Lean Production Part II

Course: Production Management and Logistic Systems [10592713]

Economia e management (Latina Campus)

AA 2024-2025 | Prof. Alessandro Pietrogiacomi

SAPIENZA
UNIVERSITÀ DI ROMA

Latina 26 March, 2025

Lesson Plan for Tuesday, March 26

Overview of the lesson, and educational objectives,

Topic: **Reducing Production Timelines and Improving Quality.**

Part I Lean Production

Time: **14:00–17:00**

Duration**: 3 hours**

Learning Objectives

By the end of this lesson, students will be able to:

- Understand the principles of Lean production and how they reduce waste and improve efficiency.

Lesson Outline

1. Objectives of Pull Systems (15 minutes)
2. Background & Introduction of Pull
3. Benefits & Impact (45 minutes)
4. Application (45 minutes)
5. Recap, Q&A and Homework Assignment (15 minutes)

Introduction

- Welcome students and recap the previous session (Introduction to Lean Production).

Pull systems Lesson objectives

This session will:

- **Define pull systems and types of pull systems**
- **Contrast pull systems with push systems**
- **Discuss the goals of pull system application**
- **Illustrate the benefits and impact of pull systems on key performance indicators**
- **Describe how to implement and maintain pull systems**

Pull system – definition and history

Definition

A pull system is a production control system that synchronizes a manufacturing process with customer requirements. The system replenishes product as it is consumed by a subsequent processing step or, eventually, the customer . A pull system seeks to produce only the exact products needed in the exact quantity needed in the shortest lead time possible

History

Pull systems were developed by Toyota after recognizing the benefits of replenishment systems used by supermarkets in America. Toyota observed that retailers simply replaced what was just taken off shelves and purchased by customers, a concept especially important when customers wanted the freshest product possible. Toyota found that this approach could be adapted to many manufacturing and logistics operations.

Pull systems have been applied in a wide variety of industries from grocery supermarkets to the high-volume automotive industries. Today, there are successes applied across mixed-volume production arenas like aerospace, biomedical, electronics, and process industries.

Basic concept and principle

Production process and material flow

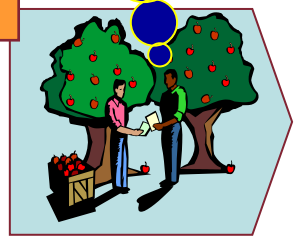
Information flow

"My customer just took [pulled] 10 apples from my distribution center. I better order and replenish those apples"

"10 apples have been purchased [pulled] by my customer from my store. I need to get 10 more from my supplier so that my next customer also can purchase apples"

"I need 10 apples today. I'll go shopping and 'pull' 10 apples from the supermarket"

