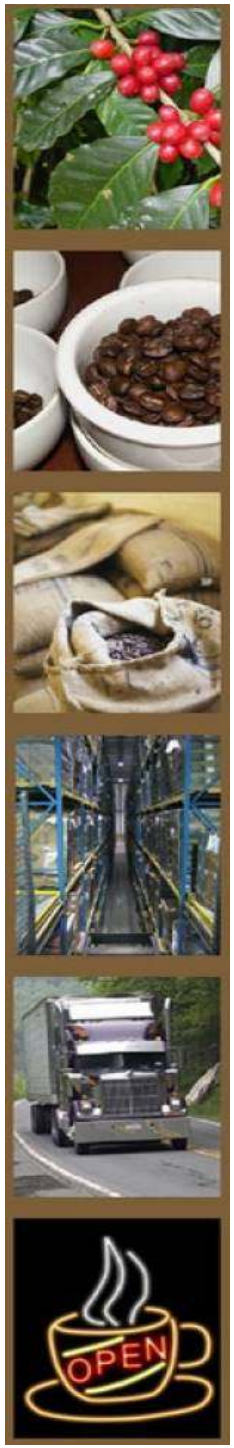
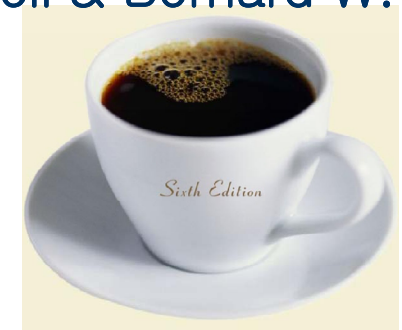


Chapter 16

Lean Systems

Operations Management - 6th Edition

Roberta Russell & Bernard W. Taylor, III



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University of Tennessee at Chattanooga

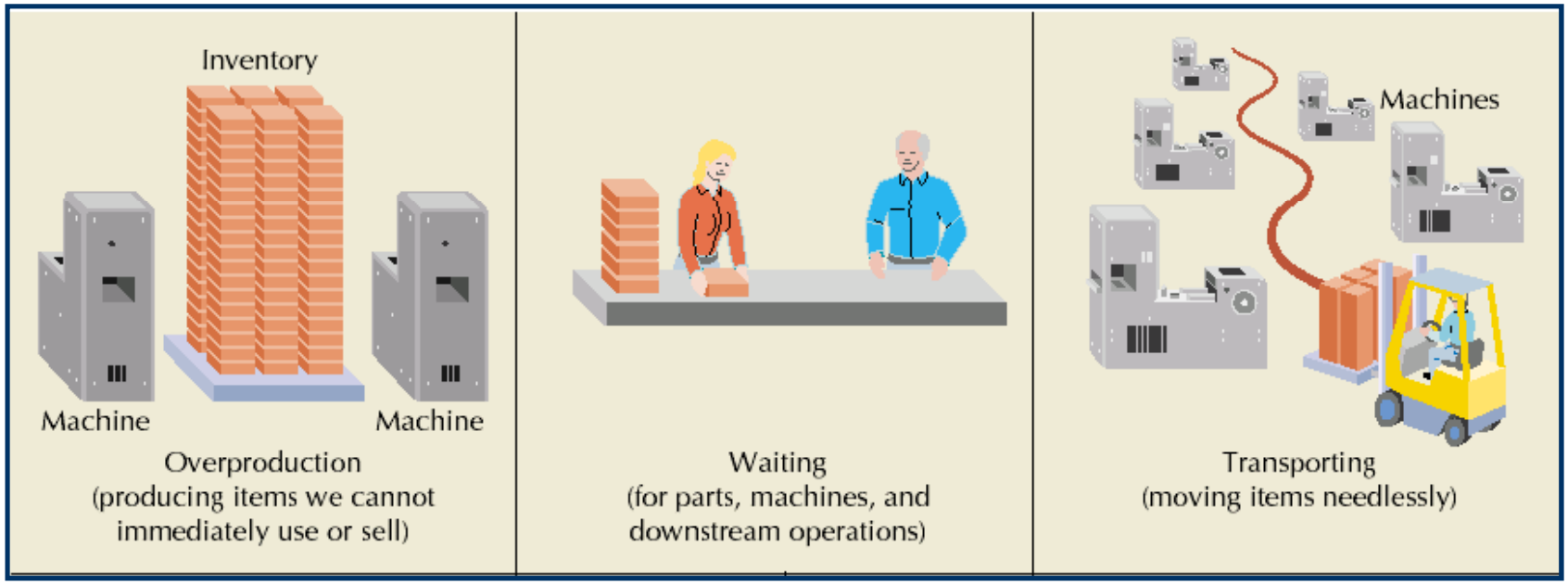
Lecture Outline

- Basic Elements of Lean Production
- Benefits of Lean Production
- Implementing Lean Production
- Lean Services
- Leaning the Supply Chain
- Lean Six Sigma
- Lean and the Environment
- Lean Consumption

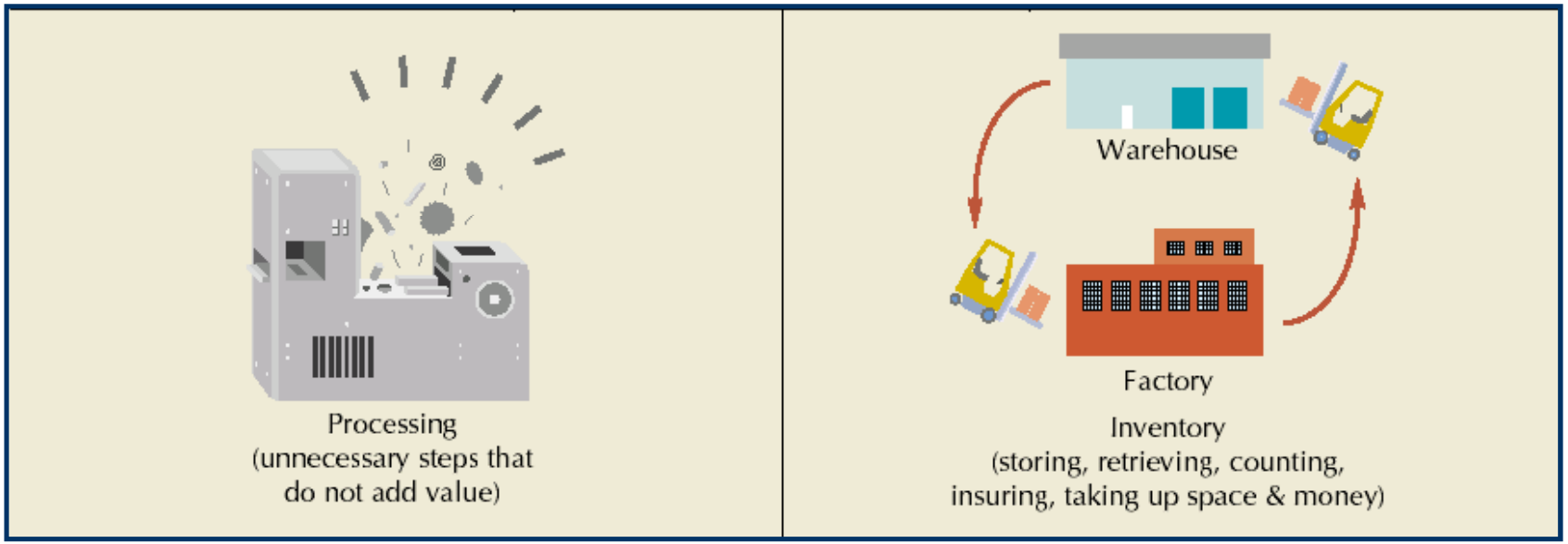
Lean Production

- Doing more with less inventory, fewer workers, less space
- Just-in-time (JIT)
  - smoothing the *flow* of material to arrive just as it is needed
  - "JIT" and "Lean Production" are used interchangeably
- Muda
  - waste, anything other than that which adds value to product or service

