Value Stream Mapping: A Foundation Step for Lean Manufacturing[+]

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[+] A summary-cum-review of: **Rother, M. & Shook, J. (1999, June).** ***Learning to See*** **(Version 1.2). Brookline, MA: Lean Enterprise Institute.**

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Lean Manufacturing

- Lean means "More for Less".

- More profit, more productivity for less costs and investments in raw material, labor and other capital resources.

- The main goal of Lean Manufacturing is to reduce/eliminate 'Muda' (waste).

The Road to Lean

How does a company go about eliminating waste ?

- Find the sources of waste.
- Eliminate/reduce those sources of waste.
- Sustain efforts to reduce waste by supporting a Continuous Improvement program.

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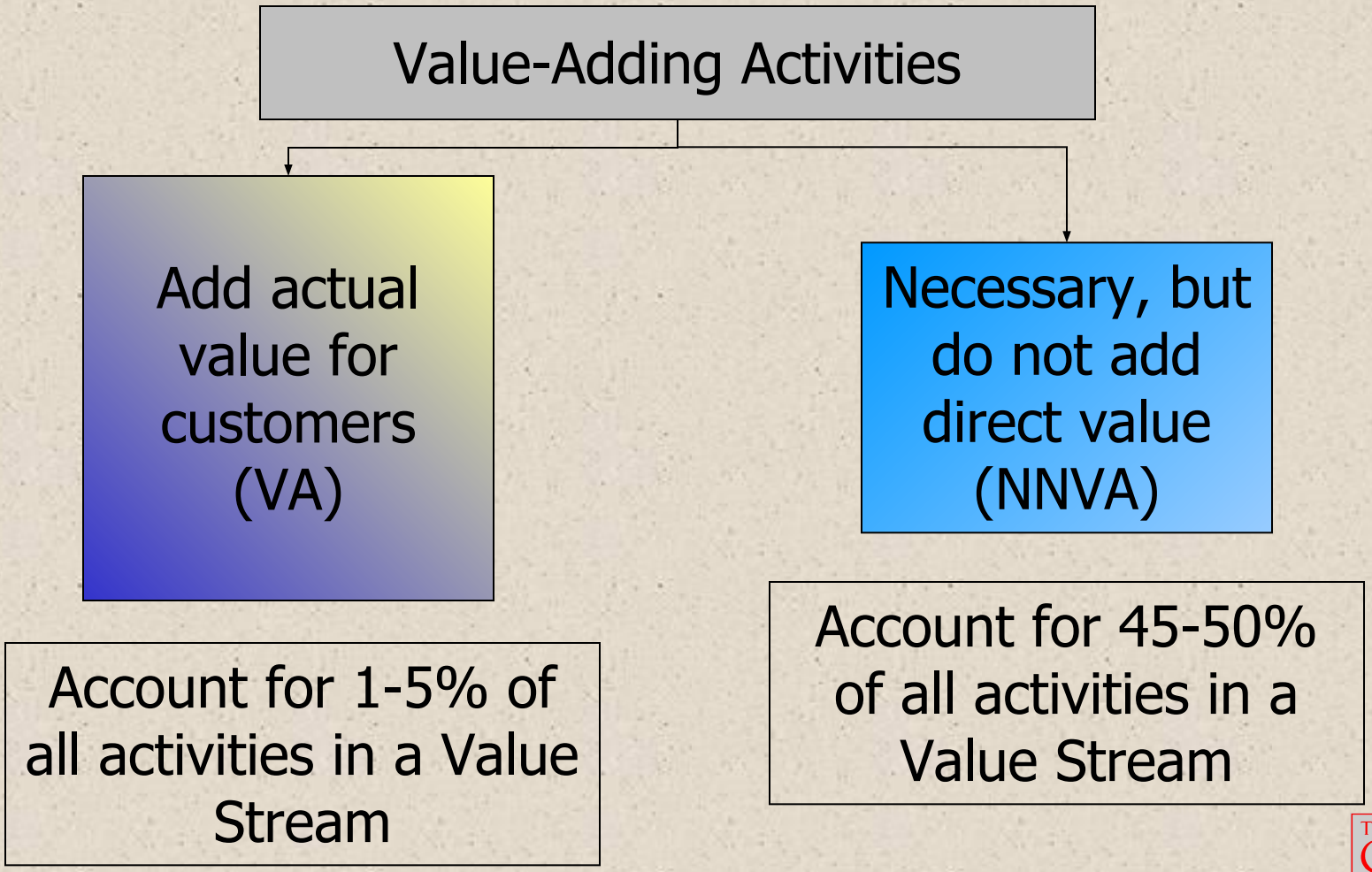
What is Value?



