Quality Management

L_9

04/02/2023

The Plan

The first activity in any assessment of performance is to determine the current operating parameters. Where are we today? What systems do we have in place, and how do they work? What is the current condition of the plant and equipment? Are we starting from scratch, or do we have workable systems that only need to be improved?

TPM

Total Productive Maintenance (TPM) is an extension of the Total Quality Management (TQM) philosophy to the maintenance function. Seven basic steps get an organization started toward TPM:

1. Management learns the new philosophy.
2. Management promotes the new philosophy.
3. Training is funded and developed for everyone in the organization.
4. Areas of needed improvement are identified.
5. Performance goals are formulated.
6. An implementation plan is developed.
7. Autonomous work groups are established.

1. Management learns the new philosophy.

One of the most difficult things for senior management to deal with is change. They need to learn about TPM and how it will affect their operations. There are many successful examples; there are also many organizations that have tried various techniques to improve performance and failed. Benchmarking with a successful organization will provide valuable information.

2. Management promotes the new philosophy

Senior management must spend significant time in promoting the system. They must sell the idea and let the employees know that they are totally committed to its success. Like TQM or any other major change in an organization, there must be total commitment from the top. If the belief in the new philosophy and commitment are not there, then positive results will not happen.

3. Training

Teach the philosophy to managers at all levels. Begin with senior management, and work down to first-line supervisors. Don’t just teach the HOW: also teach the WHY. Senior management must spend time learning about and understanding the ramifications of applying this philosophy to their organization.

4. Improvement Needs

There are usually some machines that seem to be on the verge of breaking down or require an excessive amount of maintenance. Employees who work with the equipment on a daily basis are better able to identify these conditions than anyone else in the organization. A good first step is to let the operators and maintenance technicians tell management which machines and systems need the most attention. An implementation team of operators and technicians to coordinate this process is essential. This action will build credibility and start the organization towards TPM.

Six major loss areas need to be measured and tracked:

Downtime Losses

1. Planned

a. Start-ups

b. Shift changes

c. Coffee and lunch breaks

d. Planned maintenance shutdowns

2. Unplanned Downtime

a. Equipment breakdown

b. Changeovers

c. Lack of material

Reduced Speed Losses

3. Idling and minor stoppages

4. Slow-downs

Poor Quality Losses

5. Process nonconformities

6. Scrap

Losses

These losses can be quantified into three metrics and can be summarized into one equipment effectiveness metric. Equations for these metrics follow.

Downtime losses are measured by equipment availability using the equation

$$A = \left(\frac{T}{P}\right) \times 100$$

where A = availability
T = operating time (P − D)
P = planned operating time
D = downtime

Reduced speed losses are measured by tracking performance efficiency using the equation

$$E = \left(\frac{C \times N}{T}\right) \times 100$$

where E = performance efficiency
C = theoretical cycle time
N = processed amount (quantity)

Losses

Poor quality losses are measured by tracking the rate of quality products produced using the equation

$$R = \left(\frac{N - Q}{N}\right) \times 100$$

where R = rate of quality products
N = processed amount (quantity)
Q = nonconformities

Equipment effectiveness is measured as the product of the decimal equivalent of the three previous metrics using the equation

$$EE = A \times E \times R$$

where EE = equipment effectiveness, or overall equipment effectiveness (OEE)

The target for improvement is 85% equipment effectiveness.

Example

- Last week's production numbers on machining center JL58 were as follows:
- Scheduled operation = 10 hours/day; 5 days/week
- Manufacturing downtime due to meetings, material outages, training, breaks, and so forth = 410 minutes/week
- Maintenance downtime scheduled and equipment breakdown = 227 minutes/week
- Theoretical (standard) cycle time = 0.5 minutes/unit
- Production for the week = 4450 units
- Defective parts made = 15 units

Example

P = 10 hours/day 5 days/week 60 minutes/hour = 3000 minutes/week

D = 410 minutes/week + 227 minutes/week = 637 minutes/week

T = (P D) = 3000 637 = 2363 minutes

Clearly the equipment availability should be improved to reach the goal of 85% equipment effectiveness.