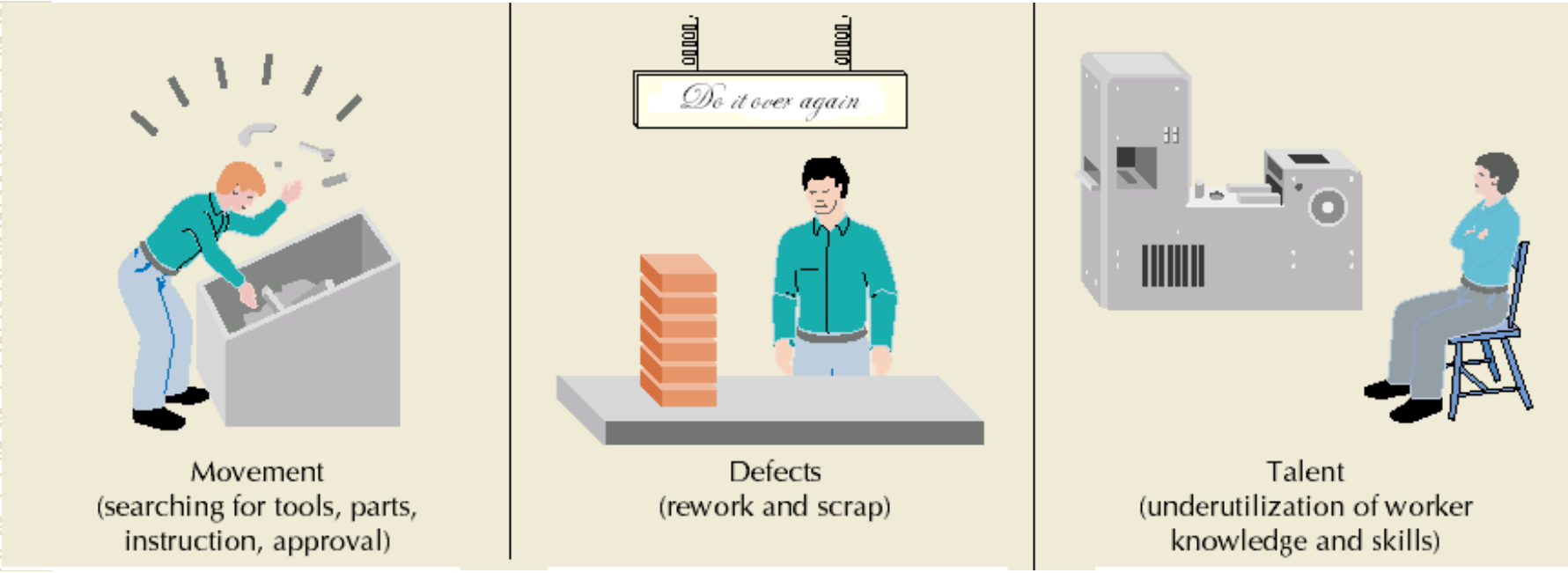
Waste in Operations



Waste in Operations (cont.)

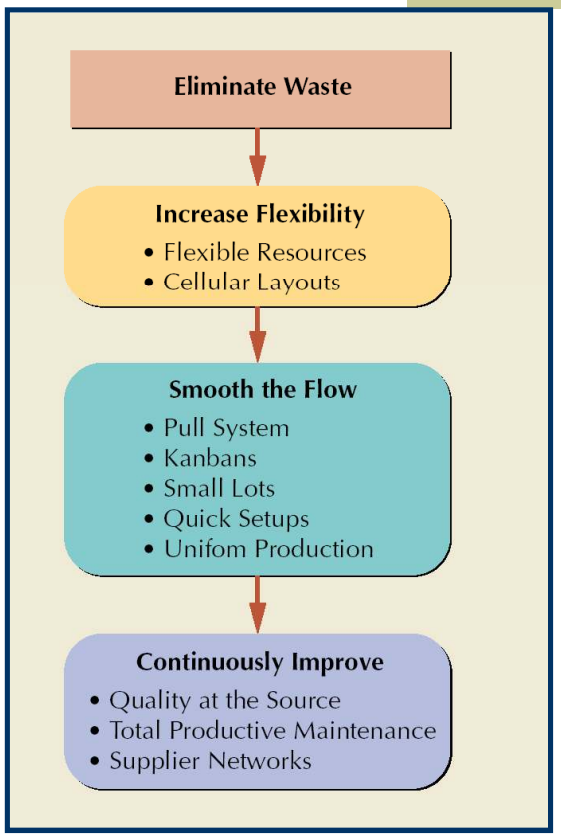


Waste in Operations (cont.)



Basic Elements

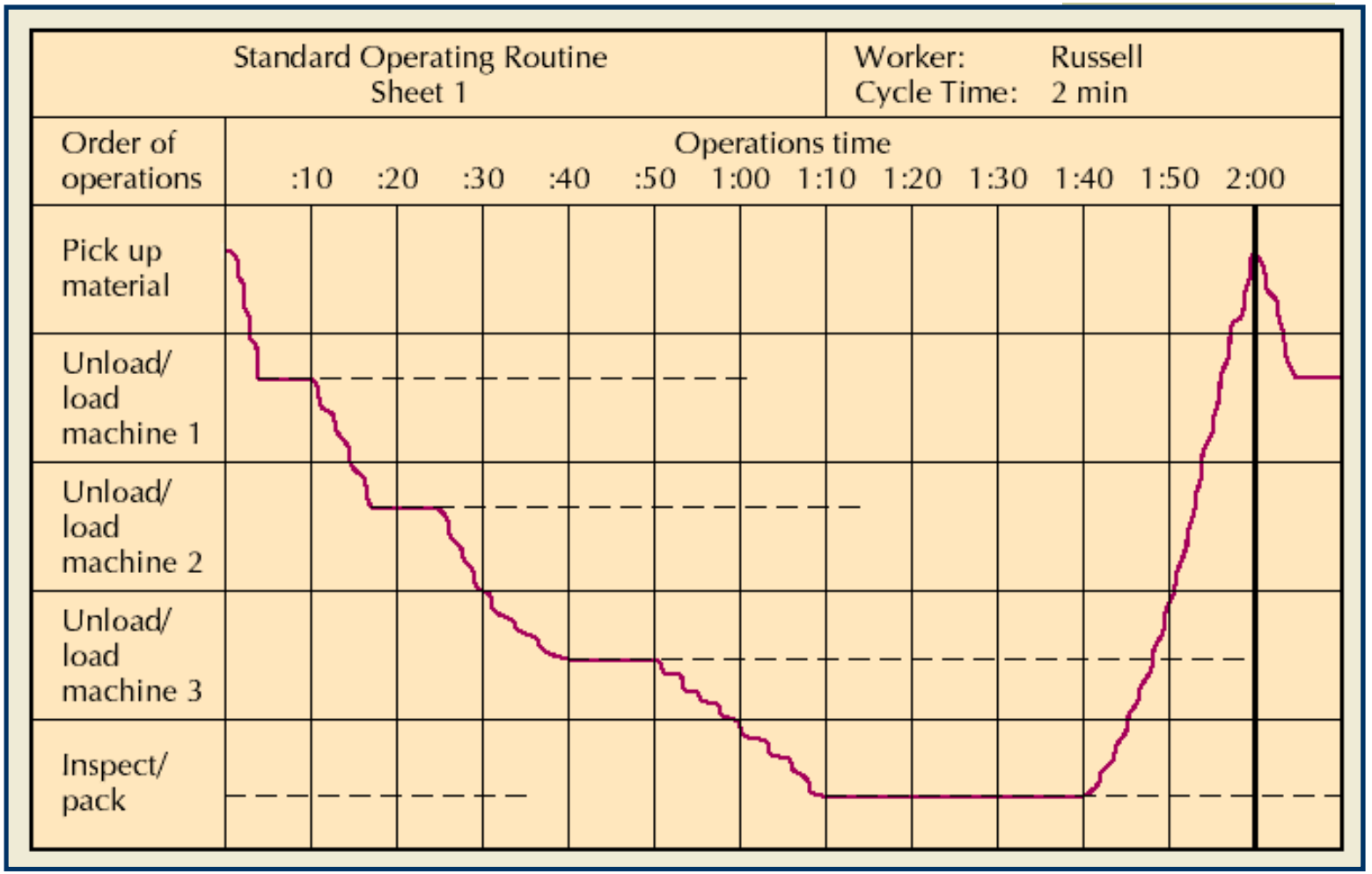
1. Flexible resources
2. Cellular layouts
3. Pull system
4. Kanbans
5. Small lots
6. Quick setups
7. Uniform production levels
8. Quality at the source
9. Total productive maintenance
10. Supplier networks



Flexible Resources

- Multifunctional workers
  - perform more than one job
  - general-purpose machines perform several basic functions
- Cycle time
  - time required for the worker to complete one pass through the operations assigned
- Takt time
  - paces production to customer demand

