Lean Thinking
Part II

Make Value *Flow*

Value | Value Stream | **Flow** | Pull | Perfection

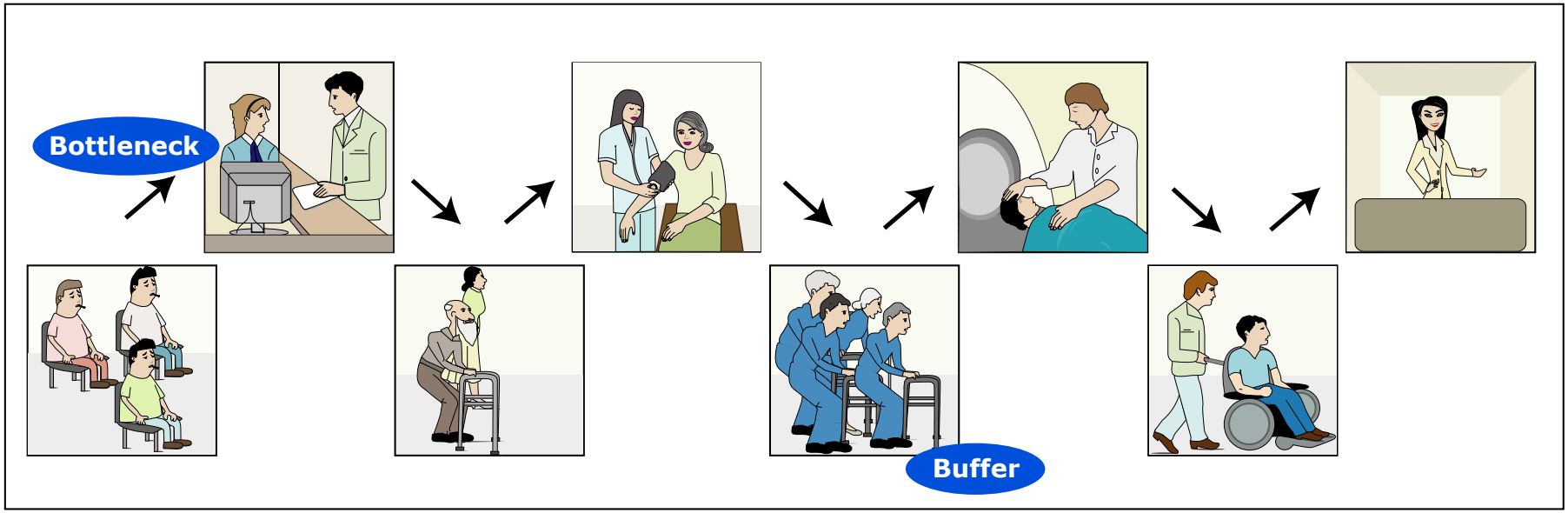


Image by MIT OpenCourseWare.

Creating flow:

- Focus on what is flowing through the process
- Don't be limited by organizational boundaries
- *Eliminate bottlenecks, minimize buffers*

Time

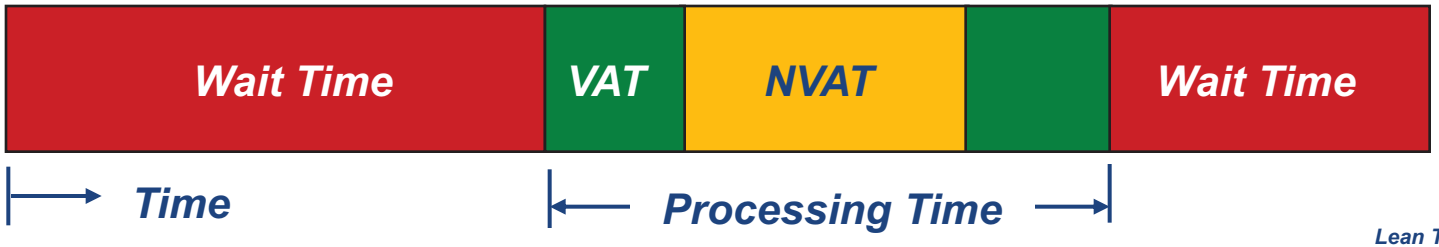
- **Time is an essential metric for improving flow**
- **There are different ways to measure time**
  - **Wait time**
  - **Processing time**
  - **Cycle time**
  - **Customer demand or lead time**

- **The key is to understand the local definition of how time is measured**

Wait and Process Time

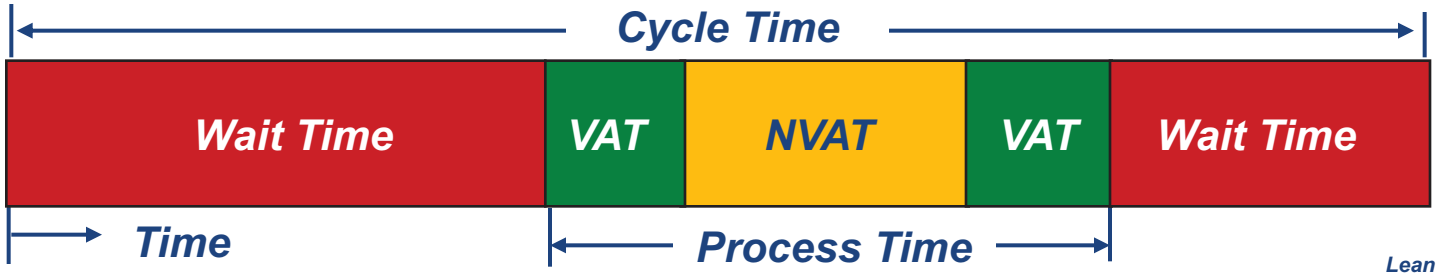
- **Wait time**
  - The time Work in Process (WIP) is idle - in queues, buffers or storage
  - Other Names: queue time, delay time

- **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



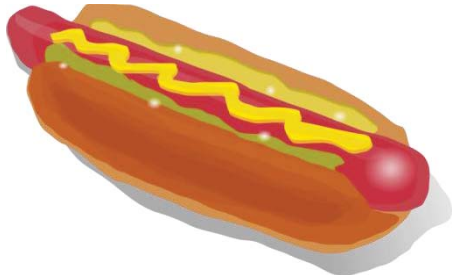
Cycle Time

- 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



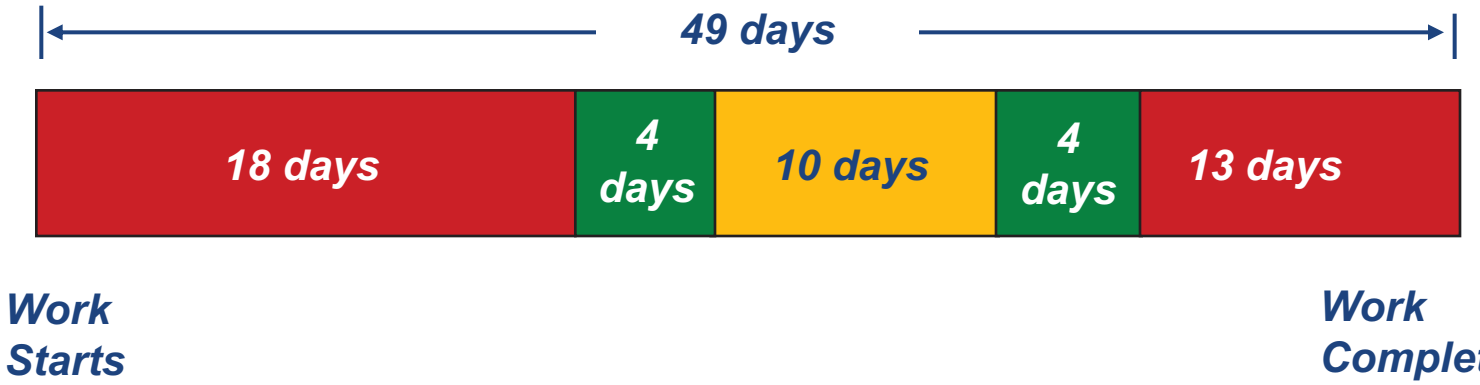
Andy

- 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

Value | Value Stream | **Flow** | Pull | Perfection

- **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

- **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

Value | Value Stream | Flow | **Pull** | Perfection

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 | 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

