Value Stream Mapping with Process Simulator

Instructor Info:
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Session Agenda

- Materials for this Session
- Value Stream Mapping vs. Process Simulation
- Discuss Case Model
- Transforming Value Stream Maps to Process Simulations
  - General Methodology
  - Specific steps for transforming Acme model
  - How to transform each VSM icon to Process Simulator
- Analysis of Current-State Model (Methodology)
  - High-level metrics
    - Throughput, WIP, Cycle/Lead Time, Labor & Equipment Utilization
  - Drill down metrics
    - Activities, Resources (Labor), General Report
- VSM Constructs for Building Future State Model
  - Supermarkets & Kanbans
  - FIFO Lanes
  - Pacemaker Processes
- Analysis of Future State Model
VSM Materials

- *Learning to See* – Lean Enterprise Institute
  - Authors: Mike Rother, John Shook
  - To Purchase: [www.lean.org](http://www.lean.org)
Acme Stamping: Current-State VSM

Poll #1

Learning to See: © 1998 LEI, Inc., pp. 32–33
Value Stream Mapping vs. Process Simulation

- **Value Stream Map**
  - Static model that describes the states of current and/or future processes
  - Tells what is happening in the process now and what the process could be later
  - Reports on cycle/lead times, and value added time
  - Requires general information regarding material arrivals, operation times, labor and equipment availability.
    - e.g. average time = 15 sec

- **Process Simulation**
  - Dynamic model that predicts the behavior of current and/or future processes
  - Tells why a process behaves the way it does or how it could behave in the future
  - Reports on throughput, inventory, cycle/lead times, VA and resource utilization
  - Requires specific information about material arrivals, batch constraints, operation times, labor and equipment uptime & availability, transportation methods and times, and any other capacity constraints.
    - e.g. Time = T(5,10,25) sec
Acme Stamping: Current-State Simulation

Runtime view of Process Simulator model
Converting Visio Charts to Simulation

Processing project related invoices

<table>
<thead>
<tr>
<th>Purchaser</th>
<th>Project Manager</th>
<th>Sign – off authority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Invoice received by purchaser</td>
<td>Enter invoice in PO System</td>
<td>Is invoice valid?</td>
</tr>
<tr>
<td>Is invoice element more than PO line?</td>
<td>Yes</td>
<td>Accept invoice</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>Reject invoice</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Raise PO for difference. Give reasons.</td>
</tr>
<tr>
<td>Is invoice valid?</td>
<td>No</td>
<td>Reject invoice</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>Accept invoice</td>
</tr>
<tr>
<td></td>
<td></td>
<td>File copy of paperwork</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Put all docs in finance pigeon hole.</td>
</tr>
<tr>
<td>Attach Pos to invoice and complete coding form</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pass invoice for authorisation</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is invoice above limit?</td>
<td>No</td>
<td>Pass invoice for authorisation</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>Reject invoice</td>
</tr>
</tbody>
</table>

stakeholdermap.com
Project Management, project planning, templates and advice

Stakeholdermap.com
Convert Drawing Process

Click this button to automatically convert your diagram to a simulation.

Poll #2
Acme Stamping: Current-State VSM

Learning to See: © 1998 LEI, Inc., pp. 32–33
Transforming VS Maps to PCS Simulations

- Focus on Material Flow
  - Information flow will take place through PCS constructs such as Storages, Send Routes, and Order Statements, or, in some cases, by using additional (dummy) activities and trigger entities to control the flow of materials.

- Convert non-functional icons (e.g. “go see”) to Plain Graphics in Process Simulator

- Collect and enter the missing behavioral data from your Value Stream Map.
Actions to Transform Acme VSM to Simulation

- **Arrivals**
  - Make assumptions regarding material delivery times and starting quantities

- **Entities**
  - Make assumptions regarding # Parts/Coil

- **Inventory Buffers**
  - Make assumptions regarding maximum storage capacities

- **Activities**
  - Leave times constant or make assumptions regarding op variability

- **Resources**
  - Make assumptions regarding dedication to station

- **Routings**
  - Make assumptions regarding movement methods and times
Transforming Specific VSM Icons

Model these icons as Activities in PCS
Model Inventory Signs, FIFO Lanes and Sequenced Pull Balls as Buffers in PCS
Transforming Specific VSM Icons

Model Supermarkets and Safety Stock icons as Storages
Transforming Specific VSM Icons

Model operator icons as Resources in PCS
Model transport icons as Resources or Plain Graphics
Transforming Specific VSM Icons

Model material movement arrows as Routings
Transforming Specific VSM Icons

Model these icons as Plain Graphics in PCS
Analysis Methodology

- Begin with Systemic (high-level) Metrics
  - Throughput (Can we meet the required rate?)
    - Examine Cumulative and Periodic charts
  - WIP (Is it stable? Are there trends up or down)
    - Where is WIP building up? (In front of the turtles)
    - Where is WIP being depleted? (In front of rabbits)
  - Cycle/Lead Time
    - Is it growing over time? (yes = systemic constraint)
    - Note: it should not be a time-weighted calculation
  - Resource Utilization
    - Is there a balance across Labor and Equipment?
Drill down to other statistics as necessary

- Activities
  - Single-capacity shows % setup, waiting, down, idle
  - Multi-capacity shows % empty, full, partially full
- Resources (Labor)
  - % in use, % down, % idle (do these make sense?)
  - Off-shift time is not considered down time!
- General Report (other things to consider)
  - Entity failed arrivals (due to insufficient capacity at the arrival activity/buffer/storage)
  - Entity/Resource/Activity cost summary
Current State Analysis: Throughput

Time Plot - Cumulative Throughput

Entity Exit Count - Periodic Throughput

ProModel®
Better Decisions—Faster
Current-State Analysis: Work in Progress

Time Plot - Periodic Average WIP

- Total WIP
- WIP 1
- Shipping
- WIP 2
- WIP 3
- WIP 4

Simulation Time (Days)
Note: Lead Times for initial inventory in the system are “cut off” in order to prevent skewing the average lead time calculation with partial times.