Source: http://www.rutherfordinc.com/costspage3.html

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Forms of 'Muda' (Waste)

Wastes	Associated Costs
• Over-production	• Inventory/Storage
• Waiting	• Delay, Inventory/Storage
• Transport	• Transportation, Labor
• Inappropriate Processing	• Equipment, Labor
• Unnecessary Inventory	• Inventory/Storage
• Unnecessary Motion	• Labor
• Defects	• Scrap materials, Labor to do Rework, Equipment,

Source: Hines, P. and Rich, N. (1997). 'The Seven Value Stream Mapping Tools'. IJOPR, Vol. 17, No 1, p. 47

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Overview of Value Stream Mapping

- Value Stream Mapping is the tool that helps management find the sources of waste.
- Value Stream Mapping "is a paper and pencil tool wherein you follow the product's production path from customer to supplier, carefully drawing a visual representation of every process (step) in the material and information flow (networks)."

Source: Rother & Shook, p. 4

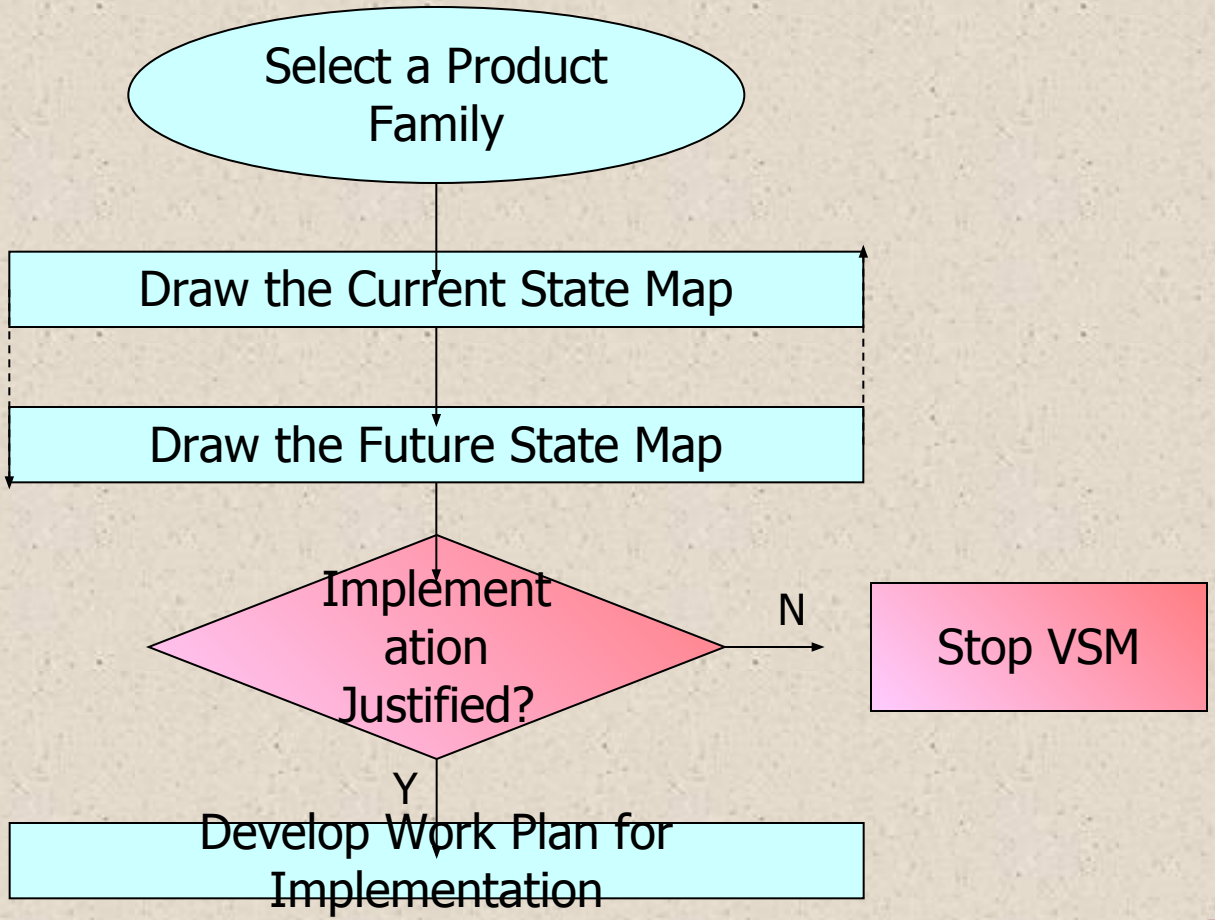
Aim of Value Stream Mapping

- The objective of 'Lean' is to have a value-adding flow.

- In order to do so we need a vision of the flow.

- Value Stream Mapping is a tool which enables us to "see" the flow. Thereby, we can see where the sources of waste lie and focus attention on those areas.