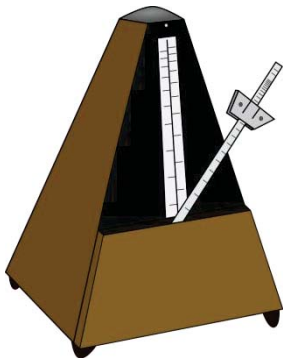
Aspects of the Dell system have become standard practice for many consumer products

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

$$\text{Takt time} = \frac{\text{Available time}}{\text{Customer demand rate for available time}}$$



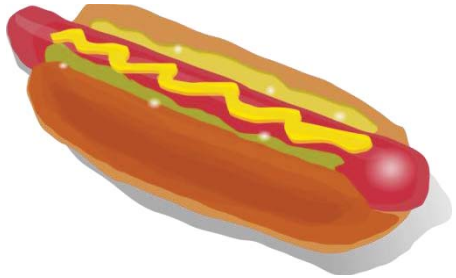
Example:

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

What is the takt time?

235/40 ~ 6 days

Hot Dog Stand Takt Time



Sasha *Andy*

- 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*

$$WIP = \frac{Cycle\ Time}{Takt\ Time} = (Throughput\ Rate\ )\ X\ (Cycle\ Time)$$

- 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?

Divide process in to 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

Single Piece Flow

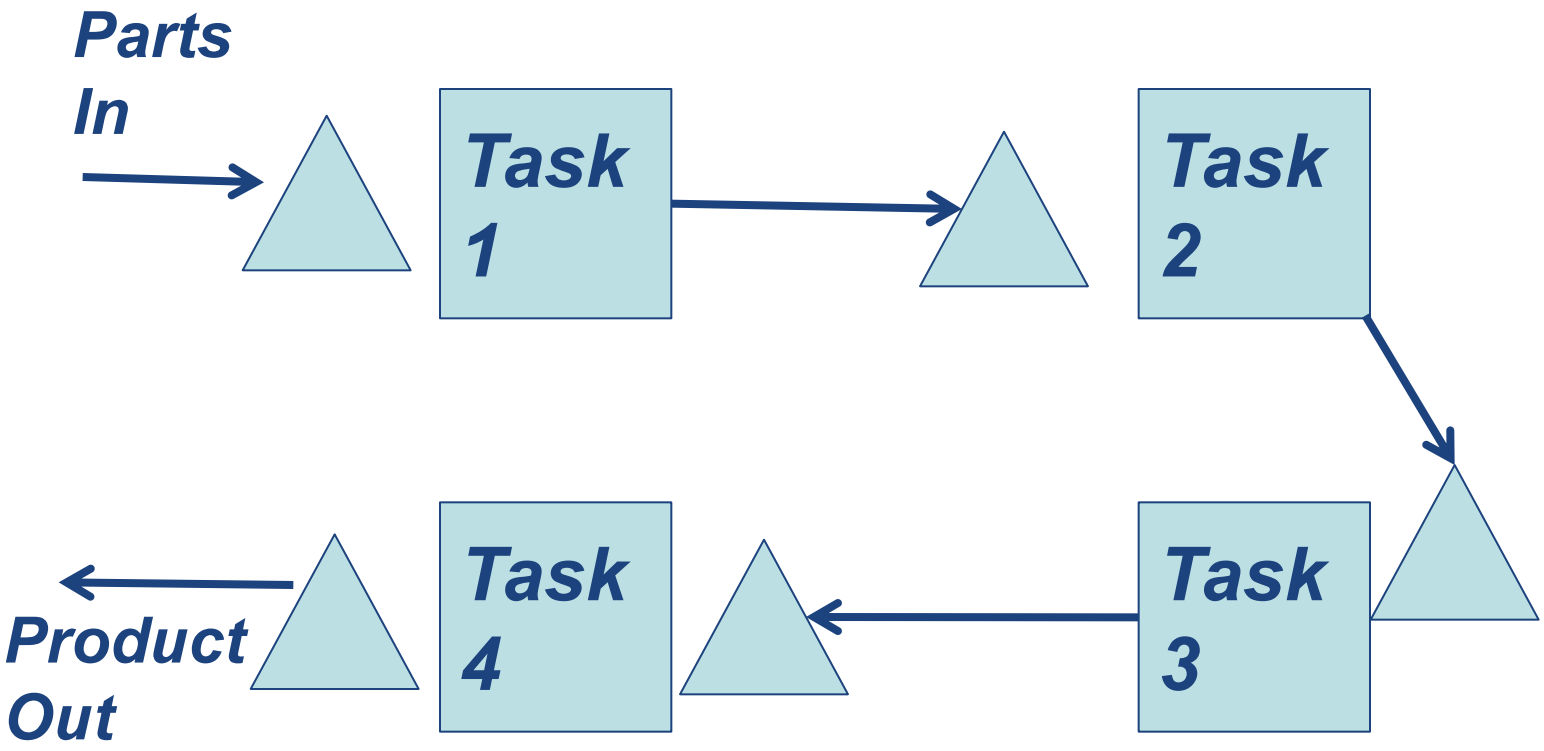
- Processing one unit at a time through all the steps to completion
- Only one unit in work at any step in the process
- Low inventory levels
- Defects immediately found