$$\begin{aligned} A &= \left(\frac{T}{P}\right) \times 100 \\ &= \left(\frac{2363}{3000}\right) \times 100 \\ &= 78.8\% \end{aligned}$$

$$\begin{aligned} E &= \left(\frac{C \times N}{T}\right) \times 100 \\ &= \left(\frac{0.5 \times 4450}{2363}\right) \times 100 \\ &= 94.2\% \end{aligned}$$

$$\begin{aligned} R &= \left(\frac{N - Q}{N}\right) \times 100 \\ &= \left(\frac{4450 - 15}{4450}\right) \times 100 \\ &= 99.7\% \end{aligned}$$

$$\begin{aligned} EE &= A \times E \times R \\ &= 0.788 \times 0.942 \times 0.997 \\ &= 0.740 \text{ or } 74.0\% \end{aligned}$$

Goal

Goals should be set after the improvement needs are identified. A good first goal is to establish the timeframe for fixing the first prioritized problem. Technicians and operators will probably want it done faster than management because it causes them more problems on a daily basis. Identifying needs and setting goals begins the process of getting the organization to work together as a team.

Developing Plans

First, develop and implement an overall plan of action for training all employees. Plans for developing the autonomous work groups should take place during the training phase. Plan to use teams of maintenance technicians and operators to work on particularly troublesome problems.

Priorities can be set and management can make a commitment with resources to correct some of the basic problems. Using the team approach will set the stage for the development of autonomous work groups, which are teams established for daily operations. At this point, employees should have input into how these autonomous teams are structured.

Part of the planning process should take into consideration that autonomous work groups will change over time. As processes and procedures are improved, the structure of the whole organization will change.

Autonomous Work Groups

Autonomous work groups are established based on the natural flow of activity. First, make the operator responsible for the equipment and the level of maintenance that he is capable of performing. Next, identify the maintenance personnel who work in certain areas or have certain skill levels. Operators and maintenance personnel are brought together, resulting in an autonomous work group. These groups must have the authority to make decisions about keeping the equipment in first-class running order.

TPM Examples

1. The U.S. Postal Service of Albany, New York used total productive maintenance to save $86,000 annually by standardizing procedures and reducing the use of outside contractors for vehicle work. Based on their revision of maintenance procedures, 11 other facilities in the Northeast are changing their practices, and $4.5 million could be saved if 179 sites nationwide also change their practices. Because of their efforts, the U.S. Postal Service of Albany, New York was a 2000 RIT/USA Today Quality Cup finalist.

TPM Examples

2. Yamato Kogyo Corp. of Japan, a motorcycle control-cable maker, received a total productive maintenance award from Yamaha Corp. in the 1990s.4 Using total productive maintenance, they improved productivity by 130%, cut accidents by 90%, reduced defects by 95%, and increased the employee suggestion rate by over 300% to 5 per employee per month.