3

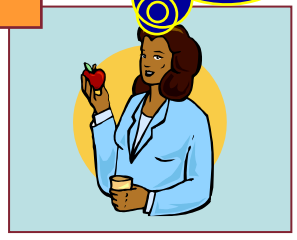


Apple processing plant

2

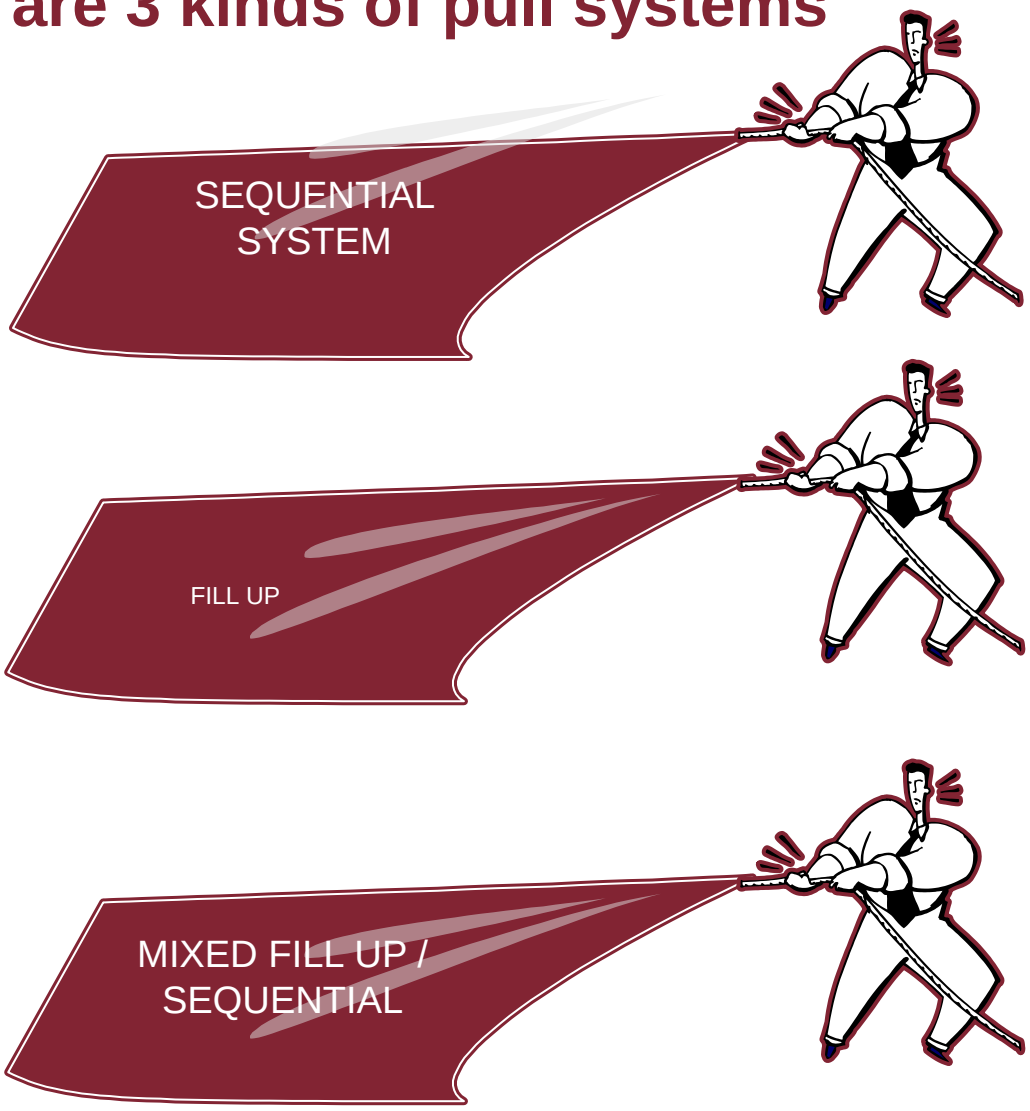
Apple Store

1



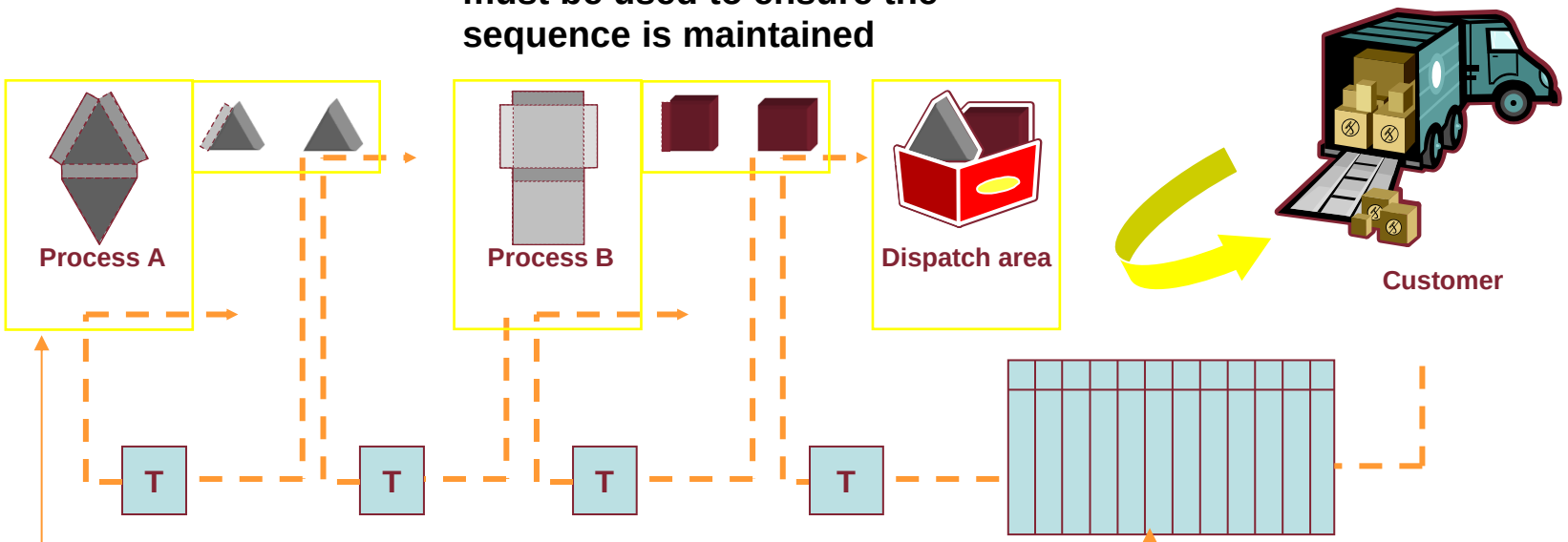
Customer

There are 3 kinds of pull systems



Sequential systems

FIFO (first in, first out) principles must be used to ensure the sequence is maintained



Tablet kanban (T) is used to authorize production or withdrawal – but not specify the product

The rate of production is controlled through the leveling board

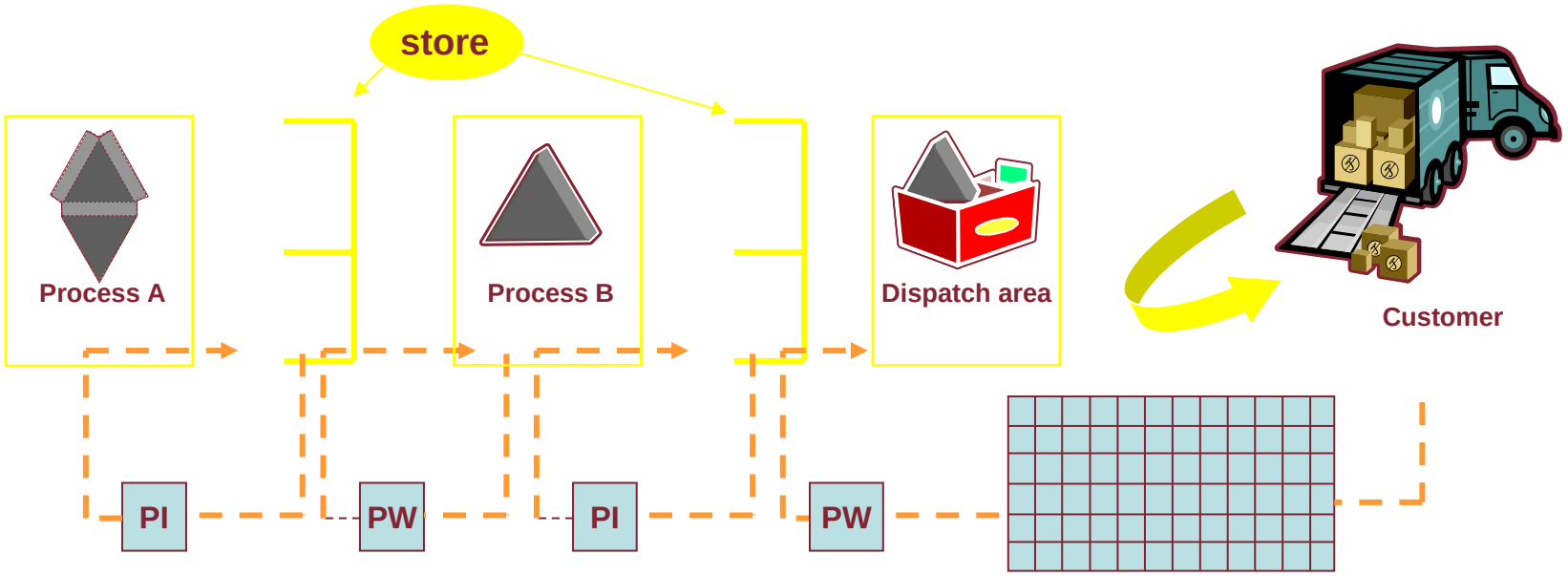
Production instruction is sent to the start of the process via a sequence list

Parts are only built to order

Fill-up systems

Stock should be located next to point of manufacture

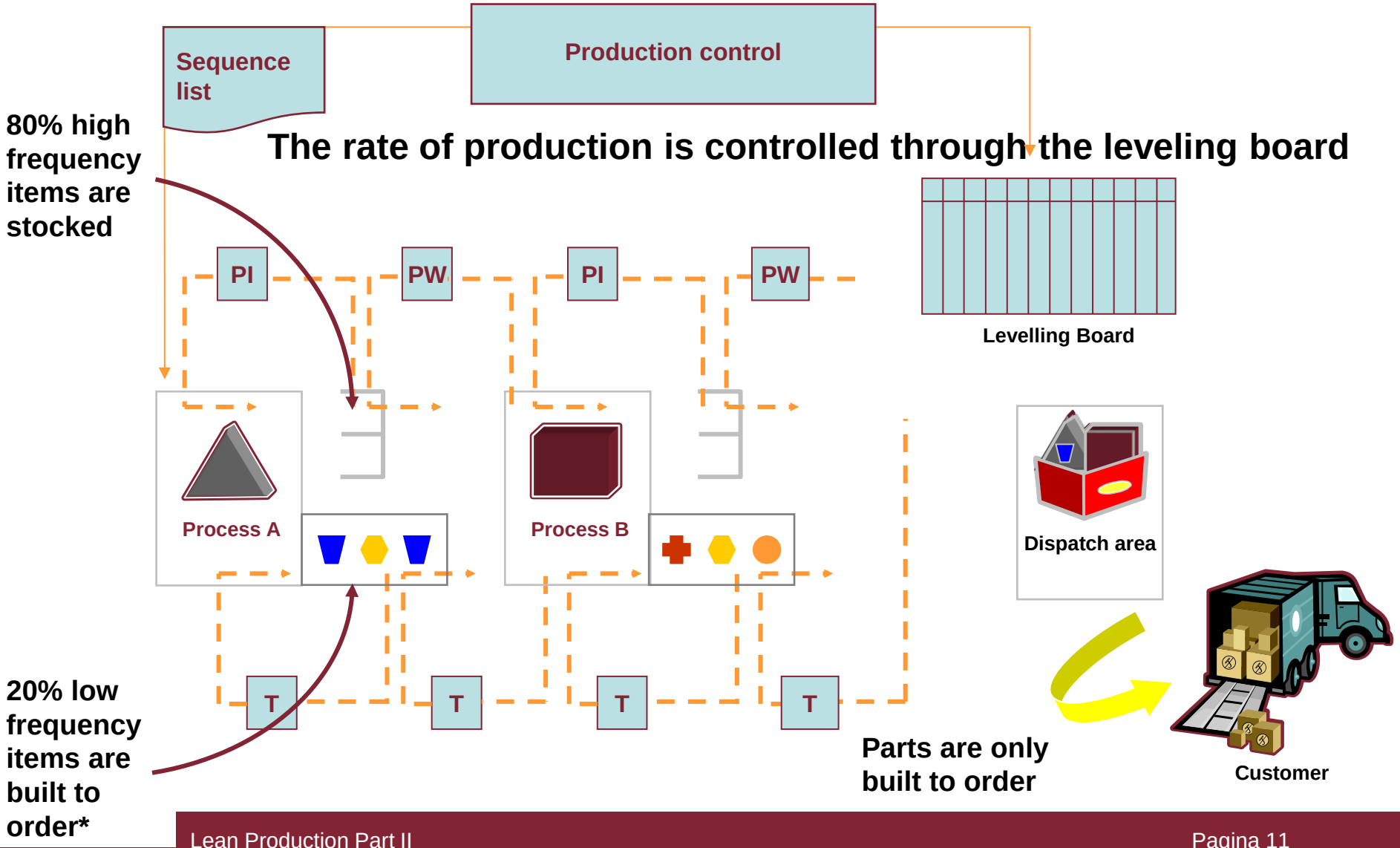
All parts/ products are available in this system