Photos by Earll Murman

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

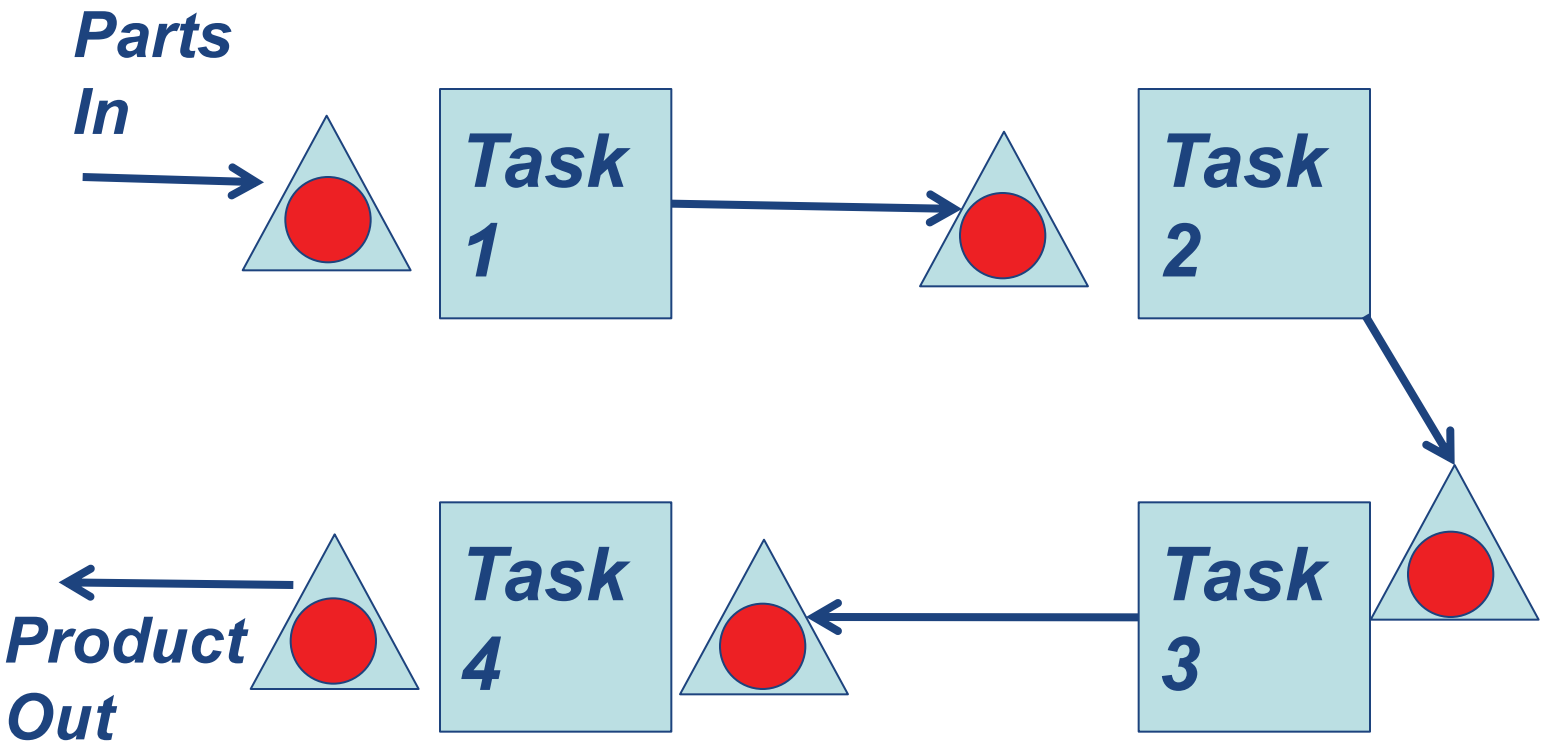
Tools for Pull: Manufacturing Cell



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



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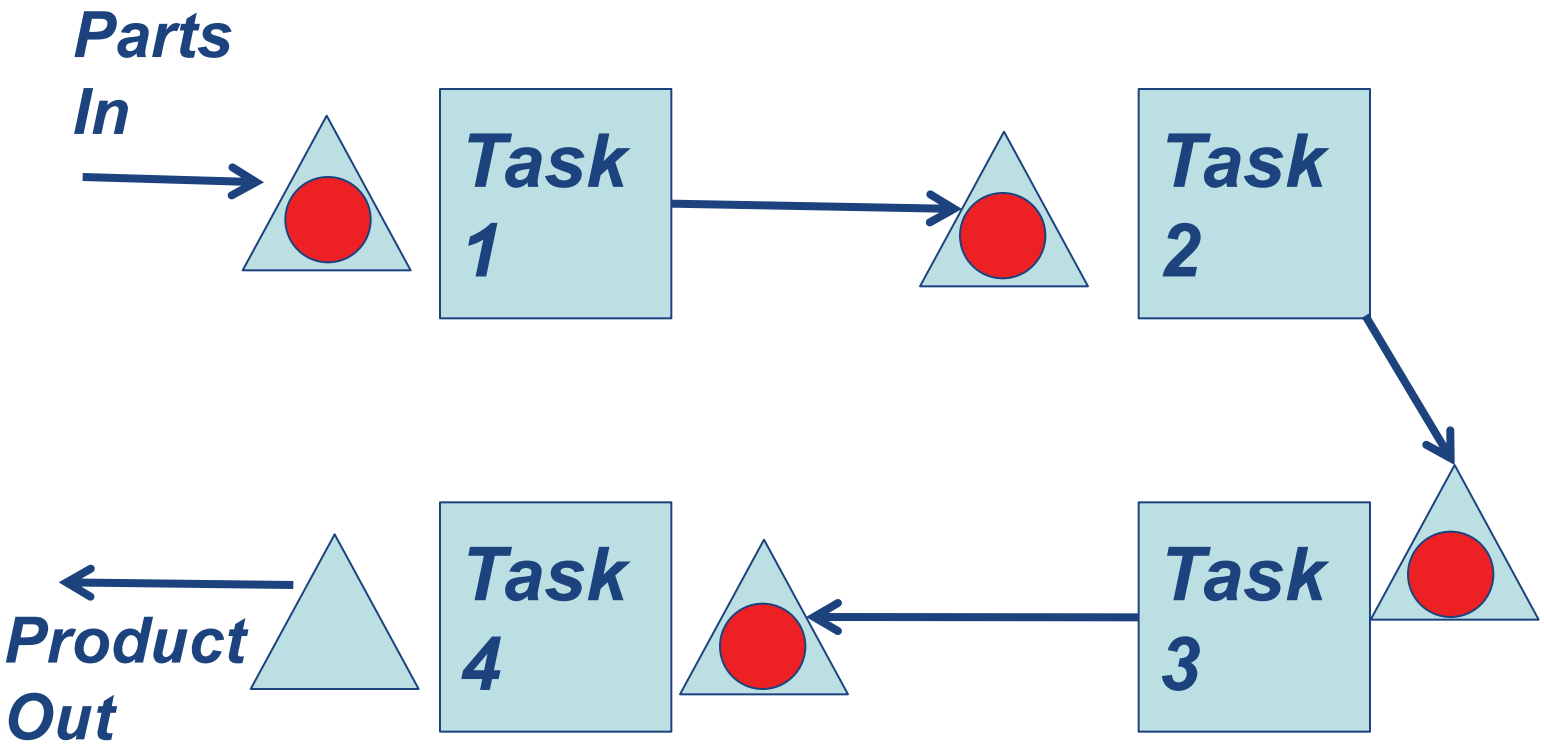
Customer Buys Product



