Value Stream Mapping—an Introduction

by **Tony Manos**

Value stream mapping (VSM) can be an extremely powerful tool, combining material processing steps with information flow as well as other important related data. VSM is arguably one of the most powerful lean tools for an organization wanting to plan, implement and improve on its lean journey. This tool allows users to create a solid implementation plan that will make the most of their available resources.

For a lean journey, think of VSM as the launch pad to begin identifying and improving a process family. VSM is about sparking change—decluttering the process of the nonessential activities that don't add value but waste time and resources.

VSM, as it is known today, stems from Toyota Motor Co.'s material and information flow diagrams.[1, 2] In its most basic form, VSM shows the process steps from order entry to delivery.

The value stream in VSM is the point at which value is actually added to the product or service by changing

A tool that combines material processing steps, information flow.

the market form or function to meet the customer's needs. For example, value adding activities can be things like: machining, assembly, welding, drilling, folding, painting and so on. If you are not adding value, you are probably adding *muda*, (the Japanese word for waste).

Pictorial representations of VSM are easy ways to learn a language that anyone in your organization can understand—a key element when communicating with process maps. Building a VSM offers detail that goes beyond the amount of information you can relay with any standard flowchart.
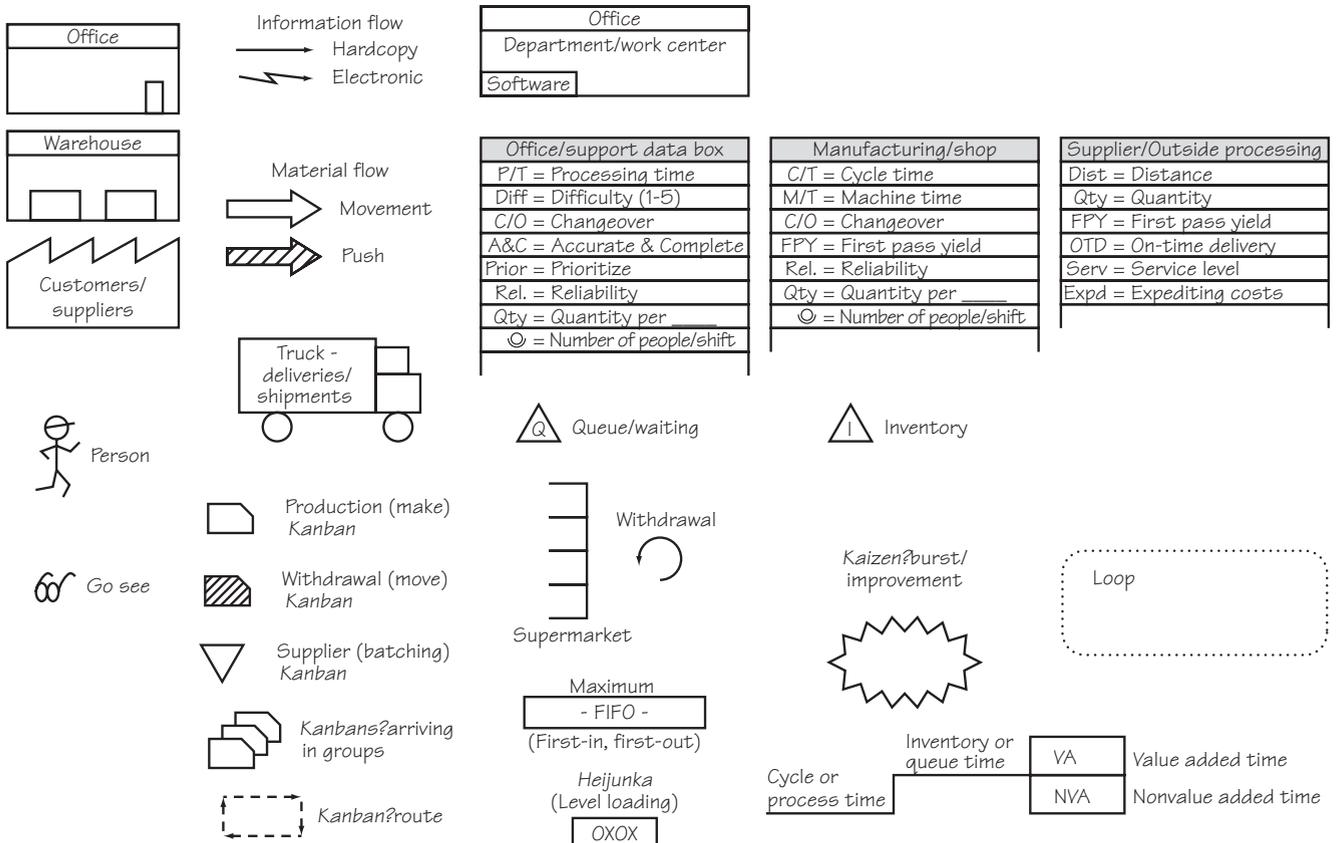
Value Stream Scope