First parts through entire process (starting as Coil material) leave the system at about 16.4 days.

Here we see that average lead time of the parts is rising, indicating a systemic constraint or “bottleneck”.
Current State Analysis: Entities (Parts)

% Blocked = Waiting as semi-finished parts in WIP buffers

% Waiting = Waiting as Finished Goods at Shipping/Staging

Very small Value Added time
Significant imbalance among processing stations

These workstations are all “maxed out”, indicated by no idle time (dark blue).

ProModel®
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Current-State Analysis: Activities (cont.)

Multiple Capacity Activity States - Base Values

- **Significant imbalance among inventory buffers**

- % Empty time for these buffers signals upstream constraints

- Significant imbalance among inventory buffers
Current-State Analysis: Labor

Significant imbalance among operators

These resources are both “maxed out”, indicated by no idle time (dark blue).
Current-State Analysis: Conclusions

- **The Good**
  - Met required production rates for LH, RH parts across the simulation timeframe (4 weeks).

- **The Bad**
  - Drawdown of Finished Goods inventory cannot be sustained indefinitely.
  - Imbalance in both Labor and Equipment usage

- **The Ugly**
  - Excessive inventory across entire process!
Acme Stamping: Future-State VSM

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Supermarkets & Kanbons

**supermarket pull system**

\[ \text{supplying process} \rightarrow \text{product} \rightarrow \text{supermarket} \rightarrow \text{customer process} \]

1. **CUSTOMER PROCESS** goes to supermarket and withdraws what it needs when it needs it.
2. **SUPPLYING PROCESS** produces to replenish what was withdrawn

**PURPOSE:** Controls production at supplying process without trying to schedule. Controls production between flows

*Learning to See: © 1998 LEI, Inc., p. 46*
First-in, First-out Lanes

an example of a “FIFO Lane”

STOP!

kanban

FULL?

max. 50 pieces

Upstream Process

-FIFO Lane-

Downstream Process

Supermarket

Learning to See: © 1998 LEI, Inc., p. 48
Pacemaker Processes

selecting the "Pacemaker Process"

*Note:
With custom products and job shops, the scheduling point often needs to be further upstream like this.

Learning to See: © 1998 LEI, Inc., p. 49
Customer Orders arrive every 30 min:

- 10 to 20 LH (left hand brackets)
- 5 to 10 RH (right hand brackets)

**Activity Logic:**
- \( v_{\text{Qty LH}} = U(15,5) \)
- \( v_{\text{Qty RH}} = \text{Round}(v_{\text{Qty LH}}) \)
- \( v_{\text{Qty RH}} = U(7.5,2.5) \)
- \( v_{\text{Qty RH}} = \text{Round}(v_{\text{Qty RH}}) \)
- \( a_{\text{Ord Qty}} = v_{\text{Qty LH}} + v_{\text{Qty RH}} \)
- Send \( v_{\text{Qty LH}} \) LH to Process_B
- Send \( v_{\text{Qty RH}} \) RH to Process_B
Acme Stamping: Future-State Simulation

Runtime view of Future-State Process Simulator model
Analysis Methodology (Review!)

- Begin with Systemic (high-level) Metrics
  - Throughput (Can we meet the required rate?)
    - Examine Cumulative and Periodic charts
  - WIP (Is it stable? Are there trends up or down)
    - Where is WIP building up? (In front of the turtles)
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    - Note: it should not be a time-weighted calculation
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Analysis Methodology (cont.)

- Drill down to other statistics as necessary
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    - Off-shift time is not considered down time!
  - General Report (other things to consider)
    - Entity failed arrivals (due to insufficient capacity at the arrival activity/buffer/storage)
    - Entity/Resource/Activity cost summary
Future-State Analysis: Throughput
Future-State Analysis: WIP & Inv. Buffers

Time Plot - Total WIP & Inventory Buffers

Total WIP

Units

Simulation Time (Days)
Future-State Analysis: Average Lead Time

Lead Time leveling off at about 3.4 days
Future-State Analysis: Entities (Parts)

Not Very Different From Current State

% Blocked = Waiting as semi-finished parts in WIP buffers

% Waiting = Waiting as Finished Goods at Shipping
Stamping activities for this cell still a small part of stamping capacity. Weld and Assembly stations are full 90% of time.
Future-State Analysis: Labor

Labor is near full capacity
Future-State Analysis Conclusions

- The Good
  - Average Total WIP reduced from over 20,000 parts to about 3,000!
  - Average Lead Time reduce from 20 days to 3.5

- The Bad
  - Still significant room for improvement.
    - Cut inventory and cycle time by another 50%

- The Ugly
  - None
Tip: Use Excel Export/Import Feature

Click this button to export all model data to Excel.
Update Data and Import to Model
Value Stream Maps are an important tool for understanding and quantifying the opportunities for system improvement.

Process Simulator can take an existing map as the starting point for a simulation model, but some work will be required to supply the missing behavioral data.

In many cases it’s easier to start over and develop a new model for dynamic analysis, rather than to modify an existing VSM.
Q & A

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5 Minute Break