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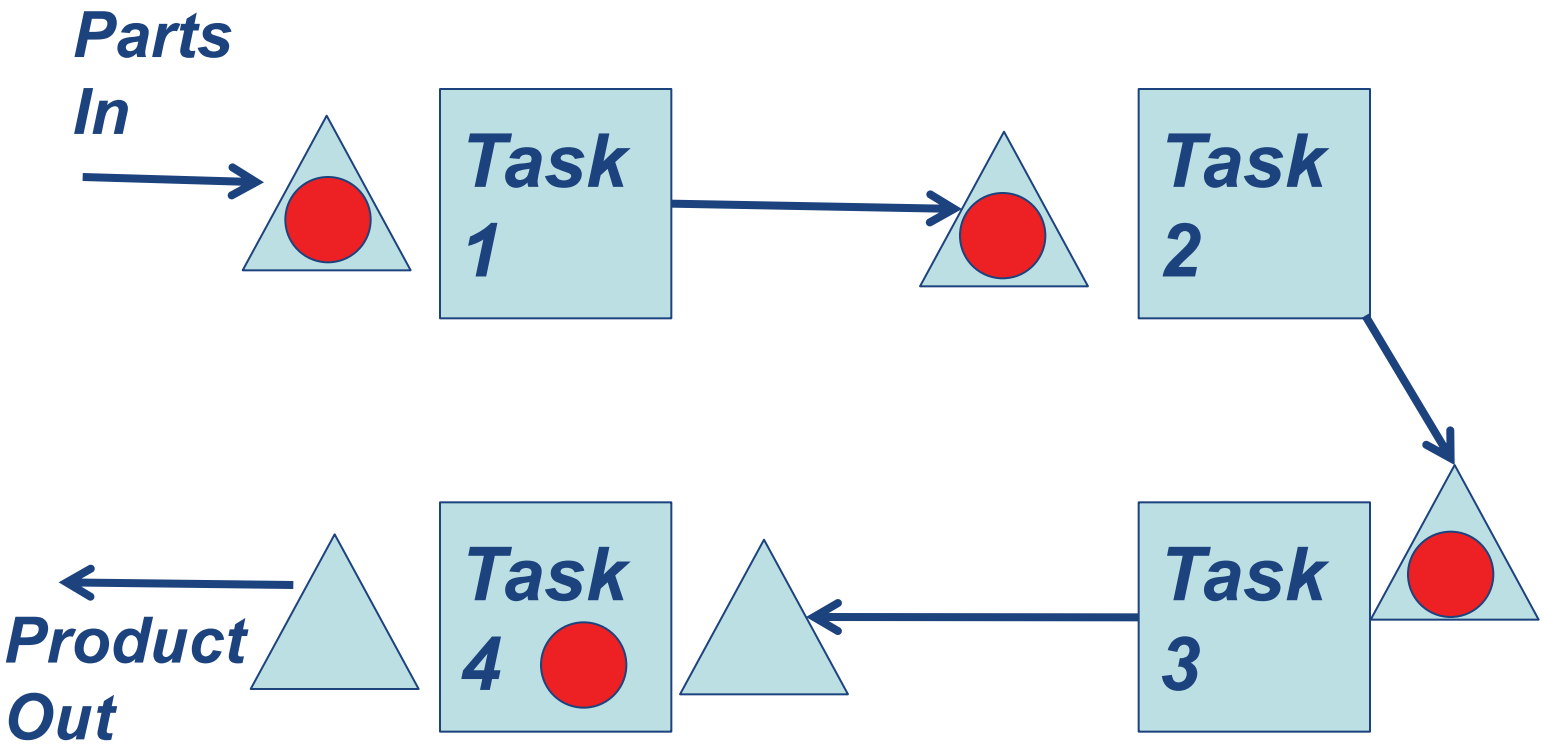
Signals Task 4 To Work



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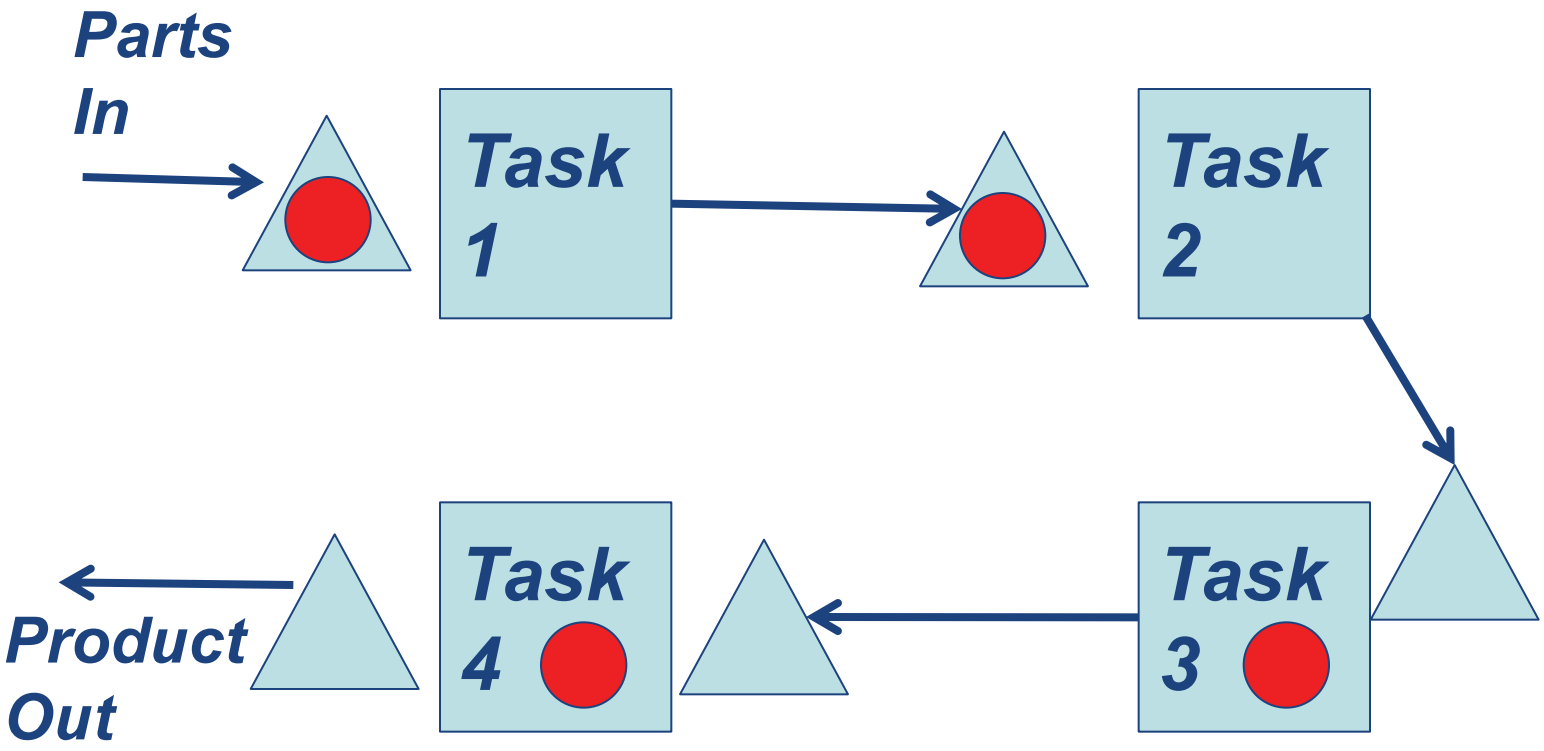
Signals Task 3 To Work