Understanding the scope of the value stream under examination is an important place to start the VSM task. Think of the scope as the door to door process for a facility level map. A departmental or interdepartmental practice is considered a process level map. When multiple plants, customers or suppliers are included, an extended level map is created.

Consider an extended level map as the view of the values stream at 60,000 feet, the facility level map at 30,000

FIGURE 1 **Process Family Matrix Example**

		1. Quoting	2. Order entry	3. Credit review	4. Purchasing	5. Order review	6. Tool preparation	7. Scheduling	8. Receiving	9. Perforating	10. Leveling	11. Shearing	12. Cut to length	13. Slitting	14. Radius rolling	15. Punching	16. Embosing	17. Press break	18. Stamping	19. Outside service	20. Packaging	21. Shipping	Process family	Name
150	80,000 lb/mo	X	X	X	X	X	X	X	X	X											X	X	1	Coil to coil
ORM005	80,000 lb/mo	X	X	X	X	X	X	X	X	X											X	X	1	Coil to coil
020 AI GLD	5,000 pcs/mo	X	X	X	X	X	X	X	X	X			X							X	X	X	2	Ornamental
020 AI Stuco	1,000 pcs/mo	X	X	X	X	X	X	X	X	X			X							X	X	X	2	Ornamental
73518	400 pcs/mo	X	X	X	X	X	X	X	X	X	X	X				X				X	X	X	3	Fab flat
Ballast	300,000 lb/mo	X	X	X		X															X	X	4	Ballast
Nordham	100 pcs/yr	X	X	X	X	X															X	X	5	Pass through
611402401	250 pcs/mo	X	X	X	X	X	X	X	X	X	X	X					X			X	X	X	6	Fab form
VT4880	50 pcs/mo	X	X	X	X	X	X	X	X		X		X			X		X		X	X	X	6	Fab form
EAW435?	150 pcs/mo	X	X	X	X	X	X	X	X		X		X		X	X		X		X	X	X	6	Fab form
YNG Filter	25 pcs/mo	X	X	X	X	X	X	X	X	X	X	X				X		X			X	X	6	Fab form
Gehl 001	150 pcs/mo	X	X	X	X	X	X	X	X	X	X	X		X					X		X	X	6	Fab form
509566	700 pcs/mo	X	X	X	X	X	X	X	X	X	X										X	X	7	Coil to sheet to size
601	250 pcs/mo	X	X	X	X	X	X	X	X	X	X									X	X	X	7	Coil to sheet to size
020 AI MF	8,000 pcs/mo	X	X	X	X	X	X	X	X	X			X								X	X	8	Coil to blank
Nailor	500 pcs/mo	X	X	X	X	X	X	X	X	X			X	X							X	X	8	Coil to blank
202262	20,000 pcs/mo	X	X	X	X	X	X	X	X	X			X							X	X	X		
Stock Plate	250,000 lb/mo	X	X	X	X	X	X	X	X	X	X										X	X	9	Stock plate