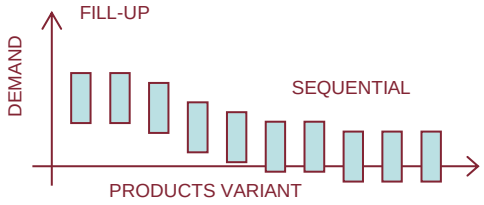
Production instruction (PI) and parts withdrawal (PW) used to authorize replenishment and control sequence of build

The rate of production is controlled through the leveling board

Mixed fill-up/sequential pull scheduling

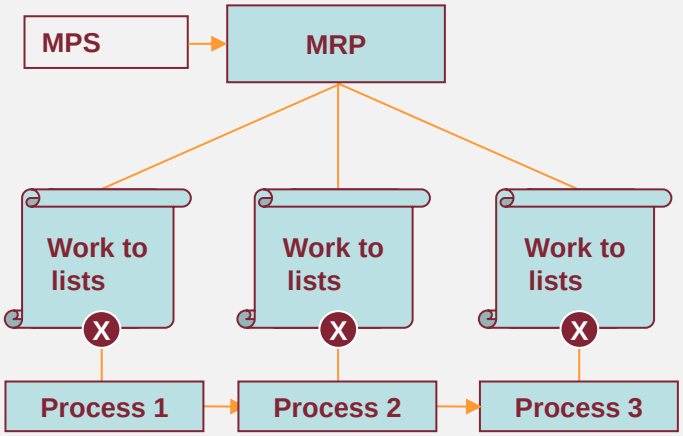


Considerations for pull system selection*

	Fill up	Sequential	Mixed Fill-up/Sequential
Market	• Low-medium market change • High response time	• Medium-high market change • Customer lead time greater than production lead time	
Product	• Low WIP cost • Low customization • High usage frequency	• Medium-high WIP cost • Medium-high customization • High process lead times • Low usage frequency	• Both high- and low-demand products • Pull system strategy dependent on business needs to respond
Process	• Medium process fluctuation • Medium tolerance for short periods	• Low process fluctuation • Low tolerance before WIP build up	• Fluctuation in 1 type of system may bleed waste into other system
Potential penalties	• Obsolescence risk • High inventory • Stores can be excuse for increasing stock	• Slower customer response time • System has sensitivity to production fluctuation • Difficult to catch up once a unit is missed	• Mixed pull system may create initial complexity • Difficult to balance workload

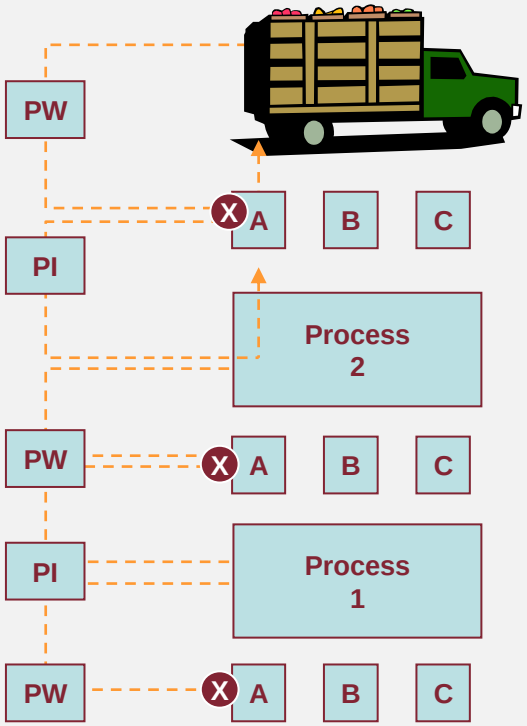
Push vs. Pull – system comparison “at-a-glance”

Push System



- Based on week or month demand forecast
- Product “forced” downstream
- Functional process improvement may work against system

Pull System



- Based on daily demand
- Cannot build unless downstream triggers
- Connected process linked with system improvements

X **Build triggers**

Comparing the push to pull system exposes significant differences in production control methods

Environments favoring push and pull*

Environmental factor	PUSH/MRP	Pull Fill up	Sequential
Inventory holding cost	High	Low	Low
Replenishment leadtime	Long	Short	Medium
Set-up times**	N/A	N/A	N/A
Product variants	Many	Few	Many
Production system	Complex	Simple	Moderate
Volume	Low	Low to high	Low to high
Demand pattern	Variable***	Steady	Variable
Example environment	Custom excavators made to customer specification	Standardized automotive components made at even rates	Custom computers produced to specifications at leveled rates

- Demand behavior is differentiating factor
- Demand behavior is not controllable
- Key point is to create effective system to best match demand

A kanban system – what is it?