Steps in Value Stream Mapping



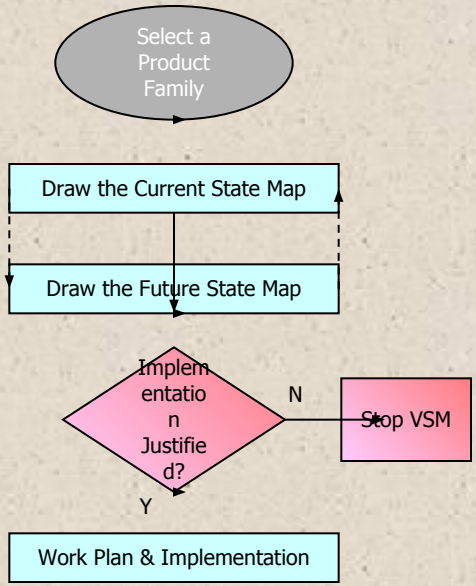
Source: Rother & Shook, p. 9

Selecting a Product Family

- A product family is a group of products that have similar manufacturing steps or routings.[1]

- This family should be selected from a group of high volume-high revenue products using PQR$T Analysis.

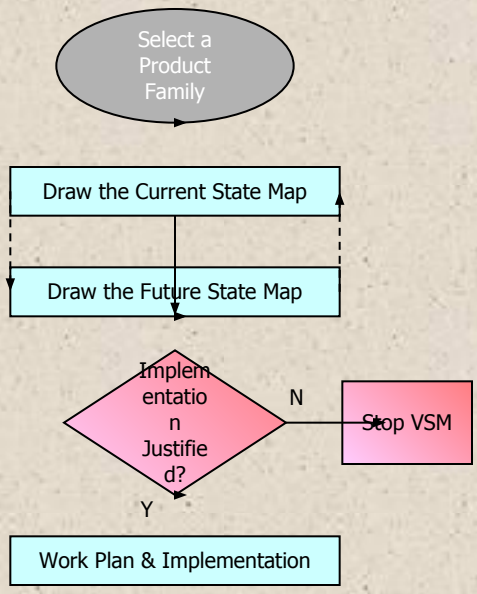
- Other criteria that could be used: market segment, customer group, BOM complexity, common components, high order lead times, etc.



Source:[1] Rother & Shook, p. 6

Selecting a Product Family (contd.)

Volume/ Revenue	Runners	Repeaters	Strangers
High Earners	Select products from here		
Medium Earners			
Low Earners			



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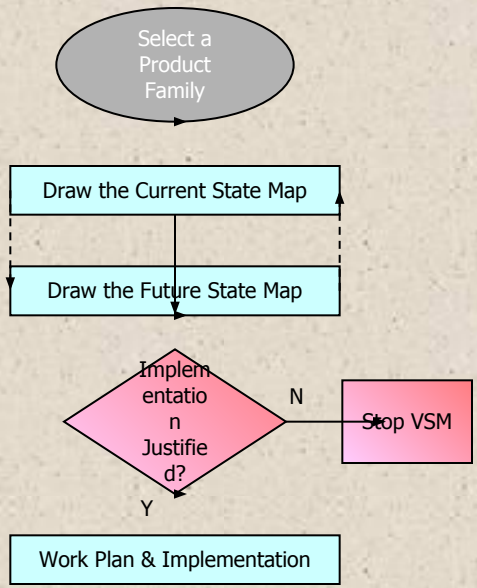
Selecting a Product Family (contd.)

- A family of products with similar routings can be identified using Production Flow Analysis, Group Technology, PQR$T Analysis, etc.
- **Caution:** Choose the product to map based on the different part numbers in the family, the customer demand and the frequency of demand for the product.

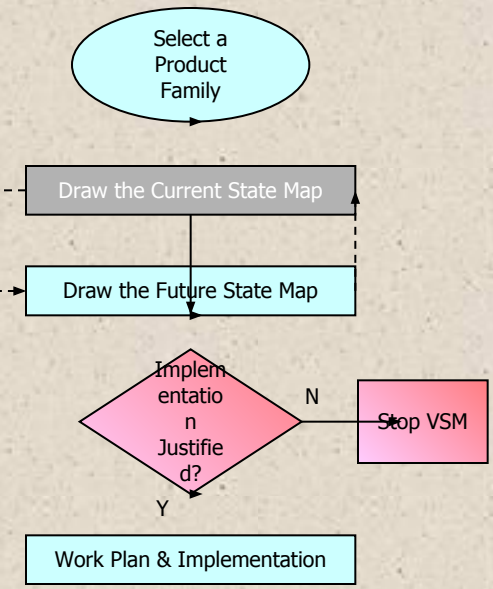


Drawing the Current State Map

The Current State Map tells us what our *present flow* looks like *(and the waste embedded in it)*.

Procedure:

- Start mapping the current flow from the most downstream operation since it is closest to the customer demand.
- Use symbols to show the various processes (as a whole and not individual workstations in each process department).
- Obtain time information for each step in the flow.
- Show a time-line/cost-line capturing the total time/cost taken for each step in the flow.