FIGURE 2 Common VSM Icons

Office

Information flow
→ Hardcopy
↯→ Electronic

Office	
Department/work center	
Software	

Warehouse

Material flow
⇨ Movement
▨⇨ Push

Customers/
suppliers

Office/support data box
P/T = Processing time
Diff = Difficulty (1-5)
C/O = Changeover
A&C = Accurate & Complete
Prior = Prioritize
Rel. = Reliability
Qty = Quantity per _____
☺ = Number of people/shift

Manufacturing/shop
C/T = Cycle time
M/T = Machine time
C/O = Changeover
FPY = First pass yield
Rel. = Reliability
Qty = Quantity per _____
☺ = Number of people/shift

Supplier/Outside processing
Dist = Distance
Qty = Quantity
FPY = First pass yield
OTD = On-time delivery
Serv = Service level
Expd = Expediting costs

Truck -
deliveries/
shipments

Person

Go see

Production (make)
Kanban

Withdrawal (move)
Kanban

Supplier (batching)
Kanban

Kanbans?arriving
in groups

Kanban?route

Q Queue/waiting

Withdrawal

Supermarket

Maximum
- FIFO -
(First-in, first-out)

Heijunka
(Level loading)
OXOX

I Inventory

Kaizen?burst/
improvement

Loop

Inventory or
queue time

Cycle or
process time

VA	Value added time
NVA	Nonvalue added time

feet and the process level map at 10,000 feet.

It is best to start at diagramming a facility level map before attempting to draw a process level map or extended level map so you do not optimize one area and suboptimize another. This column will focus on the facility level map.

Ready a Team for the Event

The best—and probably easiest—way to create a VSM is to form a cross functional team that includes supervisory or managerial level members from throughout the organization.

Representatives from departments like sales, customer service, scheduling, purchasing, operations, inventory control, maintenance, quality and information technology can be valuable contributors to this part of the VSM journey. Even customers or suppliers—both internal or external—add unique perspectives.

Be aware of the actual size of this team and how it can affect decision making and action. A good team size is usually between seven and 10 members. This size makes it easier for members to conduct interviews and "walk the flow," that is, actually visiting each of the work areas affected by the process evaluation and included in the VSM to see firsthand how things work or don't work.

Predictably, the larger the team, the more difficult it may be to manage. If the team has fewer than seven members, there may not be enough voices to provide well-rounded input.

Finally, never create a map with a team of one. You will not get enough valuable input or cross functional dialogue or the results may be biased for one area, person or department.

Kaizen Kick-Off

Once the team is formed, a three day *kaizen* (Japanese for "change for the better") event, as seen in Table 1, is usually enough time to create the current state and future state maps, along with the draft plan (more detail on these deliverables is highlighted later). More time may be needed to

TABLE 1 Typical Three-Day VSM Kaizen Event Agenda

Day 1	Day 2	Day 3
• Introduce VSM. • Determine process families. • Walk the flow and gather information.	• Draw the current state map. • Perform lean concepts training.	• Create the future state map. • Develop the draft plan.