A kanban system is

- Literally, a signboard to signal production* that often uses cards
- Information transfer for production and conveyance
- A visual management system
- A transparent, shop floor controlled process
- A subcomponent of a pull system

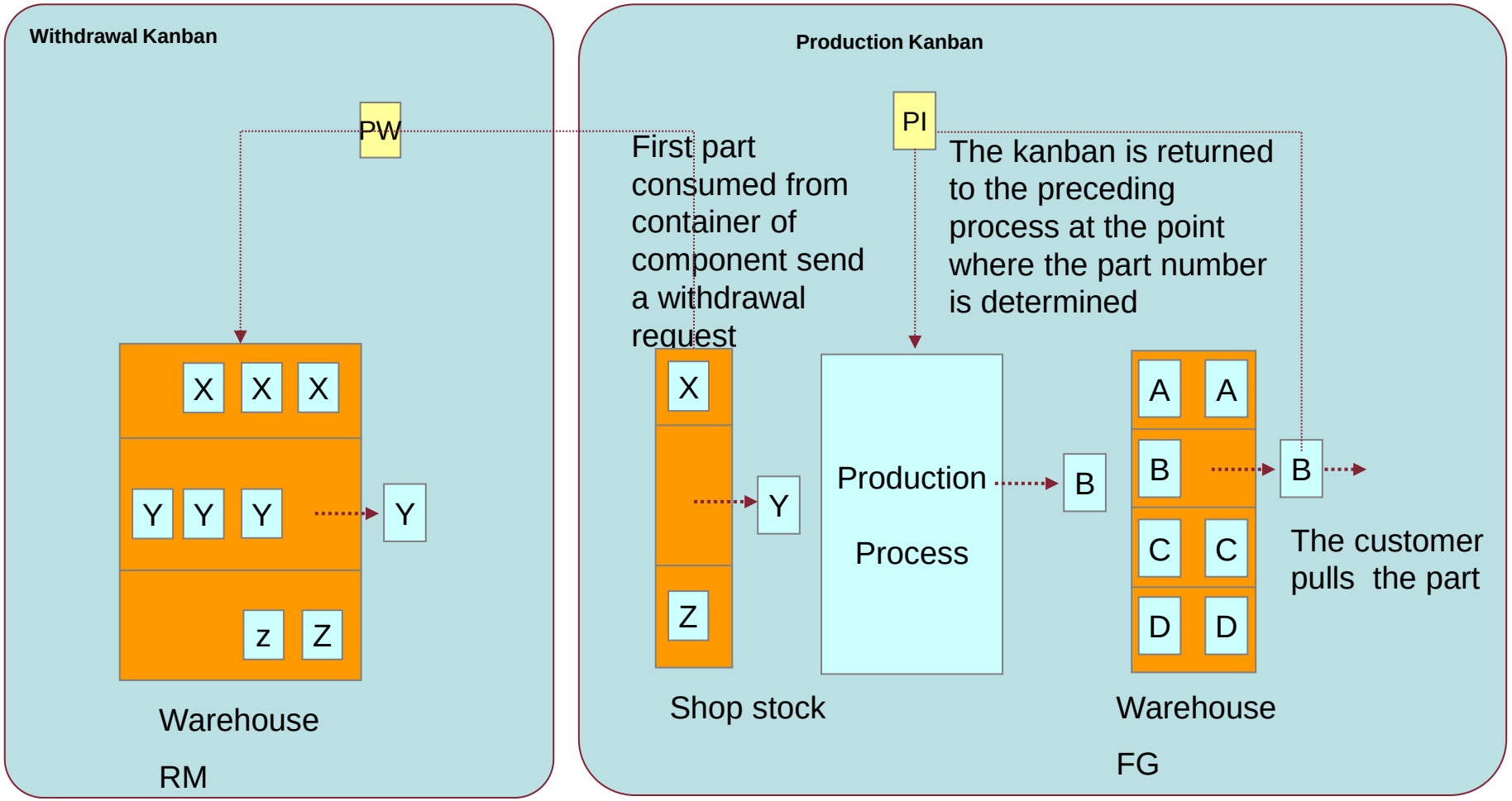
A kanban system is not

- Material idly staged as inventory
- Elaborate computer systems to control production
- A system of cards

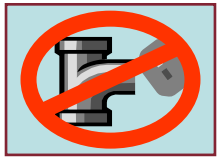
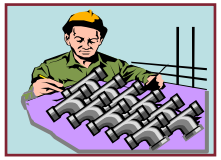
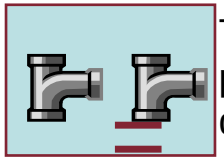
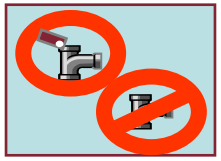
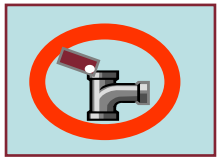
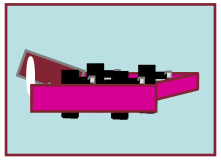
Kanban systems were originally developed in Japan as card-based signaling systems; they have been redefined in many ways

Kanban should be used as a tool to achieve pull and ultimately JIT

Basic kanban flow*



6 rules of kanban

	Kanban Rule	Why important/impact
	Do not pass defective parts to the next process	Moving defective parts leads to high inventory and unnecessarily fills pipeline with unwanted material, causing more handling
	Subsequent process withdraws from preceding process	Forces preceding process to take ownership and manage its own production responsibility to meet customer demand
	The quantity of parts produced must equal the quality of parts withdrawn	Parts-quantity fluctuation leads to variability in material handling and inventory quantity, requiring extra floor space and labor
	Parts should not be produced or conveyed without a kanban	This undermines the trust in the system. A pull system on its own will surface problems automatically
	Kanban should be attached to actual parts	Materials identification is crucial to know production status, direction, location, etc., to eliminate conveyance confusion or material shortages
	The number of parts in a container should match the kanban	Forces consistency in each process to allow for 100% first-pass yield and resolve the problems that prevent 100% yield

Different types of kanban

	Type	Purpose
Production instruction kanban	**In-process kanban**	• Used within a line process to signal changeover; associated with high mix in a fill-up system
	Signal kanban	• Used with long set-up times and small lot production in a fill-up system
	"Tablet" kanban	• Does not tell what to build, only that the next sequenced order start. Used with low volumes and make-to-order
Parts withdrawal kanban	**Interprocess kanban**	• Indicates what material to pull from preceding processes. Commonly used to initiate production
	Supplier kanban	• Same as above but used strictly for suppliers

Kanban differentiation helps prioritize improvement opportunity in:

- Processing
- Conveyance
- Stagnation
- Inspection

Benefits of pull

Using pull is simply the downstream customer signaling upstream

The frequency and quantity of material pulled with respect to takt time creates the dynamic environment to foster just-in-time (JIT) production:

- **Reduced inventory**
- **Increased productivity**
- **Simplified information technology**

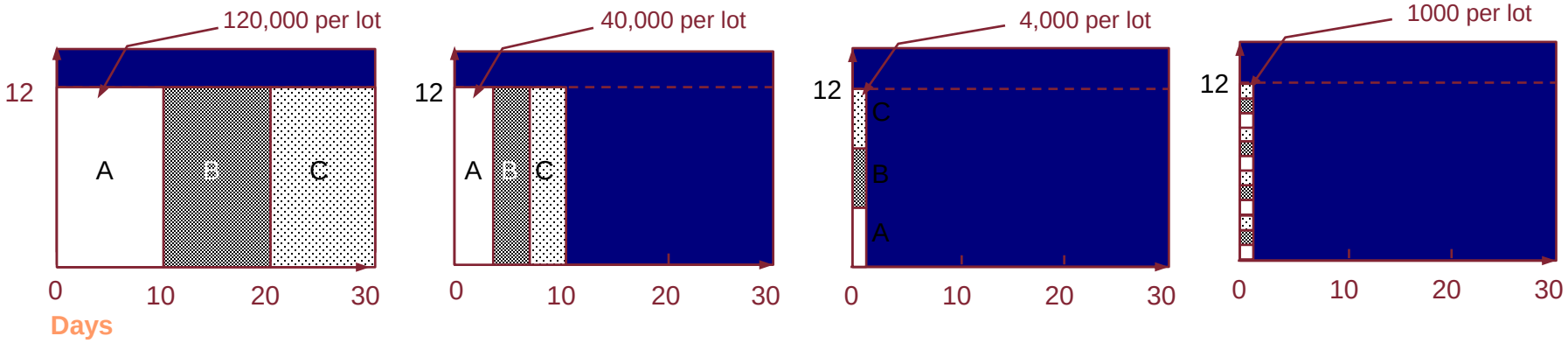
Reducing inventory through pull and small lot production