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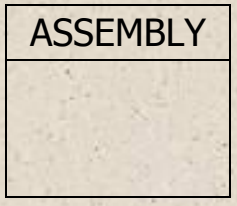
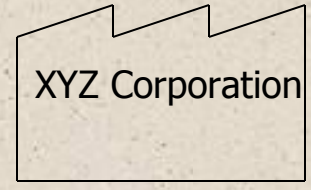
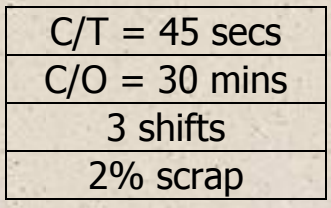
Standard Symbols for VSM



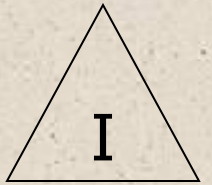
Process Box



Outside Sources

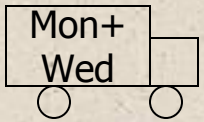


Data Box



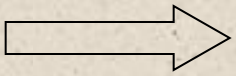
300 pcs/day

Inventory

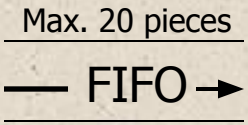


Transportation

Push System

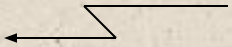


Finished Goods
to Customer



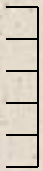
First-in-First-Out

Manual



Electronic

Information Flows



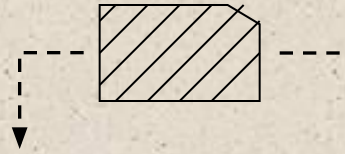
Supermarket

Schedules

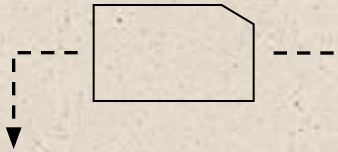
Operator

Source: Rother & Shook, Appendix

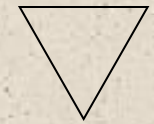
Standard Symbols for VSM (contd.)