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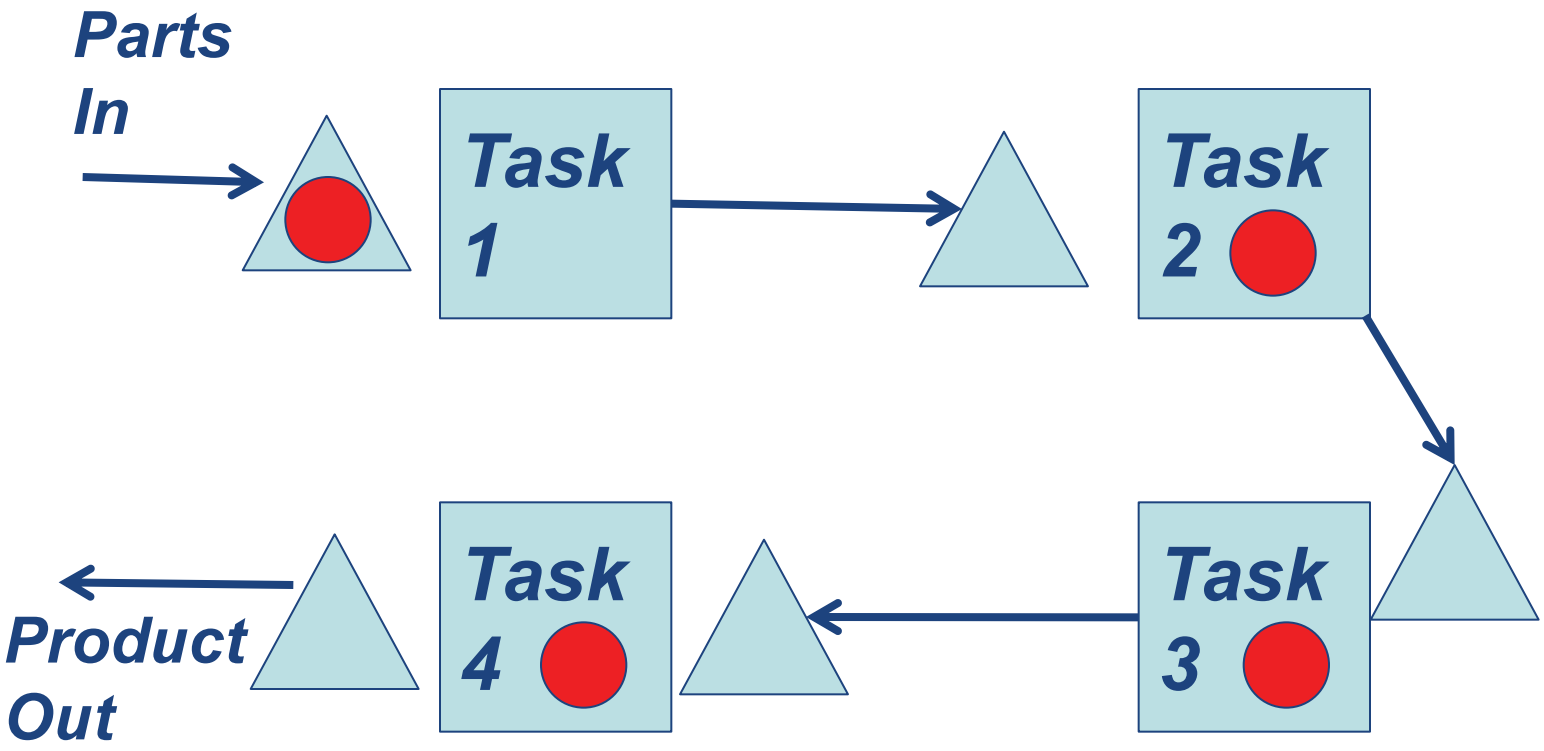
Signals Task 2 To Work



Operating rule:

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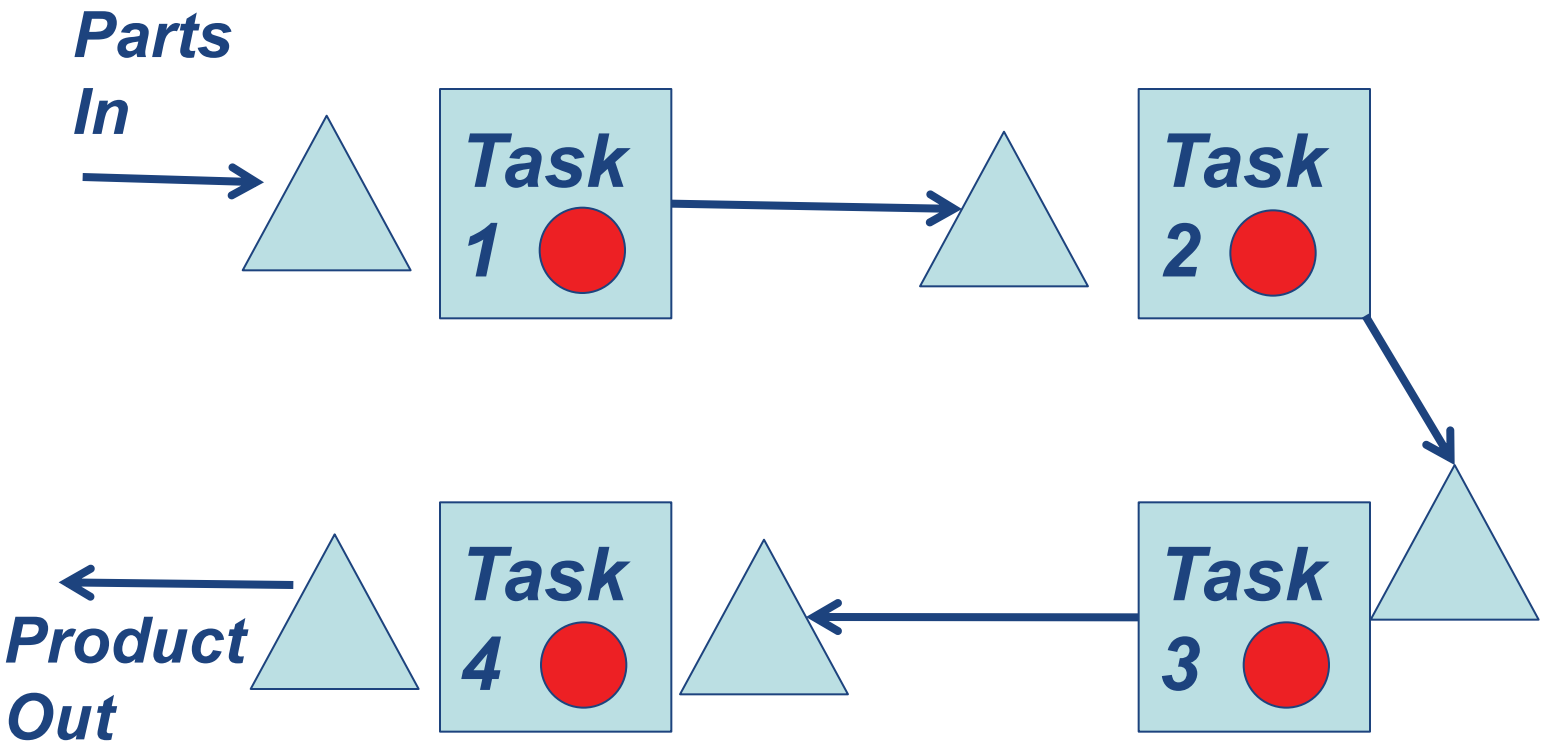
Signals Task 1 To Work



Operating rule:

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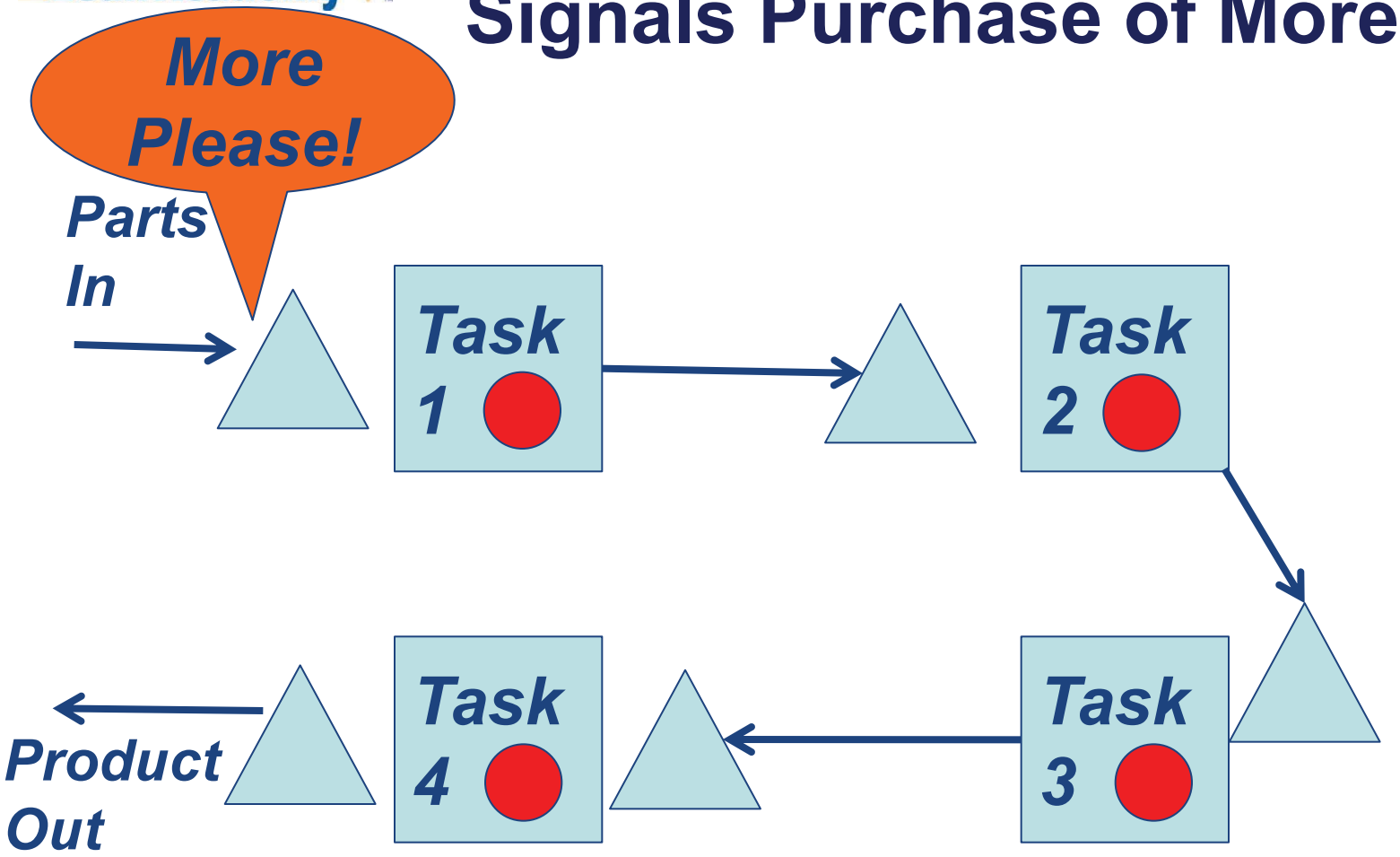
Signals Purchase of More Parts



Operating rule:

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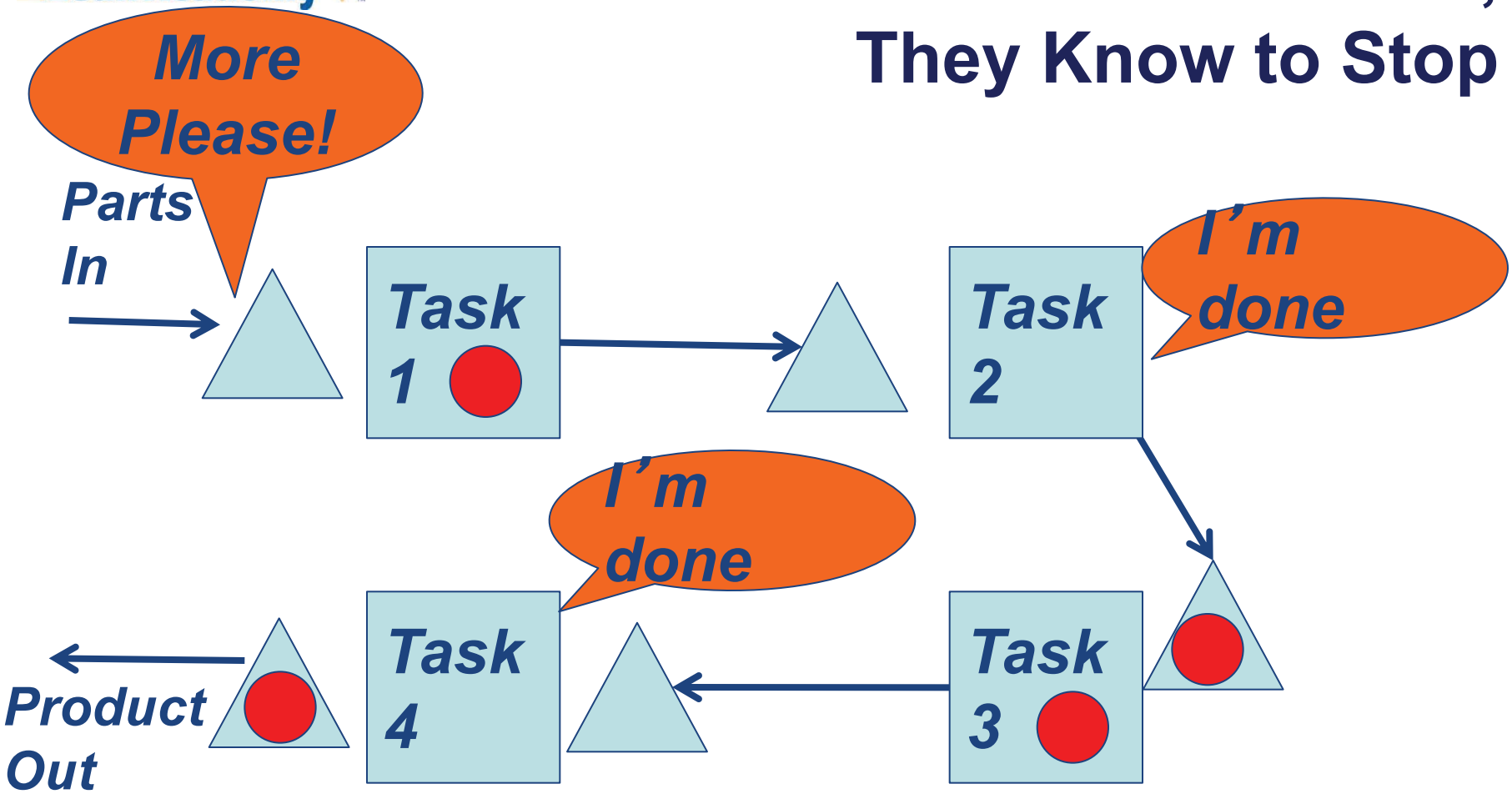
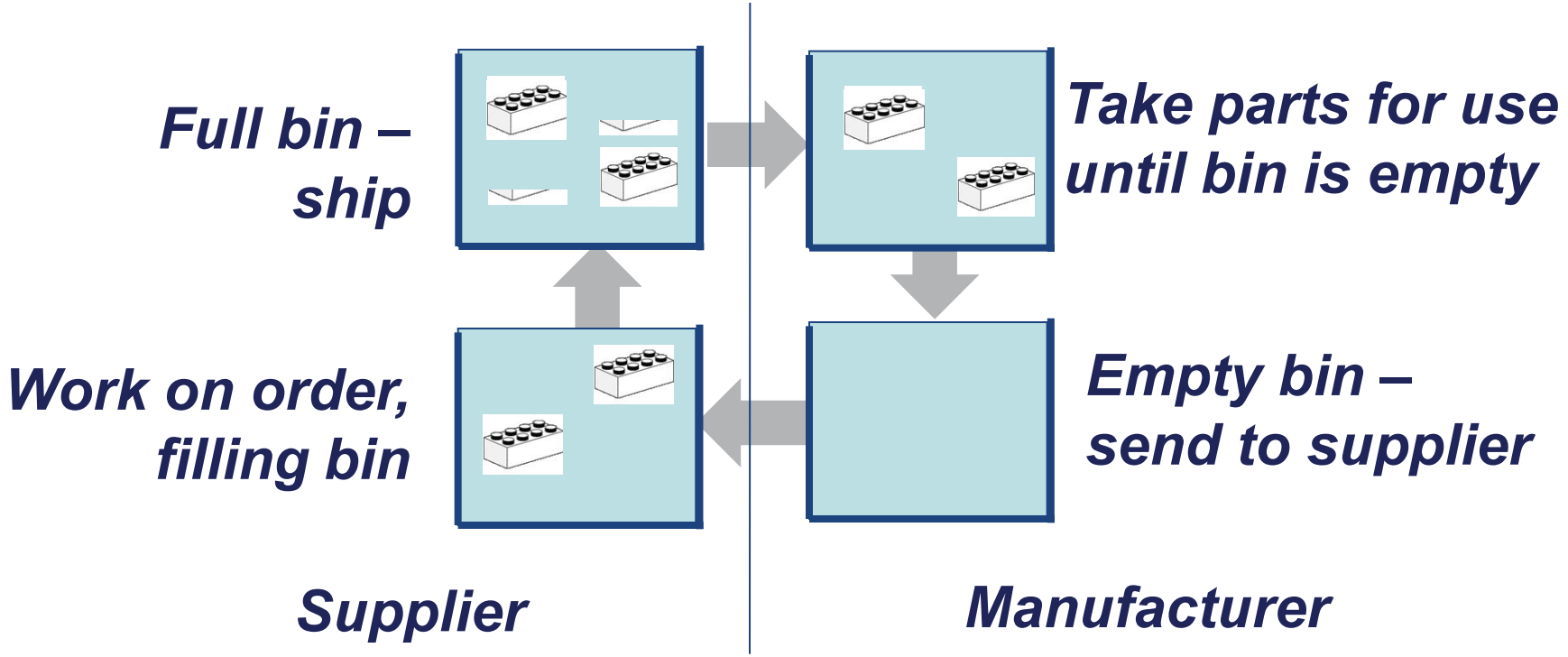
As Faster Tasks Finish, They Know to Stop



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

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



Visual Control and Andon

Value | Value Stream | Flow | **Pull** | Perfection

- *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

Value | Value Stream | Flow | **Pull** | Perfection

Employee has found a part that doesn't fit right.

The employee pulls on the line-stop cord overhead.

LINE STOPPED!

Team leader sees the lamp and comes to help.

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.

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

Source: http://www.toyota.co.jp

Virginia Mason Medical Center Patient Safety Alert™ System

Value | Value Stream | Flow | **Pull** | Perfection

- 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*

Value | Value Stream | Flow | Pull | **Perfection**

- 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

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.