Traditional large lot with low build frequency

Meet demand of 360,000 units per month

Small lot size with leveled production build

Volume
Thousands



Downstream customer forced to take very large quantity infrequently

Downstream customer forced to take quantity but at greater frequency

Downstream customer able to pull closer to what is needed

Downstream customer able to pull what is needed, when needed, in the quantity needed

Increased productivity benefit

Consistent use or movement of material

- Decreased fluctuation in materials usage allows for conveyance to work in **standard cycles**
- Smaller quantities of material allows for **higher mixed load** to increase conveyance efficiency

Less material handling required to cover inefficient cycles

Increased communication

- Customer-supplier interaction allows for **frequent communication** in case of problems
- **Quality problems are caught** and addressed sooner to decrease scrap and potential rework

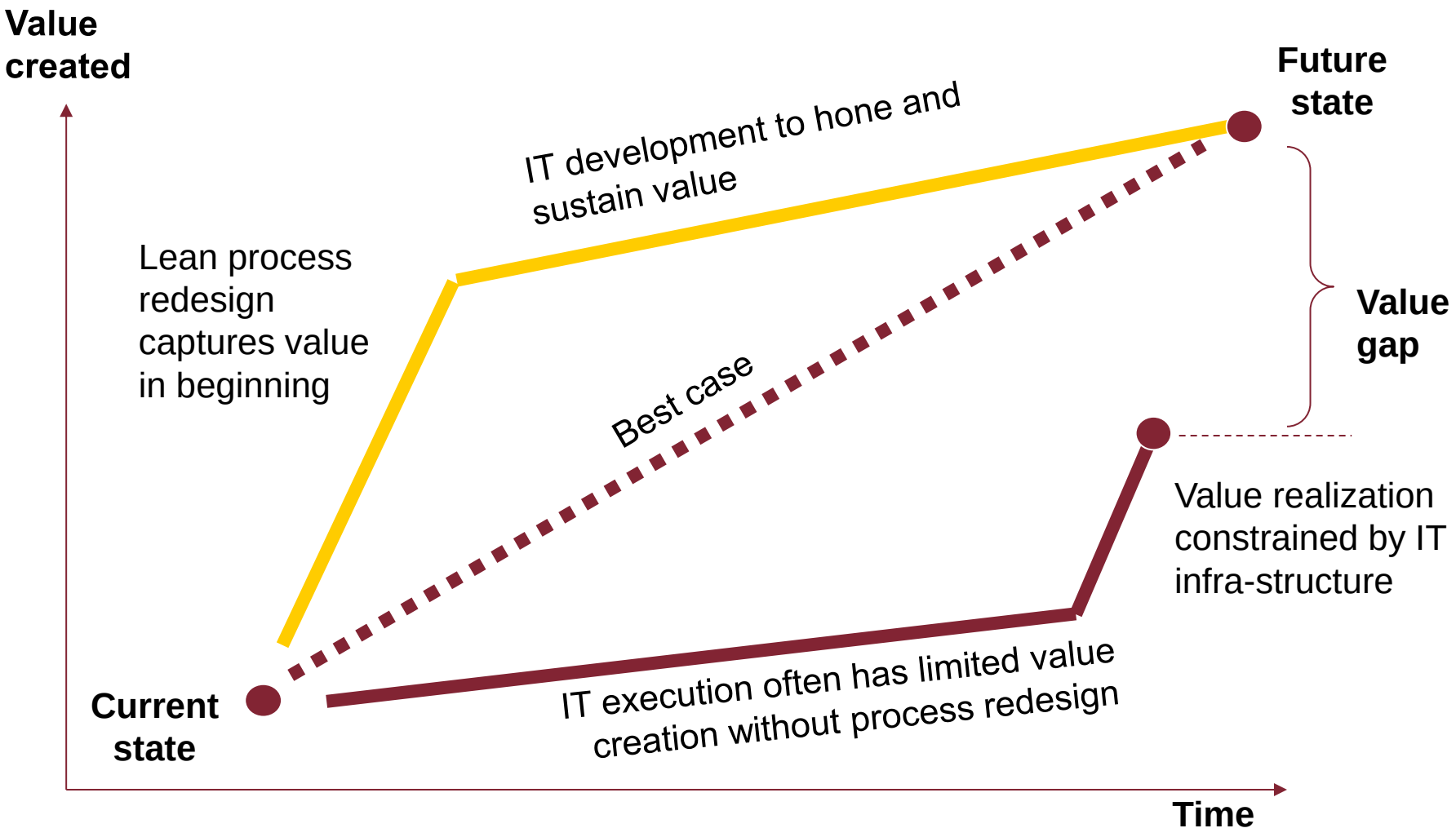
Less time required for rework and scrap processing

Less downtime due to material shortages

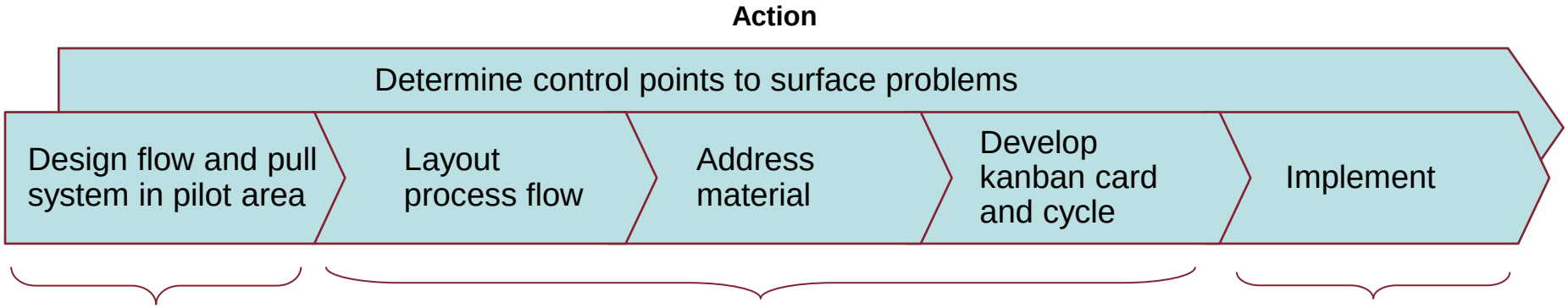
- Materials just used or pulled are replenished in determined time period
- **Fewer emergency runs** since material will be delivered in next cycle

Less material hand-ling required for expediting and less operating time required to make up loss production

Simplified information technology



Applying a pull system – road map to implementation



- **Define optimum process flow**
- **Determine pull system type**
- **Determine pack-aging, transportation, signal methods**
- **Design flow, staging and positioning**
- **Determine range of flexibility**