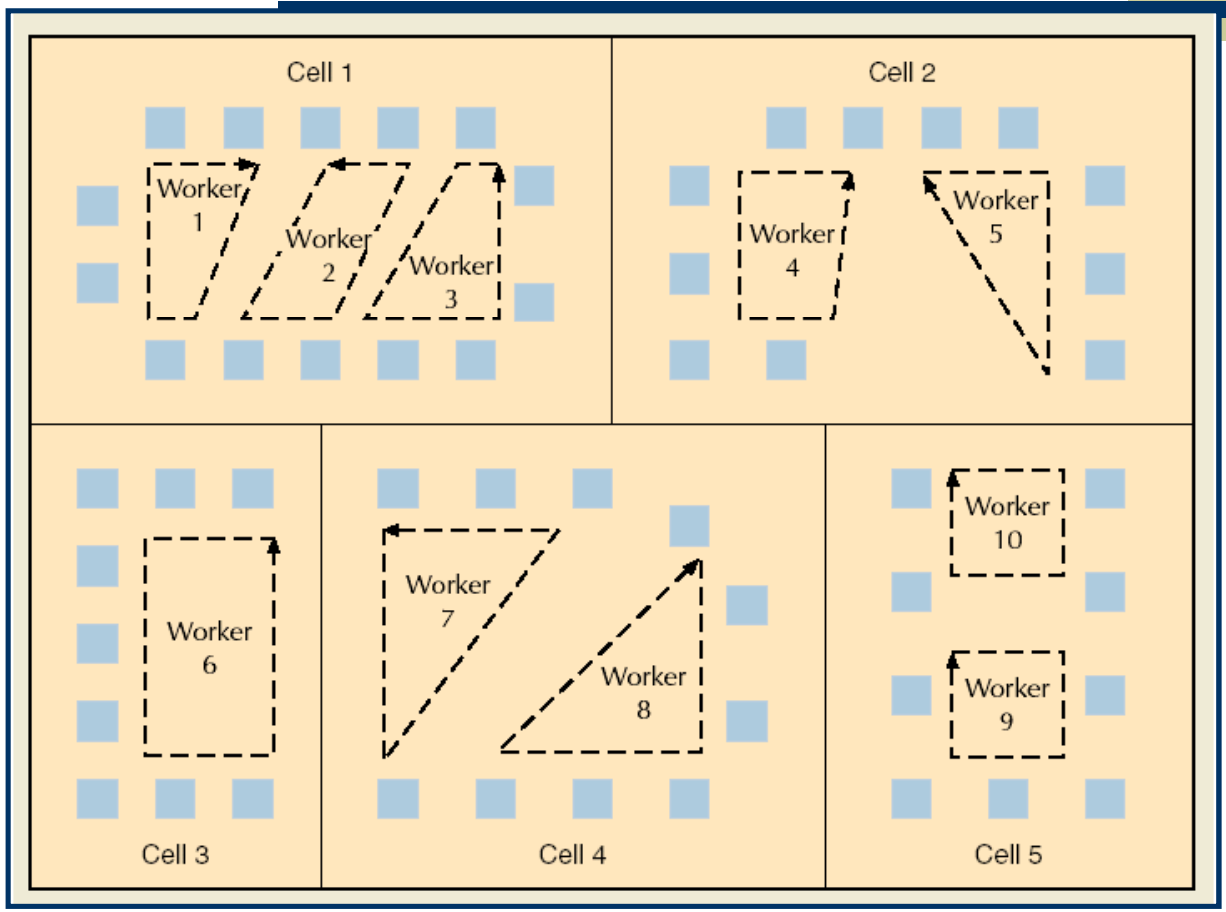
Standard Operating Routine for a Worker



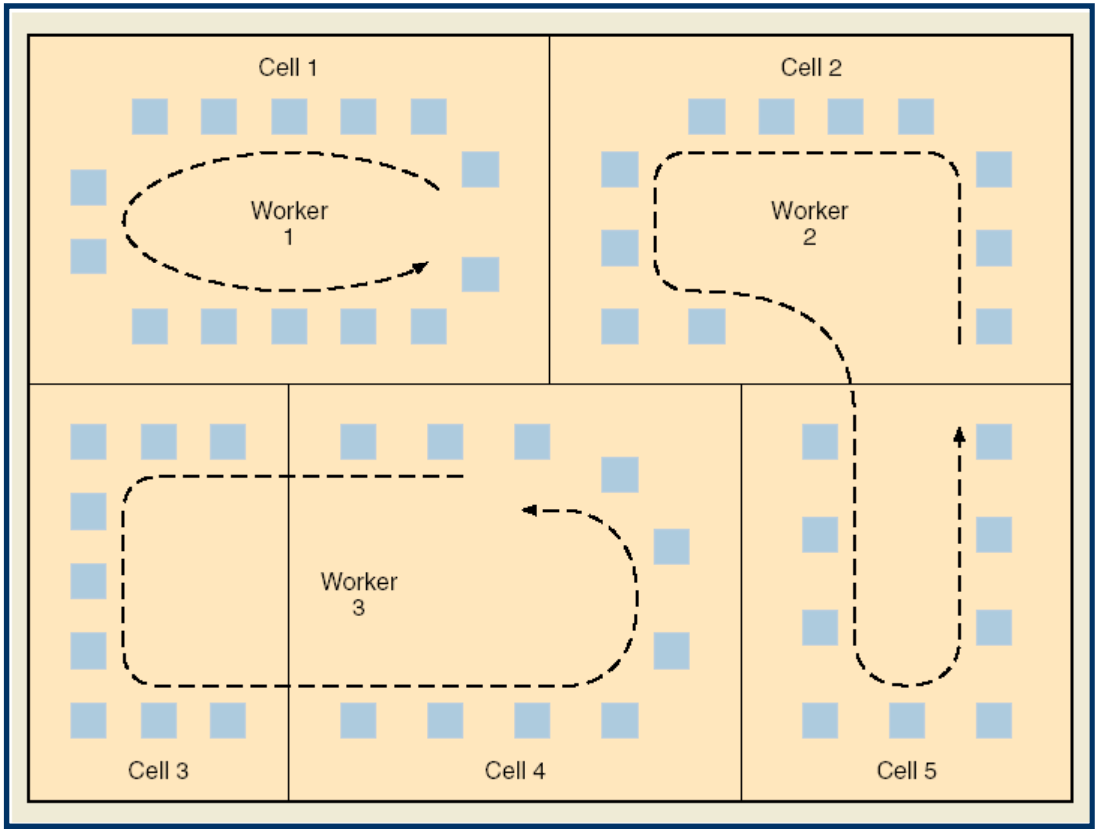
Cellular Layouts

- Manufacturing cells
  - comprised of dissimilar machines brought together to manufacture a family of parts
- Cycle time is adjusted to match takt time by changing worker paths

Cells with Worker Routes



Worker Routes Lengthen as Volume Decreases



Pull System

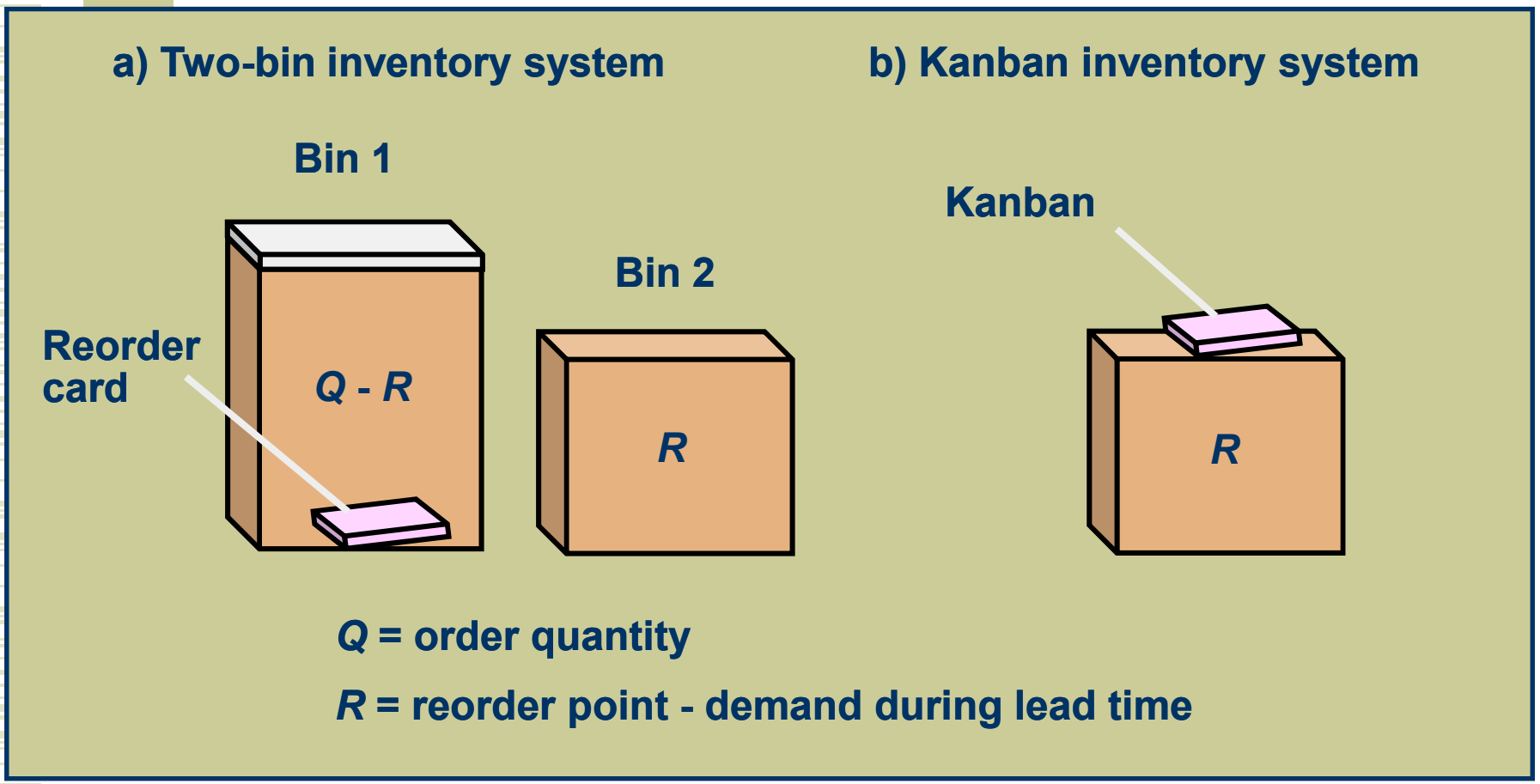
- Material is pulled through the system when needed
- Reversal of traditional push system where material is pushed according to a schedule
- Forces cooperation
- Prevent over and underproduction
- While push systems rely on a predetermined schedule, pull systems rely on customer requests

