EPFL School of Engineering

# Continuous Improvement (CIP)

## Module 3 – Process

## Lean Management

Amin Kaboli

May 16th, 2024

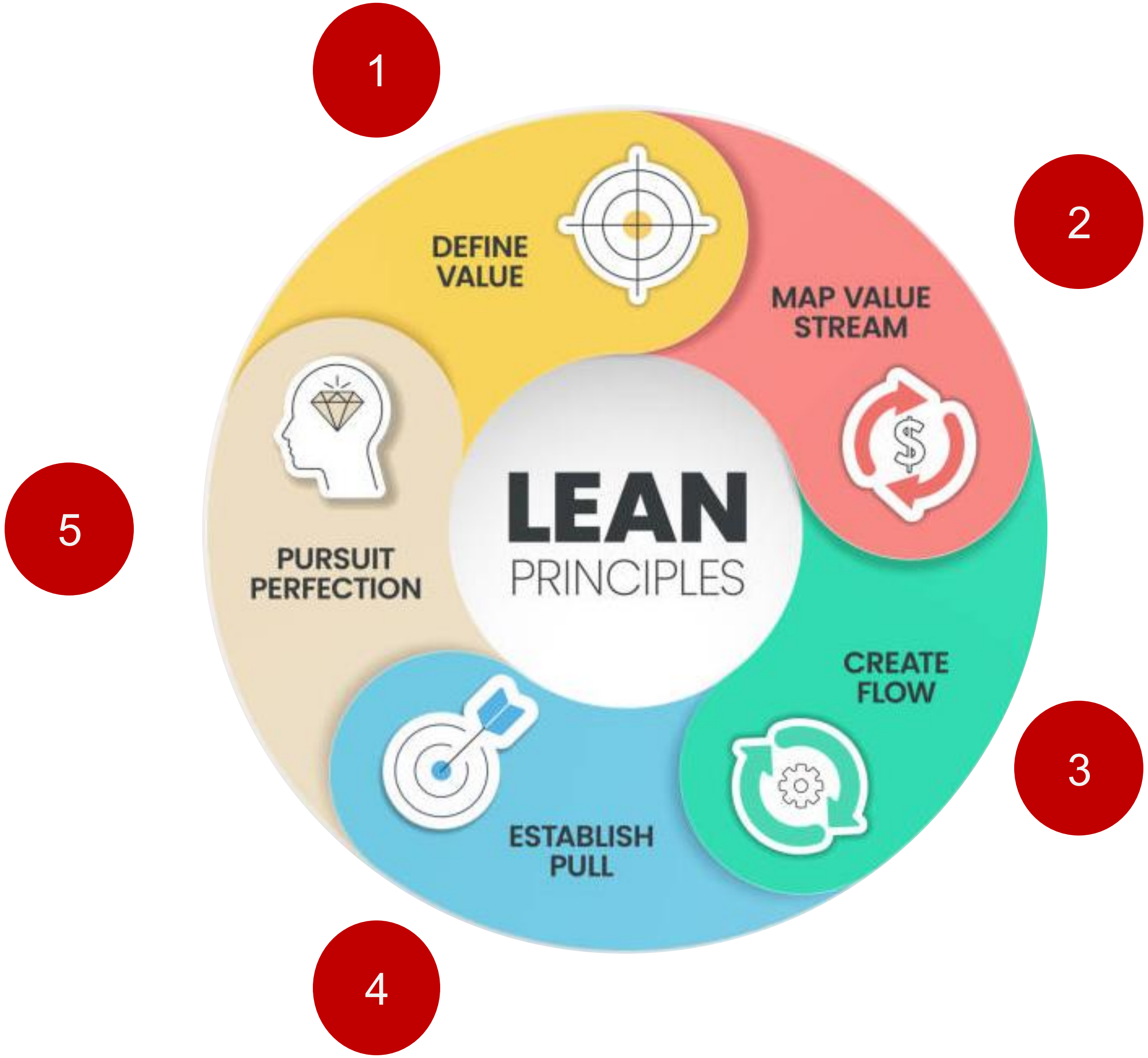
# Course Framework

**Change Plan**
Strategic plan

## Continuous Improvement (ME-498)

| Module 1 | Module 2 | Module 3 | Module 4 | |
|---|---|---|---|---|
| Introduction | People | Process | Technology | Final |
| Feb 23rd | March-May | March-May | March-May | May 31st |
| CIP Foundations<br>CIP case studies | Managing Change<br>Emotional Intelligence<br>Managing Oneself<br>Connection & Bonding<br>Effective Change Comm.<br>Managing Conflict | Capacity Planning<br>Constraint Management<br>Managing waiting lines<br>Quality Planning<br>Quality Control<br>Quality Improvement<br>Process selection<br>Facility Layout<br>Lean Management | AI for CIP<br>Data Analytics, ML&AI<br>Digital Ecosystems<br>Best case practices | Final presentation & solid understanding of the course |

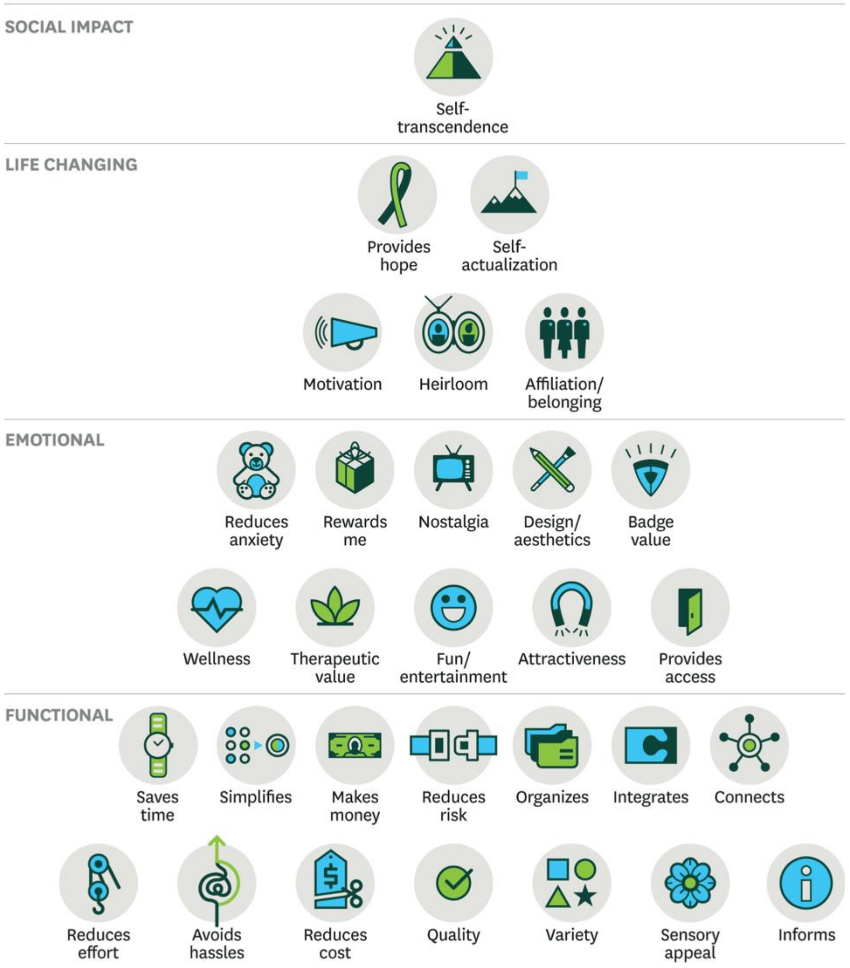
# Reminder: Continuous Improvement in Action (W1)

