

Product Planning and Quality Control

Answers to the questions C1 t/m C16

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1. Introduction

1. Explain how each of the following is a basis for competitive advantage in manufacturing: cost, quality, time, agility.

Cost: making things cheaper → achieve low cost by redesigning and simplifying products and processes, standardizing products etc.

Quality: making things better → SPC, proper placement of equipment's, SMU, improvement- focused employee teams

Time: making things faster → continuous reduction of lead times, setup times, maintenance etc.

Agility: being more agile → ability to introduce new products and to respond quickly to changing customer demands. Programs aimed at producing things better and faster are also aimed at achieving manufacturing agility.

2. Distinguish between delivery time and time to market.

Time to market means the time before a product/object is introduced towards customers, delivery time is the time between the order and delivery of a product.

3. In 10 words or less, what is the primary focus of lean (JIT) production?

Continuously identifying and removing sources of waste → continuously improvement

4. What is meant by the term production pipeline? What does the production pipeline have to do with lean production?

The pipeline is an analogy in this context. It gives impression that barriers to production can be removed once and for all (in reality that is impossible). Lean production continuously seeks way to make the pipeline more adaptable to whatever materials or flow rates are desired.

5. What features differentiate lean organizations from other organizations?

2 features distinguishes lean organizations; 1 → the large number of people involved in identifying and eliminating obstructions. 2 → primary process is reduction of inventory (removal of inventories will make obstructions visible)

6. What is craft production?

workmanship and manual skills using hand tools

7. What is mass production?

The combination of interchangeable parts and the moving production line

8. What were Henry Ford's most significant contributions to mass production?

The interchangeability of the worker, the moving assembly line

2. Fundamentals of Continuous Improvement

1. Explain why change is an essential process for businesses to be competitive. In what ways must businesses keep changing?

Because of the fact that external factors over which an organization has little control but which influence its competitiveness and profitability are constantly changing

→ organizations must adapt. But also internal factors change over time: **what was good enough yesterday, will probably not be good enough tomorrow.**

2. Compare and contrast incremental improvement with innovation improvement.

Innovation improvement → once the limit of improvement is changed, higher performance is achieved only by adapting a new way or technology. Incremental improvement → process of making something better through the accumulation of small, piecemeal improvements, one at time.

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3. Explain the concept of the S-curve as it relates to continuous improvement.

The S-curve shows the relationship between the effort or resources to improve something and the incremental results of that effort. First, progress is slow.. after better understanding the object learning improvement occurs → great improvement eventually comes from a series of small incremental gains (kaizen)

5. Give examples of new product and process technologies not mentioned in the chapter that made the older technologies they replaced obsolete, and that led to competitive advantage.

Improvement of computer chips → has led to the establishment of for example the iPhone 5s

6. Explain the role frontline workers play in continuous improvement.

If they appear uncaring, disinterested, or unmotivated in seeking improvement, it is because they never before were given the opportunity, or the organization did something to turn them off.

7. Describe the steps in the PDCA (Deming or Shewhart) cycle.

Plan →

1. Collecting data to understand the current situation
2. Defining the problem
3. Stating the goal
4. Solving the problem

Do → implementation of the plan

Check → assess the results and see to what extent goals are being accomplished

Act → if planned changes were successful: retaining, standardizing and institutionalizing.

8. What is the meaning of “ask why five times”?

The purpose is to assure that the root causes are corrected, only then a solution can be suggested. Asking why repeatedly directs the focus toward real causes so problems can be resolved permanently.

9. What is value analysis and value engineering? How are they related to continuous improvement?

Both are techniques for assessing the value content of the elements of a product or process. Value analysis → it seeks to maximize the contributions of people in an organization (ongoing improvements)

Value engineering → refers to the first-time design and engineering of a product or process

10. What is reengineering? Where is reengineering in the context of the S-curve?

Fundamental rethinking and redesign of business processes to achieve dramatic improvement in critical contemporary measures of performance such as cost, quality, service etc. Reengineering is a counterpart in the improving process → it emphasized process simplification and elimination of Nonvalue-added steps.

11. Describe the sequence of events and what occurs in a typical kaizen event (kaizen blitz).

Kaizen blitz: attacking problems and wastes on a particular process with a team

12. What are the seven basic problem-solving tools? Describe each.

Check sheet, histogram (shows the frequency distribution of a variable), Pareto analysis (separating the vital few from the trivial many), scatter diagram (reveal possible relationships between variables), process flow chart (shows step in a process, useful for analysing a process), cause-and-effect analysis (identify all of the possible contributors to a given outcome), run diagram (shows results of observations)

13. Describe value stream mapping. What is its focus and purpose?

It visualizes the steps in the process and the material and information flowing through it. It focuses on the value stream (sequence of all activities both value and Nonvalue added).

14. Describe the consensus-building process. What is nemawashi?

After a problem solver has prepared a plan, he seeks consensus from everyone involved by the plan (it creates a better understanding of the plan). Nemawashi refers to the process of circulating a plan or proposal among all the involved people.

3. Value Added and Waste Elimination

1. What is the distinction between value-added and nonvalue-added activities in a process? Give examples of each (other than from this chapter).

Value added is the concept that every activity and element of a system (materials, humans, time, space, or energy) should add value to the output of the system. Could think of welding, milling and drilling (processes). Non added value is the concept that not add value to the output such as transport or inventory.

2. Distinguish between necessary and unnecessary nonvalue-added activities. Explain how you differentiate them. Give examples (other than from this chapter). Can a nonvalue-added activity in some places be considered necessary, in other places unnecessary? Explain.

Within nonvalue-added activities, activities are classified as absolutely necessary activities separated out, all the others are unnecessary and ready for elimination. A nonvalue added example is processing a purchase order. It's necessary but don't add value to the product. To distinguish value-added from nonvalue-added activities, it is useful to think of an organization as comprised of two organizations: one, the production organization, makes the product or provides the service; the other, the support organization, assists and supports the production organization but does little that qualifies as value added. Following categories give an idea of the expanse of activities: planning control activities (forecasting, production planning purchasing, master scheduling, requirements planning, production control, customer order processing, order tracking and expediting, responding to customer inquiries, and all associated data entry, bookkeeping, data processing, and follow-up on errors.

Logistical activities: All ordering, execution, and confirmation of materials movement within an organization, including everything associated with receiving, shipping, work orders and expediting, as well as data entry and processing, and follow-up on errors.

Quality activities: All quality-related work such as definition of customer requirements, assurances that necessary activities have occurred, defect prevention, quality monitoring, and follow-up on defects, mistakes, or complaints.

Change activities: All revisions and updates to other activities, including, for example, customer orders, product designs, and planning and control systems.

3. Describe typical support activities. Are they value-added or nonvalue-added, necessary or unnecessary? Explain

See above

4. What role do frontline workers play in distinguishing value-added from the nonvalue-added activities in a process?

The production organization is called the frontline. Frontline is a value-added activity.

5. What are Toyota's seven wastes? What are Canon's nine wastes? What are categories of waste that neither list includes?

Toyota: Waste from producing defects, Waste in transportation, Waste from inventory, Waste from overproduction, Waste of waiting time, Waste in processing, Waste of motion

Canon's: Waste caused by work-in-process, Waste caused by defects, Waste in equipment, Waste in expense Waste in indirect labor, Waste in planning, Waste in human resources, Waste in operations, Waste in startup

Two waste that neither list: no idea

6. Suggest ways to reduce or eliminate each of the wastes listed in question 5 (Toyota's, Canon's, and your own).

Waste from producing defects: standardisatie

Waste in transportation: conveyor belt

Waste from inventory: pull production

Waste from overproduction: don't do it

Waste of waiting time: ?