Kanbans

- Card which indicates standard quantity of production
- Derived from two-bin inventory system
- Maintain discipline of pull production
- Authorize production and movement of goods

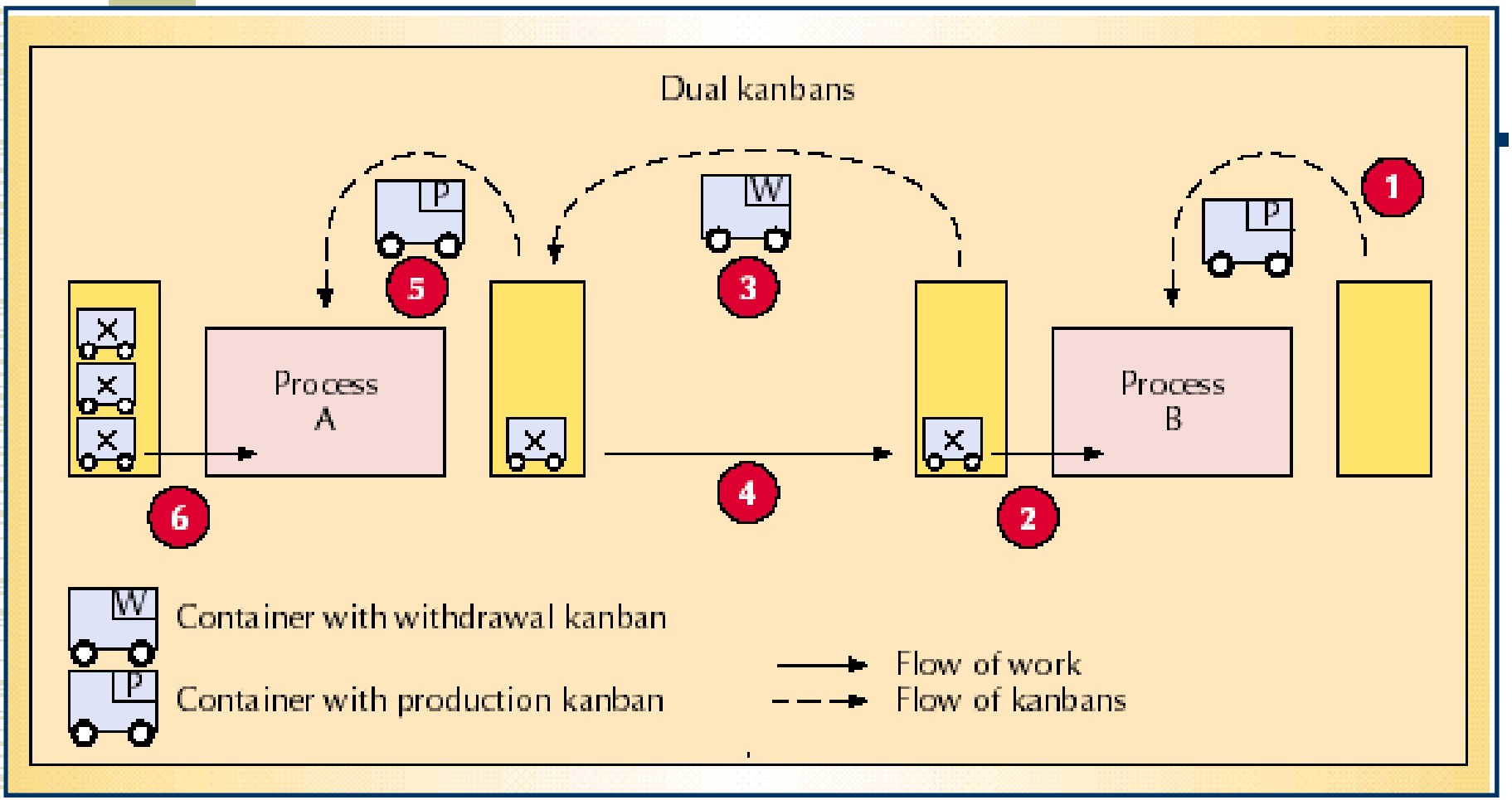
Sample Kanban

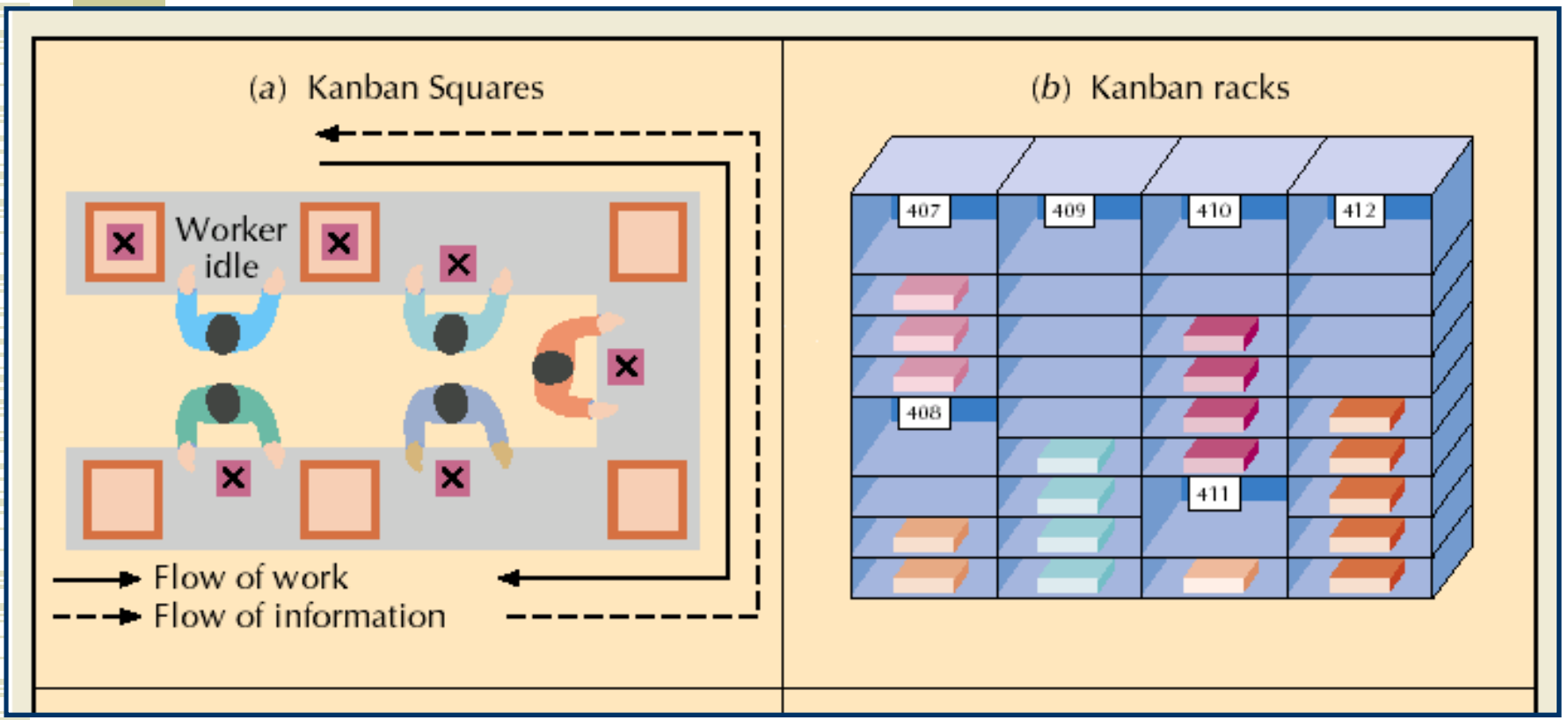
Origin of Kanban

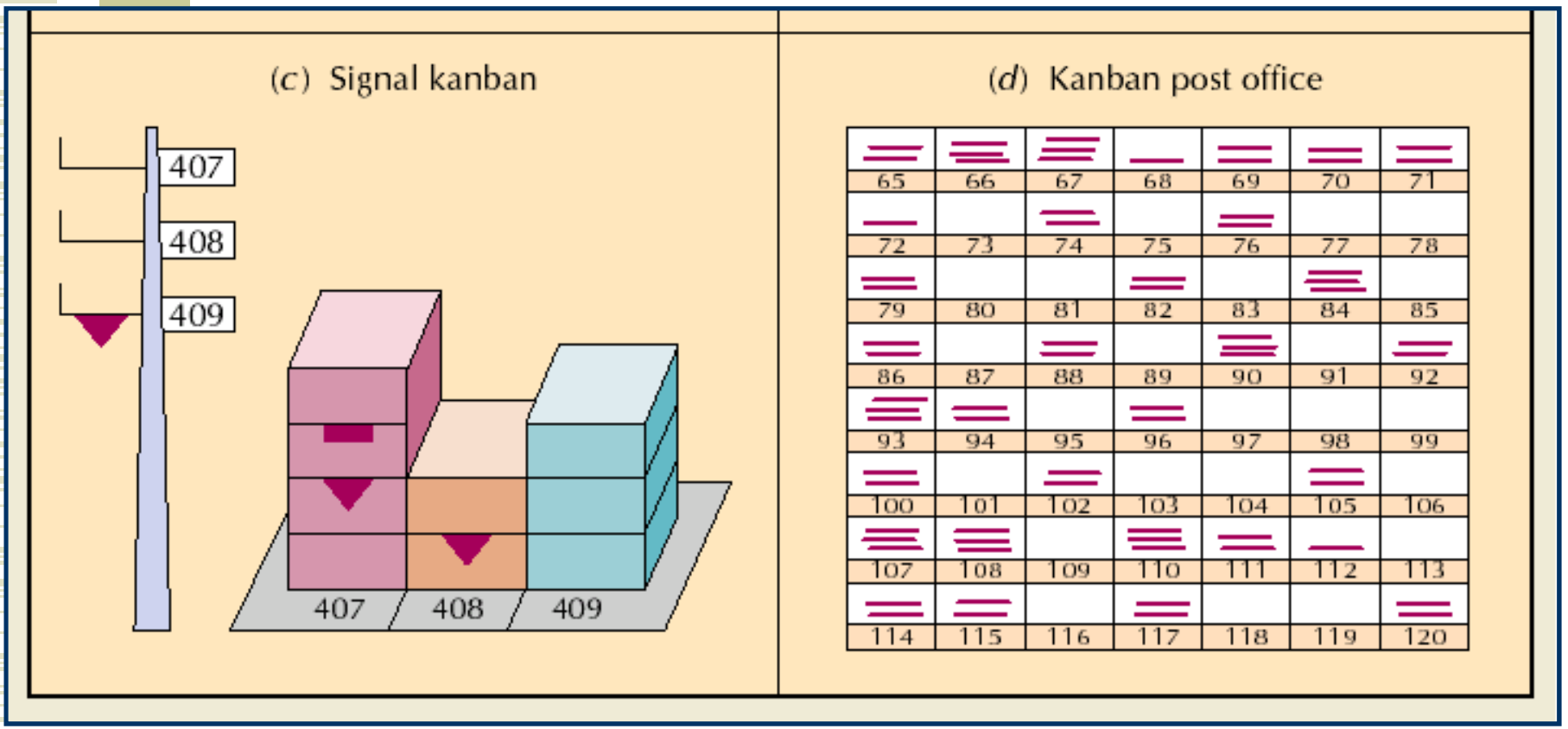


Types of Kanban

- Production kanban
  - authorizes production of goods
- Withdrawal kanban
  - authorizes movement of goods
- Kanban square
  - a marked area designated to hold items
- Signal kanban
  - a triangular kanban used to signal production at the previous workstation
- Material kanban
  - used to order material in advance of a process
- Supplier kanban
  - rotates between the factory and suppliers