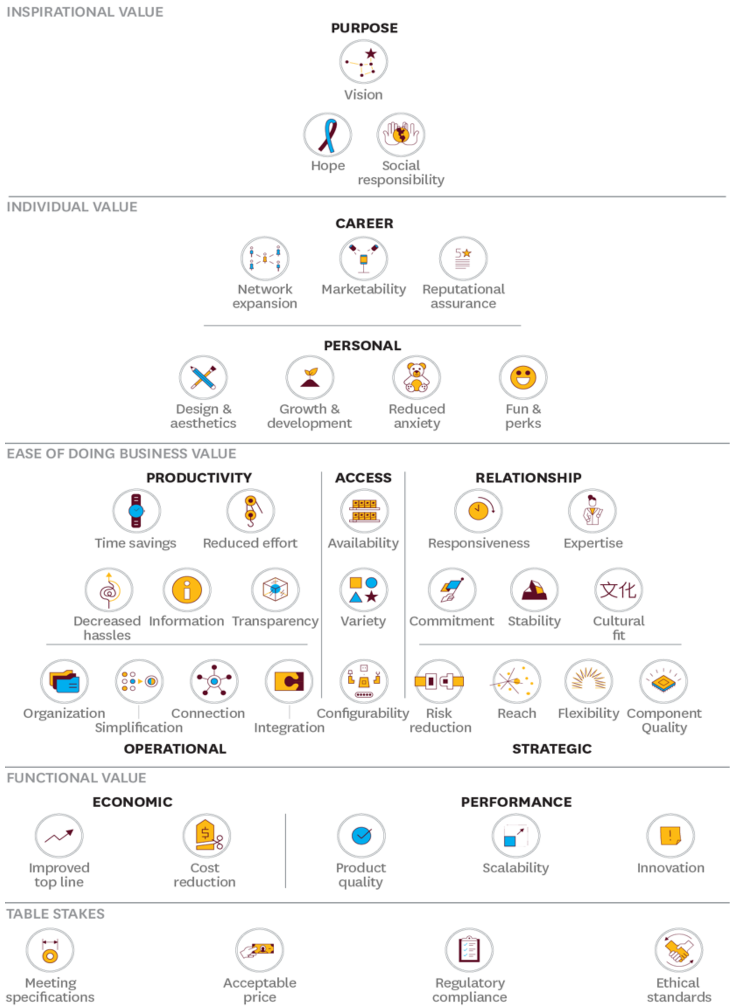

1
DEFINE VALUE
2
MAP VALUE STREAM
3
CREATE FLOW
4
ESTABLISH PULL
5
PURSUIT PERFECTION
LEAN
PRINCIPLES

1


DEFINE VALUE
MAP VALUE STREAM
CREATE FLOW
ESTABLISH PULL
PURSUIT PERFECTION
LEAN
PRINCIPLES

# Reminder: What Are Elements of Values?



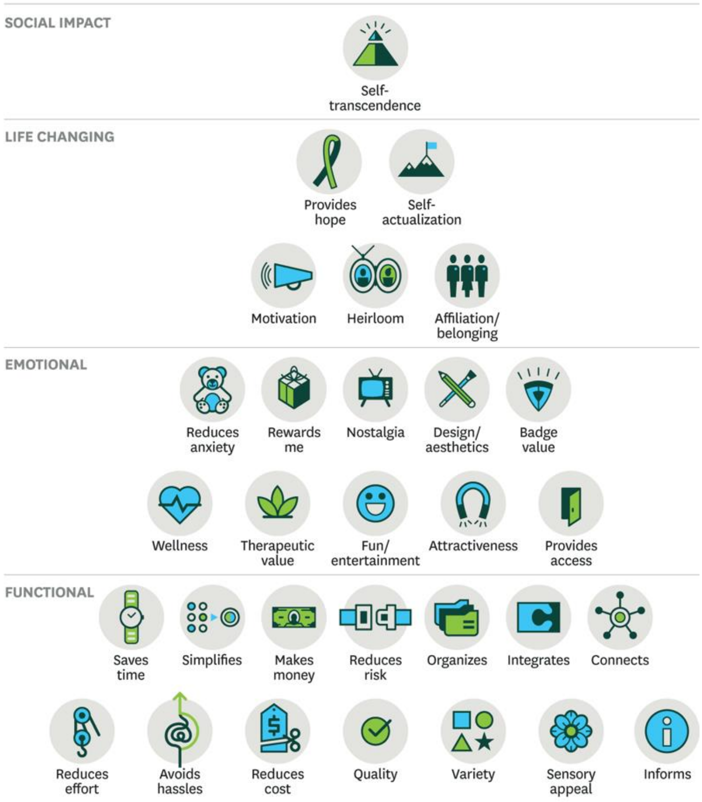



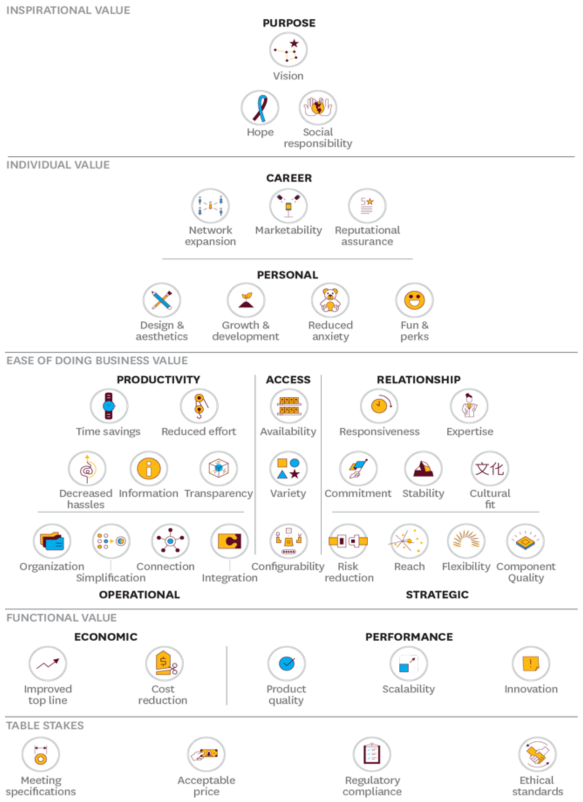

**Source:** 2015 Bain & Company - The Elements of Value, Harvard Business Review, 2015

**Source:** 2018 Bain & Company - The B2B Elements of Value, Harvard Business Review, 2018

# **Q1.** What are the main elements of value from the standpoint of your customer in your case study?

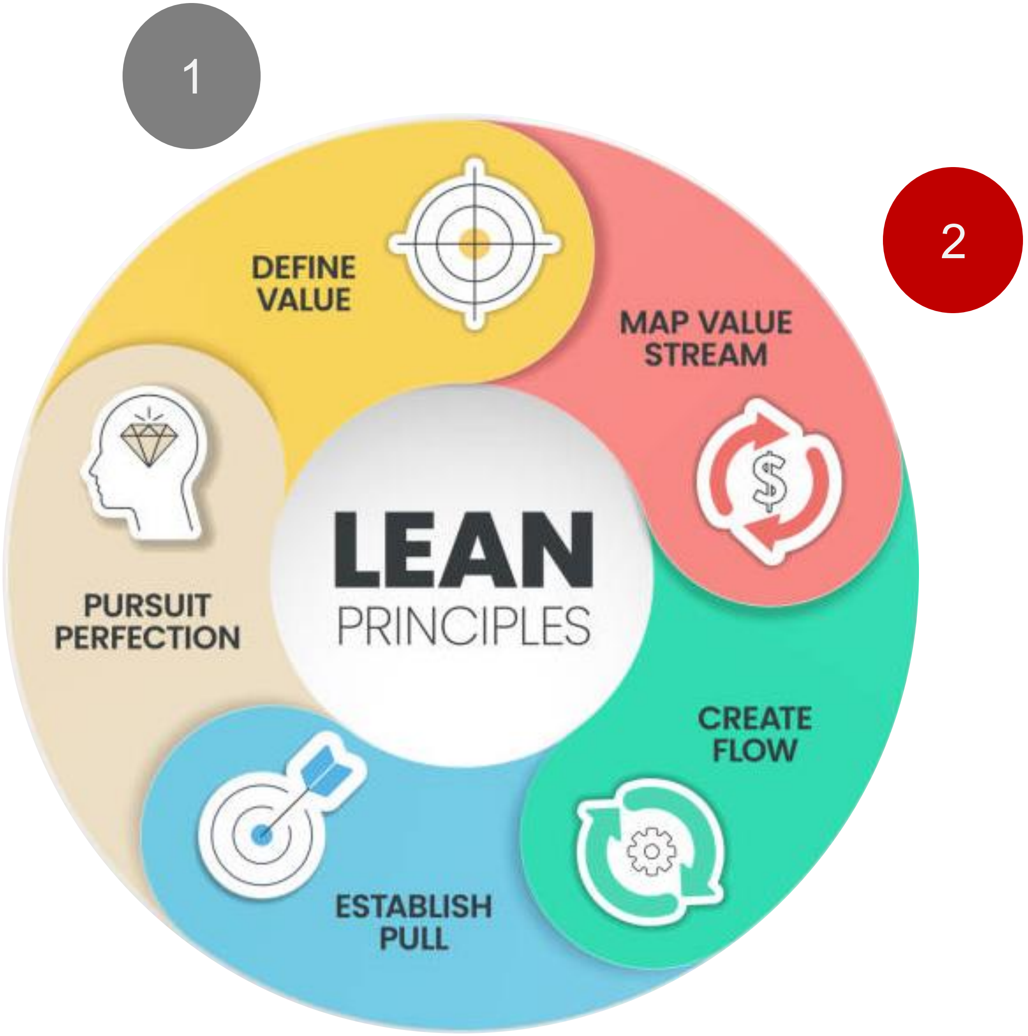
**5 min**



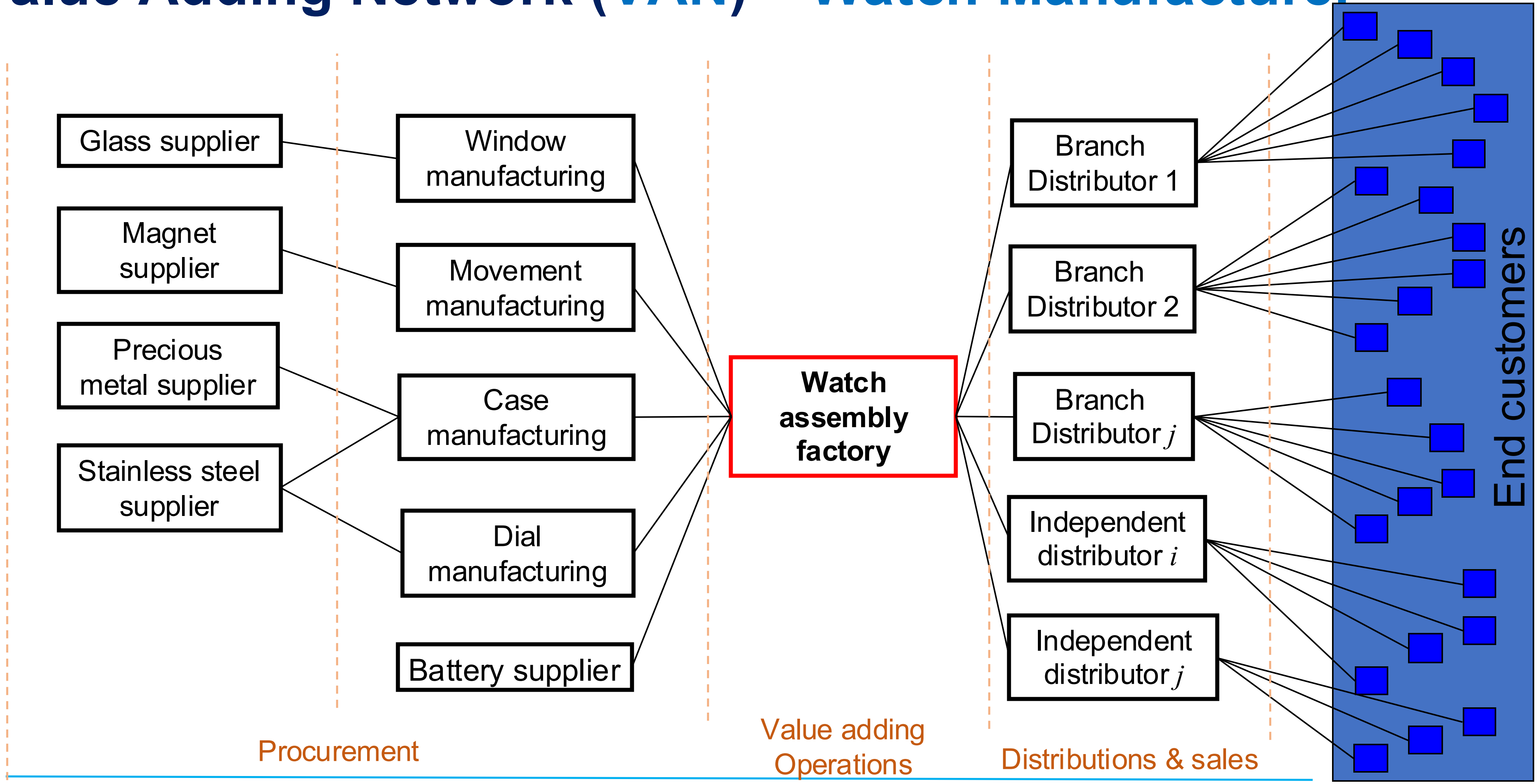