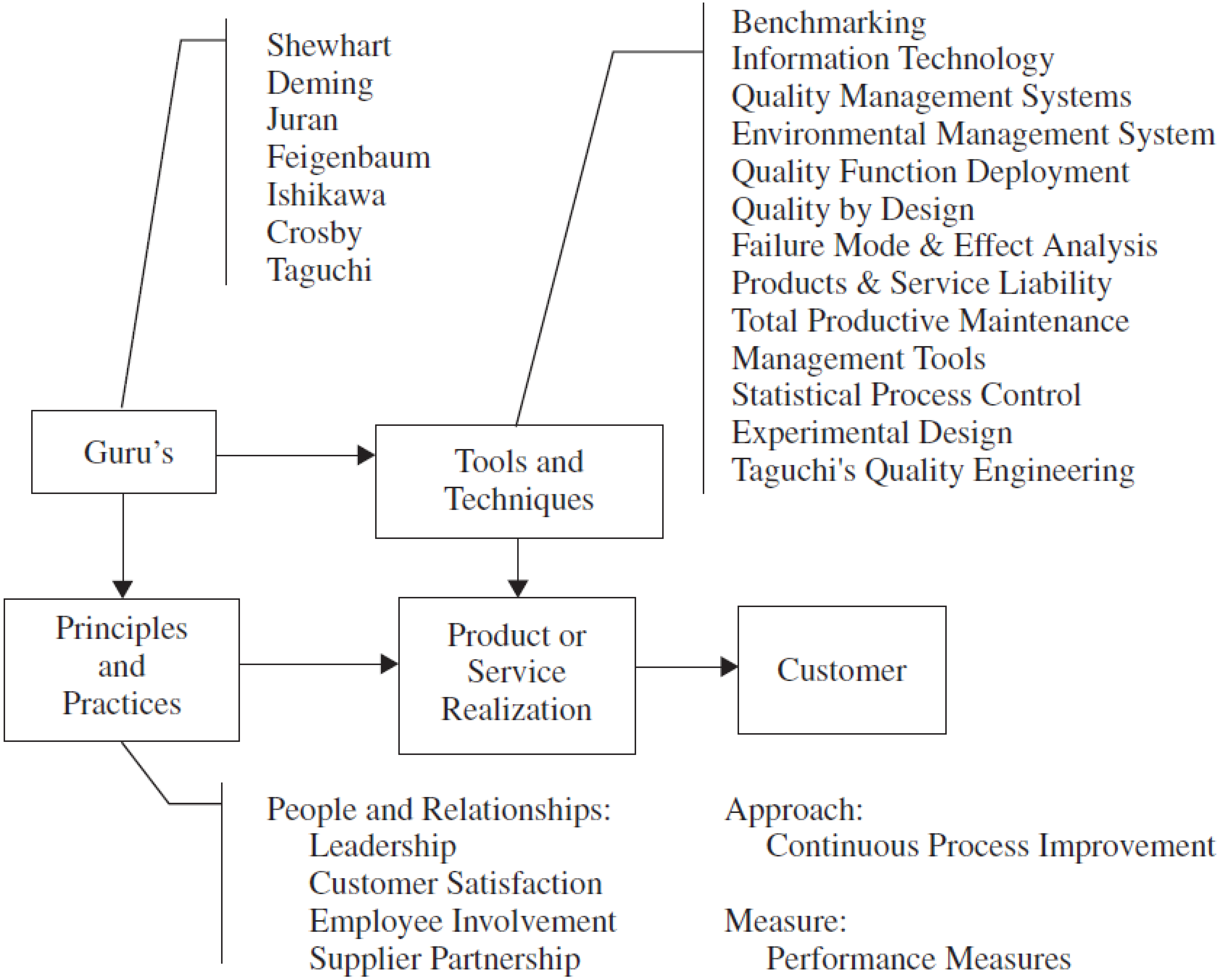
Exercise

1. The bearing department is planning their schedule for the following week. They need an understanding of last week's performance. The schedule called for two 8-hour shifts per day for five days. Downtime charged to production averaged 76 minutes per day. Downtime charged to maintenance averaged 135 minutes per day. Calculate the actual running time and the percentage of available time.

Conclusion

The seven-step plan discussed provides a framework to establish TPM. It should be modified to meet different organizational needs. An effective total productive maintenance program will lead to improved quality and productivity and, of course, an improved bottom line.

TPM is an extension of TQM to maintenance function. Like any other improvement initiative, management must manage the change by demonstrating commitment, getting involved, promoting the philosophy, providing resources and supporting training.


Shewhart
Deming
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Feigenbaum
Ishikawa
Crosby
Taguchi
Benchmarking
Information Technology
Quality Management Systems
Environmental Management System
Quality Function Deployment
Quality by Design
Failure Mode & Effect Analysis
Products & Service Liability
Total Productive Maintenance
Management Tools
Statistical Process Control
Experimental Design
Taguchi's Quality Engineering
Guru's
Tools and Techniques
Principles and Practices
Product or Service Realization
Customer
People and Relationships:
Leadership
Customer Satisfaction
Employee Involvement
Supplier Partnership
Approach:
Continuous Process Improvement
Measure:
Performance Measures

Just-In-Time Systems

JIT

- Just-in-time (JIT) production is a process-control method and production philosophy that provides parts, components, and assemblies to production at the exact time they are needed.

- The result of JIT production is less inventory of raw materials, smaller inventories of parts, less work in process, and shorter lead times. Benefits of JIT production are a significant reduction in floor space, less overhead, and, most importantly, a reduction in cost.

- A possible pitfall of JIT production is a reduction of inventories to critically low levels. Consequently, care must be taken to choose suppliers with excellent quality products and services as well as a knowledge of production lead and process times.