Determining Number of Kanbans

$$\text{No. of Kanbans} = \frac{\text{average demand during lead time + safety stock}}{\text{container size}}$$

$$N = \frac{\bar{d}L + S}{C}$$

where

N = number of kanbans or containers
$\bar{d}$ = average demand over some time period
L = lead time to replenish an order
S = safety stock
C = container size

Determining Number of Kanbans: Example

$\bar{d}$ = 150 bottles per hour
L = 30 minutes = 0.5 hours
S = 0.10(150 x 0.5) = 7.5
C = 25 bottles

$$N = \frac{\bar{d}L + S}{C} = \frac{(150 \times 0.5) + 7.5}{25}$$

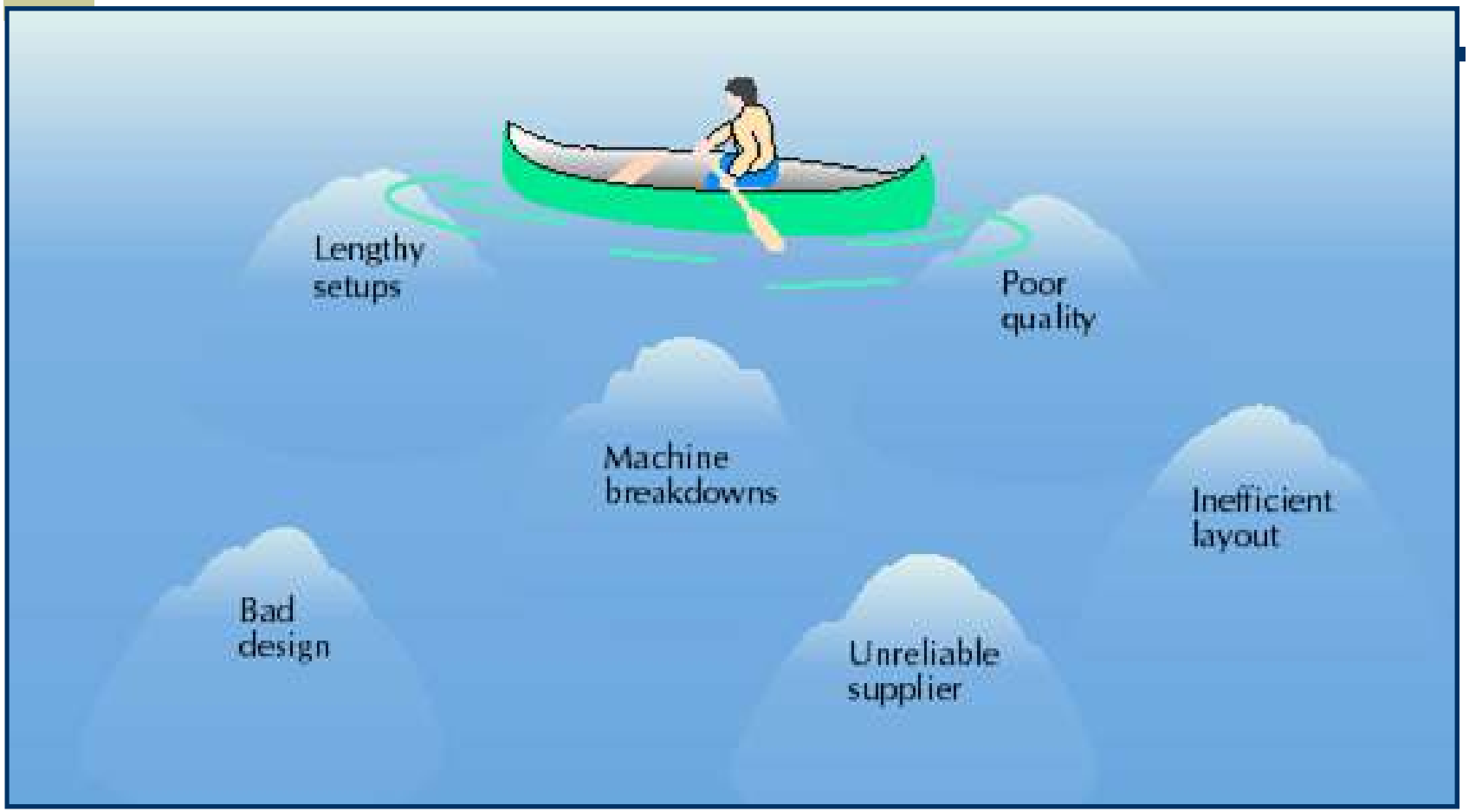
$$= \frac{75 + 7.5}{25} = 3.3 \text{ kanbans or containers}$$

Round up to 4 (to allow some slack) or down to 3 (to force improvement)