Waste in processing: smaller batches

Waste of motion: klaar zetten van materialen

Waste caused by work-in-process

Waste caused by defects

Waste in equipment

Waste in expense

Waste in indirect labor

Waste in planning

Waste in human resources

Waste in operations

Waste in startup

7. Explain the following lean principles and give an example of each:

- Simplification: Given multiple ways to achieve the identical result, simpler is better.

Example: Product design aanpassen

- Cleanliness and organization: A clean, organized workplace promotes a disciplined attitude about work and products, reduces waste, and helps pinpoint incipient problems. Example: 5S

- Visibility: Visible information available to everyone who needs it enables people to do their jobs better, motivates them to do the right thing, and eliminates nonvalue-added activities.

Example: overzichtsborden

- Cycle timing: Regularity and recurrence of workplace patterns reduces uncertainty, increases learning, and permits better planning and action toward meeting customer demand.

Example:

- Agility: Changing customer demand is a fact of life; companies must be able to quickly adapt to such changes without relying on inventory and other wasteful means.

- Measurement: Improvement and waste elimination efforts at any level of the company depend on people using data to assess where they are now, where they should be going, and how well they are doing. (grass roots measurements, visual management: information post-it)

- Variation reduction: Reducing the variability by which a process deviates from standards, goals, or expectations results in less process waste and improved process performance.

8. Explain the various interpretations of the term lean production. In its broadest interpretation, what is lean production?

Lean production is management that focuses the organization on continuously identifying and removing sources of waste so that processes are continuously improved. Lean production is also called just-in-time or JIT.

9. A hospital administrator turns down his assistant's request to attend a lean production seminar, saying, "We don't make things here. It is not relevant to us."

Comment.

Ook in ziekenhuis wordt productie gedraaid en kan je te maken hebben met alle soorten waste. Inventory kan gezien worden als wachtlijsten. Er zijn redenen waarom wachtlijsten oplopen. Het reduceren van waste in ziekenhuizen kan zorgen voor reductie in wachtlijsten. Het is dus onzin dat ze niets te maken hebben met lean.

4. Customer-focused Quality

1. What is meant by the customer's perspective of quality? The producer's perspective? How do these perspectives relate to customer-focused quality?

The customer's perspective of quality, called fitness for use, is how well the product compares to what the customer expects from it.

Producer's Perspective: two aspects of the producer's perspective are quality of design and quality of conformance. It focus on the design requirements.
customer-focused quality, which is the way customers view or feel about a product.

2. What are the eight dimensions of quality as identified by Garvin? What are other possible dimensions of quality? Select three products and discuss how the dimensions apply to each

1. Performance: 2. Features: 3. Reliability: 4. Conformance: 5. Durability: 6. Serviceability: 7. Aesthetics: 8. Perceived value: Other possible dimension of quality is service quality.
Derde vraag doe je maar mooi zelf.

3. What is the meaning of quality of design? Quality of conformance? Quality of performance and service?

Quality of design: quality of design represents the ability of a product as designed to satisfy or exceed customer requirements.

Quality of conformance: Quality of conformance is the term used to connote that the manufactured product consistently upholds the requirements as set in the product design

Quality of performance and service: can be shown in a TQWM framework. In this schedule, an overview of the relations between the different departments is given. These departments are Marketing sales and finance / product design and manufacturing design / purchasing and suppliers / production management and frontline workers / customer service

4. In what ways is employee involvement and employee ownership in the quality concept cultivated in TQM organizations?

Total quality management emphasizes the role of the employee by increasing the frontline worker responsibility. Besides this responsibility, it is continuously focus on process orientation.

5. What is concurrent engineering?

Concurrent engineering: in concurrent engineering the functional areas of design and manufacturing work as a team to concurrently create a product design that will satisfy the customer and address issues regarding the product's manufacture

6. What is design for manufacture and assembly (DFMA)? What is the relationship between DFMA and concurrent engineering?

DFMA (design for manufacture and assembly) considers features in the product's design that will simplify its manufacture and assembly, and, usually, simplify the manufacturing process, reduce manufacturing costs, and improve manufacturing quality

7. What is meant by Six Sigma? What is the statistical interpretation of Six Sigma?

Six sigma: Six Sigma programs provide direction and priority in quality improvement and are a natural partner to continuous process improvement in lean production. Statistical Interpretation: The word sigma refers to standard deviation.

8. Describe the steps in the DMAIC procedure.

Define, measure, analyze, improve and check. See book for further description.

9. Describe SPC. What is the main purpose of SPC?

Statistical process control (SPC) is a methodology for establishing and maintaining high-quality output.

10. What is a control chart? What are its main features and how is it used?

Control Chart: The tool used to monitor a process for potential change is the control chart. The features of the control chart are a center line and upper and lower control limit, all of which are computed from sample data and statistical formulae. The process is considered in control if the results are around the center line.

11. What does it mean for a process to be stable?

A stable process is one where fundamental features of the process are repetitive and unchanging. In a stable process the mean and standard deviation are unchanging

12. What does it mean for a process to be capable?

A process that is behaving as it should is called capable, which implies that with rare exceptions it produces output that conforms to specification requirements.

13. Many large corporations have demonstrated their commitment to TQM by requiring that every employee attend seminars on quality concepts, and know the tools for problem solving and SPC. Everyone belongs to a problem-solving group, and groups are expected to meet once a week. Comment on this approach to TQM.

Ja goeie. Lekker mee door gaan

14. What is quality at the source? What role do frontline workers have in quality at the source?

Quality at the source is a lean manufacturing principle which defines that quality output is not only measured at the end of the production line but at every step of the productive process and being the responsibility of each individual who contributes to the production or on time delivery of a product or service.

15. What are the difficulties in implementing TQM? What distinguishes companies that say they are TQM companies from those that are TQM companies?

Two difficulties were given: lack of long-term management commitment and leadership and lack of empowerment of frontline workers. Die tweede vraag kan ik niet vinden.

16. Why be a TQM and lean company? Why not be lean only?

Lean is a process broadly aimed at increasing value added and eliminating waste, and includes techniques geared toward those things. But eliminating waste cannot be achieved solely through efforts directed at manufacturing. Process improvement and waste reduction require a companywide, integrated effort that includes all functions —marketing, sales, finance, product engineering, purchasing, customer service, accounting—as well as manufacturing, which is the emphasis of TQM and its companywide commitment to quality. While lean production seeks improvement through reduction of waste, TQM seeks improvements that matter most to customers.

5. Small Lot production

1. What factors are included in order and setup costs? What about holding and carrying costs give examples. Why is it difficult to attach a precise dollar value to these costs?

Setup costs, S , is the cost of preparing to make a batch or of ordering a batch. When applied to manufacturing, S is the cost of changeover from making one kind of item to another kind. It may include the cost of lost production while a machine or process is being changed and the cost of scrap incurred while adjusting the machine.

Order cost (S applied to purchasing), is the cost of placing and receiving an order. S is a fixed cost, independent of the size of the batch produced or ordered.

2. How does the batch size affect the average inventory?

Lot sizing has a major impact on the efficiency, cost, and flexibility of production.

The lead time will be reduced when batches are small. In general, the smaller the size of a job, the less time the job ties up an operation, and the less other jobs at the same operation have to wait to be proceed.

Carrying cost will be reduced when batches are small. This because WIP is proportional to production lead time. With small inventories, items are easier to keep track of so inventory records can be kept more accurate.

Quality will increase when batch sizes are smaller. Defects are often batch specific; they result from an incorrect setup or method unique to the production batch.

Flexibility will increase if the batch size is small. Large WIP inventory ahead of every operation reduces the ability of a process to adjust to changes in products or demand.

