A Value Stream Map is a material and information flow diagram that helps you see waste throughout the whole value stream. This can be applied to any collection of processes, internal processes, or an entire value stream from suppliers to customers. The use of this tool and a visioning process of future states guide improvement. Over the past 4 years at Madico, application of this technique to the value stream has helped to improve throughput, reduce lead times, reduce inventory levels, and improve customer delivery. This process is used on an iterative basis, where stepwise changes and improvements are utilized and then on roughly a 6 month schedule, the process is repeated. Some of the gains that have been recognized are:

- 90% reduction in inventory
- 90% reduction in time to customer response
- 75% reduction in lead time

Madico has experienced drastic demand swings common in newly forming markets. From months of skyrocketing demand to prolonged lulls, we have built, survived, and prospered in this space. Through the effort, we gained insight into a primary problem that can arise from these large swings and the “distance” in the supply chain between manufacturing services and the true end user demand. This problem is supply chain inventory. It hinders a market and cripples the players in it by reducing cash flow and supply chain responsiveness. In short, inventory causes a supply chain to be sluggish and costly.

While it is alluring to focus simply on material-of-construction costs, it is essential to recognize that value stream wide waste significantly contributes to cost. From Toyota, we know the 7 wastes (Defects, Overproduction, Transportation, Waiting, Inventory, Motion, and Processing) and we know that overproduction is the worst of them all because it causes the other wastes to occur. Yet, many companies find comfort in high levels of inventory.

Traditional supply chain management leads to waste in all forms. Some aspects of traditional supply chain management thinking follow. Customer demand requirements are not known. There is large lot production; “It takes us 6-8 hours to changeover this machine, so we like to make as many as we can when we get it running good!” Pacing to maximize resources; “We just spent $10MM on this machine and our accountants say we have to keep it running to get it to payback.” Limited communication prevails throughout the value stream. Forecasting is the primary tool used to determine production scheduling. Quality is questionable because the customer may not see the product until much later down the road at which time, we have made 1,000 more just like it, leading to large quality rejections. Continuous improvement efforts attempt to
change this type of thinking in an effort to provide what the customer wants, when they want it, with high quality and the best price.

An excellent way to go about improving the traditional supply chain effects, as described by the Lean Enterprise Institute is to first define what value is for the customer. What are they willing to pay for and not willing to pay for? Next, map the value stream, create flow, establish pull, and seek perfection, then repeat. Further understanding this repetitive, iterative process is the focus of the rest of this document.

A typical value stream with lead time, let’s say for example of 20 days as shown in Figure 1, is made up of only 10% value added activities with the rest being waste. Elimination of that 90% waste and convergence on a lead time equal to the value added time is the aim in achieving the principle known as flow.

Value stream mapping is a tool that a team can use to agree on a current state, identify opportunities for improvement and then agree on a future state. What it shows is material and information flow and it indicates the time associated with each step. Inventories are expressed in terms of days by dividing the amount of inventory on hand by the daily demand. The current state VSM in Figure 2 is showing that material is pushed from step to step rather than being pulled as indicated by the striped arrow and triangle between each process step. The term pushing material from step to step describes how a product is made by a supplier without having a direct signal from the customer indicating a need.

Reading the current state VSM in Figure 2 is simple. Starting in the upper right hand corner with the customer a, an order is given to Production Control, who then places orders on suppliers and schedules each of the processes. Material moved from the supplier at the top left down through the step going left to right, eventually making it to the customer. Inventory in terms of days and cycle times for value added processes are listed at the bottom and added up at the end to allow a comparison of value added time to the overall lead time. Each value added step should have listed the associated cycle time, changeover time, uptime, available time, every part produced every X days, yield, and any other measure pertinent to the capability of that step.
In the current state, an aspect of traditional supply chain management that you probably will run across is called the bullwhip effect, also known as demand amplification. This effect was first described by Jay Forrester in 1961 and can be seen very easily in a simulation called the beer game developed by MIT in the 1960’s. The bullwhip effect describes the increase in variation for both order quantity and inventory the further upstream you go in a supply chain, as shown in Figure 3. It is the result of a forecast driven, push system, with little to no communication across the entire supply chain.

The solution is to synchronize the entire supply chain. To do this, we have to create flow and adopt pull from a total system perspective. Locally implementing this will not have the desired effect on the whole system. The key is to think of the entire supply chain as one and to implement a system that will link or synchronize each piece together, similar to a timing belt on the VW Passat engine in Figure 4. Each piece, the camshaft, the water pump, and the crankshaft are linked via the belt. The converting
industry needs the timing belt. The main lesson you get out of playing the Beer Game I mentioned previously is that the structure of our management process creates the behavior. Changing the people without changing the structure doesn’t improve things permanently. Therefore, the highest leverage lies in redesigning the structure of a process. Systemic thinking is essential for effective redesign.