FIGURE 3 **VSM Current State Map Example**
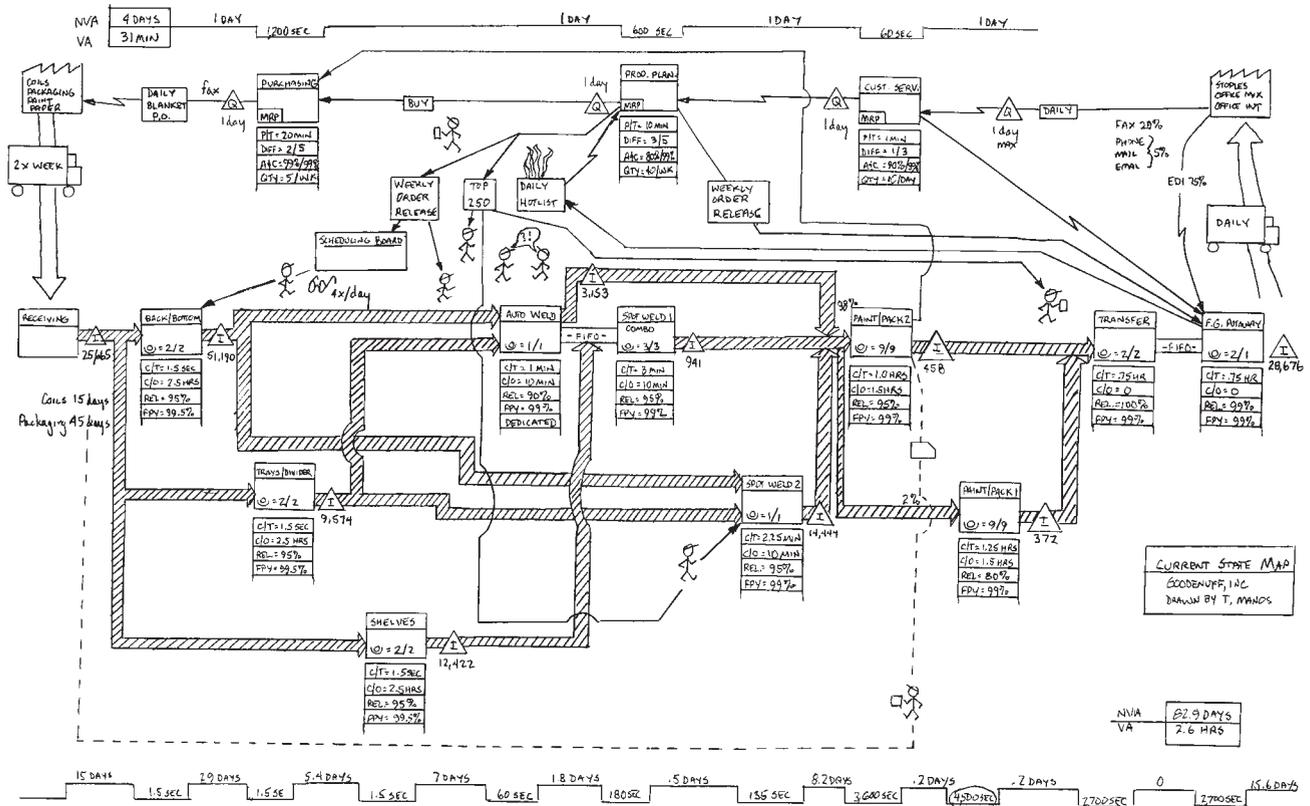
complete the detailed draft plan and determine the resources required to implement the lean ideas. It is important to designate an individual with previous experience in VSM to facilitate this *kaizen* event.

At the *kaizen* event, the team must complete four important steps to progress through VSM:

- Determine the process family.
- Draw the current state map.
- Determine and draw the future state map.
- Draft a plan to arrive at the future state.

Process Family

A process family, also known as a product family, is a group of products or services that go through the same or similar processing steps. To determine your process family, create a matrix similar to the example shown in Figure 1 (p. 64).

- Along the top row, write all the process steps your organization performs from a 30,000-foot point of view.
- In the first column, write down

the parts (for example, components, stock keeping units, finished good items or services) your organization makes or provides.

- Place an X in the corresponding box if the part goes through the processing step.

Many cross functional teams skip this step in the process. A team may decide this step seems unnecessary. The team may mistakenly believe it has already identified the value streams, or it may consider this step too difficult or complicated to perform.

I must emphasize this point again: Do not skip this step. Building a process family matrix can save you much time in the future and help avert headaches down the line. Taking this step will help everyone understand the value streams and where they are in the process.

For example, one company claimed it had a very simple process and the team elected not to perform this step. There were many process steps the team didn't consider and steps not in the main flow, so these parts were not

included in the original matrix. After closer examination, the team that thought its company had only one process family actually had nine families.