3. Explain the tradeoff between setup cost and carrying cost.

As suggested in the LFL and POQ examples, there is an inherent tradeoff in inventory systems between setup costs and carrying costs; as one goes up, the other goes down. If a few large lots are produced, setups will be few and overall setup costs low, but it will take longer to deplete the lots, so carrying costs will be high. If many small lots are produced, the carrying costs will be low because each small lot will be used up quickly, but the overall cost for setup will be high because of the many setups.

4. Comment on the following statement: The EOQ and EMQ models are not appropriate for determining the batch size of items processed through a sequence of multiple operations, but they might be appropriate for determining the batch size of items fully produced at one operation or procured from a supplier.

This is true, the EOQ model gives the lot size that most economically satisfies demand for a given time period; that is, it minimizes the sum of setup costs and carrying costs over a specified period. The economic manufacturing quantity (EMQ) also takes into account the production rate p . The EMQ model is more applicable than the EOQ model for determining the lot size of production batches.

5. What factors and costs do the EOQ and EMQ models ignore?

1. Demand is constant and continuous
2. Demand is independent
3. Setup (order) costs are fixed, regardless of lot size.
4. Unit carrying cost, H , is constant; total carrying cost is a linear function of lot size.
5. The entire lot is produced or delivered all at once.
6. Unit purchase price of manufacturing cost, P , is fixed, regardless of lot size (no quantity discounts or production economies).
7. Stockouts (or subsequent backorders) do not occur.

Not many companies have the accounting finesse to determine setup, order and carrying costs accurately.

6. How does the process batch size affect quality?

Quality will increase when batch sizes are smaller. Defects are often batch specific; they result from an incorrect setup or method unique to the production batch.

7. Discuss the effects of reducing the size of process batches.

Lot sizing has a major impact on the efficiency, cost, and flexibility of production.

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8. Discuss the effects of reducing the size of transfer batches.

Many of the problems with large process batches come from the fact that a large batch takes a long time to produce, which ties up the machine or operation, prevents it from doing other

jobs, and causes WIP inventory to build up both in front of and behind the operation. This increases the time other jobs must wait at the operation, which increases production lead times for all jobs. One way to reduce production lead time and WIP for process batches of any size is to use lot splitting and move items in smaller size transfer batches.

In general, using transfer batches that are smaller than the process batch reduces production lead times because items finished at an operation wait less time before they are moved to the next operation.

9. In general, at a bottleneck operations should the process batch size be large or small? Explain. (assume a setup between each batch, and that larger process batches can be formed by combining multiple job orders for identical or similar items.) Should the transfer batches at a bottleneck be large or small? Explain.

The process batch size at a bottleneck should be large. So that the setup time per unit is low and the machine can keep producing. The transfer batches should be small. This will keep the bottleneck (and also the following operations) running.

10. If the setup times between products at a bottleneck operation are negligible, should job orders for identical or similar items be combined to increase the process batch size or should the jobs be processed separately? Explain.

??

Although the setup times are negligible, I think the job orders should be combined to increase the process batch size. It still is the bottleneck and each (negligible) setup time will still increase the overall lead time.

11. Suppose an operation has excess capacity (i.e., it is not a bottleneck); however the setup time between batches is not insignificant. Should process batches be large or small? What determines the size of a process batch?

Smaller (but not too small), this will have a positive influence on the carrying costs, WIP, quality and flexibility. The company has to look for ways to reduce setup time.

Note: the key factor in the feasibility of small lot process batches is setup time. Shorter setup times enable smaller production batches.

12. Discuss the reasons for carrying buffer stock. Give examples illustrating why buffer stock is carried between stages of a production process, and why it is carried for incoming materials.

Buffer stock is the excess inventory held between stages of a process to avoid running short. The two reasons for carrying buffer stock are uncertainty about demand and uncertainty about lead time.

A buffer stock could be placed for a bottleneck, to protect it from running out of material. This is a manner to save the minimum throughput time.

It could also be used for incoming materials (when a supplier has a long delivery time).

13. Discuss how the following costs can be reduced:

a. Order placement and processing

Order costs are analogous to setup costs in that they are independent of the size of the purchased quantity.

One way to reduce order costs is to move some of the responsibility for purchasing department to the production department and even to the shop floor, where supervisors and frontline workers place the orders. This reduces purchasing overhead costs and order lead times.

Another way to reduce order costs is to reduce the number of suppliers and to develop standard agreements and trusting relationship with them. Additionally, suppliers and customers in a partnership work together to determine ways to mutually reduce ordering, transportation, and receiving costs. The two parties can agree on standardized containers so that incoming items can be moved directly into the customer's point of use rather than being unpacked and transferred to different containers.

In many cases the vendors also take responsibility for determining the customer's order requirements. With each delivery, the driver checks the customer's stock level and determines the size of the order quantities for subsequent deliveries.

b. material handling

Reorganizing the facility layout to reduce material transfer distances and cost.

Relocating materials to the point of use. This will reduce the double handling and double accounting that occur when materials are put into stockrooms and then later withdrawn and moved to the places where needed. With point of use, materials are moved directly from the receiving area to operations on the shop floor.

c. Shipping and delivery

To make small sized deliveries from suppliers practical, the per – unit transportation cost must be reduced. One way to do this is to use smaller trucks and vans for short-distance deliveries or to use large trucks, but visit more customers on each trip.

When transportation costs stay the same or even increase slightly, smaller shipments result in overall savings from smaller inventories of incoming and finished materials, higher-quality materials, and better responsiveness to short-term demand.

6. Set-up time reduction

1. Describe ways that companies have traditionally dealt with equipment setup. What are the advantages of each? From a lean perspective, what are the drawbacks?

Companies have traditionally sought to keep the number of setups to a minimum. After all, a setup operation takes time, costs money, and produces nothing.

Most traditional setups require a specialized knowledge of machines, tools, fixtures, and materials, and special skills for changing over and adjusting equipment to meet product requirements. As a result companies assign setup operations to skilled workers with the title 'setup person'.

Companies could reduce the number and types of setups by making products that are largely the same.

The number of setups required to process a list of jobs can be reduced by scheduling the jobs in a sequence so that all jobs with similar or identical setups are produced back to back. This method uses similarity of setup as the criterion for work scheduling.

Increasing the production lot size can mitigate the relative effect of setup time on each production unit. The larger the lot size, the smaller the effect of the setup on each unit.

2. Discuss the cost, quality, time, and flexibility ramifications of reducing setup times.

Benefits of simplified setups:

1. Costs; when changeover time is small, batches can be produced on a daily basis, which, in turn, eliminates WIP and finished goods inventory investment. Simpler setups reduce the required labor hours and skill level for setups, and eliminate scrap produced during the setup. As a result, setup related costs are reduced.

2. Quality; as a rule, people make fewer mistakes when they follow simpler procedures. That applies to setup procedures, too. A mistake during setup has potential to cause defects in every unit in a batch. Simplifying a setup procedure can thus improve product quality.

3. Time; ??

Simple setups do not require special skills and can be done when needed by the equipment operators, which in turn reduces their idle time. This gives setup specialist more time to devote to working on technically difficult setups and on ways to improve setup procedures. For instance, there is a clear benefit when an operator can do a setup in just 10 minutes that used to take a specialist 90 minutes.

4. Flexibility; with quick setups, manufacturing has more flexibility to adjust to changing products and changing levels of demand or to changes in demand for different products.

3. What is the difference between internal and external setup procedures? Give examples of both.

An internal step is a step that must be performed while the machine or operation is stopped; internal setup time is downtime.

Example: Remove old die. Attach new die.

External step: is a step that can be performed while it is running.