- **Simulate system off-line to test and for training**

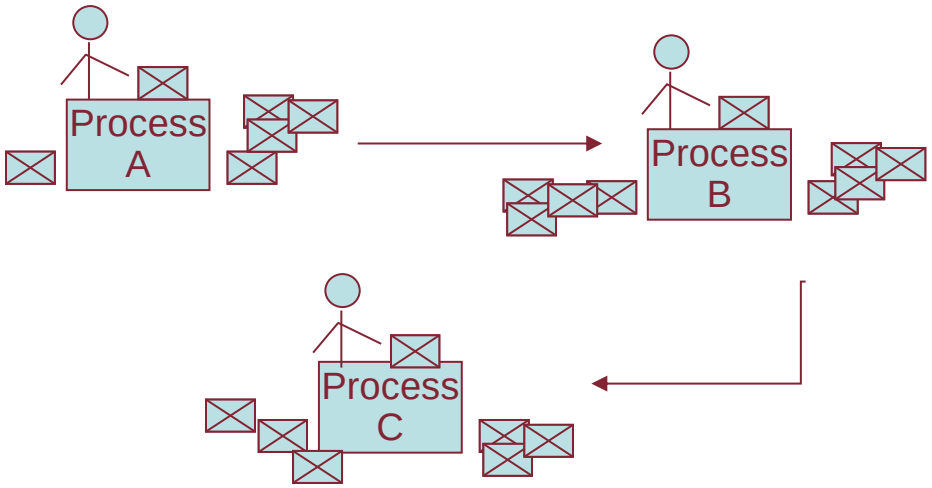
- **Locate ‘stores’**
- **Define line-side storage and containers**
- **Quantify both buffer and safety stock**
- **Test for FIFO**
- **Add visual management**

- **Implement information loops for withdrawal and production kanban cycles**
- **Determine number of kanban required**
- **Create pull signal methods**
- **Locate kanban mailboxes**

- **Start with lean system**
- **Perform early audits of kanban cycle, FIFO, and material quantity**
- **Standardize material movements**

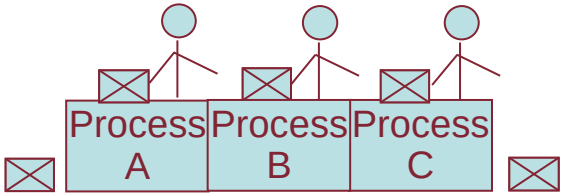
Transformation to continuous flow

Traditional batch production



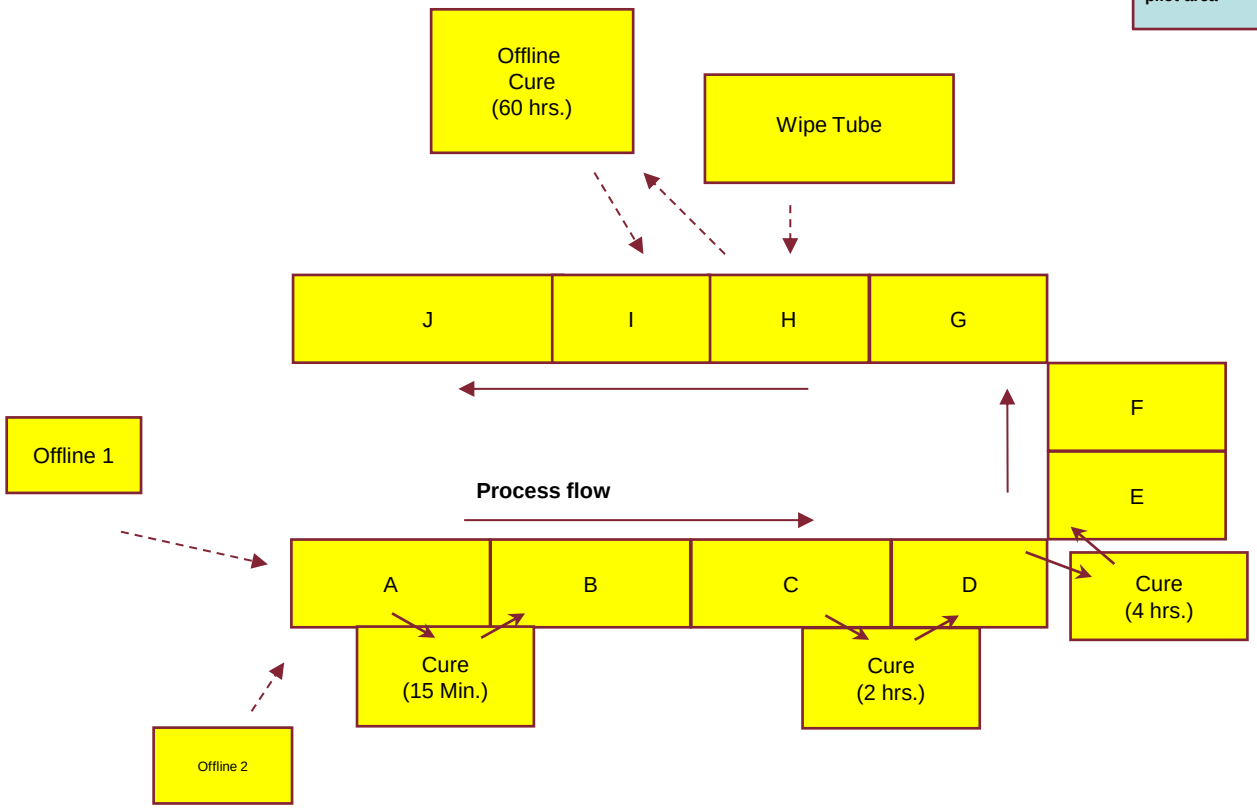
- Operators work independently
- High productivity gained by increased output at each station
- High WIP and stagnation

1 piece at a time production



- Operators work as connected team simply passing piece to next station
- Not enough space to allow for excessive WIP
- Material moves through rapidly