After completing this vital step, examine the matrix and look for parts that go through similar or the exact same processing steps. Search for items or parts that share about 80% of the steps. Look for items or parts that would make sense if they were created alongside each other in a manufacturing cell. In other words, consider items or parts that share many of the same steps and procedures that can be created together—by the same workers using similar or related steps—more efficiently in a manufacturing cell.

At this point, the team must select the particular process family it will concentrate on for the current state map.

Every organization may have a different reason for selecting one process family over another when deciding which map to draw first or which order it should map out its value streams. Here are some criteria the

VSM team may use to decide which process family to draw:

- Biggest bang for the buck.
- Largest reduction in lead time or inventory.
- Biggest impact to the customer.
- Highest probability for success.
- Most visible to stakeholders.
- New product line.
- Volume or quantity.

Plotting the Current State

The current state map should illustrate how your organization's processes perform in today's work environment. To create a current state map, collect the data and information by walking the flow and interviewing the people who perform the task. There are two main reasons why walking the flow is more beneficial to creating the map than staying seated at your desk in front of the computer:

- The team will have the opportunity to see the entire process and look for waste.
- Value-adders—the people who actually perform the work (operators, assemblers, technicians,

etc.)—can answer questions and clarify any misconceptions or preconceived notions on how tasks are performed.

From walking the flow, the team can collect on a worksheet several types of information, such as:

- Cycle time or processing time.
- Changeover time.
- Reliability of equipment.
- First pass yield.
- Quantities.
- Number of operators and shifts.
- Hardcopy information.
- Electronic information.
- Inventory levels.
- Queue or waiting times.

There's a rule of thumb to help the team: If the information is in the ballpark then it can be used to get started. For example, if an operator says her machine breaks down about four hours every week, the team can mark down 90% for reliability (of equipment). If it's discovered later the actual reliability was 91%, that difference wouldn't have that much of an impact. Ninety percent was bad enough for the team to know some

changes were necessary. You do not have to wait for perfect data (analysis paralysis), but wrong or disinformation needs to be clarified. If you are in doubt about any of the data, then consider measuring it to verify.

Pencil And Paper

With the information gathered from walking the flow and the ensuing team discussions, it's now time to sharpen the pencil and put the lead to paper. Any VSM can be drawn using simple symbols or icons, some of which are shown in Figure 2 (p. 65).

Once the information has been collected, I recommend drawing the map on 11 by 17 paper (landscape) using pencil and—probably a large eraser. Key areas on the map are:

- The upper right corner for customer information.
- The upper left corner for supplier information.
- The top half of the paper for information flow.
- The bottom half for material (or product) flow.
- The gutters on top and bottom to