JIT/Lean Production

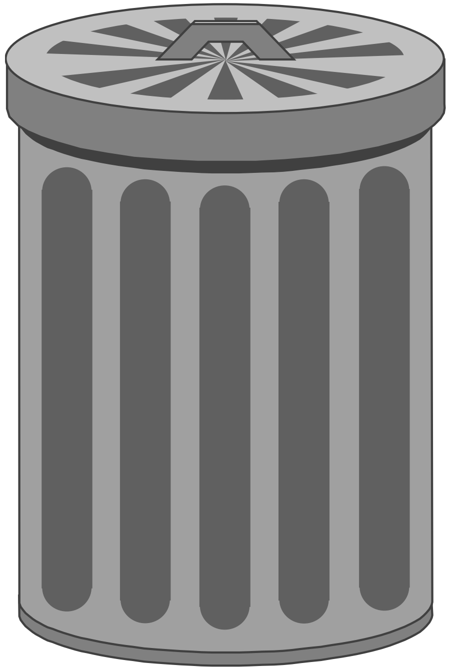
- *Just-in-time*: Repetitive production system in which processing and movement of materials and goods occur just as they are needed, usually in small batches
- JIT is characteristic of lean production systems
- JIT operates with very little "fat"

JIT Goals

- Eliminate disruptions
- Make system flexible by reduce setup and lead times
- Eliminate waste, especially excess inventory

Sources of Waste

- Overproduction
- Waiting time
- Unnecessary transportation
- Processing waste
- Inefficient work methods
- Product defects

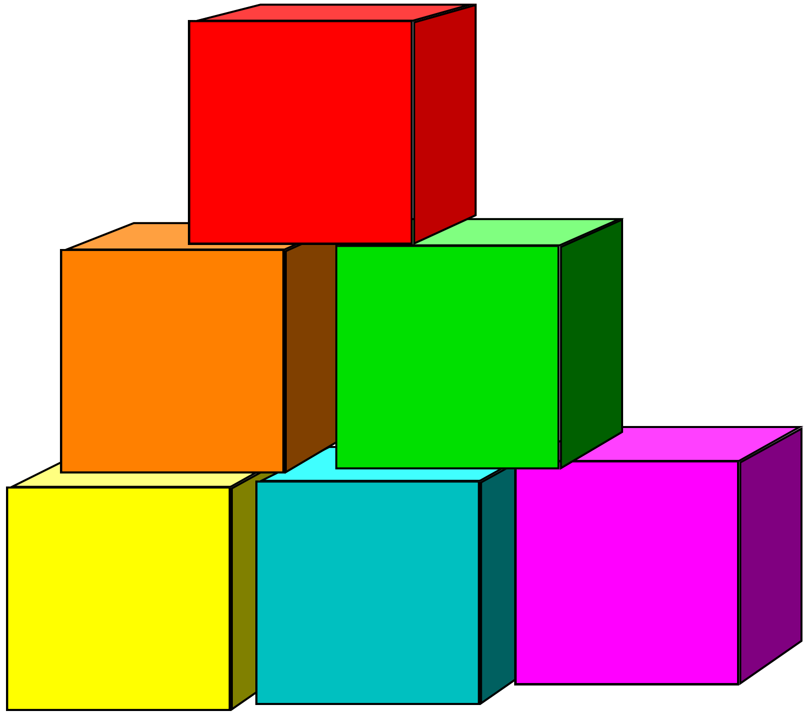


Big vs. Little JIT

- Big JIT – broad focus
  - Vendor relations
  - Human relations
  - Technology management
  - Materials and inventory management
- Little JIT – narrow focus
  - Scheduling materials
  - Scheduling services of production

