Creating flow:

- Focus on what is flowing through the process
- Don’t be limited by organizational boundaries
- Eliminate bottlenecks, minimize buffers
Time is an essential metric for improving flow.

There are different ways to measure time:
- Wait time
- Processing time
- Cycle time
- Customer demand or lead time

The key is to understand the local definition of how time is measured.
Wait and Process Time

- **Wait time**
  - The time Work in Process (WIP) is idle - in queues, buffers or storage
  - Other Names: queue time, delay time

- **Processing time**
  - The time that activities are being performed on WIP
  - Processing time may consist of Value Added Time (VAT) and Non Valued Added Time (NVAT) activities.
  - Other names: Touch Time (TT), In Process Time (IPT), Response Time (RT), Activity time
Cycle Time

- The time required to execute activities in a process
- It can be measured for:
  - A single task or activity
  - A group of tasks or activities
  - A single process
  - A group of processes, e.g., customer order to customer delivery
- Cycle time includes processing time and wait time
- Other names: lead time or span time or throughput time
Hot Dog Stand Times

- Sasha
- Andy

- Calculate the time in seconds for the 11 process steps and the total cycle time.
  - Make sure to convert everything to time per order
  - Don’t forget effects of rework

- Sum times to calculate an average cycle time for the customer to get a hotdog (order to delivery)

- Use the sheet provided
  - You will be reporting your total cycle time to the instructor
  - Record all times on a flip chart for presentation to the class if instructed to do so
Time Value Charts

- Visual display of the breakdown in time for a given process
- Actual numbers must be measured or estimated

Big cycle time savings comes from removing wait and non-value added time out of a process!
Let Customers *Pull* Value

<table>
<thead>
<tr>
<th>Value</th>
<th>Value Stream</th>
<th>Flow</th>
<th>Pull</th>
<th>Perfection</th>
</tr>
</thead>
</table>

- **Push** system – each activity delivers its output when it is done
  - Results in build up of batches with lots of inventory; defective goods pile up
- **Pull** system – each activity delivers its output just as the next activity needs its input
  - Triggered by the customer (external & internal)
  - Results in smooth flow with no batches or voids
  - Minimizes inventory and rework due to defects
  - Inherently, there is very little waste in a pull system
  - Pull systems are agile and responsive to customer demand
Moving from Flow to Pull

Pull requires flow plus predictable cycle time, using

- Takt time
- Balanced work
- Standard work
- Single piece flow
- Kanban system
- Just in time delivery of all material and information

Creating pull:

- Start with the customer and work backwards through the system
- If cycle time <= customer expectation time then pull can be accomplished
- If cycle time > customer expectation time then buffer inventory is needed (or cycle time must be reduced!)
Pull System: Dell Computer

Value Stream Flow Pull Perfection

• Dell developed the selling highly customized computer systems direct to customers
• Customer order initiates the pull process
• Orders can ship same day
• Partnerships with suppliers allow very quick replenishment of vendor-owned Dell inventory
• Dell ships 110,000 systems/day with very low inventory costs

Aspects of the Dell system have become standard practice for many consumer products
Takt Time -
Measure of Customer Demand

Takt Time is…

- From the German word “Taktzeit”
  - “takt” is German for “stroke”
  - “zeit” is German for “time”
- A reference number that provides a drum beat for the process

*Takt time* = \( \frac{\text{Available time}}{\text{Customer demand rate for available time}} \)

**Example:**
The available time is a year or 235 days. There are 40 orders for this year.

What is the takt time?

\[ \frac{235}{40} \approx 6 \text{ days} \]
What is the takt time for S&A Hot dogs for

- 50 customers?
- 75 customers?

Time available is 4 hours (240 minutes)

- 50 customers – takt time is $240 / 50 = 4.8$ min
- 75 customers – takt time is $240 / 75 = 3.2$ min
Little’s Law

For most systems, average values of work in progress (WIP), cycle time and takt time satisfy Little’s Law:

\[ WIP = \frac{Cycle\ Time}{Takt\ Time} = (Throughput\ Rate) \times (Cycle\ Time) \]

For example, for a specified takt time, large amounts of WIP implies a long cycle time, as each article spends a lot of time in inventory!

*Cycle time, WIP and takt time or throughput rate are interdependent.*
Balanced Work

Takt time example, continued…

To meet takt time, a product has to be delivered every 6 days. But if it takes 30 days to build, how is this possible?