Process flow development and layout for continuous flow



Simulate system offline for training and reality check

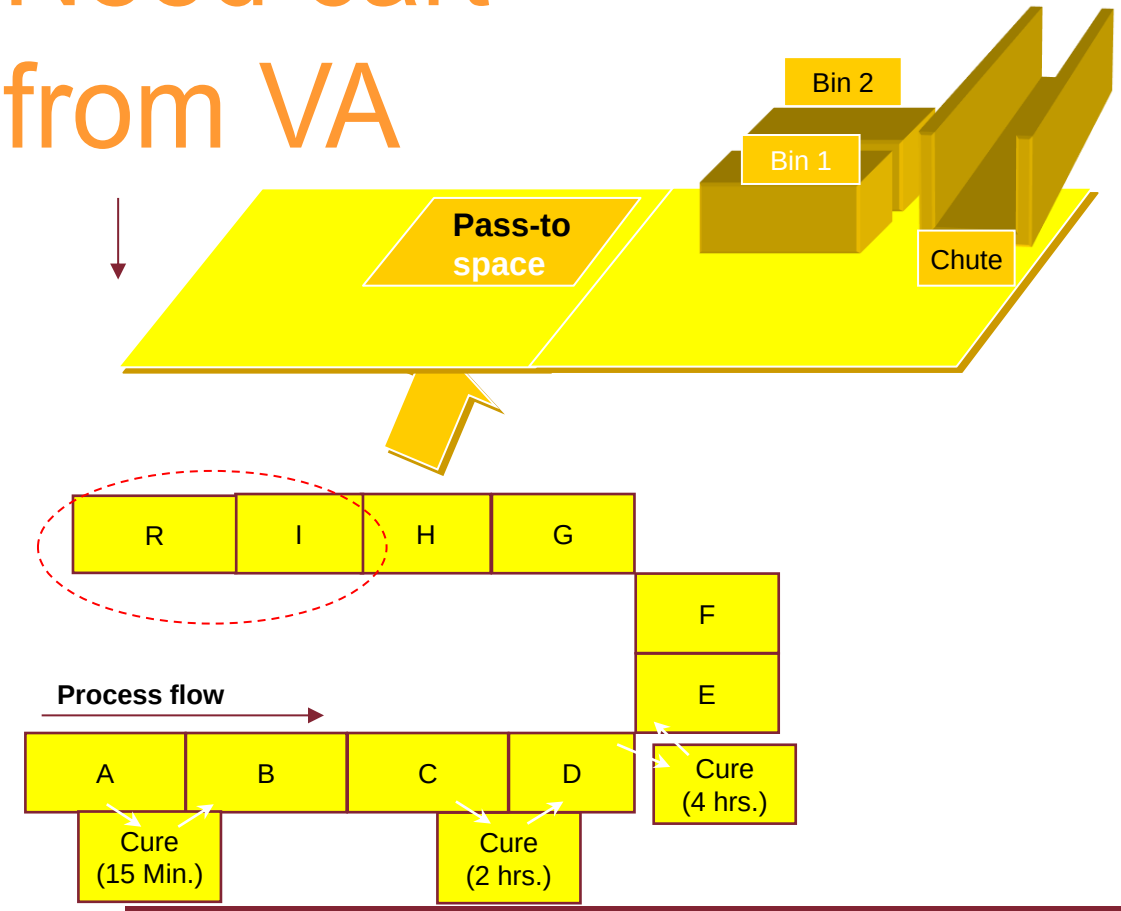
- Use cardboard, extra tables, can even build product
- Build mock components if possible
- Lay out all in-process stock, materials, etc.

- Check for impact on subassembly processes
  - Actually walk from process to process
  - What is the reliability of subassembly process
- Start with lean pilot; less material and resources are needed
  - Forces ingenuity to think about material presentation issues

Material positioning and addressing throughout the line

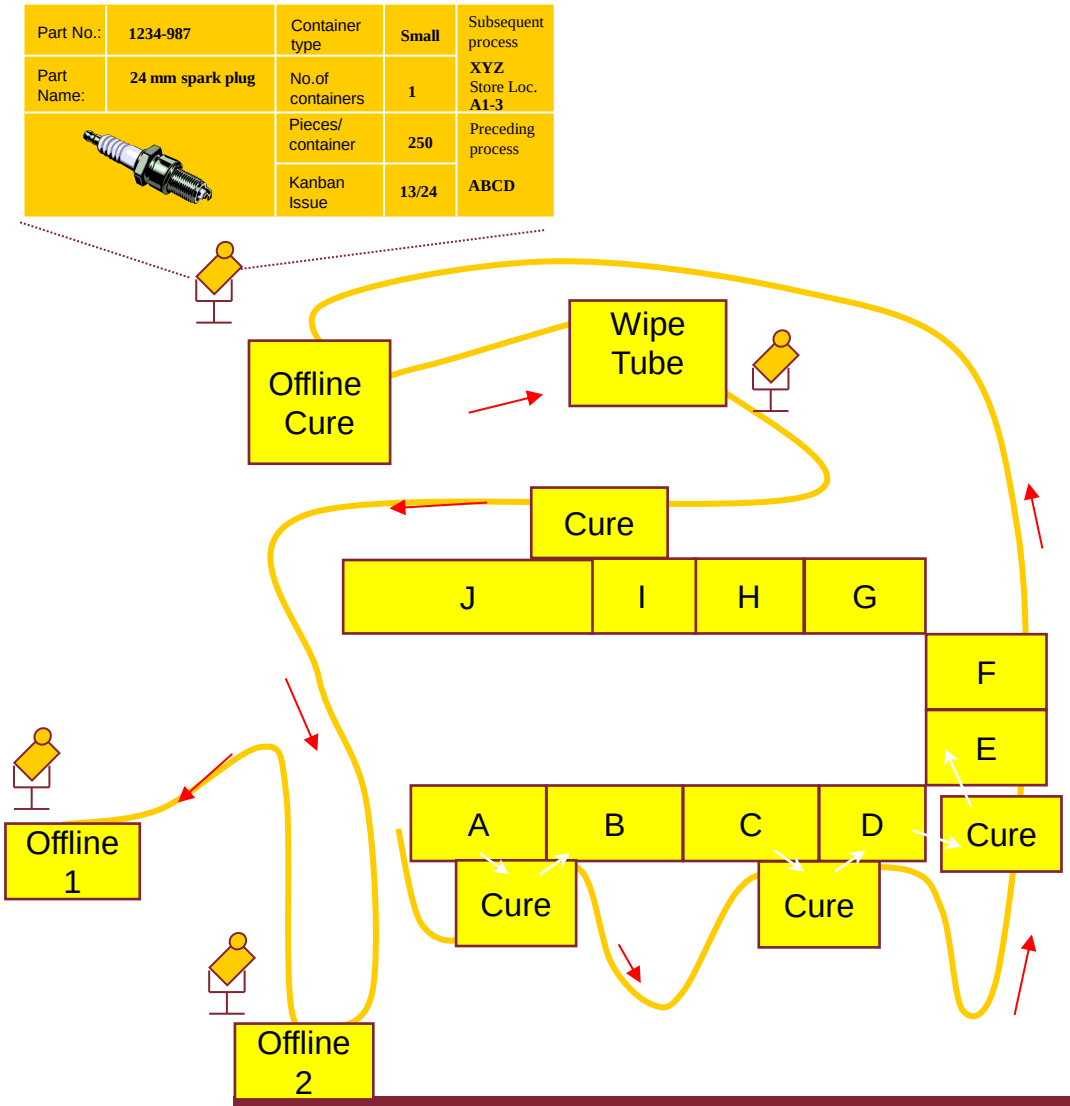
Biomedical industry

Need cart from VA



- **Once the process flow is established, the methods for presenting pulled material must be established**
- **A number of methods may be used, including:**
  - **2 Bin systems**
  - **Swapped push carts**
  - **Chutes**
  - **Hand-passing**