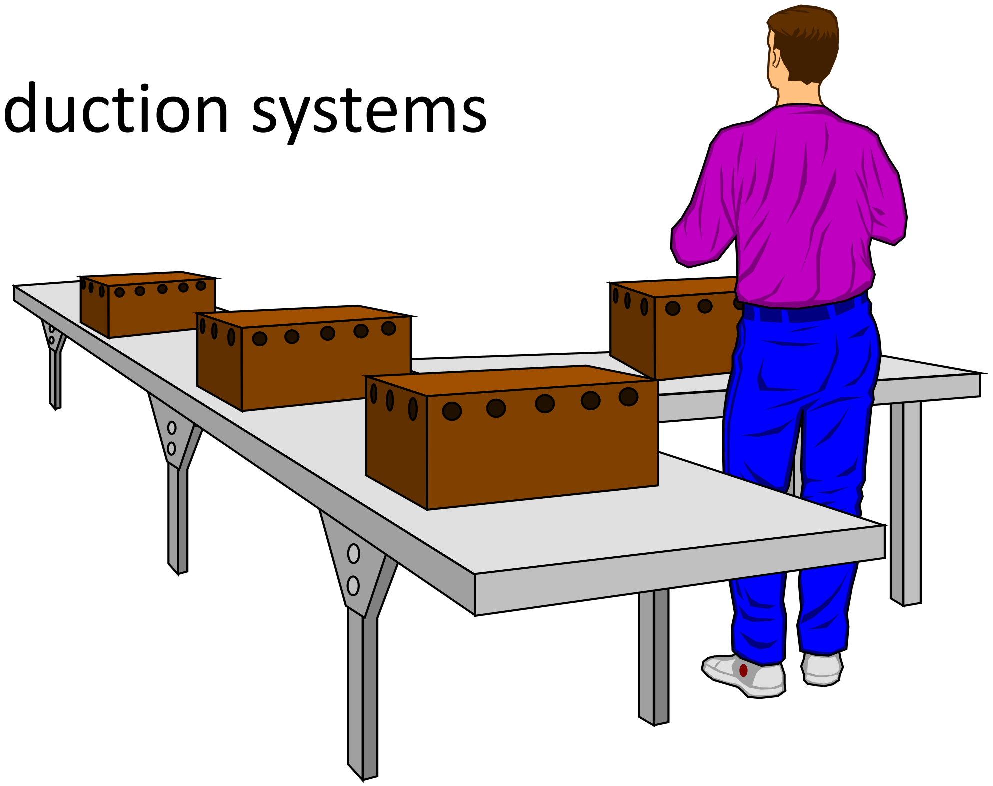
JIT Building Blocks

1. Product design
2. Process design
3. Personnel/organizational elements
4. Manufacturing planning and control



1. Product Design

- Standard parts
- Modular design
- Highly capable production systems



2. Process Design

- Small lot sizes
- Setup time reduction
- Manufacturing cells
- Limited work in process
- Quality improvement
- Production flexibility
- Little inventory storage

Benefits of Small Lot Sizes

- Reduces inventory
- Less rework
- Less storage space
- Problems are more apparent
- Increases product flexibility
- Easier to balance operations

Production Flexibility

- Reduce downtime by reducing changeover time
- Use preventive maintenance to reduce breakdowns
- Cross-train workers to help clear bottlenecks
- Reserve capacity for important customers

3. Personnel/Organizational Elements

- Workers as assets
- Cross-trained workers
- Continuous improvement
- Cost accounting
- Leadership/project management

4. Manufacturing Planning and Control

- Level loading
- Pull systems
- Visual systems
- Close vendor relationships
- Reduced transaction processing
- Preventive maintenance