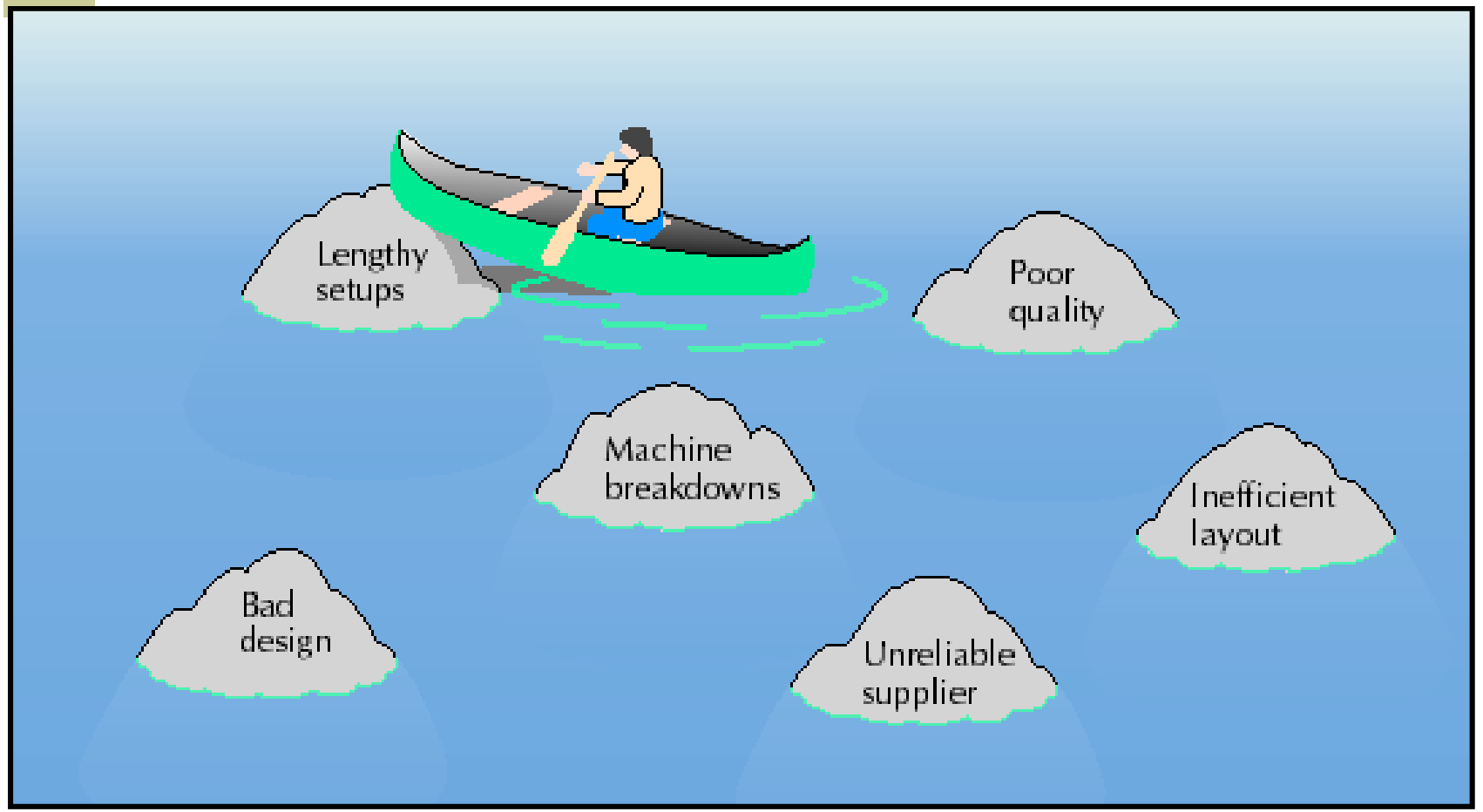
Small Lots

- Require less space and capital investment
- Move processes closer together
- Make quality problems easier to detect
- Make processes more dependent on each other

Inventory Hides Problems



Less Inventory Exposes Problems



Components of Lead Time

- Processing time
  - Reduce number of items or improve efficiency
- Move time
  - Reduce distances, simplify movements, standardize routings
- Waiting time
  - Better scheduling, sufficient capacity
- Setup time
  - Generally the biggest bottleneck

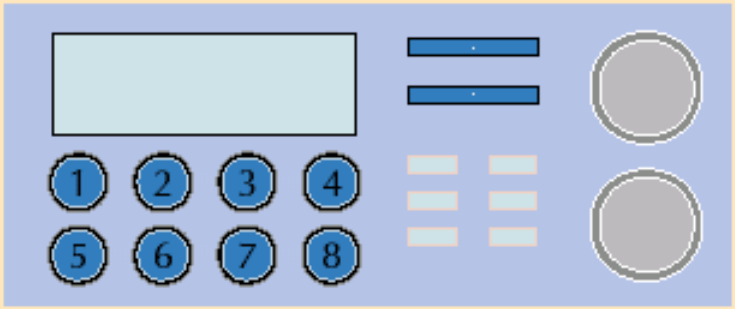
Quick Setups

- Internal setup
  - Can be performed only when a process is stopped
- External setup
  - Can be performed in advance

- SMED Principles
  - Separate internal setup from external setup
  - Convert internal setup to external setup
  - Streamline all aspects of setup
  - Perform setup activities in parallel or eliminate them entirely

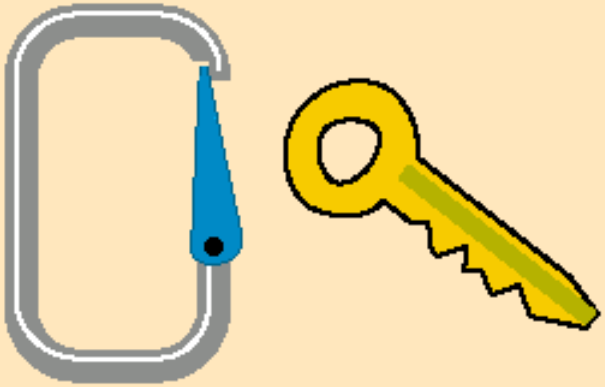
Common Techniques for Reducing Setup Time

Preset desired settings



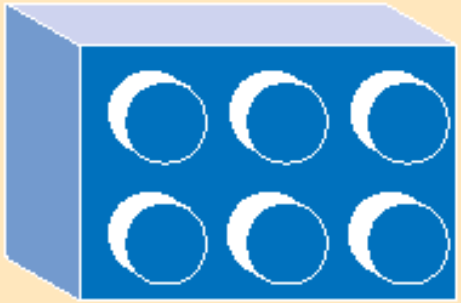
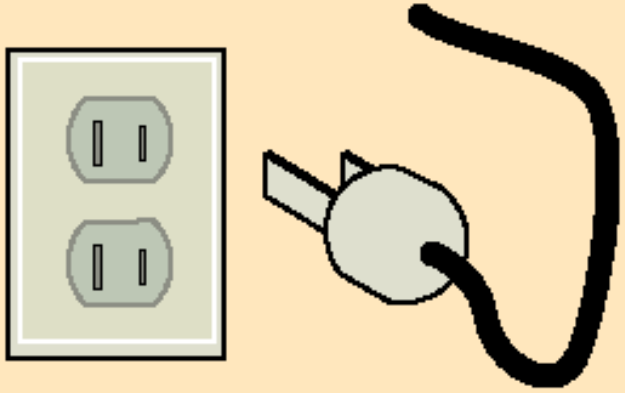
. . . like the stations on your car radio.

Use quick fasteners



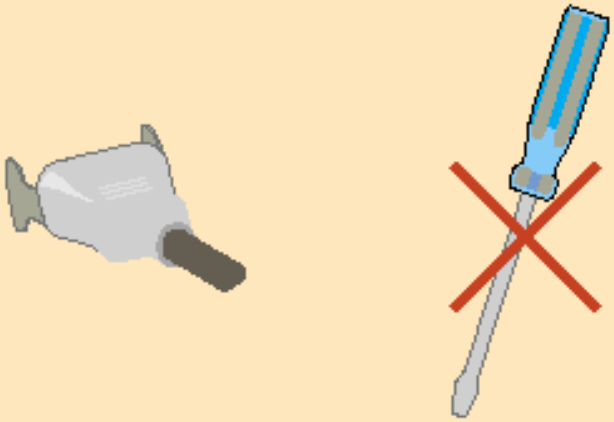
. . . like key rings that allow keys to be added easily.

Common Techniques for Reducing Setup Time (cont.)

Use locator pins	Prevent misalignment
	
. . . like Lego blocks	. . . like electrical plugs with one longer prong

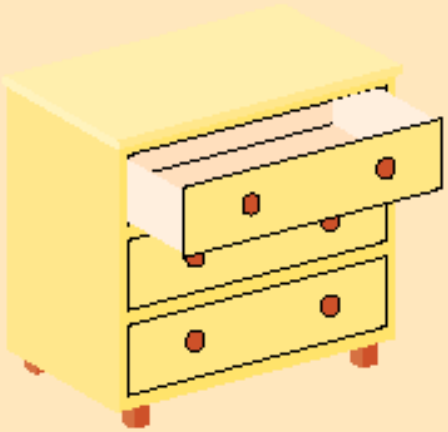
Common Techniques for Reducing Setup Time (cont.)

Eliminate tools



. . . like snap on connectors for computers.