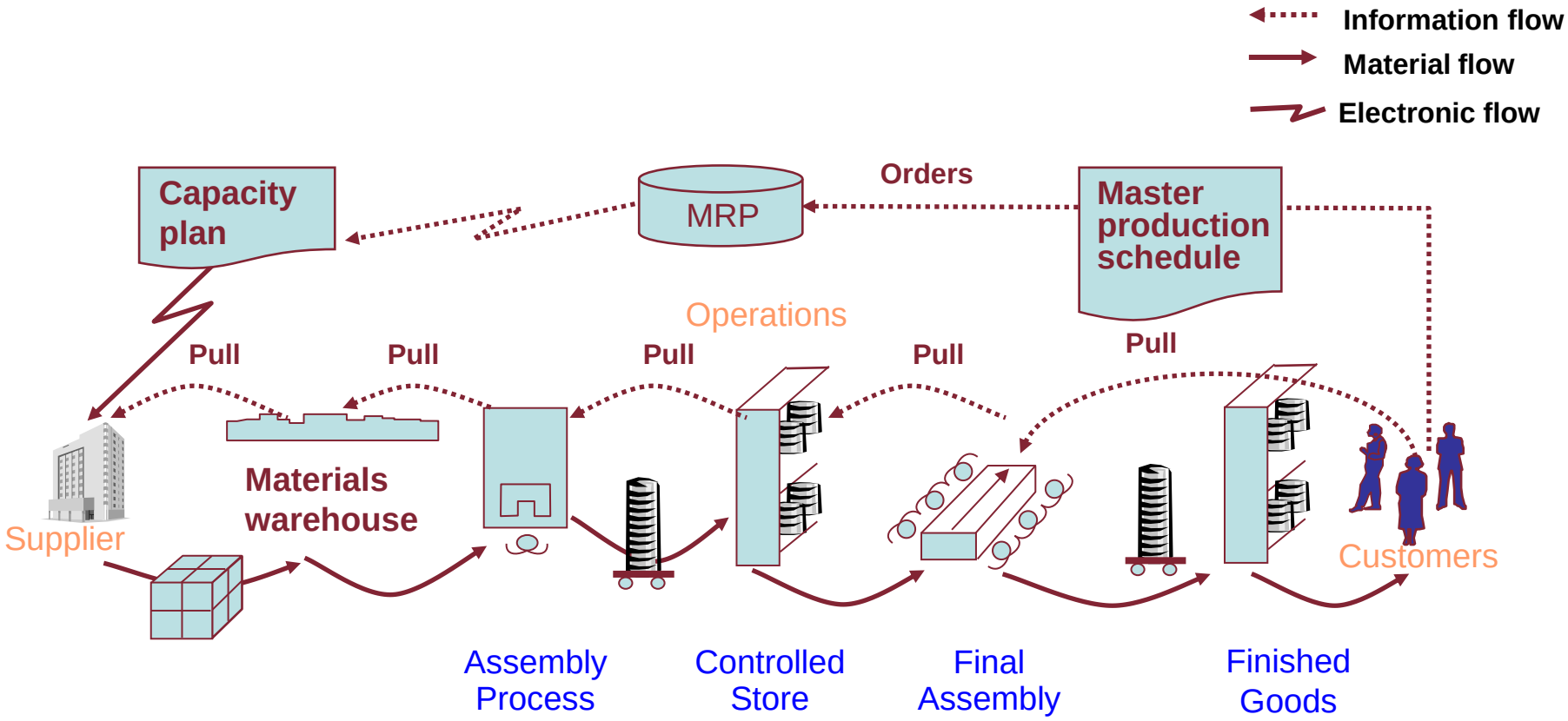
Developing kanban card and material handling pull cycles



Design flow and pull system in pilot area | Layout process flow | Address material | **Develop kanban card and cycle** | Implement

- Once material presentation methods are established, the kanban methods and material replenishment routes must be created
- The kanban and replenishment routes should ensure that all material will be delivered to the area that pulls for it in a proper amount of time

Using pull to connect customers, operations, and supplier

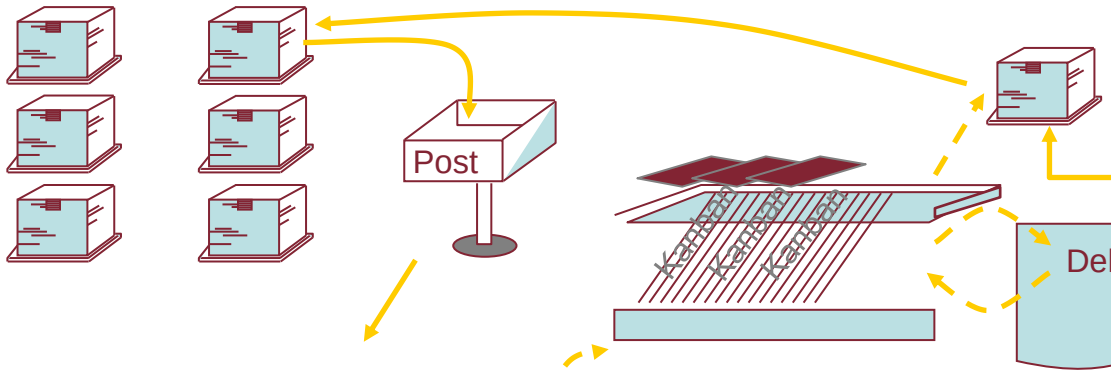


- Sub-assembly operation pulls from purchased goods warehouse; this signals suppliers to replenish
- Final assembly pulls from controlled store; this signals sub-assembly to replenish materials
- Customer pulls/orders product from finished goods store; this signals final assembly to replenish what customer has pulled

Example of supplier kanban utilizing fax signal

1. When product is used, kanban is detached and put on post

7. Kanban are attached to corresponding items and delivered to storage site

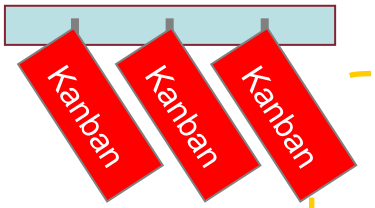


5. The supplier fills and ships the order

2. Kanban are collected at specified times and hung on a reorder board

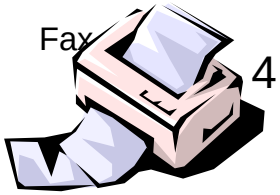
Kanban already used for ordering are placed here

6. Upon order receipt, the delivery list and kanban are exchanged



3. When kanban reach the specified reorder point, a new order sheet is filled out

Order sheet



4. The order sheet is faxed to supplier

Benefits of extending pull system to customers, suppliers

Integrating suppliers

- Stable purchasing and pricing agreements due to overall reduced variability in orders placed on suppliers
- Lower inventory and resource carrying costs due to frequent signals and easily monitored orders
- Contractual flexibility established to create longer-term, trusting relationships with customers

Customer response

- Ability to service market demands without the risk of obsolescence
- Opportunity to offer product at more competitive prices to consumer
- Ability to integrate customer pull and purchasing methods

Recap of Key Points - Q&A

- A pull system synchronizes production with actual customer demand, replenishing only what is consumed.
- Originated from Toyota's adaptation of supermarket replenishment techniques.
- Aims to minimize waste, reduce lead times, and produce exact quantities needed.
- Types of Pull Systems: Sequential System: Parts are built-to-order using FIFO (First-In-First-Out) principles.; Fill-Up System: Parts are stocked near the point of manufacture and replenished as used.; Mixed System: Combines both sequential and fill-up methods (e.g., 80% high-frequency items stocked, 20% built-to-order).
- Push vs. Pull Systems: Push: Based on forecasts; products are "pushed" downstream, risking overproduction and waste.;Pull: Driven by real-time demand; production starts only when triggered by downstream signals.
- Kanban Systems: A visual tool to signal production and material movement in a pull system Production only with a kanban. Quantities must match kanban instructions.
- Benefits of Pull Systems: Reduced Inventory: Smaller lot sizes and just-in-time production., Improved Productivity: Less downtime, better communication, and fewer emergencies. Simplified IT: Visual management reduces reliance on complex systems. Quality: Defects caught earlier, reducing rework and scrap.
- Extended Benefits :Suppliers: Stable orders, lower inventory costs, and stronger relationships. Customers: Faster response to demand, competitive pricing, and reduced obsolescence risk.