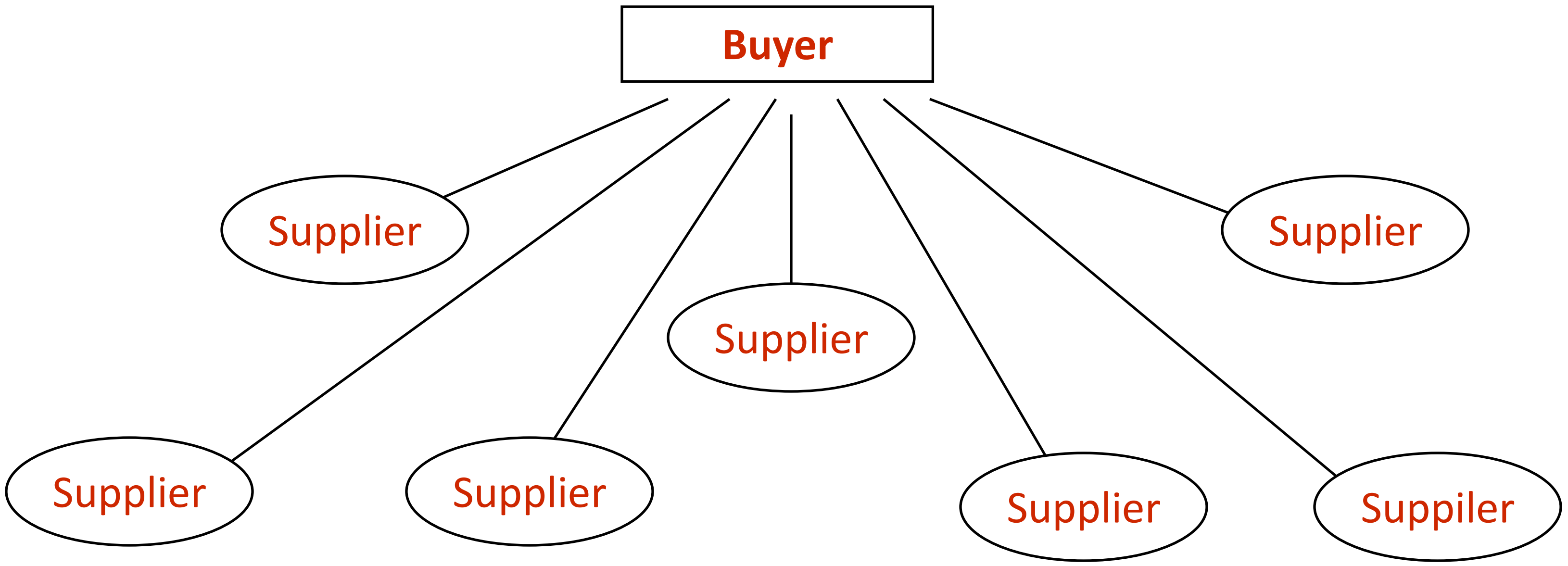
Pull/Push Systems

- *<u>Pull system</u>*: System for moving work where a workstation pulls output from the preceding station as needed. (e.g. Kanban)
- *<u>Push system</u>*: System for moving work where output is pushed to the next station as it is completed