Make movements easier

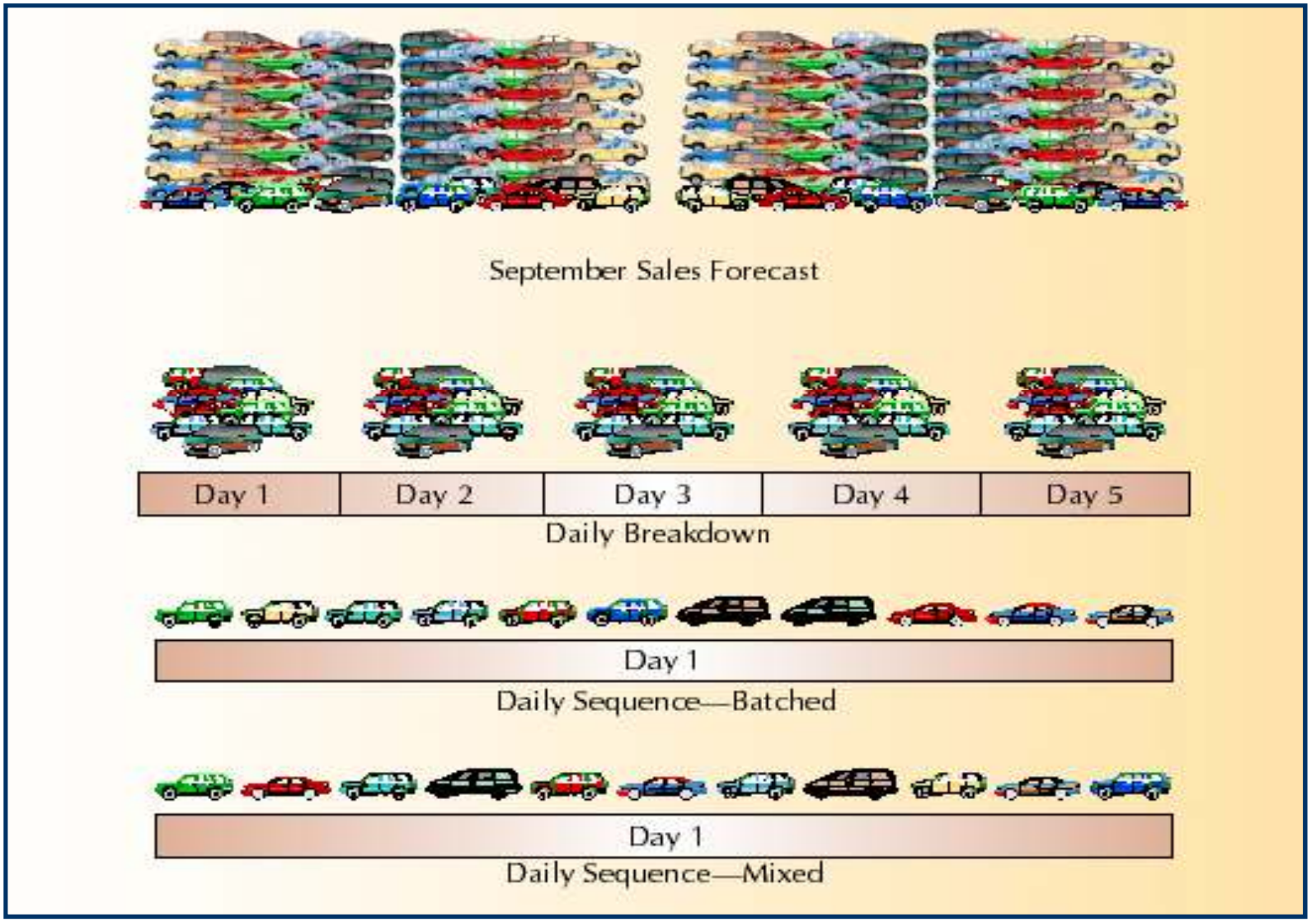


. . . like exchanging the drawers in your dresser.

Uniform Production Levels

- Result from smoothing production requirements on final assembly line
- Kanban systems can handle +/– 10% demand changes
- Reduce variability with more accurate forecasts
- Smooth demand across planning horizon
- Mixed-model assembly steadies component production