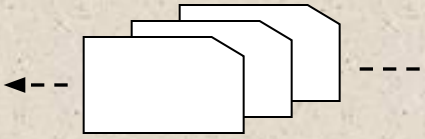
Withdrawal Kanban



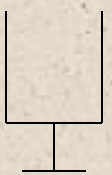
Production Kanban



Signal Kanban



Kanban arriving in batches



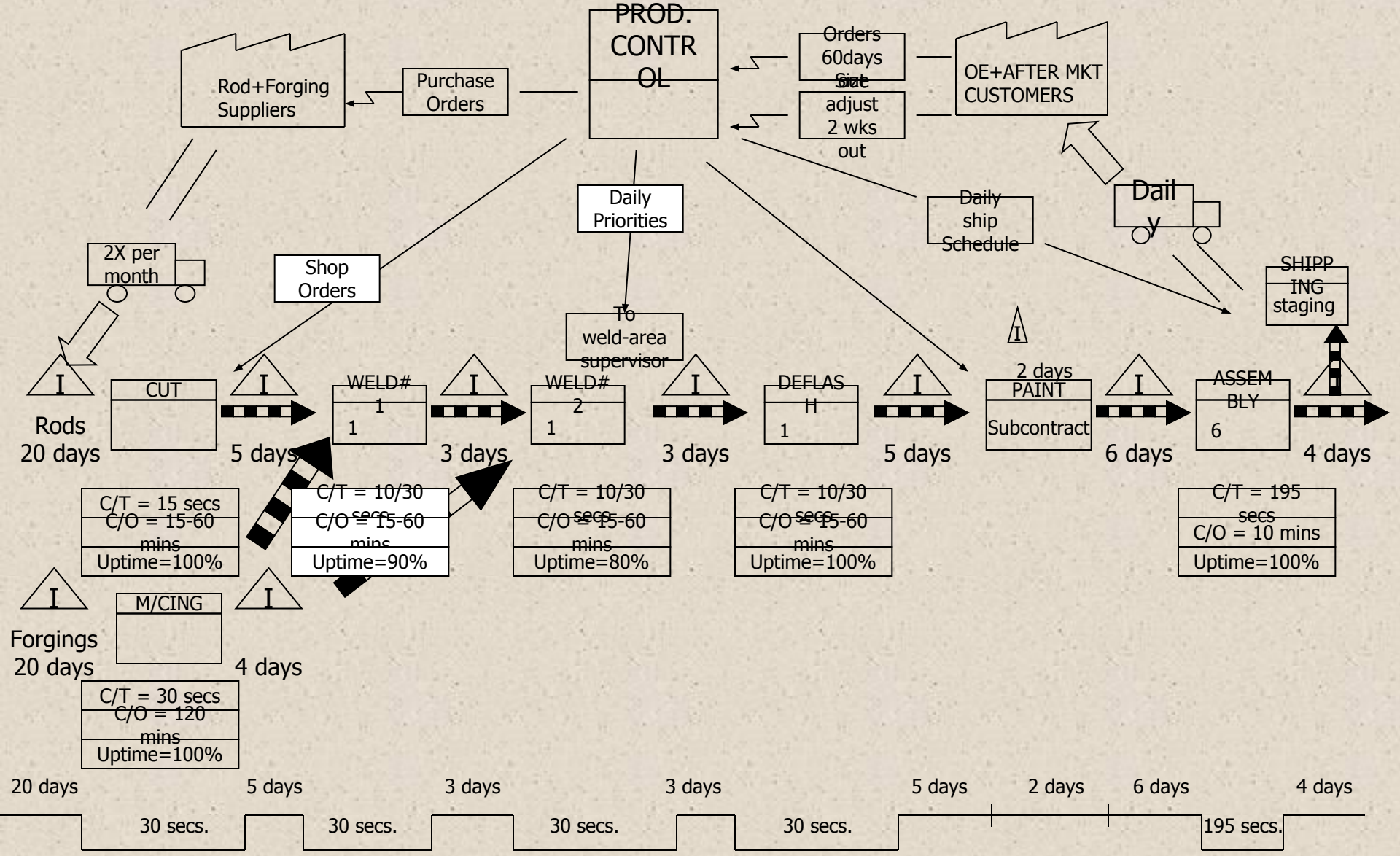
Kanban Post

Kaizen Bursts

'Go See' Scheduling

Source: Rother & Shook, Appendix

An Example of a Current State Map



Analysis of the Current State Map

Total Throughput Time = 48 days

Value Adding Time = 315 seconds

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Costing the Wastes in the Value Stream Map

- Equipment Costs – Costs for purchase/lease, maintenance and installation of the machine/s.
- Quality Costs – Costs for scrap/reworked parts.
- Space Costs – Costs for space allocated for storage of inventory (RM, WIP and FG), space for parking and maintenance of material handling equipment, material handling aisles, etc.
- Labor Costs – Costs for direct and indirect labor.

Costing the Wastes in the Value Stream Map (contd.)

- Transportation Costs – These include the costs of purchasing, operating (power, labor, idle time, etc.) and maintaining the handling equipment.
- Queuing Costs – These are simply a function of the throughput time for each part less the processing time, due to competition for processing resources, Push Scheduling, etc.
- Inventory/Storage Costs – These are all the costs associated with inventory control ex. carrying costs, building expenses, security, obsolescence, etc.

Parameters for Estimation of Equipment Costs

- Number of workcenters.
- Purchase cost per machine.
- Installation cost.
- Depreciation over the life of the machine.
- Maintenance cost.

Parameters for Estimation of Quality Costs

- Demand for a product.
- Scrap rate for that product.
- Rework rate for that product.
- Material cost.
- Fabrication cost.

Parameters for Estimation of Space Costs

- Rental cost (or building cost) for space.
- Area occupied by equipment.
- Area occupied by material handling equipment.
- Area occupied by aisles.
- Area occupied by inventory (RM, WIP, FG).
- Value of material stored in inventory.

Parameters for Estimation of Labor Costs

- Labor hour rate for Direct Labor.
- Labor hour rate for Indirect Labor.
- Number of operators.
- Base salary.
- Overtime rate.
- Number of overtime hours worked.

Parameters for Estimation of Transportation Costs

- Capital cost.
- Overhead cost rate per piece of equipment.
- Frequency of flow between all pairs of locations.
- Number of parts flowing between all pairs of locations.
- Distance traveled between all pairs of locations.
- Load/Unload time for each order at each machine.
- Number of pieces of equipment ex. forklifts, pallet jacks, cranes, etc.
- Life of any piece of equipment.
- Average velocity of a move between any pair of locations.

Parameters for Estimation of Queuing Costs

- Processing rate for a particular operation and a particular part on a particular workcenter.
- Batch size for a particular part on a particular workcenter.
- Average delay due to queuing at each operation.
- Setup time for a particular operation and a particular part on a particular workcenter.
- Demand for a particular part.
- In-process inventory holding (or carrying) costs.

Parameters for Estimation of Inventory Costs

- Volume of product in inventory.
- Value per unit (or batch) of product in inventory.
- Time for which a unit (or batch) of product is held in inventory.
- Inventory holding cost of product in inventory.

Reading the Current State Map

- How does the Current State Map show us the sources of waste ?
- Every step in the Current State Map should be questioned. Use the 5W and 1H (Why, Where, What, Whom, Which, How) method to analyze the causes of each problem (else use tools of Total Quality Management such as the Fishbone Diagram or the Cause-Effect-Cause Analysis method of TOC).