**Source:** 2015 Bain & Company - The Elements of Value, Harvard Business Review, 2015

**Source:** 2018 Bain & Company - The B2B Elements of Value, Harvard Business Review, 2018


1
2
DEFINE VALUE
MAP VALUE STREAM
CREATE FLOW
ESTABLISH PULL
PURSUIT PERFECTION
LEAN
PRINCIPLES

# Value Adding Network (VAN) – Watch Manufacturer



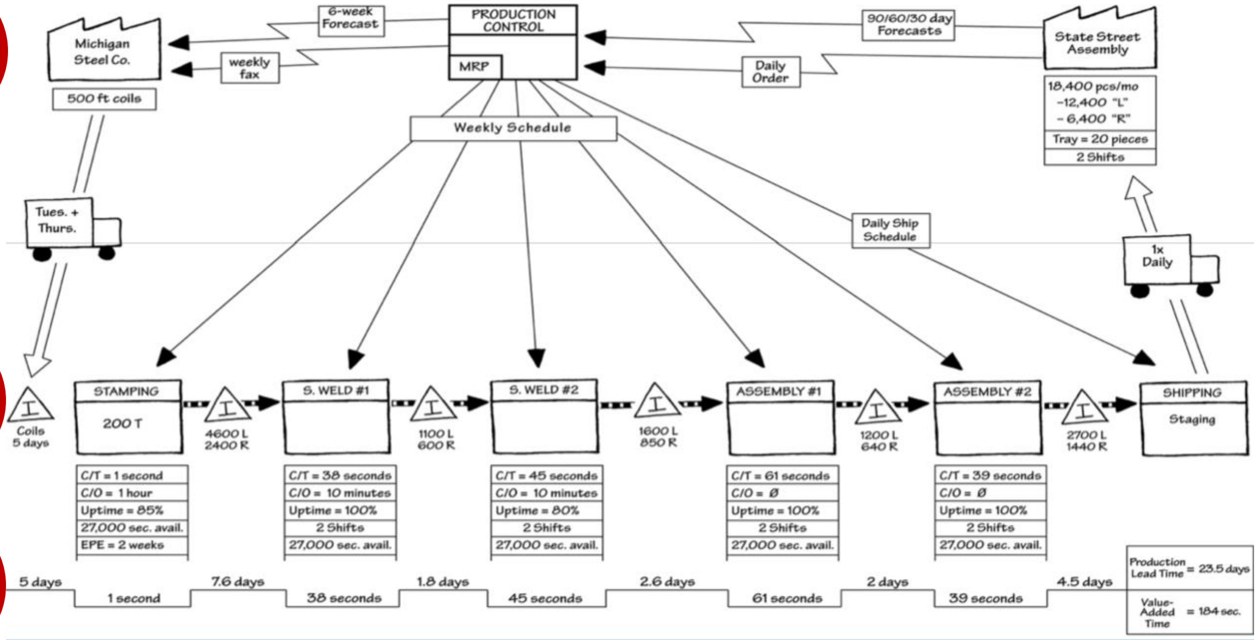

Reminder: Production Management (ME419); Module 1 – Introduction to PM

# Value Stream Mapping (VSM)

1

2

3



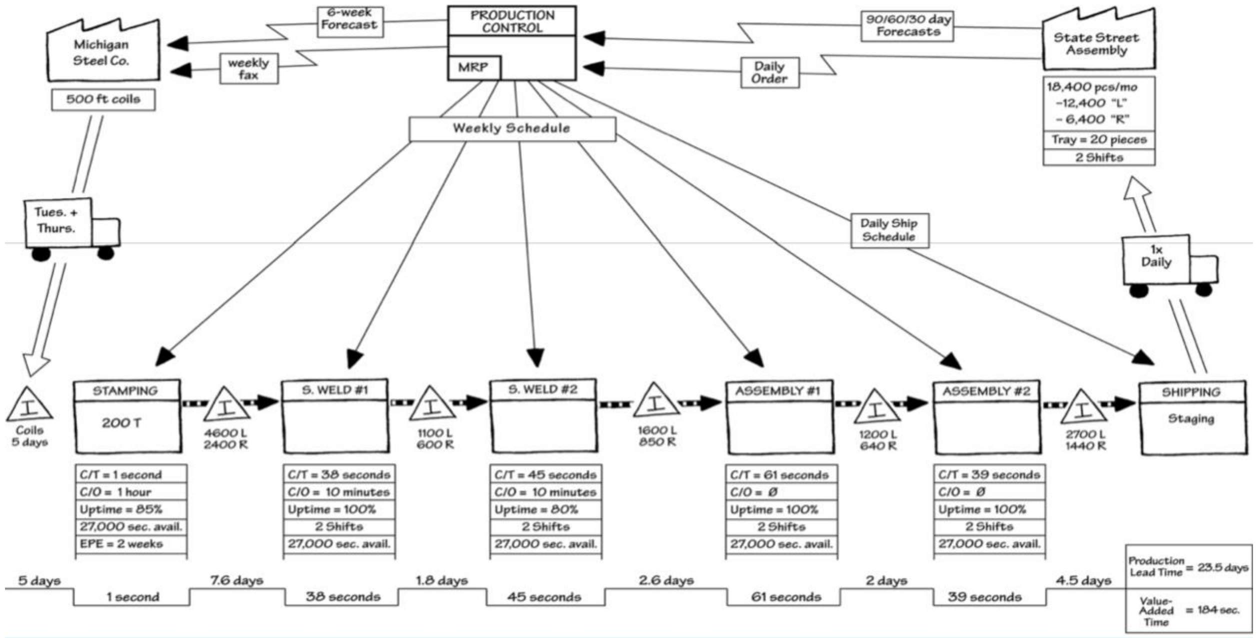

1. Specify value from the standpoint of the end customer.

2. Identify the value stream for each product family.

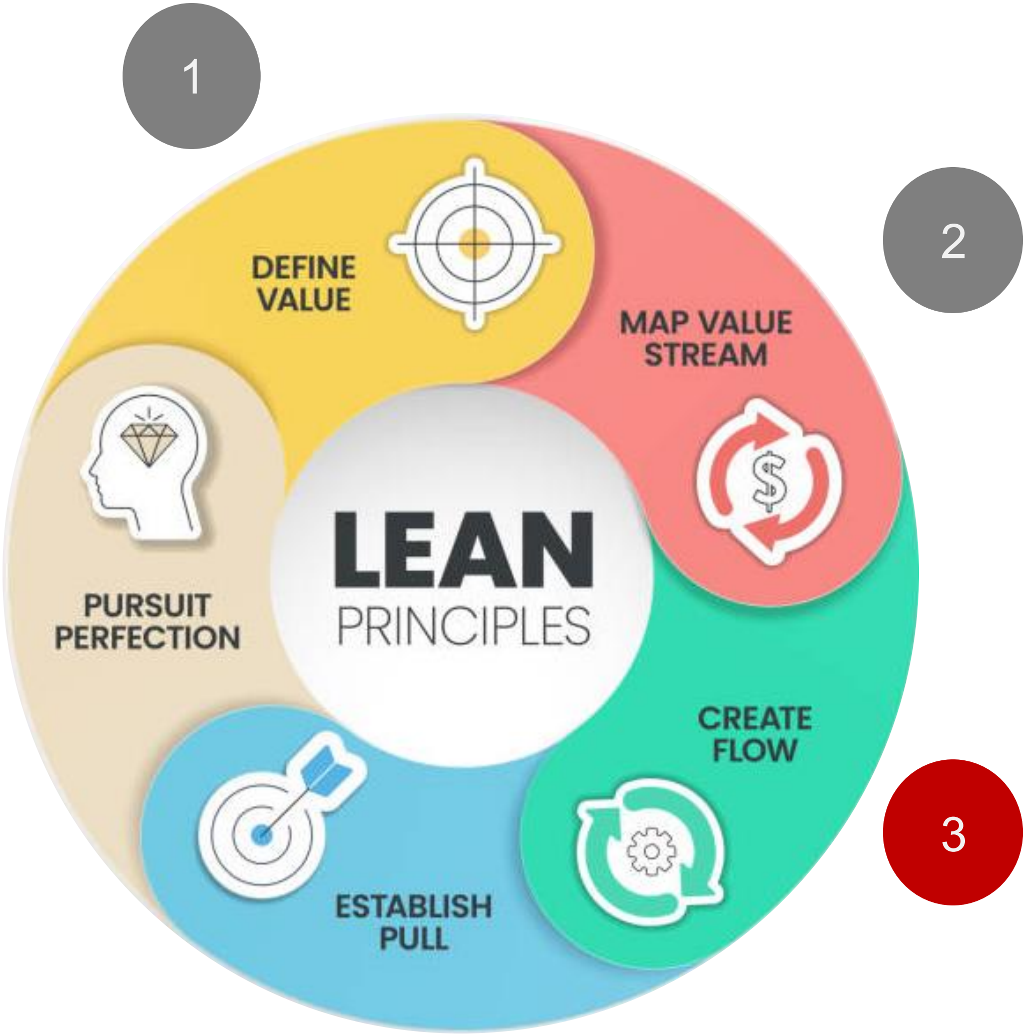
3. Define the ideal state (make the product flow that customer can pull)