“Pull” is about making something or providing a service when and only when the customer needs it and only in the amount needed. What does it mean to need something? It does not mean that we order additional inventory to make one feel secure in the ability to supply down the supply chain. It means when you ACTUALLY have real demand that you can send the pull signal to the supplier.

The key to waiting until the real demand signal is being able to provide the product or service with a lead time and quality that is acceptable to the customer. This is where “flow” comes in, which is where a product or service would go from value added step to value added step without delay. There are many reasons why we can’t flow in the beginning. Those reasons can be categorized into one of the 7 forms of waste, which we know from Toyota to be DOTWIMP or Defects, Overproduction, Transportation, Waiting, Inventory, Motion, Processing (Over). Overproduction is underlined because it is considered to be the worst of the 7 wastes because it causes the other wastes to occur.

After creating a current state, the cross functional team is encouraged to create an ideal state map. In this ideal state, we go outside the box in our thinking and document it. We do this because sometimes the ideas we consider to be extreme in our own mind turn out to be viable in one form or another. By skipping this step, creative ideas can be lost that may have contributed to a better target state.

The next step is to create a target state. Certain specific questions are to be answered to help facilitate this effort. Some of the questions are:

1) What is the Takt time? Takt time is analogous to the beat of a drum and is the amount of time that should elapse between the completion of parts. Takt time is available time divided demand. For example, if there are 24 hrs available in the day and the customer demand is 24 parts per day, then every 60 minutes, a part needs to be completed. Any faster is considered overproduction and slower obviously does not meet customer demand.

2) Can all of your process steps meet the Takt time? If not, you have a bottleneck to address.

3) Where can we flow? Departments that are physically located apart from one another may be relocated to facilitate flow in a cell, eliminating stagnation in between steps, creating flow.
4) Where we can’t flow, can we install a supermarket based pull system? The answer to this is yes.
5) What is the pace setting process, usually considered to be the last value adding process?
6) What will lot sizes be and how much standard WIP do we need? Little’s law will help you calculate the standard WIP needed by multiplying the lead time by demand and adding a fudge factor for when things go wrong.
7) How can we level load production?
8) Do our machine reliability and changeover times meet our needs?

As you create the target state, the team will naturally mention ideas they have to improve. You want to capture these ideas in starbursts on the map itself. The target state map shown in Figure 5 is showing the move from push to pull as indicated by supermarkets and circular arrows. Supermarkets were used to be able to fill orders quickly, but ideally in a flow environment with minimal waste, you would not require any inventory to be held in between processes.

The terminology used in VSM is very specific and words are often chosen very carefully. For example, you may call the VSM in Figure 5 a Future State Map and in general terms, it is a state that we wish to reach in the future, however, using the word future leaves the state open and somewhat intangible by definition. Therefore, Target State VSM is preferred with the intent of actually making the changes required to get there in the next few months.

![Figure 5. Target State VSM example.](image-url)
Another key feature in the Target State is the scheduling of the “pacesetting” process, usually the furthest downstream value adding process, in this case labeled as “Slit/Sheets, Pack, Palletize”. Also shown in Figure 5 are pull loops indicated by the dotted lines surrounding a collection of processes. In this case, each of those loops have inventory controlled by a set of Kanban cards that indicate when and what to produce as well as when and what to withdraw. Figure 6 below shows an example of a Kanban board used to collect and display the Kanban cards for Raw Material, the loop on the left side of Figure 5.

In general, a VSM effort will typically start within the bounds of a single company. A common starting point is to go from raw material delivery to shipping. Then, the effort may evolve into how orders are taken and how the work is planned, eventually extending out to include everything involved from paying for raw materials to getting paid. Value Stream Mapping can be very powerful when looking at a complex value stream that involves many manufacturers. A complex value stream future state, perhaps similar to a value stream you may find in the converting industry, is shown in Figure 7, where a pull system with supermarkets and Kanban signals synchronizes the various locations and controls inventory levels.

**Future State Supply Chain Example**

![Figure 7. A future state supply chain example.](image-url)
Changing your “focal plane” is required to see the whole in terms of the true end to end value stream. In “Seeing the Whole”, Dan Jones and Jim Womack write that “When we get managers to change their focal plane from their assets and their organization to look at the product itself and what is actually happening on its long journey, they immediately realize that the performance of the entire stream is abysmally sub-optimal. Indeed, most wonder how they have worked for years in traditionally compartmentalized operations and somehow failed to notice the waste everywhere. Then, they wonder what they can do about the mess.” Yes, this is the challenge, what can we do about the mess? VSM gives us a tool to see the waste and agree to it in cross functional teams. Achieving future state after future state and eventually reaching the ideal state will take courage, creativity, patience, and resolve. Competitive advantage awaits those that get started first and make the quickest progress.