Example: Get new material. Return old die to storage.

4. Suppose that in the setup procedure shown in Figure 5.1 step 5 takes 25 minutes and step 6 takes 15 minutes. How long should the setup procedure take?

Step 5 is external (increases from 15 minutes to 25 minutes) → 0 extra minutes are added.

Step 6 is internal (increases from 12 minutes to 15 minutes) → 3 extra minutes are added to the total time.

The total time increases from 42 minutes to **45** minutes.

5. List and discuss the setups in Shingo's SMED methodology.

Stage 1: Identify Internal and External steps.

The primary focus in setup time reduction is not on total setup time (internal + external) nor on setup labor time, but on internal time alone. While reducing total setup and labor hours is desirable, it is only of secondary.

Learning the setup steps and classifying them requires an actual study of each setup procedure. The study is performed by detailed observation of the procedure and may involve stopwatch analysis of the steps, worker interviews, and video recording the operation. During the analysis certain steps might be identified as obsolete or no longer practical for the current application. Such steps are classified as unnecessary and eliminated from the procedure.

Stage 2: Convert Internal Steps to External

The initial principal objective of setup improvement is to reduce internal setup time. The more setup steps, decisions, adjustments, whatever, that can be done on external time, the better. All internal setup steps should be reexamined closely to determine if any of them could be reclassified as external.

Stage 3: Improve All Aspects of the Setup Operation

The emphasis in the setup should be on decreasing internal task time. Reducing setup time focuses on simplifying and standardizing procedures on existing equipment. Although procuring new equipment that requires little or no setup is an option, it is often less costly and more effective to improve the setup on the existing equipment.

Setup reduction should reduce setup time to the point where setup is no longer an issue in lot-size determination, that is, to the point where the cost associated with setup is minuscule compared to inventory carrying costs. For that to happen, the rule of thumb is that a setup

should take less than 10 minutes and involve no more than a single-touch procedure. Shingo has dubbed the latter part of this goal OTED for one-touch exchange of dies. The setup procedure should be simplified enough so that eventually machine operators can do it themselves.

Stage 4: Abolish Setup

Beyond OTED comes the ultimate setup improvement: complete abolishment of the setup.

Some ways to eliminate setups:

1. Reduce or eliminate differences between parts (design for manufacture).
2. Make multiple kinds of parts in one production step; for example, form two kinds of parts from the single stroke of a press.
3. Dedicate machines to making just one item.

If the setup is abolished it is not necessary to have gone through the other steps. The goal of setup reduction is to maximize the transfer of setup responsibility to operators, to minimize machine downtime, and to abolish setup.

6. How does the external setup time constrain the minimum process lot size?

The external setup time may not take longer than the process itself. Otherwise the operator is still busy with external setups, while the machine stopped.

7. What is the purpose of a setup checklist? How is it used? How is it created?

The checklist should provide all necessary information about the setup: the setup steps and their sequence; the fixtures, tools, dies, and other items required; numerical values of all settings, dimensions, and measurements for the machine, tools, fixtures and materials; and specifications of the product.

One purpose of the setup checklist is to make explicit the logic of the setup procedure and aspects of it that might need improvement.

Another purpose is to ensure that no steps, parts, tools, or requirements are overlooked in the setup procedure.

8. Give industry and household examples from your experience of devices that simplify installation and attachment, and that eliminate trial-and-error adjustment. Give examples from your experience of situations where trial-and-error adjustment could be eliminated by simple means.

- Making use of clamping devices.
- Fixed-Position Holders on Machine.
- Making use of shims.

9. On what operations should the first setup reduction efforts focus?

Each setup-reduction project must be undertaken in the context of a larger, ongoing setup-reduction program. This is because a few, standalone setup improvements will have little effect. In general, reducing setup times at an operation increases the operation's throughput. However, unless the operation is a bottleneck that has starved downstream operations for work, increasing the operation's throughput might only serve to speed up the growth of WIP waiting at downstream operations. Thus, the eventual focus of setup reduction should be plant wide.

Setup reduction has the most immediate impact at bottleneck and near-bottleneck operations because there the setup time delimits production capacity. As setup times are reduced, more time is available for production. Eventually if the setup reduction is great enough, small batch production becomes possible, even at operations that were formerly bottlenecks.

10. Who should participate in the setup reduction team?

This team should include people who know the most about the machine and the existing setup, who will be affected by changes, and who have ideas for improvement; usually, these are the setup people and machine operators.

The team should also include others, for example, tool and die makers, or industrial and manufacturing engineers, depending on the analytical and technical expertise required for the project.

7. Total Productive Maintenance

1. List the consequences of equipment malfunction and breakdown in terms of cost, quality, safety, and lead time.

Shortened machine life, high repair cost, scrap / rework, injuries, inventories, high production cost and schedule delays.

2. Contrast the following kinds of maintenance: repair, preventive, total productive.

With breakdown repair, equipment is only cared for after it breaks. It leads to a lot of waste. Preventive maintenance (PM) is the practice of tending to equipment so it will not break down. Total Productive Maintenance (TPM) goes beyond PM by maximizing the potential of equipment. The goal of TPM is to upgrade equipment so it performs better and requires less repair. To do so many departments are made responsible for equipment maintenance.

3. How does investing in maintenance help an organization?

It will reduce waiting time, improve productivity, reduce defects, increase morale, improve safety and reduce cost (in the long term).

4. What are the six sources of equipment waste?

- Downtime (from equipment setup)
- Downtime (from breakdowns)
- Idling / stoppages (equipment is running, but there are problems downstream or upstream)
- Reduced speed of operation (equipment is running, but is worn out or needs adjustment)
- Reduced yield (because of defects)
- Reduced yield (because of non-optimal operations i.e. start up time after setup or breakdown)

5. Define and give examples for each of the following terms: maintainability, reliability, availability, equipment efficiency, equipment quality rate.

- Maintainability: the effort and cost of performing maintenance.
- Reliability: the probability that equipment will perform properly (under normal circumstances).
- Availability: the proportion of available time that equipment is actually able to perform work.
- Equipment efficiency: how well a machine performs while it is running.
- Quality rate: an index of the equipment's ability to produce non-defective output.

6. What is the difference between repair time and downtime for repair?

Repair time is the actual time spend on repair. Downtime for repair is the time from when the failure is first discovered until the equipment returns to operation. It also includes additional time such as waiting for the maintenance crew to start the repair.

7. What are the five principal causes of equipment problems?

- Deterioration: parts wear out over time, neglected parts wear out faster.
- Equipment ill-suited for purpose: using equipment for what it is not designed.
- Failure to maintain equipment requirements: dirty, dusty, etc.
- Lack of skill of operators: crew is unskilled in maintenance and does not recognize potential equipment problems.

8. What is the failure pattern of a system or component?

Failure occurrences spread over time, often visualized with a figure. It displays the likelihood of failure at certain moments in time. I can help determine the cause of failure.

9. What is the bathtub function? What is the burn-in period? What is the wear-out period? How does knowledge about these help in maintenance scheduling?

- Bathtub function: a kind of failure pattern that have a burn-in period and eventually wear-out. Resulting in high failure during infancy as well as old age.
- Burn-in period: an early period in the lifecycle of equipment in which failure is relatively high.
- Wear-out period: the period at the end of a lifecycle where old age will cause failure.
- Recognizing the type of failures certain equipment is prone to can help determine when to schedule preventive maintenance to ensure the equipment will not breakdown.

10. Why should a component that is well functioning be replaced?

If the component is believed to be approaching the end of its estimated useful life (based on historic failure patterns) then replacing it will help ensure availability, efficiency and quality output for the machine it belongs to.