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Reading the Current State Map (contd.)

- What is the takt time for the plant? Which areas are producing slower than this takt time? How do we increase their speed?
- Why is the factory producing to a forecast and not actual demand? Is the demand for every product stable? Or a product mix segmentation based on demand characteristics is necessary?
- Are the processes balanced in terms of speed? If not, what can be done to balance them?

Reading the Current State Map (contd.)

- Why is batching necessary? Can we reduce the setup times to facilitate smaller batches?
- Why is the average machine uptime low? Should we initiate TPM programs to increase it?
- What are the reasons for scrap? Which processes cause scrap? What are the root causes for why the processes cause scrap? Were SPC, DOE, etc. studies conducted to identify the root causes for out-of-control processes?

Reading the Current State Map (contd.)

- Why is there inventory between pairs of consecutive operations? Why do the operations produce and **push** product downstream? Why not **pull** product from buffers located strategically at these processes only when finished products are **shipped to customers**?
- Can operations be eliminated to reduce the throughput time? Can operations be combined? Can operations be simplified? Can operation sequences be modified to shorten throughput times?

Reading the Current State Map (contd.)

- Where can we use a supermarket? Which products should we inventory in it? Why not make Shipping the supermarket and schedule upstream processes that feed into it using Drum-Buffer-Rope? Or should a restaurant model for inventory control be adopted in Shipping?
- How many operators are doing a job? Can they be trained to do more than one operation? What are the union issues that go with it?
- Why are the suppliers supplying in large lot sizes? Can their supply quantities be made smaller with more frequent deliveries based on Pull scheduling?

Reading the Current State Map (contd.)

- What time buckets should be used to level the production? Can we produce all products every hour (?) in every shift (?) on every day?
- What is the product diversity? Should all of the products be treated the same? *How do we overlap multiple value stream maps that use the same manufacturing processes, perhaps even sequences?*
- How late in the process does the product customization occur?

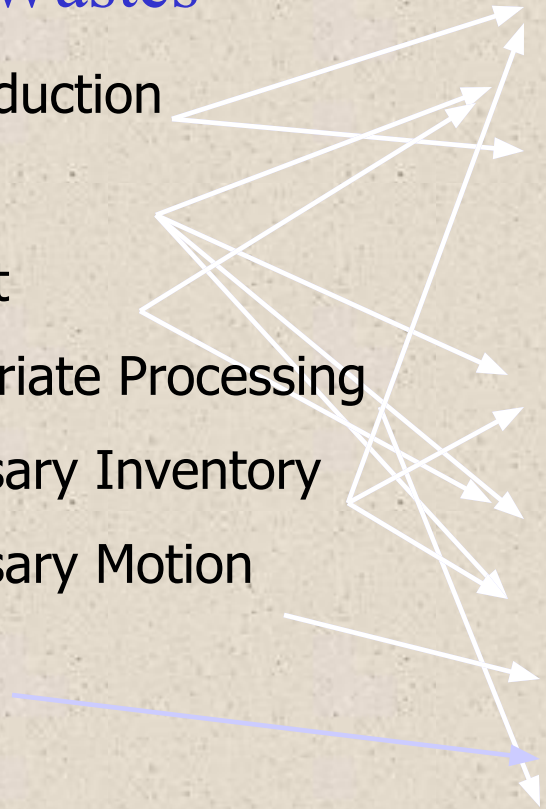
What to do after Reading the Current State Map?

- The answers to the earlier questions will guide the development of the Future State Map.
- The focus should be on first eliminating those sources of waste that have the highest benefit/cost ratio and yield the maximum sales revenues.
- While answering the questions to develop the Future State Map, a strategic project plan for Continuous Improvement i.e. perpetual improvement of productivity and ongoing achievement of "delay-free flow" will emerge.

Best Practices for Eliminating Wastes

Wastes

- Over-production
- Waiting
- Transport
- Inappropriate Processing
- Unnecessary Inventory
- Unnecessary Motion
- Defects



Best Practices

- Make-to-Order.
- Optimize Layout.
- Setup Reduction.
- Total Productive Maintenance.
- Multi-function Workers.
- Pull Scheduling/Production Smoothing/FCS.
- Line Balancing to Takt Times.
- One-Piece Flow.
- Supplier Control for JIT.
- Time Study/Motion Study.
- Quality Control/DOE.
- Design for Manufacture.