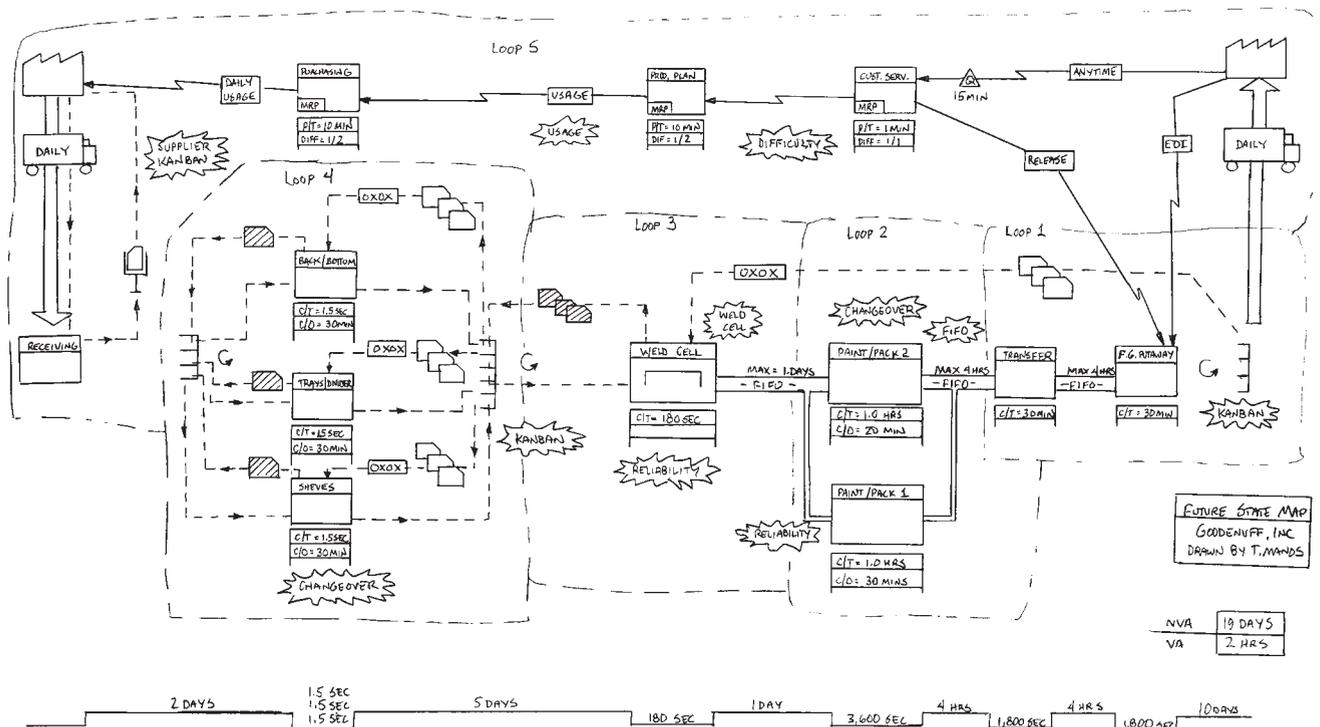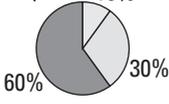**FIGURE 4** **VSM Future State Map Example**

FIGURE 5 Example of a VSM Plan

Project:						Value Stream Mapping					Percentage complete 10%
Status						Goals and objectives					
N = Not started		2	20%			Reduce lead-time by 50% Reduce inventory by 50% Improve teamwork	Location/facility: Promedica - North Campus Lab Process family: Chem Line Automatic Value stream manager: Eileen Allott Date reviewed: NOTE: Update value stream map				60% 30%
I = In-progress		4	40%								
C = Closed		4	40%								
Total:		10									
ID	Status	Loop	Effort	Impact	Priority	Description	Start date	End date	Leader	Team	Comments
1	C	1	L	H	1	5S *kaizen* in assembly area	XX/XX/XX	XX/XX/XX	Tom		Improved safety
2	I	1	L	L	3	QCO on press #31	XX/XX/XX	XX/XX/XX	Joanne		Waiting for parts
3	C	1	L	M	2	Poka-yoke the assembly process	XX/XX/XX	XX/XX/XX	Bob		No errors
4	C	2	L	H	1	Create standardize work in assembly	XX/XX/XX	XX/XX/XX	George		Reduce cycle time by three minutes
5	C	2	M	L	3	Redux=ce batch size by 50%	XX/XX/XX	XX/XX/XX	Ralph		Improved flow, no late deliveries
6	I	3	M	M	2	Eliminate paperwork in order entry	XX/XX/XX	XX/XX/XX	Jennifer		Need help from IT
7	I	3	M	H	2	Improve FPY on part family #502	XX/XX/XX	XX/XX/XX	Homer		SSBB leading project
8	I	3	H	L	3	Perform TPM event to improve reliability of WC #12	XX/XX/XX	XX/XX/XX	Bart		In progress this week
9	N	4	H	M	3	Create assembly cell	XX/XX/XX	XX/XX/XX	Marge		Not started
10	N	5	H	H	2	Set up *kanban*/supermarket pull system	XX/XX/XX	XX/XX/XX	John		Not started

calculate value added and nonvalue added time.