11. Where does probability data come from for determining failure potential?

Statistical analysis of failure of the item itself. To learn this we must allow the item to fail many times.

12. What is meant by predictive or condition-based maintenance?

When it is difficult / impossible to determine useful life, traditional PM is replaced by condition-based maintenance. Periodic inspections are held to determine the state of components and equipment. When impending problems are detected, remedial actions are scheduled.

13. A warning light on a copier indicating the toner level is low is an example of a device for condition-based maintenance. Give some other examples

- Using X-ray to find cracks in equipment.
- Measuring the temperature of a machine to determine its condition.
- Measuring the output (speed, quality) can determine its condition.

14. Discuss at least five common practices in preventive maintenance programs.

- Maintain normal operating conditions: ensure the machine runs under prescribed conditions.
- Maintain equipment requirements: ensure the machine is used as described.
- Keep equipment and facilities clean and organized: for dirt gets into machines very easily.
- Monitor equipment daily: to ensure signs of problems are promptly detected.
- Schedule preventive maintenance: create a little downtime to prevent large downtime.
- Manage maintenance information: to know the state of all machines and use that in decision making with regards to maintenance and investment in new equipment.
- Use predictive maintenance: schedule inspections if useful life is unknown

15. What role do equipment operators serve in PM?

Help determine state of equipment, keep equipment clean and perform basic maintenance work.

16. Describe the meaning of in-house equipment restoration and redesign. What potential advantages does it offer over outsourcing of equipment restoration and redesign?

Obtain a better understanding of your own equipment needs by being responsible for the restoration and redesign of the equipment you use. By up keeping and renovating equipment you obtain an understanding that allows you to alter the design of equipment to suit the unique needs of your company. You become less dependent on outsiders who lack knowledge of the company itself. So in-house restoration is actually more effective than outsourcing.

17. What steps are taken in TPM to eliminate human error in equipment operation and maintenance?

Education / training, foolproofing and improved maintenance procedures.

18. In the implementation of companywide TPM, what roles do the following groups serve: steering committee, TPM program team, target area committees.

- Steering committee: guide the TPM implementation by formulating TPM policies, strategies and give advice. A top-level manager should serve on the committee and be the TPM champion.
- TPM program team: coordinate the implementation activities and provide oversight.
- Target area committee: determine how much improvement is needed in every machine (within target area). Decide which PM tasks are assigned to operators, train operators and determine which equipment requires predictive maintenance.

19. Discuss the difference between centralized and decentralized maintenance staff. What are reasons for decentralizing the maintenance function?

- By decentralizing the maintenance staff they become more familiar with the production process, operators and better understand their equipment needs. This removes interdepartmental barriers (FUNCTIONAL SILOS!!!) and eventually they are no longer considered outsiders. The drawback is that equipment problems are not universally

dispersed so a decentralized maintenance staff is either overworked or underutilized. So only high-maintenance areas should have a decentralized staff.

- A centralized maintenance function remains necessary for plantwide issues that don't fall within a particular department. This function is responsible for storing important parts, monitoring the overall TPM program and identify best practices and use the as benchmark for improvement.

8. Pull Production Systems

1. Describe the fundamental differences between push production systems and pull production systems. How are they the same?

- Differences: in push production a production schedule is made for all operations, in pull it's only for the last operation and the rest is controlled by a kanban (pull) system). Order priority is determined by shop floor in a push system and by order categories in pull.
- Similarities: Batch size is determined by central planning in push and dictated by kanbans in pull. But the kanban size are based on planning of final operation thus essentially by central planning. When there are multiple orders within the highest order category then shop floor decides which order goes first, just like in pull. Both systems can handle rush orders but require special policy to do so, neither system has an easy build in mechanism to deal with it.

2. What are the necessary conditions for pull production?

- Decentralization of planning and control responsibilities to frontline supervisors and teams.
- Emphasis on meeting demand (required utilization) not overproduction (maximum utilization).
- Motivation to reduce in process inventory and remove unnecessary stock.
- Preventive maintenance efforts must be ongoing and geared towards eliminating breakdowns. Breakdowns will halt the production flow in pull since it has minimal buffers.
- Setup times must be small, otherwise pull cannot produce any variety at all.
- Plant layout must link all operations into the process for smooth flow. All operations must produce at the rate of the final stage of the process.
- Production schedules must be somewhat uniform, large variations must be levelled (max 10%).
- Workforce development must be geared towards cooperative attitudes and providing opportunities to expand skills and attain problem solving capabilities.

3. Discuss the relationship between pull production and demand stability and variation.

There is hardly any inventory within a kanban-based system and the output is planned ahead of time. So pull production works best when demand is stable and continuous. Only then can the required flow be achieved and the benefits of pull production achieved. For the same reason a pull system can't produce a high degree of variation. Production is standardized and made as efficiently as possible through repetitive production that fits the continuous and stable demand.

4. Under what situations is pull production inappropriate?

- The main reason: demand is unknown or unstable.
- Final production can't be levelled because of adjustments, testing, trials, etc. This mimics the effects if unstable demand and makes pull inappropriate.
- Operations need to be started in advance of kanban signal because of lengthy operation, difficult setup, etc.
- High product variety making demand for each option small and unstable (and modulization is impossible).
- High (unavoidable) defect rate, leading to too many interruptions of the production flow.
- Products must be produced as batches for quality control / certification reasons.

5. Describe the reorder-point system. How is it different from a Kanban system? How is it the same?

The reorder-point system places an order when inventory falls below a critical level. The remaining stock is enough to meet demand until replenishment arrives. There are many variations of the reorder-point system. Kanban can be viewed as a variation where the ordered quantity is fixed (the size of the kanban). Through this the concept is simplified for the workers. It also uses bins to visualize the 'critical level' but this is not exclusive to kanban.

6. How is pull production more than just a way of controlling inventory?

Through pull production the inventory is kept at a desired level. Through kanban it also authorizes production in upstream operations. In this way it is also an alternative to scheduling.

7. List various ways for authorizing material movement or production in a pull system. How does the proximity of operations determine which of the ways are most appropriate?

- Alternative ways that function like kanbans: wheeled carts, kanban squares (designated floor space), golf balls and electronic kanban.
- Some ways work best when operations are back to back (kanbans), when operations are further apart it isn't doable to move around bins and other ways are used (golf balls). When operations are even further apart, non-physical ways are applied (electronic kanban signals).

8. Explain how some pull systems operate without the use of cards.

Sometimes a system is simple and doesn't need cards, a simple empty container is signal enough. Other times the information is written on the container itself and cards are not necessary. Or operators become so familiar with the procedure that they know what needs to be done. Other times alternatives to cards are used such as golf balls that signify the need for production (with the colour of the ball representing the desired amount).

9. For the following, indicate whether MRP or Kanban would be more effective for production control.

- a. An automobile assembly plant that produces 10 car models. -> KANBAN
- b. A shop that produces a large variety of custom-ordered products. -> MRP

- c. An assembly operation that involves 20,000 part numbers. -> MRP
- d. An assembly operation that involves 50 part numbers. -> KANBAN
- e. An assembly line plant where all parts are outsourced. -> KANBAN

10. What is the role of Kanban in process improvement?

In the lean philosophy inventory is the root of all evil. Inventory is kept in kanbans. By removing kanbans from the production process the problems in the system are exposed. Kanbans allow an organization to improve a process by slowly decreasing the amount of inventory, find causes of exposed problems and fix them. Afterwards the amount of kanbans can be decreased further.

11. Four kinds of signal and control mechanisms are (1) kanban cards and general-purpose containers, (2) special purpose containers that had only one kind of item, (3) kanban squares, and (4) an automated conveyor system with no containers. Explain which is best for each of the following situations.