Alone, VSM is simply a tool and for it to have an impact on a business, the tool must be incorporated into a system. Shigeo Shingo taught us why so many companies have visited Toyota, returned to their facility and failed at implementing continuous improvement tools, like 5S, Kanban, etc. in a sustained fashion. Shingo points out that Toyota’s way of thinking was such that there was a deep understanding in their culture as to why certain tools would be used, so deep that Toyota’s employees would use the tools on their own when needed without a Continuous Improvement office, manager, or consultant prompting the effort. This deep understanding of why is the differentiating factor and is why those that would see the tools in use would not be able to duplicate the results in their plants. The same can be said for VSM. Without a deep understanding of why, the tool will give you small gains and maybe is perceived as a once and done exercise. Shingo went so far as to say that a more sustainable approach to continuous improvement is to start with why and then learn about the tool. Shingo also points out that there are 3 levels of transformation, tool, system and principle level. It is the principle level that is most sustainable and the tool level that is least sustainable. To take VSM from a tool level to a system level, a repetitive, time-based, aspect has to be incorporated. For example, a team creates a current state and target state this week, puts together an action plan on how the target state will be achieved over the next four months, and implements the plan. Four months later, the team reconvenes and creates another current state, target state, and plan to reach the target state over the next four months. As this repeats, it’s becomes more clear how VSM as a system can provide significant results.

In closing, some important highlights from above and key thoughts follow:

1. VSM is a tool that helps a team see where waste exists in a Value Stream and encourages systemic thinking instead of local optimization.

2. Creating a current state VSM with a cross functional team, then an ideal state and target state along with a plan to get to the target state and repeating this process make VSM a system, and as such, can help reduce waste significantly.

3. An ideal state should be created so that creative ideas can be captured and used.

4. Understanding why and reaching a principle level is critical to the sustained use of any Continuous Improvement tool.
5. Overproduction is bad for individual players and an overall industry.
6. The speed at which information flows has a direct effect on overproduction. The further upstream you are, the more variation you will see in inventory levels and order quantities.
7. Pull and Flow combat push and offer an alternative to traditional manufacturing.
8. We need to think of the entire value stream as one synchronized process.
9. The bounds of your VSM can be small (a subset of processes within your building) to start, but use of VSM in entire value streams including all value adding and supporting steps across multiple locations is where significant competitive advantage may lie.
Recommended Reading:

1. “Learning to See” by Mike Rother and John Shook

![Learning to See](image1)

2. “Seeing the Whole Value Stream” by Dan Jones and Jim Womack

![Seeing the Whole Value Stream](image2)

3. The Shingo Model and Guidelines

   Link can be found here…

VSM Symbols:

**Truck Shipments**
- Shows material shipment by truck. Include the frequency or any other important info. inside.

**PUSH Arrow**
- Use to show material pushed by a schedule.

**PUSH Arrow**
- Use to show finished goods material to a customer or supplied material from a supplier.

**FIFO**
- Shows material sequenced first-in-first out where the sequence was initiated upstream based on pull.

**Supermarket**
- Symbol illustrates a supermarket where material quantities are calculated based on demand and lead time. The material movement is controlled using signals or kanban.

**Physical Pull**
- Describes removal of material from an upstream process by a downstream process based on need.

**Move by Forklift**
- Shows material shipment by forklift. Include the frequency or any other important info. inside.

**Move by Boat**
- Shows material shipment by boat. Include the frequency or any other important info. inside.

**Manual Info Flow**
- Shows information flow achieved through manual movement of paper schedules or orders.

**Electronic Info Flow**
- Shows electronic information flow by computers. EDI or E-Mail are examples.

**Vividly Schedule**
- The schedule box is used to show the use of schedules in the information flow.

**Load Leveling**
- Represents a leveling tool that mixes models. (Heijunka box or similar tool)

**Withdrawal Kanban**
- A kanban card authorizing removal of parts or material from store.

**Production Kanban**
- A kanban card authorizing production based on use in a downstream process.

**Signal Kanban**
- Represents a kanban symbol used to authorize production. Multiple cards are not used and the signal can be made in many different ways.

**Press**
- Used to depict a process, not for individual process steps but for a general process. Usually placed anywhere the flow stops.

**Heat Treat**
- Used for a process that is shared for many different products. An example would be Heat Treat.

**XYZ Corp**
- Used to represent either a Customer or a Supplier

**Data Box**
- The data box is used to put information about a process, customer etc. It should contain pertinent data. What goes in is up to you, use it flexibly but get the core numbers.

**Kanban Post**
- This is used to symbolize stationary inventory in a typical batch operation. It could be Raw, Work in process or finished inventory. A collection point for kanban cards to be placed.

**Sequenced Pull Ball**
- Represents a leveling and sequencing tool to control the sequence of production.

**Go See Production Scheduling**
- Scheduling achieved by physically looking to see what a downstream process needs. Not controlled by kanban or calculation.

**Kaizen Lightning Burst**
- Used on Future State maps to show where Kaizen activity is needed to execute the future plan.

**Driller or Safety Stock**
- Represents safety stock in place to cover for inconsistencies, quality etc.

**Operator**
- Symbol used to represent a person in the process (operator).

**Quality**
- Use to highlight Quality issues and problems.