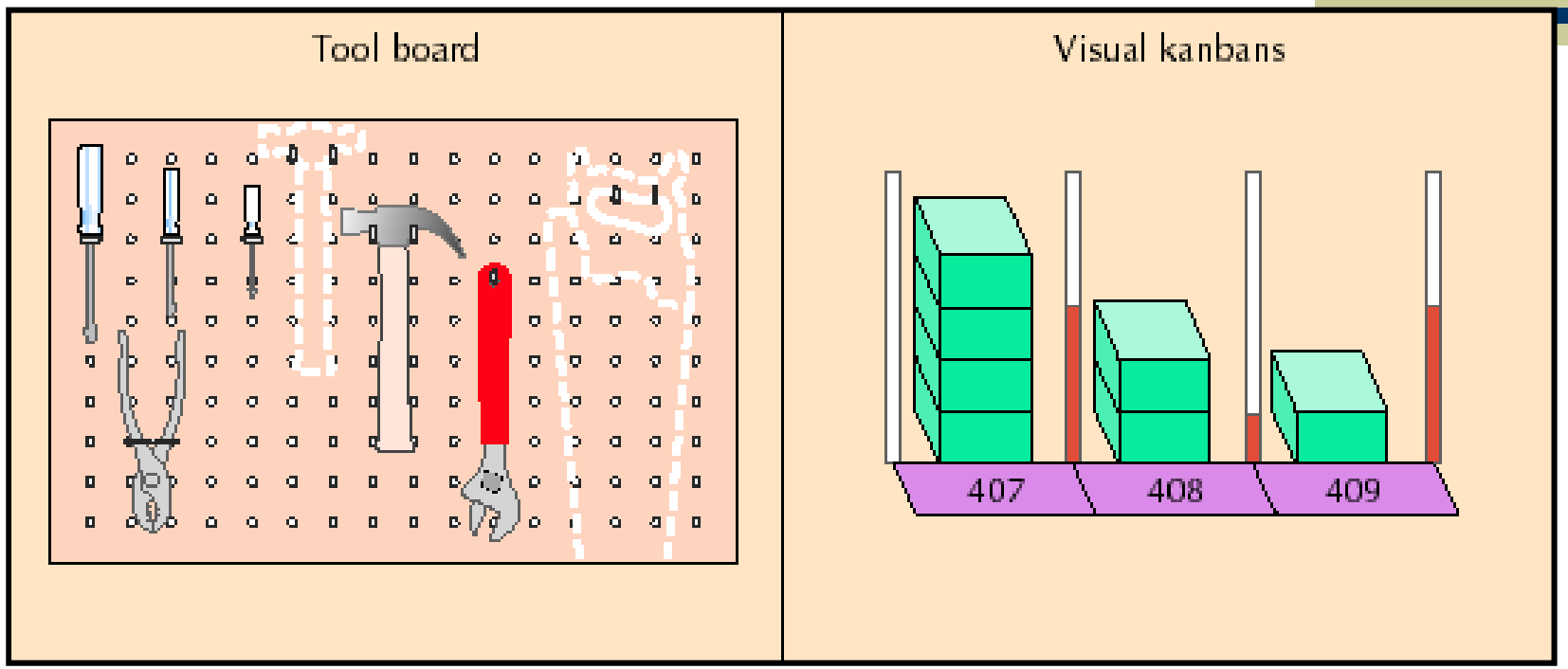
Mixed-Model Sequencing



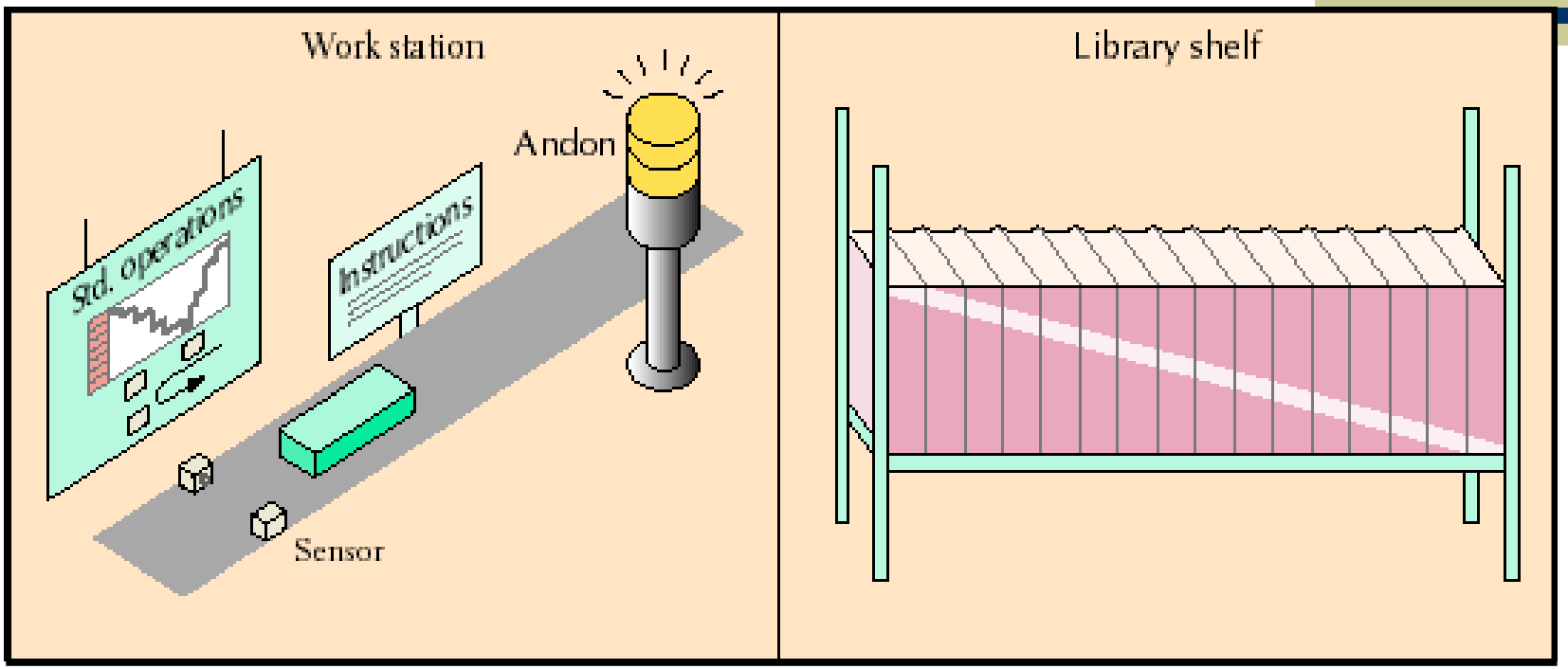
Quality at the Source

- Visual control
  - makes problems visible
- Poka-yokes
  - prevent defects from occurring
- Kaizen
  - a system of continuous improvement; “change for the good of all”
- Jidoka
  - authority to stop the production line
- Andons
  - call lights that signal quality problems
- Under-capacity scheduling
  - leaves time for planning, problem solving, and maintenance

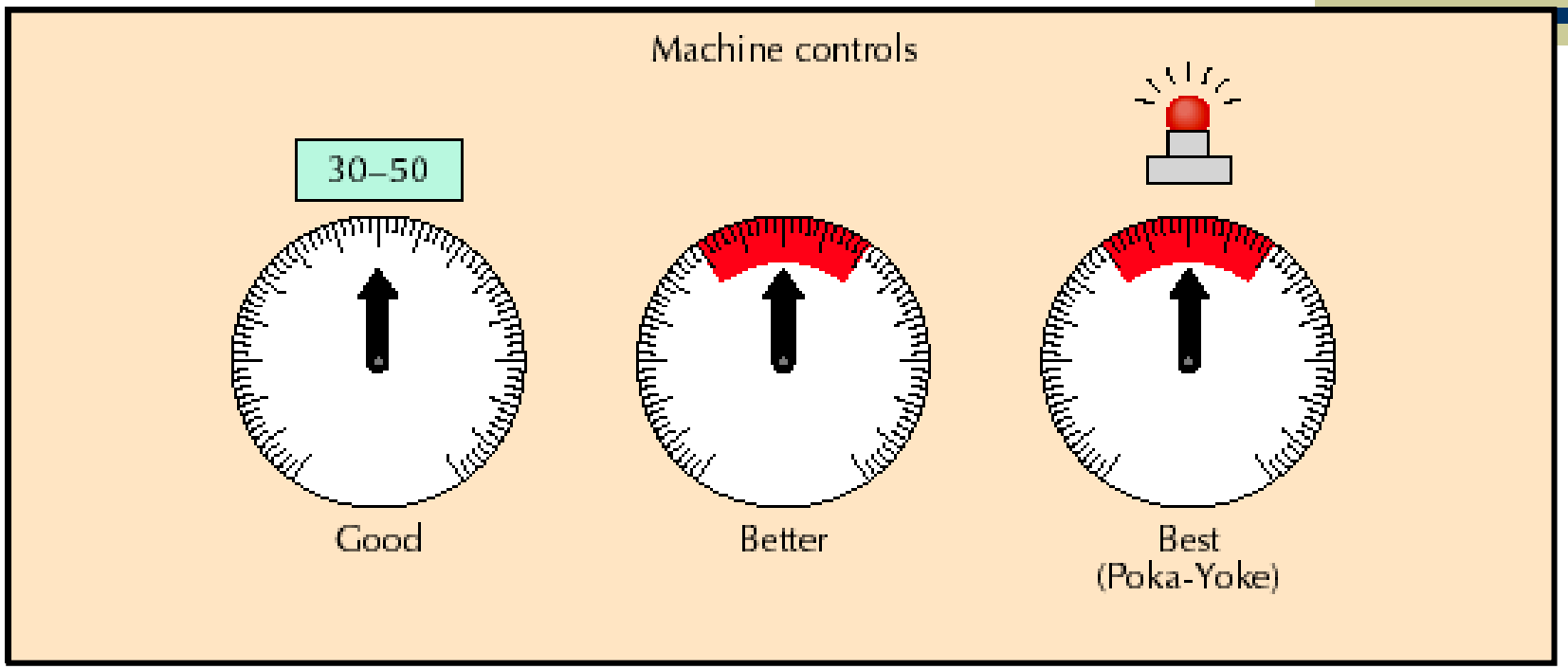
Examples of Visual Control



Examples of Visual Control (cont.)



Examples of Visual Control (cont.)



5 Whys

- One of the keys to an effective Kaizen is finding the root cause of a problem and eliminating it
- A practice of asking “why?” repeatedly until the underlying cause is identified (usually requiring five questions)
- Simple, yet powerful technique for finding the root cause of a problem

Total Productive Maintenance (TPM)

- Breakdown maintenance
  - Repairs to make failed machine operational
- Preventive maintenance
  - System of periodic inspection and maintenance to keep machines operating
- TPM combines preventive maintenance and total quality concepts

TPM Requirements

- Design products that can be easily produced on existing machines
- Design machines for easier operation, changeover, maintenance
- Train and retrain workers to operate machines
- Purchase machines that maximize productive potential
- Design preventive maintenance plan spanning life of machine

5S Scan	Goal	Eliminate or Correct
Seiri(*sort*)	▪ Keep only what you need	▪ Unneeded equipment, tools, furniture; unneeded items on walls, bulletins; items blocking aisles or stacked in corners; unneeded inventory, supplies, parts; safety hazards
Seiton(*set in order*)	▪ A place for everything and everything in its place	▪ Items not in their correct places; correct places not obvious; aisles, workstations, & equipment locations not indicated; items not put away immediately after use
Seisou (*shine*)	▪ Cleaning, and looking for ways to keep clean and organized	▪ Floors, walls, stairs, equipment, & surfaces not clean; cleaning materials not easily accessible; lines, labels, signs broken or unclean; other cleaning problems
Seiketsu (*standardize*)	▪ Maintaining and monitoring the first three categories	▪ Necessary information not visible; standards not known; checklists missing; quantities and limits not easily recognizable; items can't be located within 30 seconds
Shisuke (*sustain*)	▪ Sticking to the rules	▪ Number of workers without 5S training; number of daily 5S inspections not performed; number of personal items not stored; number of times job aids not available or up-to-date

Supplier Networks

- Long-term supplier contracts
- Synchronized production
- Supplier certification
- Mixed loads and frequent deliveries
- Precise delivery schedules
- Standardized, sequenced delivery
- Locating in close proximity to the customer

Benefits of Lean Production

- Reduced inventory
- Improved quality
- Lower costs
- Reduced space requirements
- Shorter lead time
- Increased productivity

Benefits of Lean Production (cont.)

- Greater flexibility
- Better relations with suppliers
- Simplified scheduling and control activities
- Increased capacity
- Better use of human resources
- More product variety

Implementing Lean Production

- Use lean production to finely tune an operating system
- Somewhat different in USA than Japan
- Lean production is still evolving
- Lean production is not for everyone

Lean Services

- Basic elements of lean production apply equally to services
- Most prevalent applications
  - lean retailing
  - lean banking
  - lean health care

Leaning the Supply Chain

- "pulling" a smooth flow of material through a series of suppliers to support frequent replenishment orders and changes in customer demand
- Firms need to share information and coordinate demand forecasts, production planning, and inventory replenishment with suppliers and supplier's suppliers throughout supply chain

Leaning the Supply Chain (cont.)

- Steps in Leaning the Supply Chain:
  - Build a highly collaborative business environment
  - Adopt the technology to support your system

Lean Six Sigma

- Lean and Six Sigma are natural partners for process improvement
- Lean
  - Eliminates waste and creates flow
  - More continuous improvement
- Six Sigma
  - Reduces variability and enhances process capabilities
  - Requires breakthrough improvements

Lean and the Environment

- Lean's mandate to eliminate waste and operate only with those resources that are absolutely necessary aligns well with environmental initiatives
- Environmental waste is often an indicator of poor process design and inefficient production

EPA Recommendations

- Commit to eliminate environmental waste through lean implementation
- Recognize new improvement opportunities by incorporating environmental, heath and safety (EHS) icons and data into value stream maps
- Involve staff with EHS expertise in planning
- Find and drive out environmental wastes in specific process by using lean process-improvement tools
- Empower and enable workers to eliminate environmental wastes in their work areas

Lean Consumption

- Consumptions process involves locating, buying, installing, using, maintaining, repairing, and recycling.
- Lean Consumption seeks to:
  - Provide customers what they want, where and when they want it
  - Resolve customer problems quickly and completely
  - Reduce the number of problems customers need to solve