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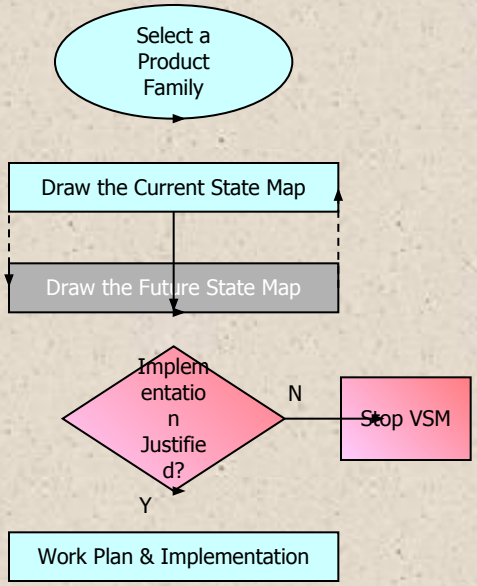
Drawing the Future State Map

- The Future State Map is the improved flow diagram for material flow and a 'How it should be' map for the (desired configuration of the) production system .

- This map should be the basis for the implementation road map to identify and **prioritize** the improvement programs funded by company management.

- The management should **support and sustain** a spirit of Continuous Improvement by making new Future State Maps to "improve an already improved" state of the production system.



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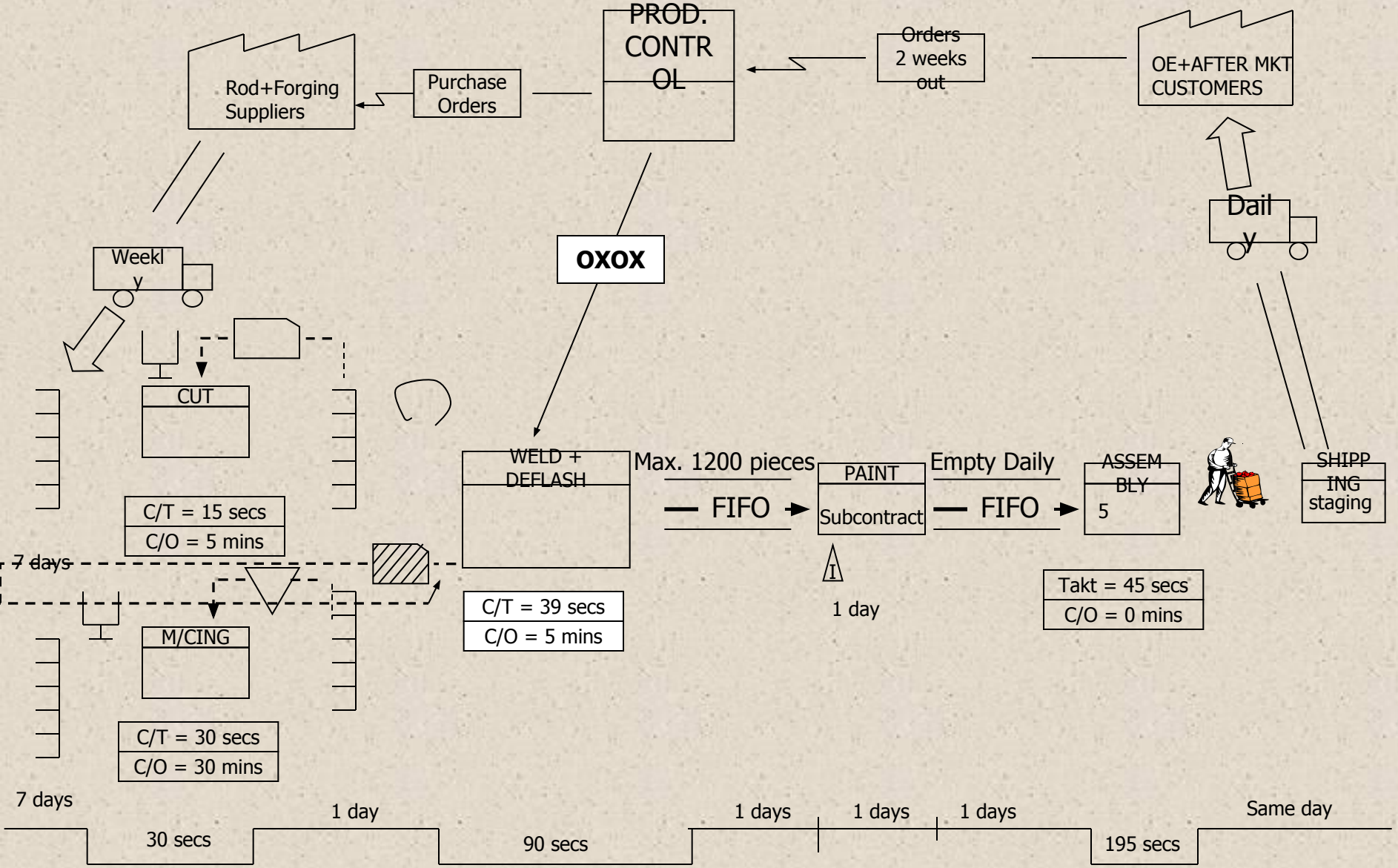
An Example of a Future State Map