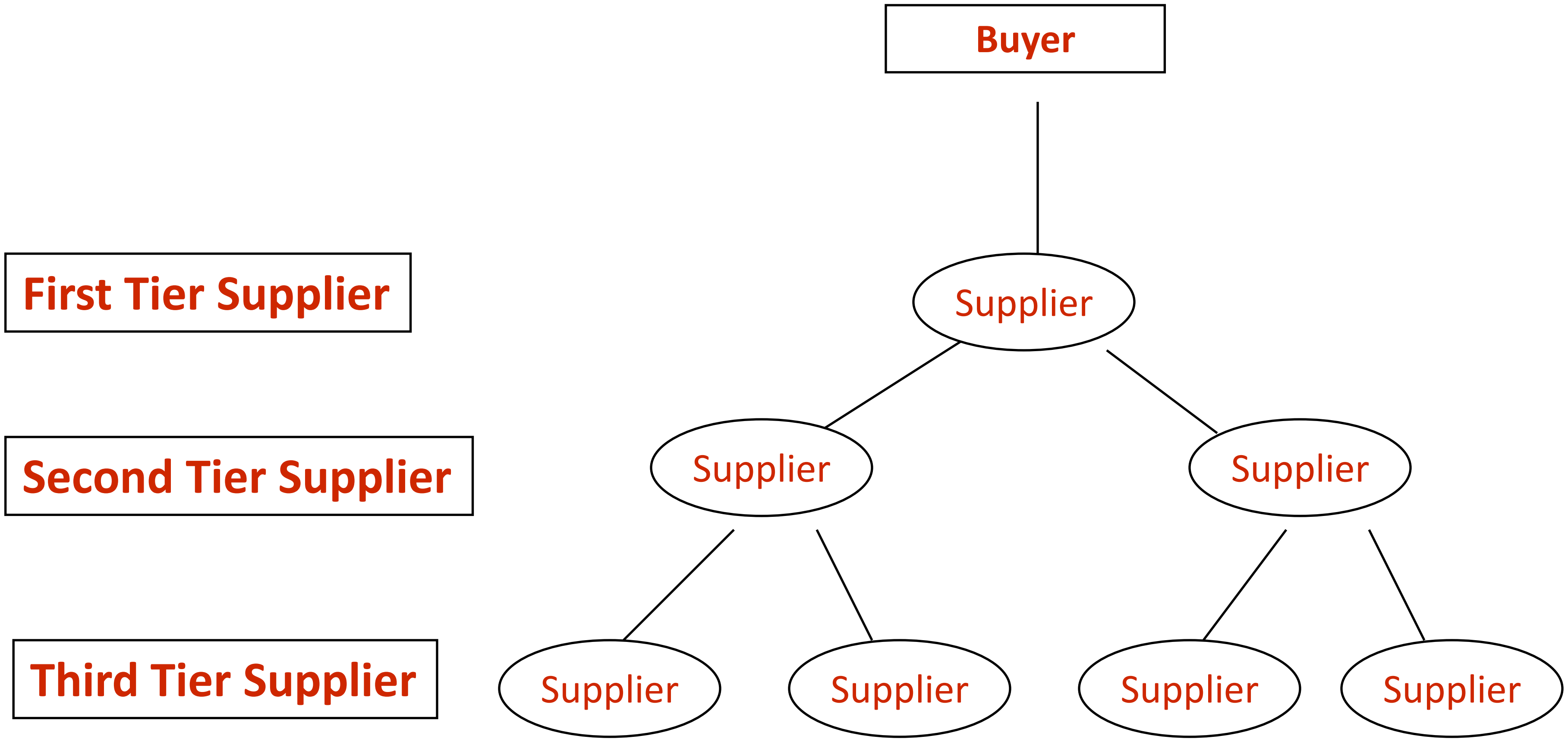
Kanban Production Control System

- *Kanban*: Card or other device that communicates demand for work or materials from the preceding station
- Kanban is the Japanese word meaning “signal” or “visible record”
- Paperless production control system
- Authority to pull, or produce comes from a downstream process.