# Q2. Using Value Stream Mapping (VSM), analyze your case study by addressing the following:

10 min




1. Specify value from the standpoint of the end customer.
2. Identify the value stream for your case study.
3. Define the ideal state (Make the flow that customer can pull)

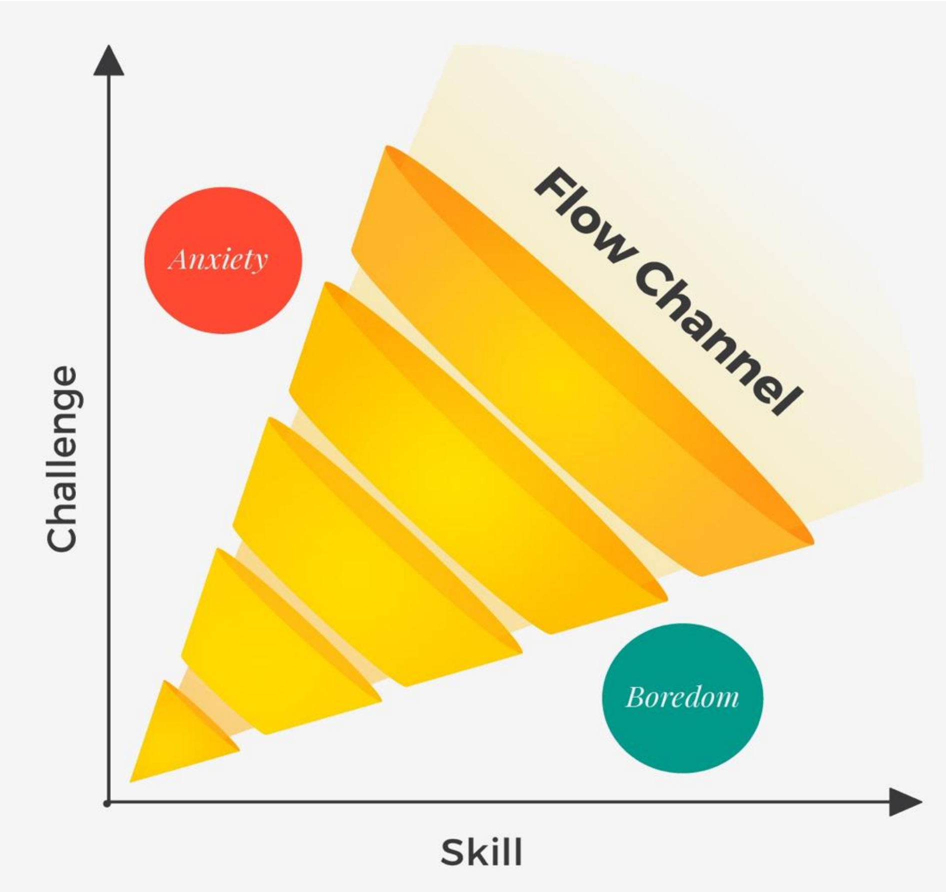

1
DEFINE VALUE
2
MAP VALUE STREAM
LEAN
PRINCIPLES
PURSUIT PERFECTION
CREATE FLOW
3
ESTABLISH PULL

# The Experience of Flow

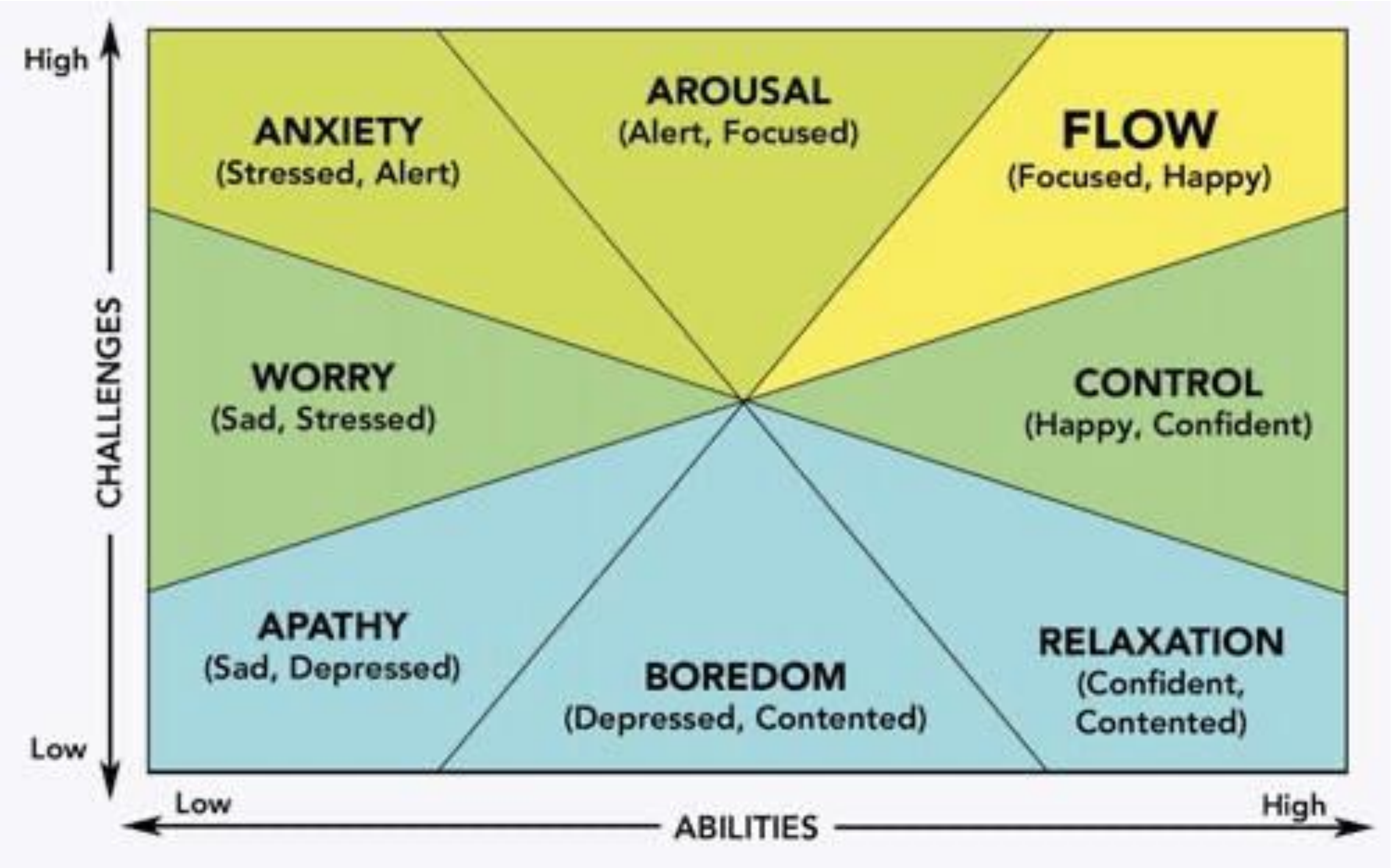
In positive psychology, a **flow state**, also known as **being in the zone**, is the mental state in which a person performing some activity is fully immersed in a feeling of energized focus, full involvement, and **enjoyment** in the process of the activity.

Source: Mihaly Csikszentmihalyi, Flow: The Psychology of Optimal Experience, Harper and Row, 1990.

# The Experience of Flow



# The Map of Everyday Experience




Source: Mihaly Csikszentmihalyi, Good Business, Penguin, 2004.

# People Are at the Heart of Lean System

Role of leaders

Role of employees

# People Are at the Heart of Lean System

## Role of leaders

- Be responsible for creating lean culture
- Ensure that workers receive multifunctional training
- Develop employee skills necessary to function in a lean environment
- Facilitate teamwork
- Develop an incentive system that rewards workers for their efforts
- Serve as coaches and facilitators, not “bosses”

## Role of employees

- Having cross-functional skills
- Quality is everyone's responsibility
- Responsibility for Preventive maintenance
- Working in teams to solve problems
- Recording and visually displaying performance data
- Empowered to make decisions
- Decisions are made from bottom-round management

Reminder: Module 2 – People

# Q3.1 Creating flow: What disruptions must be addressed in your case study?

5 min

A balanced rapid **flow**

Ultimate goals

Eliminate disruptions

Flexible system

Eliminate waste

Supporting goals

- Demand & supply disruptions
- Late deliveries
- Poor quality
- Equipment breakdown
- Changes to the plan

# Lean Management – Goals and Building Blocks

A balanced rapid **flow**

Ultimate goals

| Eliminate disruptions | Flexible system | Eliminate waste |
| --- | --- | --- |
| Demand & supply disruptions | Set-up time | |
| Late deliveries | Manufacturing cells | |
| Poor quality | Eliminate potential errors | |
| Equipment breakdown | Modular design | |
| Changes to the plan | Quality | |