- a. Final assembly of MP3s. -> KANBAN, repetitive and small items.
- b. Production and finishing of metal castings of common parts that involve casting, tumbling, heat treatment, and machining. -> special purpose containers, includes extraordinary conditions.
- c. Repetitive production of kitchen and dining room furniture. -> kanban squares, doesn't fit in bin.
- d. Replenishing stock of parts supplying an assembly line. -> kanban
- e. Producing small batches of replacement parts in a five-operation process. -> Kanban

12. Explain how each of the following works. Explain when one or the other is necessary. When are the two systems equivalent?

- (a) a two-card pull system: in a two-card system there is a card that signals the need to move a container downstream and a card that signals the production to fill a container. This way there is tight control over buffer inventories.
- (b) a single-card pull system: either one card is used to signal the movement or to signal the production. The C-kanban signals movement. When this card is taken from an empty bin and brought upstream and placed on a full bin and brought downstream. The upstream operation produces on a MRP schedule. The P-kanban signals production. In such a system the move time is almost zero and so only signals to produce need to be given. So when there is no movement needed the two systems become equal.

13. Explain the purpose of signal kanbans for production and material movement. When are signal kanbans used?

When one kanban isn't enough for production a Production-signal (SP)-kanban can be ordered which is multiple P-kanbans combined. This can be necessary when changeover time is long and thus additional stock is needed to overcome it. A material signal (MS)-kanban can be used to move all the kanbans produced with the SP-kanban at the same time.

14. The assembly shop of a manufacturer of large air conditioners for commercial and industrial buildings has numerous units at various stages of completion, most sitting unattended for lack of parts. As parts and subassemblies arrive from other departments, assembly workers install them. Is this a push or pull system? Suggest how the system might be improved.

It is a push system as parts get pushed downstream as they become available. The system can be improved by letting the downstream (assembly) operation determine when what is needed using a kanban (pull) system.

9. Focused factories and group technologies

1. Different ways of doing work

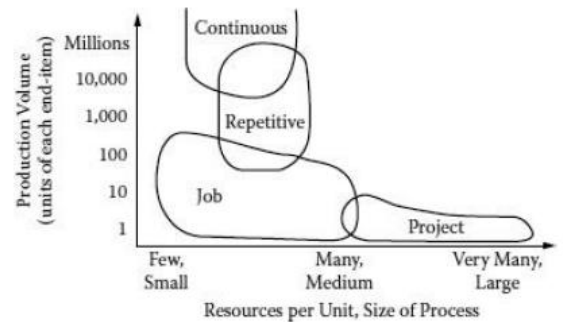
Project: Unique, large scale, 1 or few end items, tailored to fit (ships, buildings)

Jobs: small volume, small scale, 1 or few identical items, custom or handcrafted (jobshops)

Batch: several or many identical end items from for example a jobshop

Repetitive: high volume, flow shops, with few interruptions (cars, refrigerators)

Continuous: fluids, actually flow through the process



2. Question: going for efficiency or variety?

Dependent on facility layout

Fixed position: hard to move like ships and aircrafts, custom produced by craftsmen

Process (functional) layout: similar activities are clustered into the same area. + production can be increased/decreased easily (flexible). + New products can be added and old ones dropped. – possible complexity and waste (many routing). – considerable effort in scheduling, tracking, routing. – High WIP. Possibility into more lean: small batches, reduce setup time, standard operation, foolproofing. Difficult to eliminate waste.

Product layout: repetitive or continuous (production line, assembly line). + quickly extra production (because of scheduling). + no/little inventory. + Throughput time almost as production time. + much efficiency. – The cost for investment are big. – less variety is possible.

3. See question 2.

4. Product family

When products are grouped and classified in terms of the same material, overall dimensions, and require the same machining, tooling and routing it's a product family.

5. Focused factory

When there exist sufficient combined demand for products in one family (see Q4), then a focused factory can be set up: product layout (clusters for repetitive production). It is also called a plant in a plant or a subplant. Most focused factories achieve efficiency through repetitive production of a product family. However, even focused factories that produce in small-and mediumsized batches are somewhat efficient, and are certainly better in terms cost and quality than job shops. One reason is because the workers and manager in a focused factory are more focused; they have greater control over planning, scheduling, and controlling output, and over costs and quality. Small-sized focused factories (small physical size, few workers) tend to be more efficient than large ones because employees are more directly involved, know the overall process better, are more motivated, and a single supervisor or

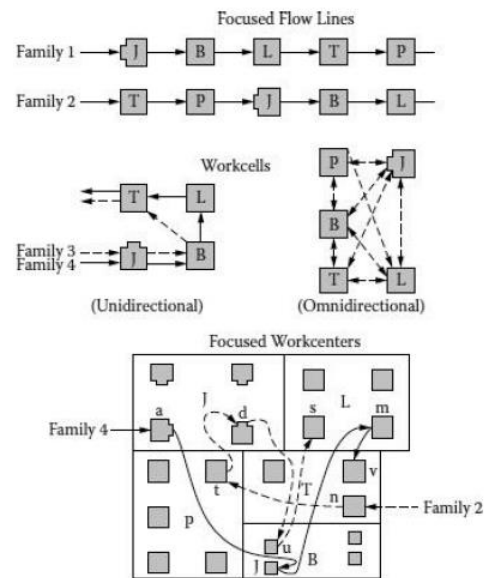
manager can oversee everything. In small subplants the physical distances are also small, which reduces waste from material handling, communication, and work coordination.

A focused flow line is similar to a product layout, except it can produce all the parts in a part family. Typically a conveyor, gravity slides, or an automated transfer system connects the operations.

A workcell has more general application. A workcell is actually a dedicated job shop with features of a product layout, except it is capable of economically producing items in small batches, even of size one. Ideally the routings within a workcell are unidirectional to allow parts production on a flow-line basis.

A focused workcenter is similar to a process layout in that machines are clustered into areas by functional type, except that in a focused workcenter certain machines in each functional area are dedicated to producing only certain part families. A focused workcenter arrangement makes sense when each department has multiple machines that are difficult or impossible to move, or where product volumes and product mix change so fast that it is impractical to move machines into focused flow lines or workcells.

How to use a focused factory: Either grouping by product/parts that are the same or by the same operations (machines, workers, tools).



6. See Q5, first sentences of the paragraphs.

7. Group technology (GT)

Ceteris paribus (same conditions), simpler is better, more standardized, more efficient. But no reduce in variety offered to the customer bus less variety in production. It's about identifying and exploiting similarities in production. It's always better than a jobshop.

Two way to use GT: *Coding and classification* (Drawbacks: expensive, complex if no data exists) or *clustering*. Two types of clustering: VPRA (visual process routing analysis) to focus on products with the highest volume and PFA (Product flow analysis) grouping in parts/machines families.

8. Polycode, monocode, hybrid code

Not too difficult.

Difference in 0011 (0 or 1 = hierarchical monocode) or 93823 in chain poly (different materials) or 396-56098-2722 the first three digits and last four digits might use a monocode structure, while the middle five use a polycode. Hybrid codes are versatile because they can be tailored to represent both general attributes of parts as well as process-specific or company-specific features.

9. See Q7

10. PFA and visual techniques

Visual too simple (only for highest volume). PFA is a (more rigorous) method for focuses on machine and product (parts) similarities (and then clustering). PFA uses for instance BOA (binary ordering algorithm).

PFA techniques are more efficient than GT coding for forming workcells because they identify product families solely by processing requirements, not by appearance or physical features. PFA techniques are more versatile than the visual method because they permit analysis of larger numbers of products and machines, and allow for other considerations such as constraints on group size and machine availability.