<table>
<thead>
<tr>
<th>Unit Number</th>
<th>Cycle Time 30 days</th>
<th>Takt Time 6 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>6</td>
<td>5</td>
<td>1</td>
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<tr>
<td>5</td>
<td>4</td>
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<tr>
<td>4</td>
<td>3</td>
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</tbody>
</table>

Divide process into 5 BALANCED steps of 6 days each

Each unit is worked at each step

This strategy requires the steps take the same time
Standard Work

Value  Value Stream  Flow  Pull  Perfection

• Best process currently known, understood, and used today (evidence based)

• Tomorrow it can be better based on continuous improvement

• Standard work is the key to repeatability and effective innovation
Single Piece Flow

- Processing one unit at a time through all the steps to completion
- Only one unit in work at any step in the process
- Low inventory levels
- Defects immediately found

Batch and Queue

- Processing multiple units at the same time
- Optimizes the efficiency at each step in the process
- High inventory levels
- Leads to larger scrap and rework

Photos by Earll Murman
Operating rule:
• Only work if the downstream process needs you to
• Sense this by seeing they have no inventory
Inventory Everywhere
– No Work To Do

Operating rule:
• Only work if the downstream process needs you to
• Sense this by seeing they have no inventory
Customer Buys Product

Operating rule:
• Only work if the downstream process needs you to
• Sense this by seeing they have no inventory
Signals Task 4 To Work

Operating rule:
• Only work if the downstream process needs you to
• Sense this by seeing they have no inventory
Operating rule:
• Only work if the downstream process needs you to
• Sense this by seeing they have no inventory
Signals Task 2 To Work

Parts In

Task 1

Task 2

Task 3

Task 4

Product Out

Operating rule:
• Only work if the downstream process needs you to
• Sense this by seeing they have no inventory
Operating rule:
• Only work if the downstream process needs you to
• Sense this by seeing they have no inventory
Signals Purchase of More Parts

Operating rule:
- Only work if the downstream process needs you to
- Sense this by seeing they have no inventory
As Faster Tasks Finish, They Know to Stop

- Ideally, all tasks are balanced and stop at the same time
- Minor variations absorbed automatically by pull rule
- Major variations immediately obvious for correction

More Please!

Parts In

Task 1

I’m done

Task 2

I’m done

Task 3

Task 4

Product Out

Lean Thinking V7.6 - Slide 25
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Tools for Pull: Kanban

- Appearance of kanban card (or bin) authorizes action to produce product for downstream processes
- Enabled by and dependent upon standard process
- Provides a quick visual representation of the state of the system

**Full bin – ship**
- Work on order, filling bin

**Take parts for use until bin is empty**
- Empty bin – send to supplier

Supplier

Manufacturer
Visual Control and Andon

- **Visual control** helps identify the status of the process at a glance
  - Makes the process apparent to everyone involved with or observing it
  - Only valuable if used for *active* process management

- **Andon** is a specific visual control device, typically a group of lights indicating the current status of the process
  - Each step has a set of lights which indicates whether the step is proceeding as planned, needs monitoring, or requires immediate attention
  - In a pull system, if action is required, the entire process stops to correct the problem

Photos by Earll Murman, used courtesy of New Balance
### Andon Systems Help Prevent Mistakes

<table>
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</thead>
<tbody>
<tr>
<td>Employee has found a part that doesn't fit right.</td>
<td>Team leader sees the lamp and comes to help.</td>
<td>The employee pulls on the line-stop cord overhead.</td>
<td>LINE STOPPED!</td>
<td>The team leader discovers a ring that has slipped out of place. He solves the problem before the production line reaches the next fixed position. The line continues moving.</td>
</tr>
</tbody>
</table>

Photographs illustrating each of these steps removed due to copyright restrictions.

Source: [http://www.toyota.co.jp](http://www.toyota.co.jp)
Virginia Mason Medical Center Patient Safety Alert™ System

- Inspired by Toyota “stop-the-line” andon system
- Implemented in 2002
- Every one of VMMC’s 5000 employees can “stop the line” whenever patient safety is threatened
- 15,000 Patient Safety Alerts, 2002 – 2010
- Data collected led to root cause analysis prevention of future incidents

Ref: C Kenny, Transforming Health Care
**Pursue Perfection**

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- Let customer demand pull value through the value stream
- Continuously eliminate waste in every process
- Design and build quality into the product and service
- Ensure transparency to everyone involved
- This is a journey…don’t give up!
5 Whys Help Achieve Perfection

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5 whys can be used to help determine the root cause of mistakes

**Example:** The Jefferson Monument is deteriorating!

**Why?** It gets washed all the time.

**Why?** It always has bird droppings on it.

**Why?** Birds come into the monument to feed on spiders.

**Why?** The spiders are there feeding on gnats.

**Why?** The gnats are there because the lights are left on all time.

Five is only a “rule of thumb” – use as many “whys” as needed to get to root cause.
Five Lean Fundamentals
Work Together

1. Customer Value
2. Value Stream
3. Flow
4. Pull
5. Perfection
Lean is not a set of tools. It is a continuous improvement mindset using multiple PDSA cycles.
<table>
<thead>
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<th>Value Stream</th>
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<td>8 types of waste</td>
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Take Aways

• The concepts of process, customer and value are essential to lean thinking

• There are fundamental principles behind lean thinking based on making value flow

• A number of simple tools and concepts underlie lean thinking


Rother, M. and Shook, J. *Learning to See, v1.2*, The Lean Enterprise Institute, Cambridge, MA June 1999


“For Athletic Shoe Company, the Soul of Lean Management Is Problem Solving”, Lean Enterprise Institute, June 24, 2008

http://www.lean.org/common/display/?o=812
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