Supporting goals

# Production Flexibility – Guidelines

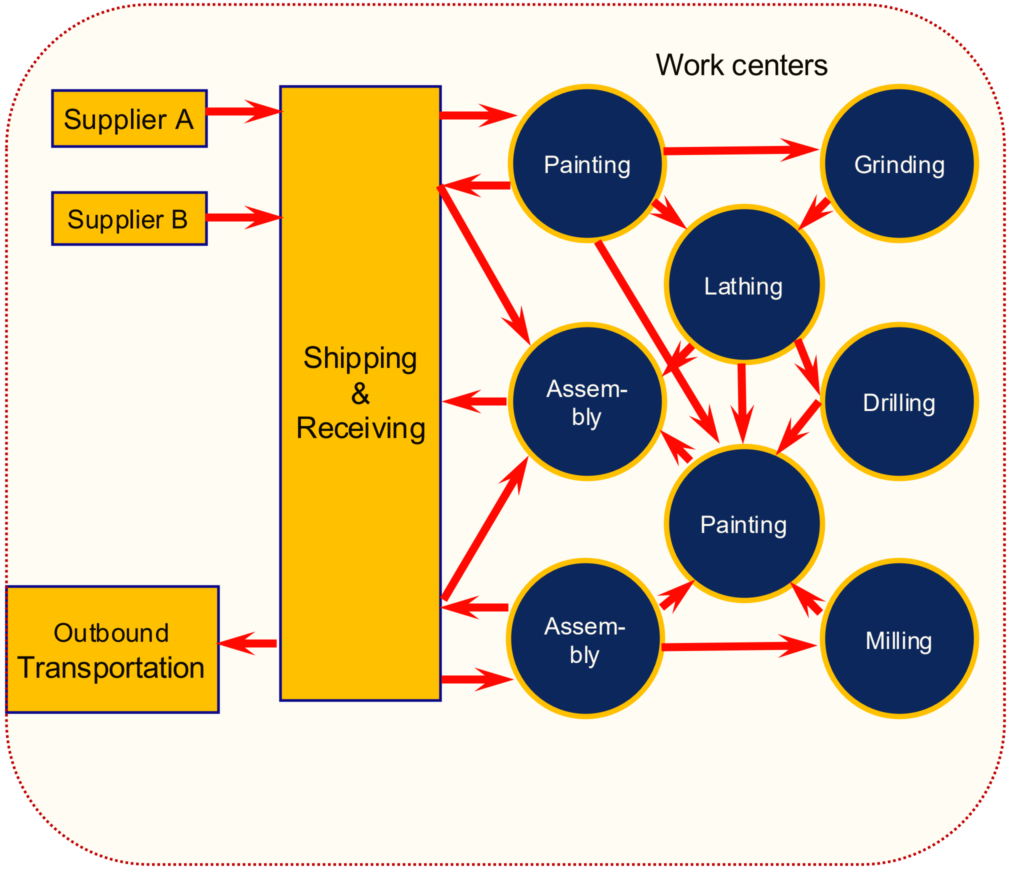
1. Reduce downtime (by reducing changeover time).
2. Use preventive maintenance on key equipment.
3. Cross-train workers (in case bottlenecks occurs or absence)

4: Use level loading - small units of capacity instead of few units of large capacity.

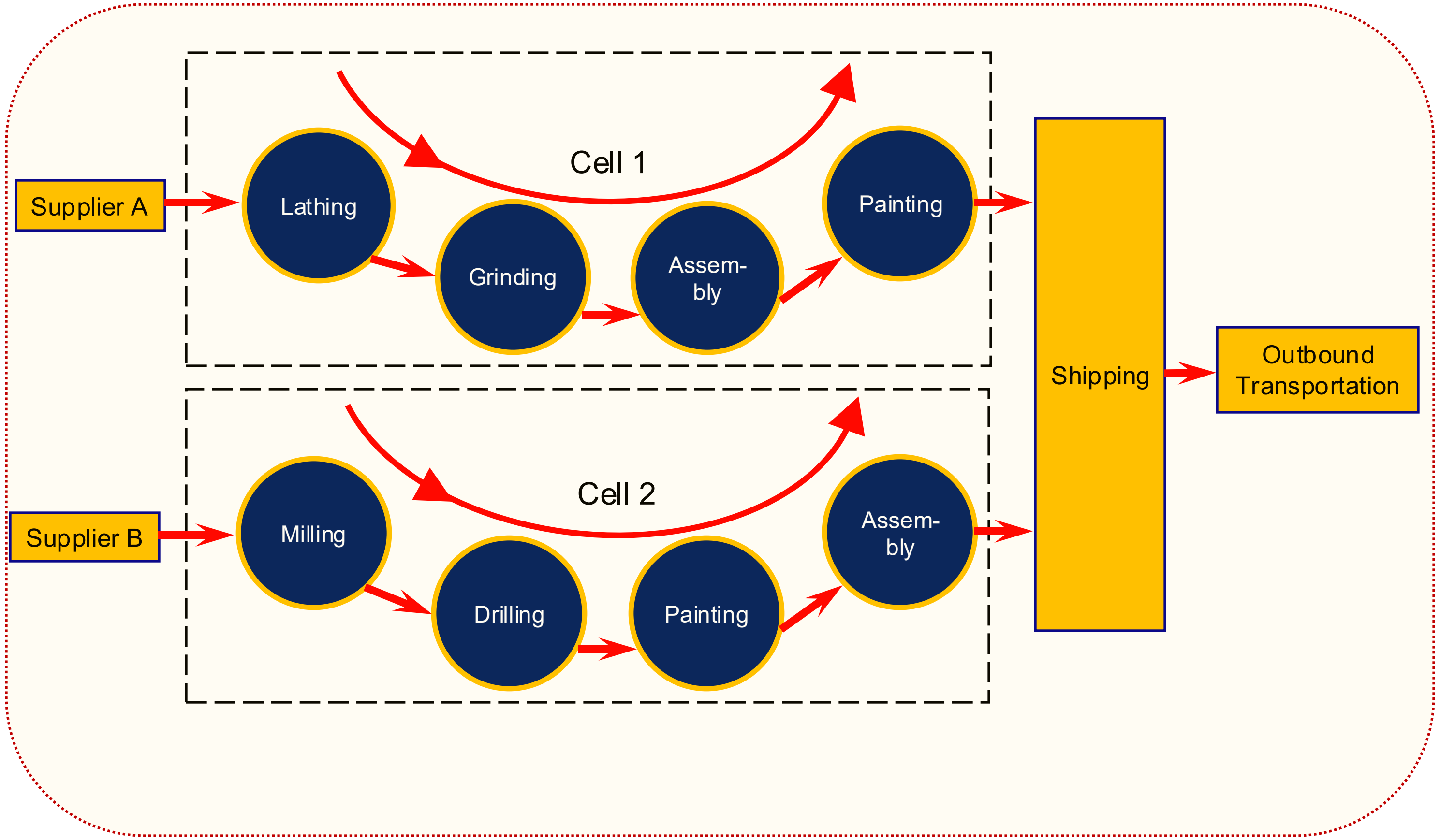
5: Use offline buffers.

6: Reverse capacity for important customers.

# Manufacturing cells




Traditional layout




Cell manufacturing

Reminder: Week 5 - Facility Layout

# Quality

- Quality at source
- Sampling and inspection
- Statistical methods
- Total Quality Management (TQM)
- Six Sigma
- …

Reminder: Week 10 – Quality Management

# Modular Design

# Standard Parts – Fewer Parts to Deal With

# Q3.2 Creating flow: how can you improve flexibility in your case study?

5 min

A balanced rapid **flow** — Ultimate goals

Eliminate disruptions | Flexible system | Eliminate waste — Supporting goals

**Eliminate disruptions**
- Demand & supply disruptions
- Late deliveries
- Poor quality
- Equipment breakdown
- Changes to the plan

**Flexible system**
- Set-up time
- Manufacturing cells
- Eliminate potential errors
- Modular design
- Quality

# Lean Management – Goals and Building Blocks

A balanced rapid **flow**

Ultimate goals

Eliminate disruptions

- Demand & supply disruptions
- Late deliveries
- Poor quality
- Equipment breakdown
- Changes to the plan

Flexible system

- Set-up time
- Manufacturing cells
- Eliminate potential errors
- Modular design
- Quality

Eliminate waste


Non-value adding activity/work
Eliminate wastes


Variations (unevenness in scheduling)
Just in Time, Kanban


Overburden due to poor management practices
Standardized work

Supporting goals


# Muda – Non-Value Adding Activity/Work

- Overproduction
- Excess inventory
- Work methods
- Waiting time
- Product defects
- Unnecessary transporting
- Under-used people

# Q3.3 Creating flow: Which wastes must be eliminated in your case study?

5 min

A balanced rapid **flow**

Ultimate goals

Eliminate disruptions | Flexible system | Eliminate waste

Supporting goals

**Eliminate disruptions**
- Demand & supply disruptions
- Late deliveries
- Poor quality
- Equipment breakdown
- Changes to the plan