11. PFA limitations

A drawback of PFA techniques is that they do not guarantee answers that can be implemented. Because the PFA algorithm ignores aspects of manufacturing such as product demand, operations sequence, number of each kind of machine, availability of machines, machine utilization, transport costs of groupings, problems of exceptional machines and products, and many others, the groups are at best provisional, and final decisions about grouping and layout require considerable additional analysis.

12. Major advantages and disadvantages of focused factories

Focused factories offer advantages over job shops and flow shops. Compared to product layouts, focused factories require less capital investment and are significantly more flexible. Compared to the process layouts, focused factories are significantly less wasteful (WIP reduction, less material handlings, less floor space required, less overall time setups, less quality-related problems, reduced overhead costs).

Disadvantage: potential for low machine utilization.

From a management perspective, a big disadvantage of focused factories is that they require considerable effort and expense associated with designing and implementing them. Simply moving equipment into groups is not enough. Workers must be cross-trained and taught to work in teams, individual machine setup times must be reduced, and equipment reliability increased. Also, reassigning workers and equipment is disruptive to ongoing operations. Suffice it to say, implementing focused factories is a long-term commitment and a big change to the way many organizations are accustomed to operating.

10. Workcells and Cellular Manufacturing

1. Opposite direction walking in a cell

Example:

Suppose that a cell forms parts A, B, C, and D in a five-machine process and that demand for the parts from a downstream cell is in one-unit quantities. To conform to the demand the cell must be capable of producing parts in batches of size one. Between each pair of workstations is a rack large enough to hold one unit each of every part A, B, C, and D. When the downstream cell withdraws a part from the outbound store area, that is a signal to replenish the part. Suppose a part B is withdrawn from the outbound store. Starting at machine 5, the cell operator takes a part B from holding area d, loads the machine and turns it on. She then goes to machine 4, loads a part B from holding area c, and turns the machine on. She also goes to machine 3, then machine 2, then machine 1, loading the B parts and turning on the machines. Upon returning to machine 5 she unloads the part and puts it on the outbound store rack. This process is repeated every time a part is withdrawn from the outbound store rack.

2. Difference required cycle time and actual cycle time

In the design of a production process, we distinguish between the required cycle time and the actual cycle time: Required cycle time, or takt time,⁶ is the production target rate of a process or operation. It is based on the **demand** for the item being produced. If the demand is 80 units per day, that translates into a required cycle time of $CT_r = \text{Time Available} \div \text{Demand} = 480 \text{ min/day} \div 80 \text{ units/day} = 6 \text{ min/unit}$. To satisfy demand, the workcell, process, or operation must be designed so that its actual cycle time does not exceed 6 minutes per unit. Actual cycle time represents the actual production **capability** of a process or operation.

3. Longer cell CT because of more workers

The unit cost will go up eventually by adding workers. Not a clear link found on how it could result in a higher CT.

No. Workers	a: Direct Labor (Cost \$/hr)	b: Machine Operating (Cost \$/hr)	Unit Cost = (a + b)/ Output (\$/unit)
1	20	80	100/7.98 = \$12.53
2	40	80	120/15.13 = 7.93
5	100	80	180/33.03 = 5.45
8	160	80	240/42.86 = 5.60

The lowest-cost staffing level is now five workers. (Further analysis might reveal a still lower cost at four or six workers had those options been considered.)

4. Cost of workers irrelevant in determine the number in a workcell.

Depends on the demand. The wanted and needed output (so eventually the wanted cell CT and the wanted output).

5. Machine sharing, drawbacks

When multiple areas (cell and noncell) of the plant require the same kind of machines, when there are not enough machines to go around, and when procurement of additional machines is cost prohibitive, then the machines will have to be shared. Two possibilities: a shared machine located between two adjacent cells so that, theoretically, it resides in them both;

a shared machine is located elsewhere and treated as a special operation. The first case is convenient for both cells, but it also interrupts the operations in both. Specifically, a shared machine must be switched over to process jobs from the cells sharing it, and while one job is being processed, jobs from other cells must wait; this further leads to WIP accumulation and increased lead times—just like in traditional batch processing. The second case has the same drawback in addition to requiring greater material handling effort; however, it is the only solution when a machine is immobile and must be shared by many processes.

6. Improvement effort directed at?

See Q2, for required cell CT should be looked at demand, for actual cell CT this should be improved for the actual capacity.

7. Advantages and difficulties in assigning workers in different areas.

Ad: cross trained, more skills, more able to be assigned in more places. Many workers welcome the opportunity to learn and apply a broadened range of skills. In working with incentives per cell, it becomes difficult to focus and to divide the incentive upon task.

8. See Q5

9. MRP modifying for workcells?

The common material requirements planning (MRP)-type planning and control system is an example of a centralized system. With MRP the focus of attention is on order releases and completion dates for all individual components and higher-level assemblies in a product. In contrast, cellular manufacturing focuses attention on completed products, that is, on what goes out of the cell, not on what is happening within it. Unless modified, all of this order-release information from an MRP system about intermediate (within-cell) operations is of no use in cellular manufacturing.

10. Production planning and control simplified

Organizations implementing workcells usually already have centralized planning and control systems in place, so ways must be found to adapt them to the control procedures of workcells. Because workcells themselves have virtually no planning or forward-looking capability, they depend on a system such as MRP for future planning and order entry. It can also easily be done by Kanban, so less use of MRP needed.

11. Impacting role of workers

Implementing workcells requires that job roles, responsibilities, and relationships be redefined. The roles of workers are expanded, teamwork is emphasized, and production output and compensation measures are group oriented. Workcell implementation usually involves considerable worker training as well as modification of performance appraisal and

pay systems. As a result, many or most of the human resource policies and practices traditionally applied in shop settings require some attention.

The most evident change that comes with cellular manufacturing is to the role of the frontline shop worker. To take full advantage of workcell production methods, shop personnel must be empowered. The locus of production-control decisions must be moved from functional support departments to the shop floor. Workers must be made responsible not only for assembly and machine operations, but also for performing tasks previously done by staff workers such as inspection, basic maintenance and repair, job prioritizing, and dispatching.

12. Why measured on a group basis

In workcell operations that require teamwork, however, such plans are usually ineffective because workers who help others have less time to devote to maximizing their own output. Further, in workcell operations the goal is to produce output to meet demand, not to maximize output.

13. Time standards set for a workcell

For a team-oriented process, the fundamental unit of measure must be the group. Since existing time standards are usually based upon one person performing a single task, they are relatively useless in cells where workers move among operations or perform tasks collectively. Thus, workcell implementation usually involves developing workcell-based standards, most of the information for which must be newly collected.

14. Pilot cell

Many companies start workcell implementation using one or two pilot cells and a product family that accounts for a sizable proportion of the firm's volume. A pilot cell should be stacked for success, meaning it should be implemented in an area where it is very likely to succeed. A pilot cell serves many purposes: engineers and workers tinker with it to fine-tune the cell design; managers collect data to assess its costs and benefits; workers train in it, learn to operate machines, do setups, maintenance, and quality-checking; and staff members use it to discover ways to reduce setup times and eliminate quality problems. A single pilot cell can usually be implemented in 6 months, though it can take longer. Assuming the cell performs well, the benefits it demonstrates will open the way to additional cells. When the intent is to establish a series of linked cells in a pull production process, the conversion to cells usually begins downstream and works backward, starting at the final assembly area and successively converting upstream areas into cells.

11. Standard operations

1. Define standard operations. What are the four key components or aspects of standard operations? Explain each.

SO = group of standards that completely define all aspects of a task, operation or process.