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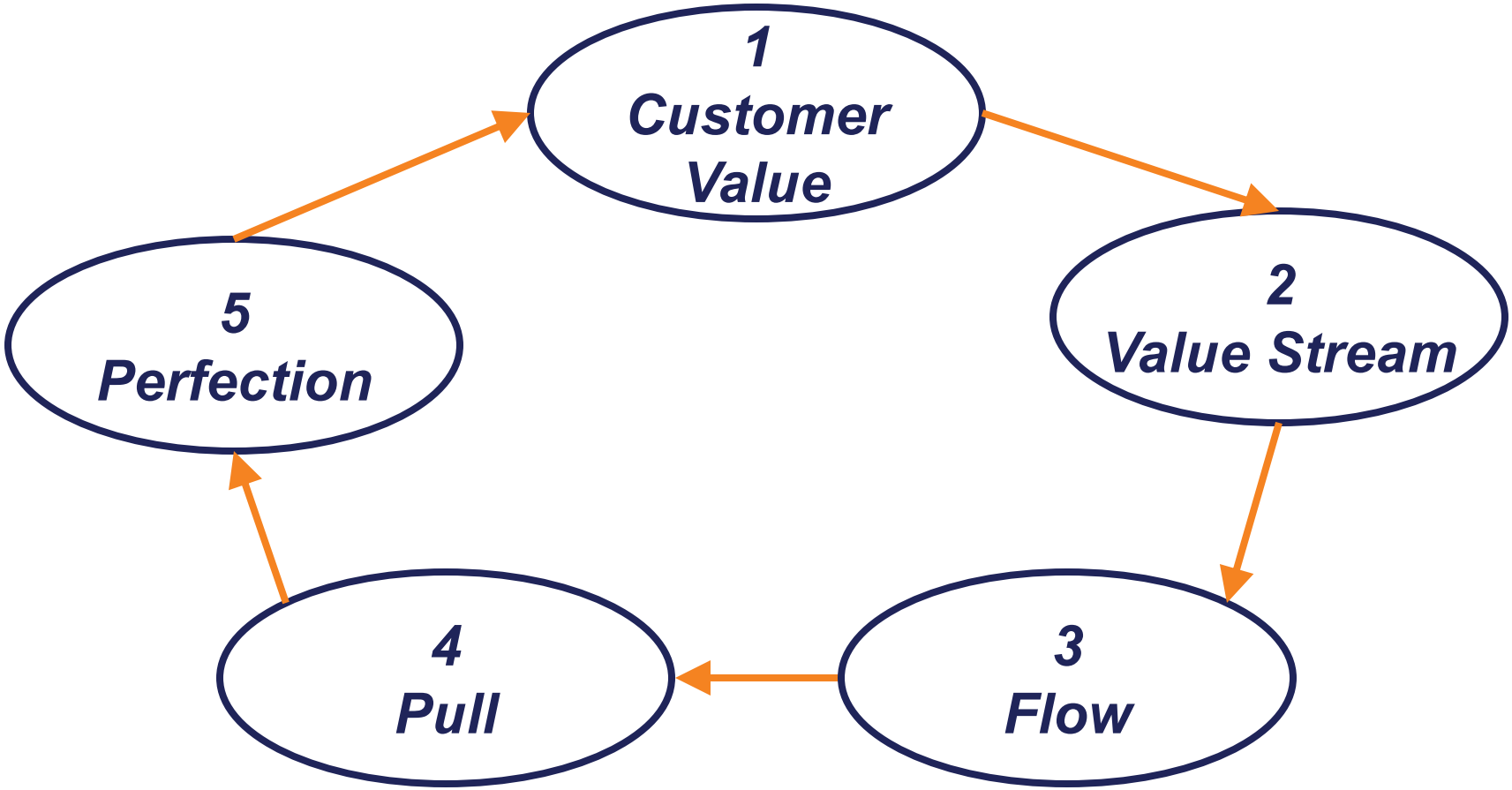
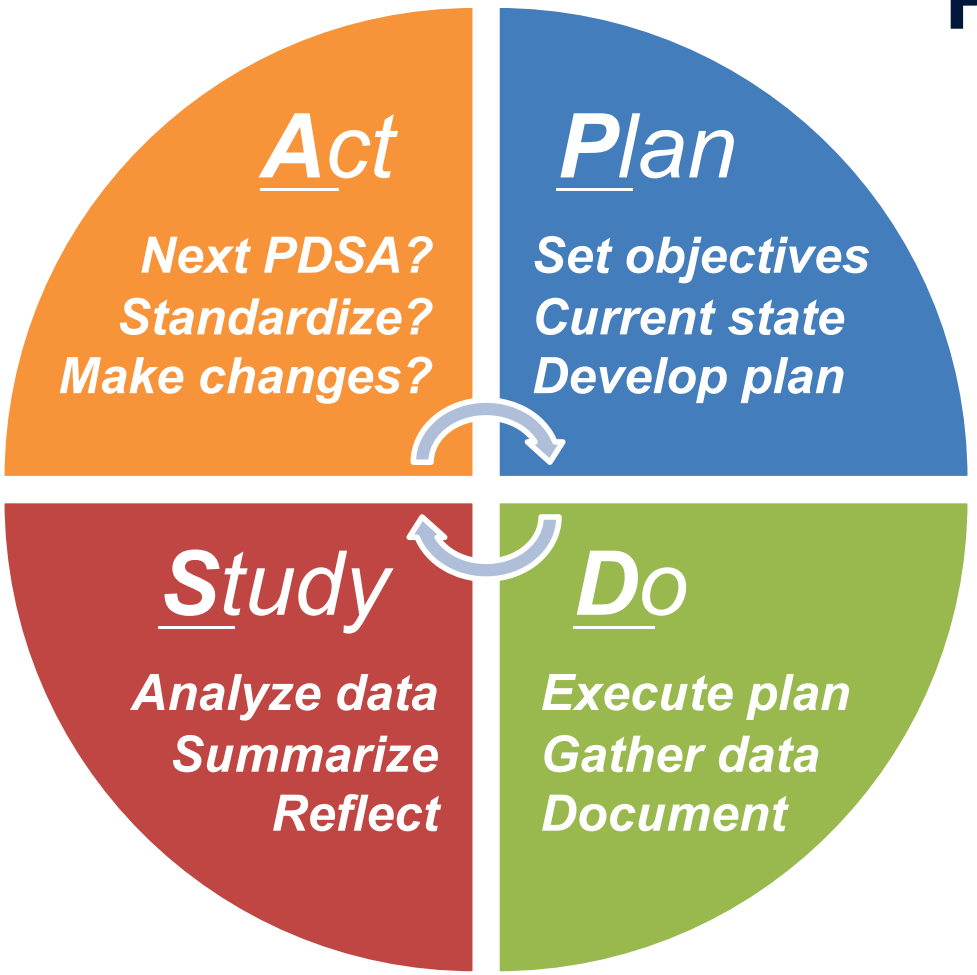
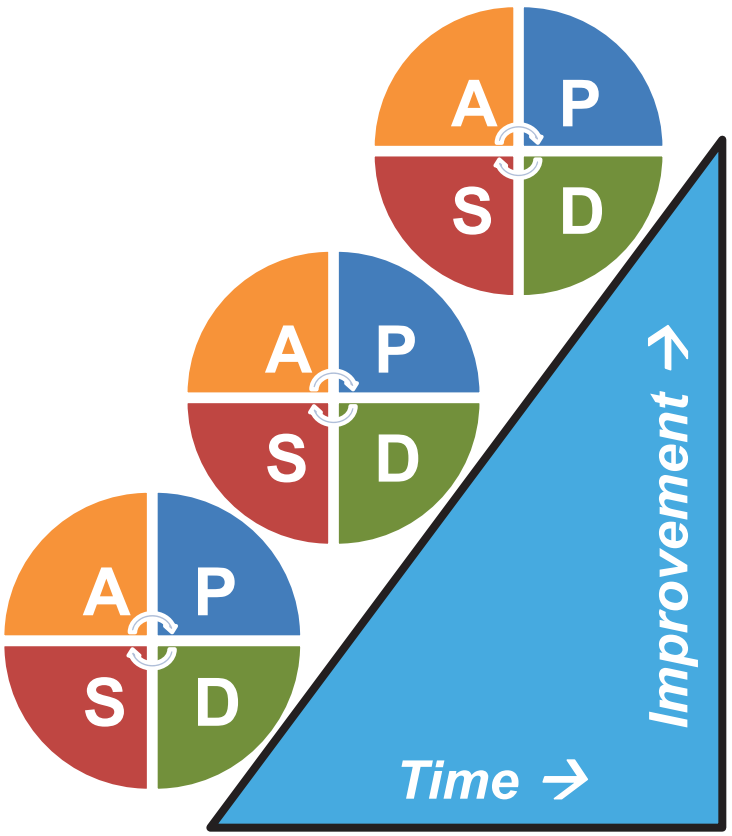
Five Lean Fundamentals Work Together



Plan-Do-Study-Act





Lean is not a set of tools. It is a continuous improvement mindset using multiple PDSA cycles.

Lean Concepts Introduced So Far

Value	Value Stream	Flow	Pull	Perfection

- Value added
- Muda, muri, mura
- 8 types of waste
- Value stream
- Cycle time
- Wait time
- Processing time
- Time value charts
- Takt time
- Balanced work
- Spaghetti diagrams
- Process maps
- Flow and pull

- Single piece flow
- Standard work
- Kitting
- Kanban
- Visual control
- Andon
- 6S
- Mistake proofing
- 5 Whys
- PDSA
- Gemba (genba)
- Genchi genbutsu
- Three actuals

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

Reading List

Womack, J. and Jones, D., *Lean Thinking, 2nd Edition*, Simon & Shuster, New York, 2003

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Murman, E., Allen, T., Bozdogan, K., Cutcher-Gershenfeld, J., McManus, H., Nightingale, D., Rebentisch, E., Shields, T., Stahl, F., Walton, M., Warmkessel, J., Weiss, S., and Widnall, S., *Lean Enterprise Value: Insights from MIT's Lean Aerospace Initiative*, Palgrave, New York, 2002

"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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