**Flexible system**
- Set-up time
- Manufacturing cells
- Eliminate potential errors
- Modular design
- Quality

**Eliminate waste**

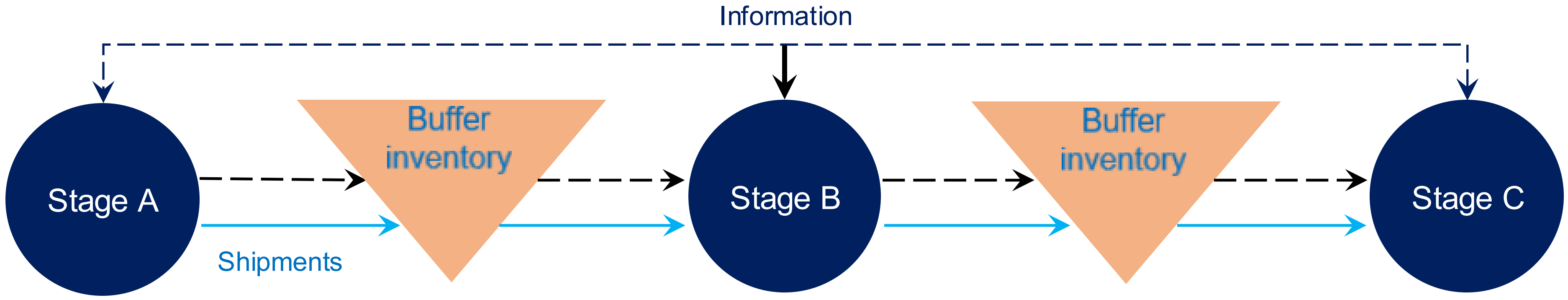

Non-value adding activity/work

Eliminate wastes

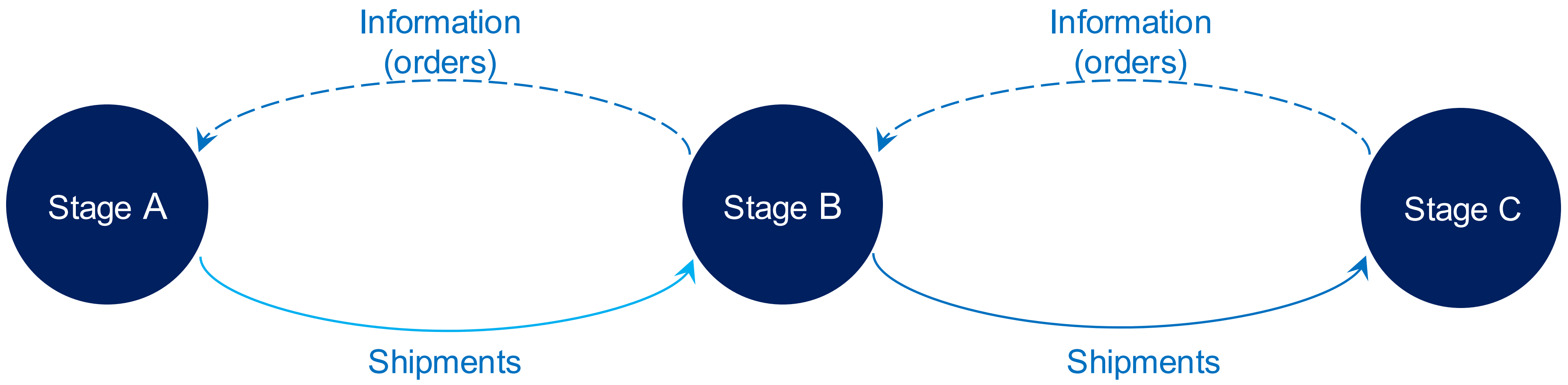

1
2
3
4
DEFINE VALUE
MAP VALUE STREAM
CREATE FLOW
ESTABLISH PULL
PURSUIT PERFECTION
LEAN
PRINCIPLES

# Push System – Stocks Are Pushed Towards Market

Scheduling and movement information from operation's planning and control system

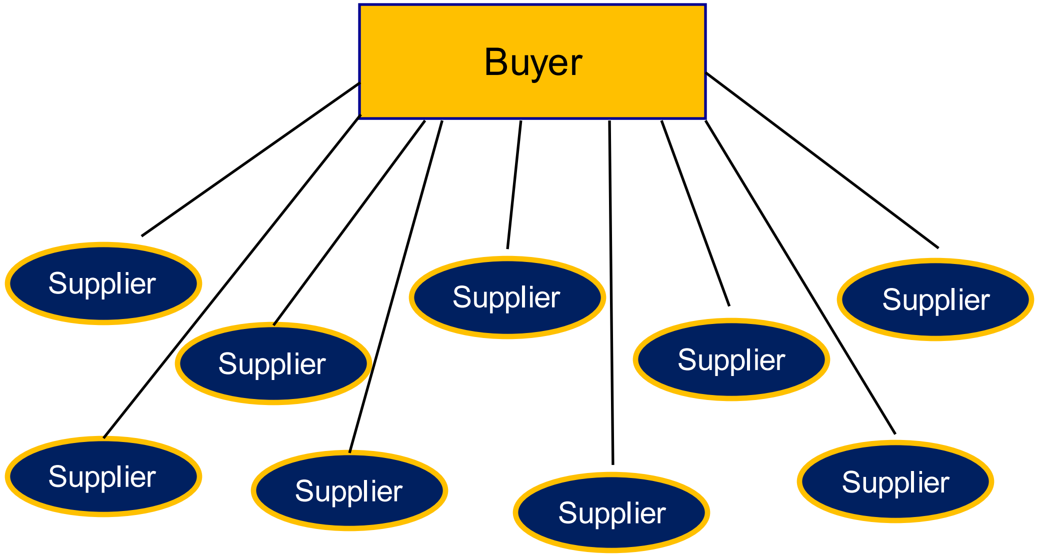


# Pull System – Demand-Driven Operations

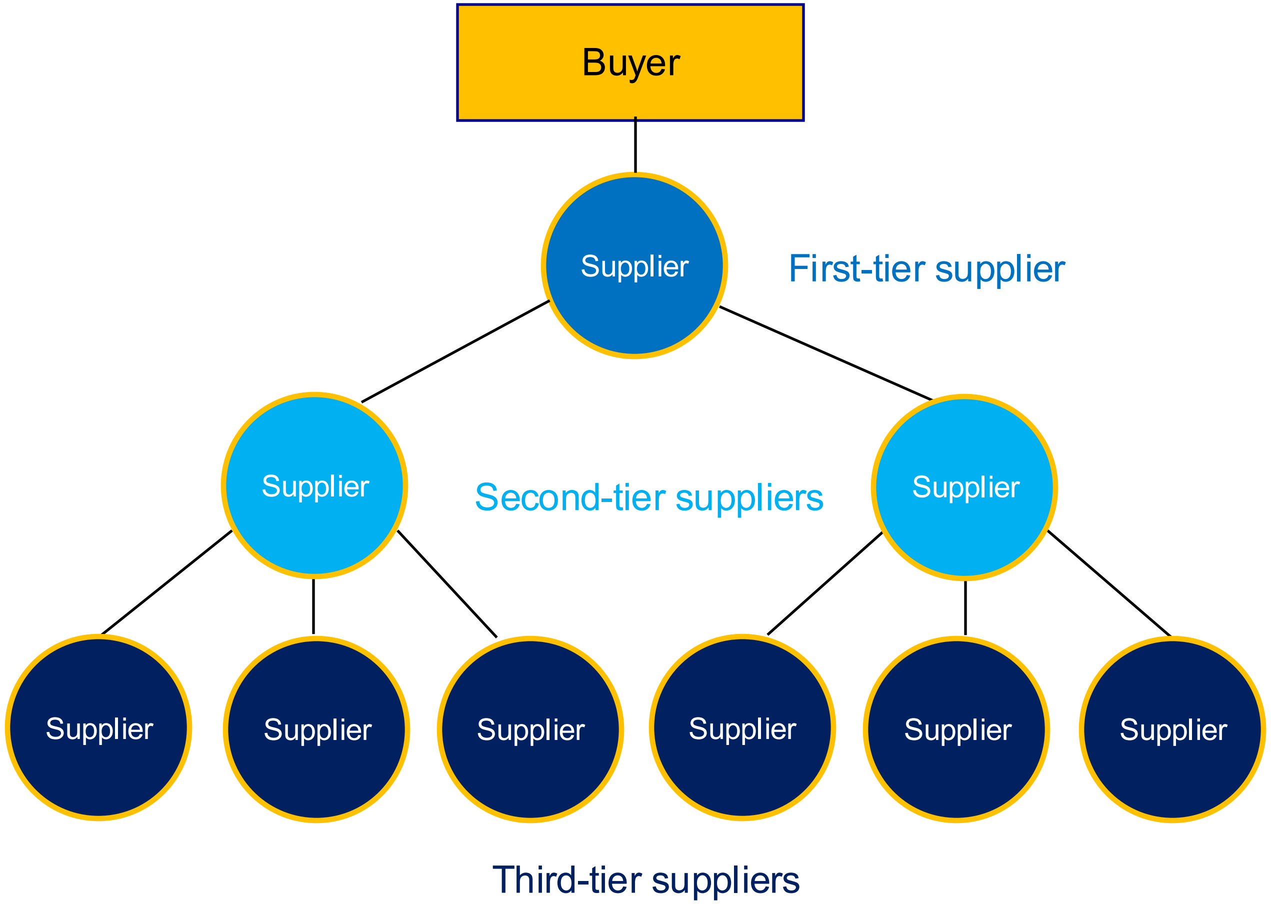



Pull systems require **fairly steady flow of repetitive work**. It underperforms in case of bullwhips (demand and supply variations), large mix of products and designs.

# 1. Vendor Relationships




A. Traditional




B. Tiered

# 2. 5S


1
2
3
4
5
5S
SORT
SET IN ORDER
SHINE
STANDARDIZE
SUSTAIN


Eraser

# 3. Level Loading

| Weekly Production Requirements by Product | |
|---|---|
| A: | 10 units/week |
| B: | 20 units/week |
| C: | 5 units/week |
| D: | 5 units/week |
| E: | 10 units/week |

**Traditional system**

| Monday | Tuesday | Wednesday | Thursday | Friday |
|---|---|---|---|---|
| A A A A A | B B B B B | B B B B B | D D D D D | E E E E E |
| A A A A A | B B B B B | B B B B B | C C C C C | E E E E E |

**Lean system**

| Monday | Tuesday | Wednesday | Thursday | Friday |
|---|---|---|---|---|
| A A B B B B | A A B B B B | A A B B B B | A A B B B B | A A B B B B |
| C D E E | C D E E | C D E E | C D E E | C D E E |

# Level Loading – Problem and Solution

5 min

Determine a production plan for these three models using the sequence A-B-C:

| Model | Daily Quantity |
|---|---|
| A | 7 |
| B | 16 |
| C | 5 |

The smallest daily quantity is 5, but dividing the other two quantities by 5 does not yield integers. The manager might still decide to use five cycles. Producing one unit of models A and C and three units of model B in each of the five cycles would leave the manager short two units of model A and one unit of model B. The manager might decide to intersperse those units like this to achieve nearly level production:

| Cycle | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Pattern | A B(3) C | A(2) B(3) C | A B(4) C | A(2) B(3) C | A B(3) C |
| Extra unit(s) | | A | B | A | |

If the requirement for model A had been 8 units a day instead of 7, the manager might decide to use the following pattern:

| Cycle | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Pattern | A(2) B(3) C | A B(3) C | A(2) B(4) C | A B(3) C | A(2) B(3) C |
| Extra unit(s) | A | | A B | | A |

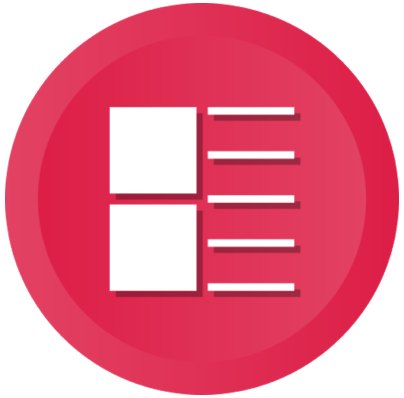
# 4. Visual System

- Communication of demand (a shout or a wave or a signal)
- In a pull system the **Kanban card** is used.