Calculate the cycle time vs. the inventory time (in days) for the material and information flow. Every VSM will look slightly different depending on the exact process, the author who drew the map and how it was drawn. See Figure 3 (p. 66) for an example of a VSM current state map used for a metal fabricating company.

If this is one of your first VSM *kaizens*, have the experienced facilitator draw the map on a large dry-erase board and the team members draw each of their own maps on paper. If your team members are more experienced, they may gather the data first and then draw the map. If they are experts they may just draw the map as they gather the data. The current state map is usually completed by the second day, but it needs to be refined a little the next morning. Remember,

when drawing your maps, your eraser is your best friend.

Future State Map

Once the current state map is complete, the team can set its sights on creating the future state map. Make sure the team members have some basic training on lean principles to develop a realistic future state map (see Figure 4, p. 67). Different authors will suggest questions to guide you to a future state. Be careful to use the questions appropriate to your type of business. Here is a short list of questions with common elements that may fit most types of business:

- **What is the *takt* time?** *Takt* is the German word for the baton a conductor uses to control his orchestra's speed, beat and timing. *Takt* time refers to how frequently a part or component must be produced to meet your customers'

demand. The formula is the time available (per shift) divided by the demand (per shift). For example:

22,000 seconds (time available)
÷ 200 pieces (demand)
= 110 seconds/piece.

- **Are there bottlenecks or constraints?** From the data collection during the *kaizen*, look at the cycle times or processing times. If any of these are greater than your *takt* time, you have a candidate for a bottleneck or constraint. This may be causing overproduction waste or work in process (WIP) in some areas or extra processing time, such as overtime, to meet demand.
- **Where can inventory (or queue time) be reduced or supermarkets used?** Look at raw material, WIP, buffer stock, safety stock and finished goods inventories to see

whether these can be reduced. Does it make sense to put in a supermarket replenishment system?

A supermarket is a controlled inventory system—the downstream process removes items from the shelf and the process owners upstream replenish that amount to the supermarket.

The key is to find ways to reduce inventory in a logical manner. Also look for opportunities for paperwork to flow and not sit around, like in batching.

- **Where can you improve flow?** Is it possible to put materials into a cell or eliminate materials from stopping and waiting? If flow improvement isn't possible, could a first in, first out lane be established between processes?
- **What other improvements are required?** For instance, does the reliability of equipment need to be improved? Are the first pass yield or quality levels acceptable? Do we need to perform training in 5S (workplace organization)? Do we need to create a new layout for an area?

On the map, place a *kaizen* burst (see Figure 2, p. 65) around any items to signal improvement is needed. Items may include low equipment reliability or first pass yield, long changeover times, large batches, any waste such as overproduction, motion, transportation, waiting, defects or adjustments, and over or extra processing.

If you are not sure whether there needs to be an improvement during this timeframe, put a *kaizen* burst around it anyway. You can determine if it will be a priority when you put together your plan.

From the answers to these and other questions related to the process, you will be able to draw a future state map that reflects how you want your operations to be based in six or 12 months, as shown in the example in Figure 4 (p. 67).

Estimate the amount of inventory and queue times based on improvements that are achievable. Recalculate the value added vs. nonvalue added time on the sawtooth line.

Draft Plan

Creating (and executing) the draft plan is the most important part of VSM. Creating the maps can be an enlightening experience. But if you do not execute the plan, you have just created more *muda*.

During a typical VSM event, it is possible to create the draft plan based on the information from the future state map. The plan will need further refinement—especially in determining resources required, such as time, people and budgets. A good plan, as shown in the example in Figure 5, will include the description of the project, name of the project leader, possible team members, a schedule (or Gantt chart) of events and deliverables, an estimate of costs and the impact, goals or benefits.

VSM can be an effective tool to build improvements and efficiencies for any organization. For completing this part of the lean journey, the payoffs can be immense for any organization. VSM requires a dedicated team ready to ask difficult questions and think beyond the current state—and a team not afraid to admit error and use that eraser a few times along the way.

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