Comparison of the Current and Future State Maps

- Total Throughput Time = 11 days
- Value Adding Time = 315 seconds

% Reduction in Throughput Time = 336 %

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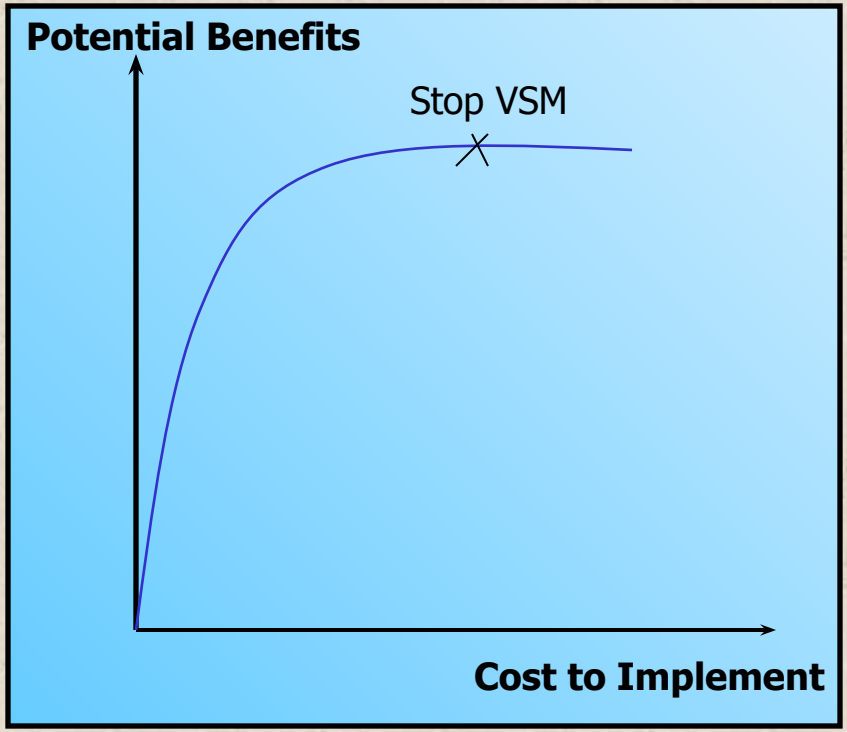
Decision-making with the Current State Map

- We have a map of the potential improvements that can be made.
- We should implement these changes in order to realize the benefits indicated in the Future State Map.
- But have we assessed the costs for implementing these changes? **And** ……. are we justified in spending thousands of dollars in worker training, down-time, and "breaking-in" of new processes?

How much to improve a Current State Map?

- Plot the potential benefits versus the cost to implement each of the changes identified to realize the Future State Map.
- The curve flattens at some point indicating decreasing margin of returns.
- At this point we need to stop the current VSM study … *and start working on some other product (or portion) of the production system*.



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Planning for Implementation

- The Future State Map is a blueprint of the plans for implementation.

- A Value Stream Manager (IE) should be in charge of the implementation and should report to the CEO or President (← *Download article from www.lean.org*).

- Representatives from core departments in the company, line operators **and** managers should be involved in the implementation process.

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Planning for Implementation (contd.)

- Regular reviews should be conducted by the Value Stream Manager to ensure smooth progress of the project.
- Complete a project to the fullest expectations set initially before moving to the next project.

Starting the Implementation

- Focus on the pacemaker process i.e. the most downstream process (the "Drum" in TOC speak).
- Create a detailed implementation plan outlining the following details:
  - Tangible goals to be achieved, ex. 1 day of WIP at the bottleneck machine.
  - Process improvement activities to achieve this goal.
  - Owner (Person/Team responsible).
  - Completion Date.
  - *Performance measures to evaluate the impact of each suggested improvement to achieve the Future State Map.*

Starting the Implementation (contd.)

- **OR**, using the Current State Map, brainstorm to identify a pilot project that seeks to demonstrate the impact of each of the critical "tools of Lean Manufacturing" ex. Cells, Quality, Setup Reduction, 5S, Process Standardization, Andon, Poka-Yoke. Execute these projects in parallel and develop a report that describes the how-to's for each tools and also shows how each of them **adds value by improving Delivery, Cost and Quality.**

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Sustaining the Continuous Improvement Program

- After completing the first Value Stream Mapping project, a process of Continuous Improvement (Kaizen) should become the norm. Repeat and reuse the Value Stream Mapping process at all levels, other processes, departments, etc. throughout the company.
- The current Future State Map becomes the new Current State Map from which a new Future State Map is developed to initiate the next cycle of improvements in the production system.

Applying VSM throughout the (Lean) Enterprise?

- Value Stream Mapping, although mainly used in manufacturing can be appplied to logistics, business and office processes (ex. generation of RFQs), suppliers in the entire supply chain, office design, etc.

- **However**, as the boundaries of the production system are extended, it could become more and more difficult to capture accurate times and costs in the maps, especially in logistics.