# Work in Process (WIP) – Controlling tools

- WIP = Cycle Time * Arrival Time

**Kanban**
Helps to control WIP of Individual workstation
More responsive in stable environment



**CONWIP (**Constant Work in Process**)**
Used to control WIP of whole system
More responsive with variations

# Takt Time

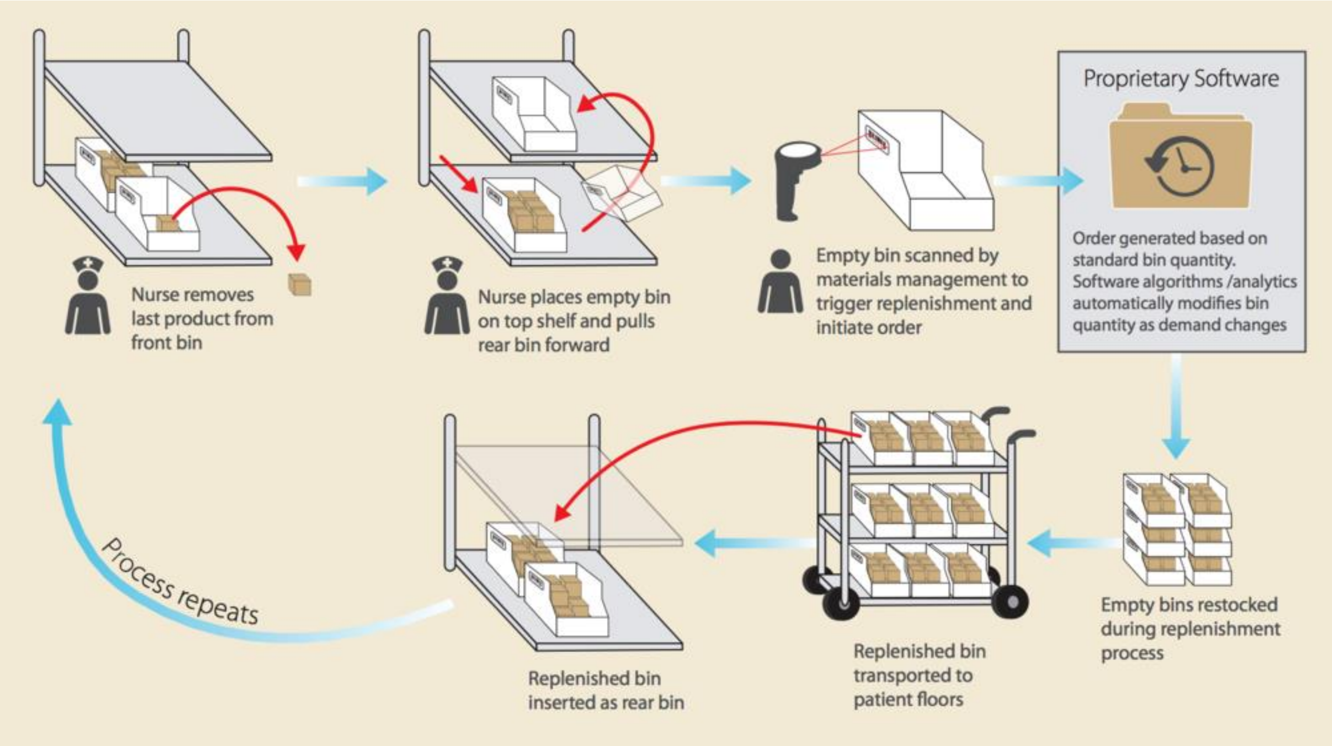
- Using takt time results in minimizing WIP.

- **Definition:** Cycle time required in a production system to match the pace of production to the demand rate.

  - **Step 1:** Determine the “net” time available per shift
  - **Step 2:** Determine the “net” time available per day
  - **Step 3:** Determine the takt time (net time per day/Daily demand)

- **Question:** what if the demand is unstable?

# Kanban – Two Bin Inventory System



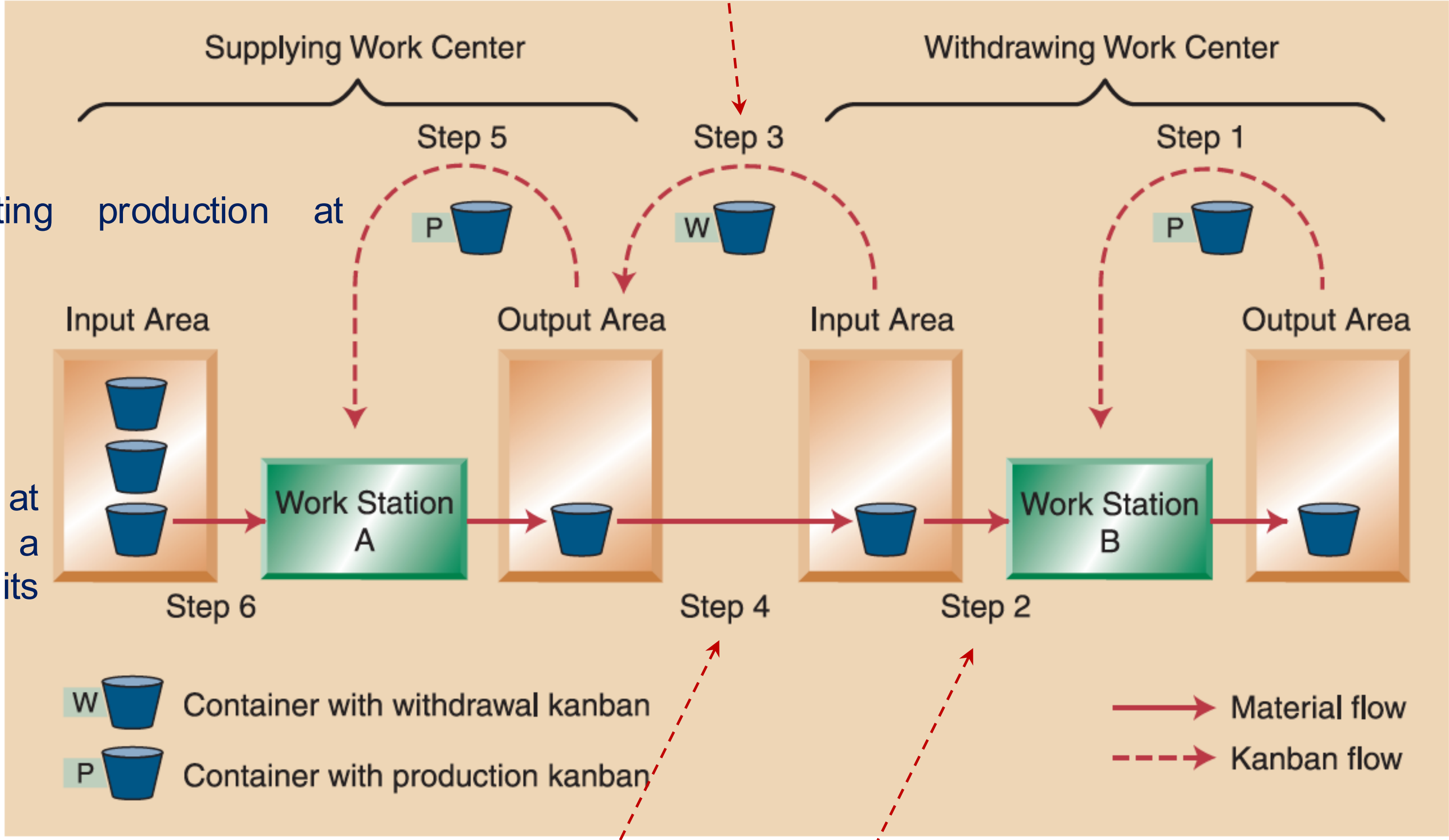

Card or other device that communicates demand (demand information) for work or materials from the preceding station.

# Kanban – Steps

- Step 3: To replenish the material just taken, the worker at workstation B generates a request for more input from workstation A by sending a withdrawal Kanban to the output area of process A.

Step 5: generating production at workstation A.

Step 6: The worker at workstation A removes a container of materials from its input area.




Step 1: the worker must produce enough of the requested material to fill the empty container.

Step 4: The worker at workstation A attaches the withdrawal Kanban to the full container and sends it immediately to workstation B.

Step 2: the worker at workstation B takes a full container of material from its input area.

# Kanban – Defining the Number (Considering Inefficiency)

$$n = \left(\frac{DT\,(1+X)}{C}\right)$$

*n*: the total number of Kanbans or containers (one card per container)

*D*: the demand rate at a using workstation.

*T*: Leadtime - the time it takes to receive an order from previous workstation.

$X$: Inefficiency in the system – set by management

*C*: the size of the container.

# Kanban – Problem and Solution

Usage at a work center is 300 parts per day, and a standard container holds 25 parts. It takes an average of .12 day for a container to complete a circuit from the time a Kanban card is received until the container is returned empty. Compute the number of Kanban cards (containers) needed if *X* = 0.20.

*n* = ?
*D:* 300 parts per day
*T:* 0.12 day
*C:* 25 parts per container
*X:* = .20

$$n = \left(\frac{DT\ (1+X)}{C}\right)$$

$$n = \frac{300*(0.12)*(1 + .20)}{25} = 1.728\text{; round to 2 containers}$$

*Note:* Usually, rounding up is used. Rounding up will cause the system to be looser, and rounding down will cause it to be tighter.

# Kanban – Defining the number (Considering Safety Stock)

$$n = \left(\frac{DT+Ss}{C}\right)$$

*n*: the total number of Kanbans or containers (one card per container)

*D*: the demand rate at a using workstation.

*T*:  Leadtime - the time it takes to receive an order from previous workstation.