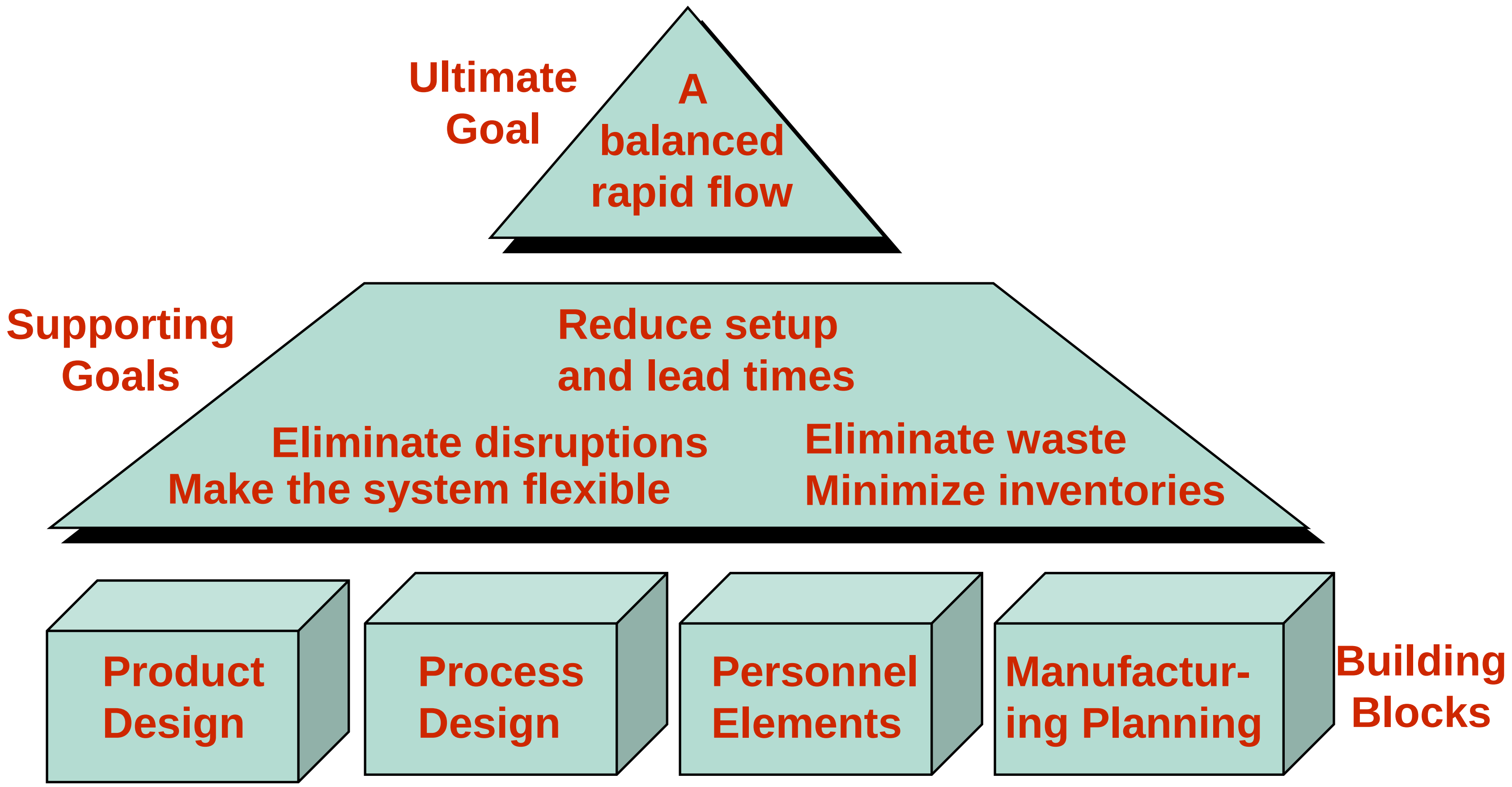
Traditional Supplier Network



Tiered Supplier Network



Summary JIT Goals and Building Blocks

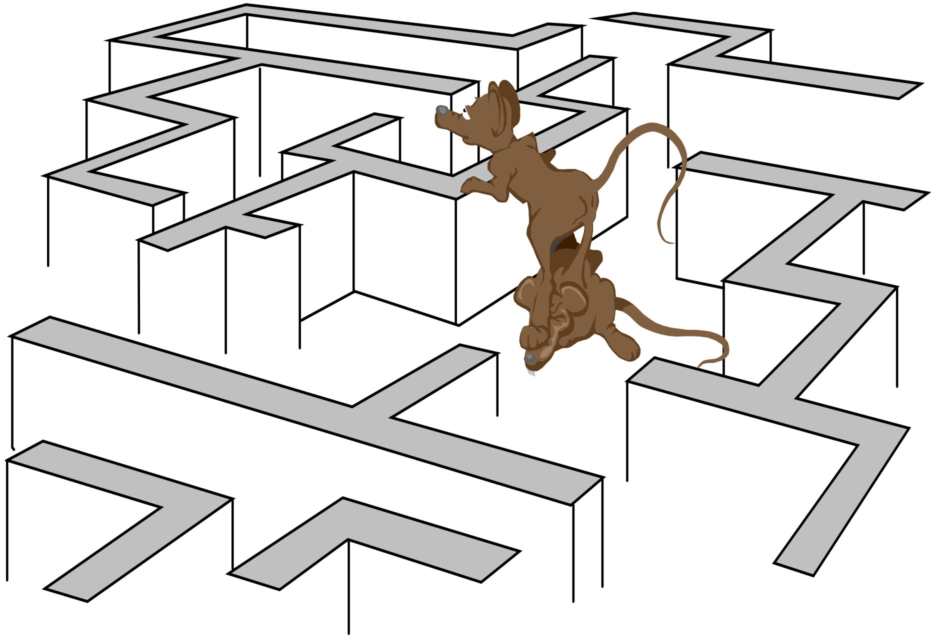


Converting to a JIT System

- Get top management commitment
- Decide which parts need most effort
- Obtain support of workers
- Start by trying to reduce setup times
- Gradually convert operations
- Convert suppliers to JIT
- Prepare for obstacles

Obstacles to Conversion

- Management may not be committed
- Workers/management may not be cooperative
- Suppliers may resist



Benefits of JIT Systems

- Reduced inventory levels
- High quality
- Flexibility
- Reduced lead times
- Increased productivity

Benefits of JIT Systems (cont'd)

- Increased equipment utilization
- Reduced scrap and rework
- Reduced space requirements
- Pressure for good vendor relationships
- Reduced need for indirect labor

Elements of JIT

- Smooth flow of work (the ultimate goal)
- Elimination of waste
- Continuous improvement
- Eliminating anything that does not add value
- Simple systems that are easy to manage
- Use of product layouts to minimize moving materials and parts
- Quality at the source

Elements of JIT (cont'd)

- Poka-yoke – fail safe tools and methods
- Preventative maintenance
- Good housekeeping
- Set-up time reduction
- Cross-trained employees
- A pull system