and extra inventories reflect this firm's decision when it first configured the value streams. Its goal had been to create large "focused factories" to gain scale economies in each manufacturing step (forging, machining, and assembly in this case). The scale imperative, in many cases, resulted in the selection of one plant to perform a given operation for products delivered to customers worldwide. The other key element in location strategy when the company configured these value streams was to utilize low-wage labor whenever possible in China, Brazil, and Mexico for customers in high-wage locations. The advantages of large-scale and machining efficiencies at company plants in Germany, Spain, Japan, and the UK and of low wages in China, Mexico, and Brazil had been judged more important than the disadvantages of long lead times, lack of responsiveness to changing customer demands, and high in-process inventories.

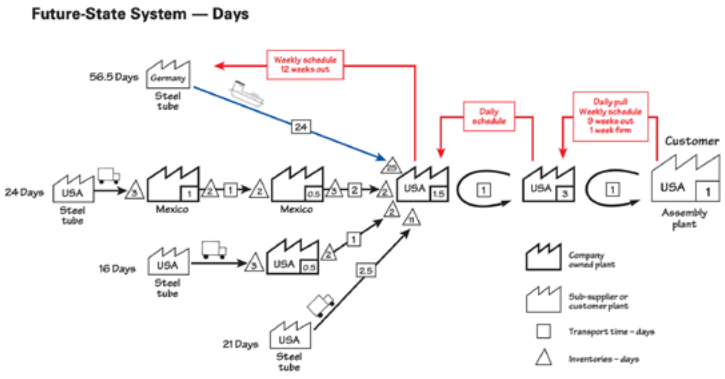
Seeing the Value Stream, End to End

The current-state map combining many value streams caused a lot of discussion, debate, and analysis, which did not please some of the managers responsible for creating it. However, once the system map was on the wall, there was no getting away from thinking about this supply system as a whole in light of the new-generation product they were planning. The result was many questions, starting with why the lead times were so long. So, once the team began to ask why all the delays and inventories were necessary, they began to see the most significant opportunities for an ideal state for the next generation.

First, it was clear that there was still scope for reducing batch sizes and speeding the production flow in plants where work-in-process inventory was less than two weeks. However, the best opportunities lay in the plants in China and the UK, plus those plants supplying the UK; this is where the team decided to focus their internal plant-level lean activities.

Still, to improve lead time further, they worked with their shipping companies to reduce shipping lead times from six to three weeks.

The system-level map also provoked analysis of the information flows that trigger this physical flow in terms of batching, lead times, and volatility. For example, how much did customer demand vary and why? And how much system-driven amplification was being passed upstream?



Shortest lead time = 16 days. Longest lead time = 56 days.

What was driving the need for special air freight, and how much time did management spend responding to changes in customer demand and supplier shortages?

The system-level map was also helpful for tracking the location of the leading quality problems and scrap. Finally, it also provoked analysis of the costs of running this supply system because it was now possible to see much of the costs, rather than piece price and slow freight costs at one part of the system, the traditional basis for location and procurement decisions.

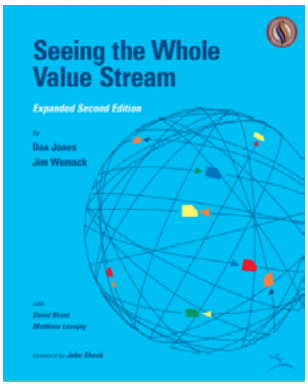
In the end, top management concluded that based on the discoveries of the supply-system team, it needed to rethink its manufacturing and sourcing strategies for the next-generation product. The decision was to trade off wage costs and focused-factory efficiencies against lead times, inventories, and responsiveness by localizing production of the new product within the region of sale.

Box Score

	2005	2012
Product variants	3	16
Continents	4	2
Countries	9	3
Value-processing time	10.5 hours	13.3 hours
Shortest lead times	26 weeks (182 days)	19 days
Longest lead times	90 weeks (630 days)	37 days
Inventory cost	9.5%	4.3%
Transport costs	3.0%	0.8%
Special freight costs	9.5%	1.6%
Demand amplification	4:1	2:1

As a result of this value-stream mapping exercise, this product is now entering production with critical timelines and performance indicators summarized in the future-state map. The difference between the two maps is striking, with only one type of specialized steel tube still being sourced from outside the region, in this case from Germany.

About *Seeing the Whole Value Stream*



Seeing the Whole Value Stream by Dan Jones and Jim Womack provides managers with a proven method for understanding and improving the value-creating process that suppliers share with customers.

By identifying all the steps and time required to move a typical product from raw materials to finished goods, the authors show that nearly 90% of the actions and 99.9% of the time spent in the supply chain's current state create no value. In addition, the method clearly shows demand amplification of orders as they travel up the supply chain, steadily growing quality problems, and steadily deteriorating shipping performance at every point upstream from the customer.

Applying the method to a realistic example, the authors show how four firms sharing a value stream can create a win-win-win-win future in which everyone, including the end consumer, can be better off.

Seeing the Whole Value Stream provides "a method to understand the current state of a value stream and envision future states that progressively reduces waste, variation, and response time, resulting in lower cost and better value for the customer," says John Shook, LEI senior advisor.

The workbook emphasizes lean's true nature as a holistic business system and "elevates value-stream thinking to total-system thinking," he adds. "Everything is connected, so the practice of point optimization invariably squeezes costs and waste in one location only to find that they pop up elsewhere in the system." ■

About The Lean Enterprise Institute

The Lean Enterprise Institute, Inc., was founded in 1997 by management expert James P. Womack, PhD, as a nonprofit research, education, publishing, and conferencing company. As part of its mission to advance lean thinking around the world, LEI supports the Lean Global Network (leanglobal.org), the Lean Education Academic Network (teachinglean.org), and the Healthcare Value Network (healthcarevalueleaders.org).

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The Lean Enterprise Institute (LEI) offers a wide range of learning resources, all with the practical knowledge you need to sustain a lean transformation:

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