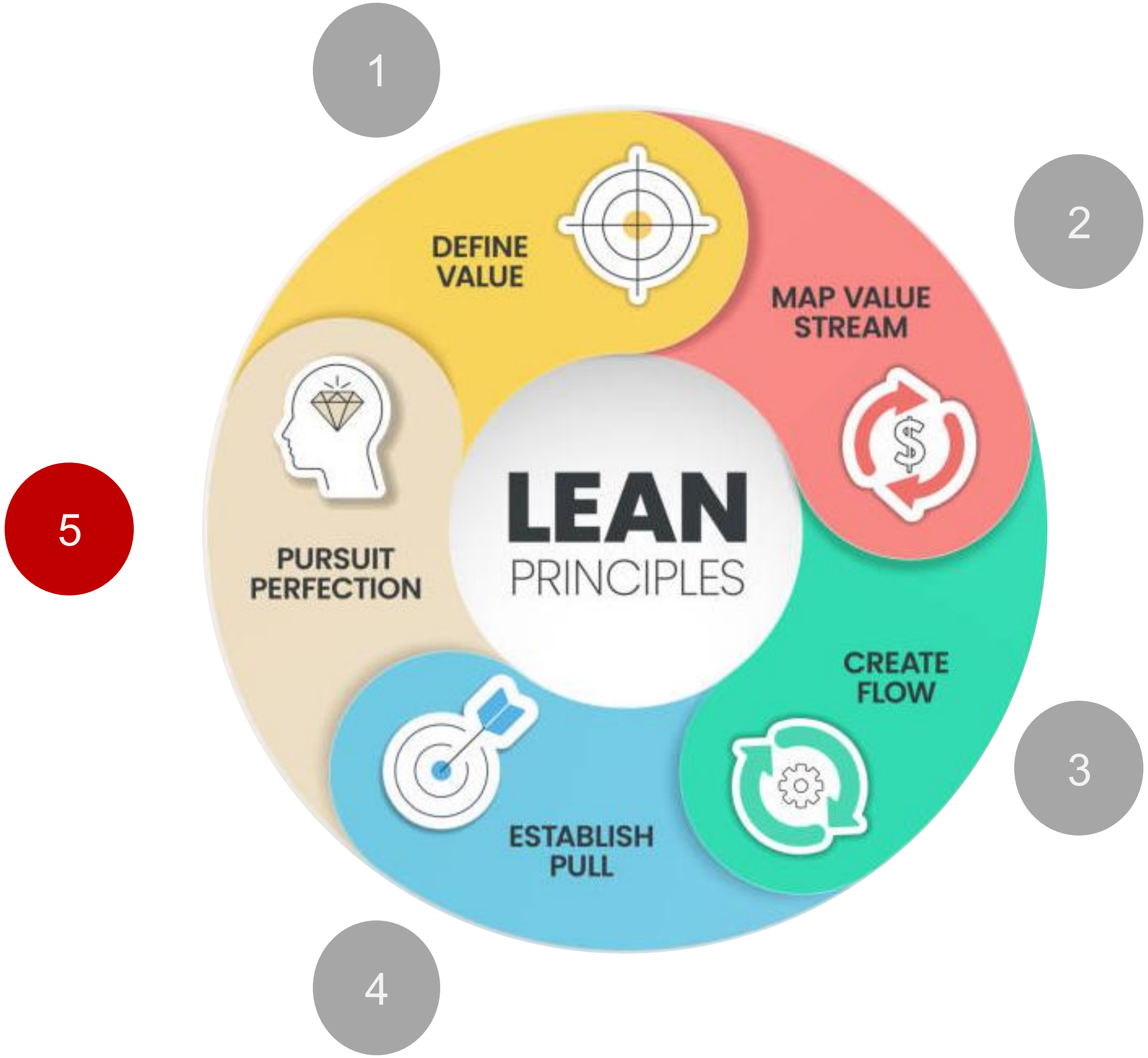
$Ss$: Safety stock – stock to protect against variability or uncertainty.

*C*: the size of the container.

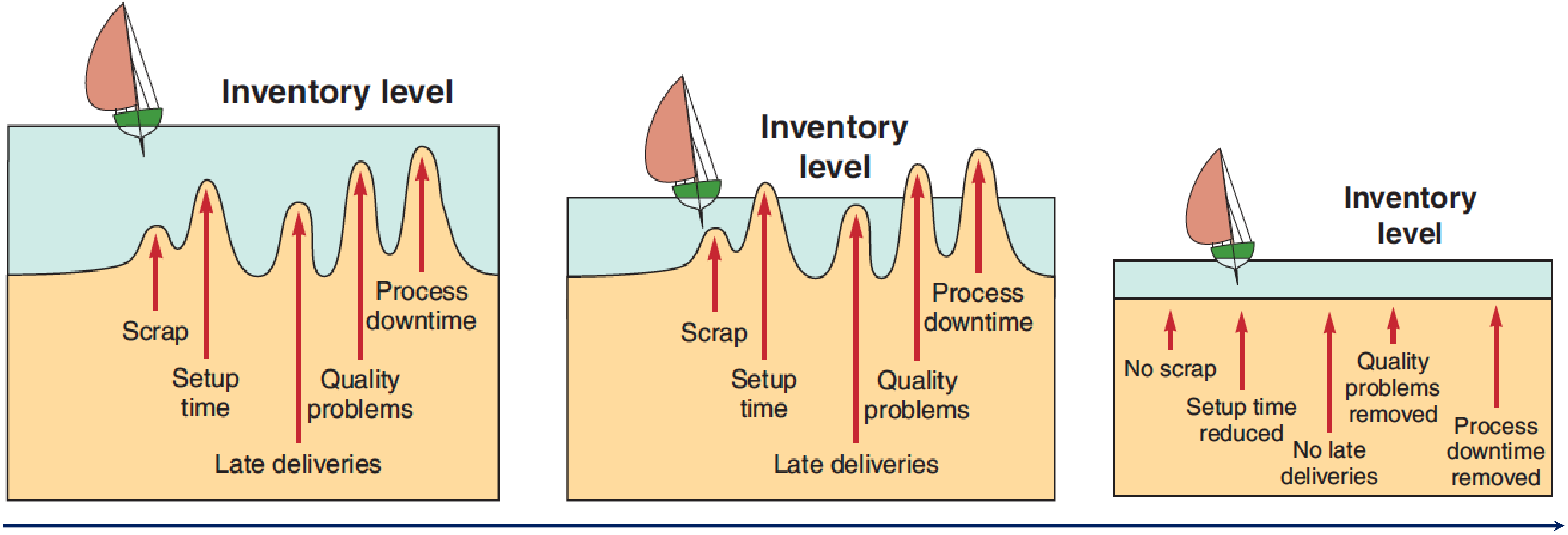
# Q4. How do you establish a pull system in your case study?

**5 min**

- What tools or techniques can support this, and how would you implement them?
- Imagine implementing Kanban cards in your case study. How many would you need, and how would you implement them? If Kanban is not suitable, explain why.

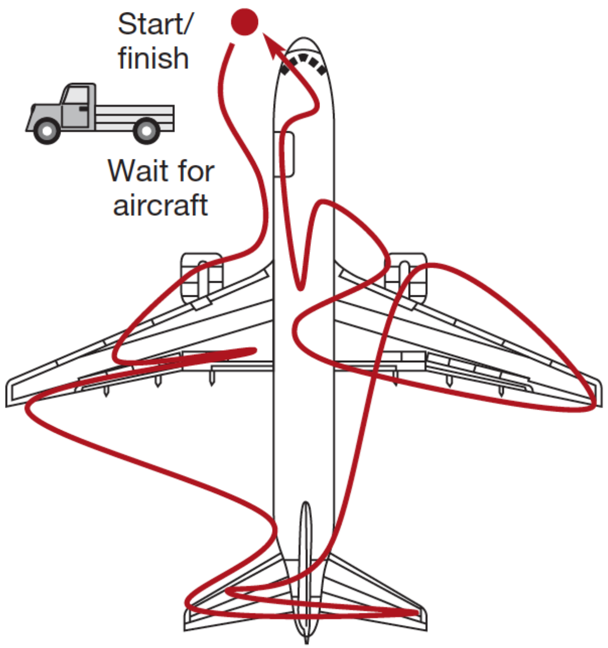

1
2
3
4
5
DEFINE VALUE
MAP VALUE STREAM
CREATE FLOW
ESTABLISH PULL
PURSUIT PERFECTION
LEAN
PRINCIPLES

# Inventory reduction – Water and Rock Analogy

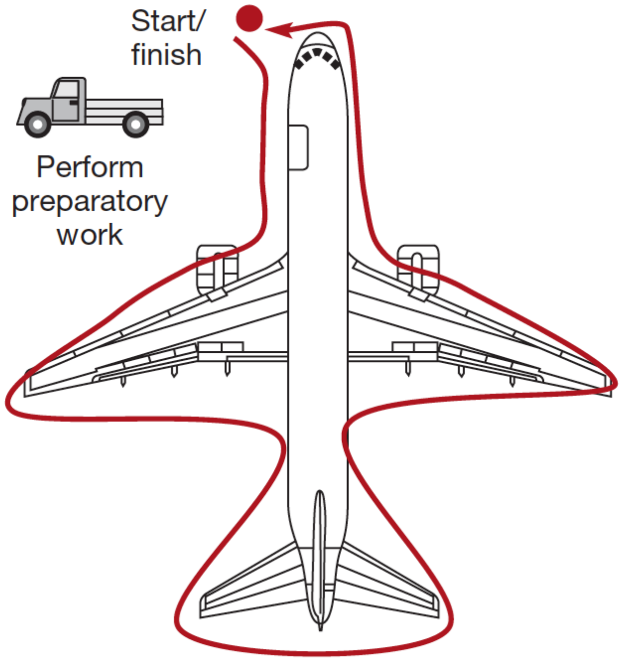



Reminder: Production Management (ME419); Module 4 – Inventory Management

# Maintenance




**Before:**
- Maintenance staff follow the steps as detailed in the technical documentation.
- The overall sequence of tasks is not optimized.
- Preparation work and set-ups included as part of the task.




**After:**
- The overall sequence of tasks is defined and allocated to minimize non-value-added.
- Preparation work and set-ups may be done ahead of time to minimize aircraft contact time.
- Increased productivity and reduced aircraft waiting time.

# Q5. How can continuous improvement be embedded in your case study to support the pursuit of perfection?

5 min

- Identify specific practices or metrics (Key performance Indicators, KPIs) you would use to sustain long-term improvements.
- How often they should be be measured and who should measure and monitor it?

# Implementing a Lean System

- Ensure the senior management team is involved.
- Study the end-to-end operations.
- List existing problems.
- Buy-in and cooperation of workers (training programs)
- Reassure the employees' job is safe.
- Start the implementation by reducing set up times and reduce inventory only at the end.
- Improve gradually and check if the step was successful (Plan, Do, Check, Act).
- Expand the lean system to suppliers and work closely with them (narrow their list, start with the most willing suppliers).
- Embrace obstacles/resistance along the way.