4 aspects: takt time, Other word for required cycle time. Because you need a goal to design for. Takt time = Daily time available/Required daily quantity = T/Q

completion time per unit, Completion time per unit is determined for every task and operation, even for nonvalue-added tasks

standard operations routine, The sequence in which tasks and operations are performed.

standard WIP inventory, minimum in-process inventory necessary for the process to function

2. Why should supervisors be involved in developing standard operations? What are the reasons for locating development of standard operations at the shop floor level?

Have the most information about the status of everything and therefore can explain the standards better to workers.

Shop floor level: More accurate, up to date and more accepted by workers than those developed by staff personnel.

3. Discuss the use of standard operations for each of the following: planning, control, worker training, and improvement.

For all it works, better planning if workers think about it, better control if everybody knows what they are doing, they know what they don't know so they accept the training which is necessary and the whole SOR is about improvement.

4. Explain the difference between standard task time per unit and completion time per unit.

Task time is time for individual tasks. Completion is all tasks together.

5. How is workcell production capacity described in the last chapter consistent with production capacity as defined in this chapter?

This chapter: the number of units that can be produced in the available production time.

The factor time is also in workcell production capacity.

6. What does the standard operations routine (SOR) show?

The sequence in which tasks are performed.

7. Why are standard operations never considered permanent?

Ongoing improvement : Monden:, standard operations are always imperfect and operations improvements are always required in a process.

8. Discuss the contents of the standard operations sheet (SOS).

Information about the completion time per unit, the SOR, and standard WIP are combined and displayed in one place → SOS.

9. Discuss how SOR could be used for setup analysis and reduction.

It gives a clear picture on all ongoing 'routines' and where losses are. This is the identification of possible improvements.

12. Quality at the Source and Mistake-proofing

1. Why is it not possible to eliminate defects by solely using SPC (statistical process control)?

There is no worker, machine, or process that does not, on rare occasions, do something incorrectly. Given the random nature of errors and mistakes in production systems, there is the probability that a defect will occur at some time other than during sampling inspection.

2. In self-checks and successive checks, what happens when a worker spots a defect?

SelfC: If the solution is within his capability, he immediately fixes it

Successive C: Whenever a worker detects a problem that originated upstream, he passes the item back to the responsible worker, who then corrects the problem and does whatever is necessary to prevent it from reoccurring

3. Why do managers resist giving line-stop responsibility to workers?

because they show commitment to finding long-term solution to quality problems.

4. Before workers can be expected to take on responsibility and the authority associated with self-checks and successive checks, what assurances and resources must they have?

minimal requirements for effective screening with self-checks and successive checks include setting check targets, enabling quick feedback and action, and management showing consideration and providing support to workers.

5. In generic terms, what are the typical sources of defects? Give examples of each.

1. Inappropriate work processes or operating procedures (e.g., unsuitable heat treatment temperature, incorrect assembly of machining procedure).

2. Excessive variation in operations (e.g., excessive play or wobble in a machine) resulting in machine wear, vibration, out-of-adjustment operation, or lack of specificity in procedures.

3. Damaged or defective raw materials.

4. Inadvertent errors by workers or machines (e.g., an occasional random oversight by assembly workers or a machine occasionally jamming because of dirt build up).

6. In 10 words or less, what is the principle of source inspection?

Find the source and eliminate it.

7. Of the different possible sources of defects, what sources do pokayoke address?

The first three.

8. Describe the difference between control pokayoke, warning pokayoke, and setting pokayoke. Give an example where you might apply each in your work or daily experience (allow yourself freedom to be creative on this).

Control pokayoke: A control pokayoke is a device that shuts down an operation whenever it detects an abnormality

Warning pokayoke: same but doesn't shut down just warn.

Setting pokayoke: are devices that check for or ensure proper settings or counts in a process

9. Word processing software contains many kinds of pokayokes. Where?

Automatic capital, automatic save, warning when shutting down without save, automatic rephrase of incorrect words etc.

10. What is Jidoka? What is autonomation? Describe the relationship between Jidoka and autonomation.

Jidoka is a Japanese term that in one sense refers to automation in the usual way, but in another sense refers to automatic control of defects, that is, a process that has built-in mechanisms that prevent it from proceeding whenever a defect or abnormality is detected.

One form of autonomation is line stop, which, as mentioned, refers to a worker's responsibility for stopping a process when a problem is discovered.

13. Uniform Flow and Mixed-Model Scheduling

What are the major sources of variability in production schedules?

Size of the production runs (batch size) and in the frequency of the runs (batch interval).

In 10 words or less define level production

Producing every product on a regular basis and in a fixed-size batch.

Why level production? What advantages are offered over nonlevel production?

At level production, the batch size and batch interval for a given product are constant. Every operation in the process follows a pattern. This uniform pattern introduces sameness into the daily work of every workcenter, and sameness is easier to handle than change. A more level production schedule result in smoother flow of material, which means less backlogs, less inventory, and shorter lead times. It also give supervisors and workers more time to focus on the work at hand. With fewer distractions from changing workloads, and fewer problems from work expediting and slowdowns, workers have more time to identify areas of the process that need improvement and to develop solutions and implement them.

Discuss the requirements for level production schedules

Three requirements must be met. The first requirement pertains to stable product demand, the other two things a company can and must do: shorten setups and match production with demand.

Continuous, stable demand

Fluctuating demand result in some quantity of finished products that must be held as buffer stock. Keeping buffer stock is only practical when demand is continuous. Recommending inventory is a contradiction to lean principles. To keep inventory small, the company must manage the demand so as to minimize variation (from fluctuating to stable).

Shorten setups

The time to change over a process from one product to another must be short. Lengthy changeovers consume too much of the workday and leave relatively less time for actual production.

Match production with demand

Batch sizes and production run intervals should be based upon product demand and not something arbitrary, like a daily work shift or half shift. The goal of each production run should be to achieve the scheduled output quantity, not to maximize output.

Suppose a monthly production schedule shows that 1,000 product Ws, 2,000 products Ys, and 1,500 products Zs are to be produced every week. Since the same quantity of every product is produced every week, is this an example of level production? If so, why? If not, what must be done to make it level?

Yes, the same amount of each product is produced every week, the requirements imposed on upstream operations will remain the same, week by week. At least for production of parts and components going into W, Y and Z, the schedules for upstream operations will be uniform

and entirely predictable. Uniformity translates into a weekly routine, which means simplified weekly work planning and scheduling for upstream operations.

What is the contribution of sales and marketing, and product engineering to level production?

Schedules are constantly refined as new, more accurate demand information becomes available. Practical, feasible scheduling requires involvement from people in sales, marketing, engineering, production and finance. Planning the production must take into account manufacturing's ability to adjust capacity, as well as sales's ability to provide quick order information and accurate sales forecast. Marketing must be sensitive to the goal of production leveling, and avoid doing anything that amplifies demand variability (promotions etc.). Achieving level production also requires that the parts and components of different products be somewhat interchangeable. Design for manufacture and assemble (DFMA) efforts must consider the effect of product design on production leveling (product engineering).

Explain how MMP results in production leveling

MMP (mixed-model production): production of multiple kinds of products on a repetitive basis, in a mixed fashion on a single line or assembly station. Mixing different products in sequence results in smooth, steady demand for the upstream operations that supply components and materials (production leveling). Maximally mixed ordering gives the smoothest flow because the smaller the batch sizes and interval, the more level the schedule and smoother the flow of materials plantwide (less WIP, shorter lead times).

Referring to the products in question 5, what would the sequences of products be if an MMP procedure was used?

Weekly demand: $W = 1000$, $Y = 2000$ and $Z = 1500$.

1) determine the daily production requirements. Assuming 5 working days per week.

$$W = 1000 / 5 = 200$$

$$Y = 2000 / 5 = 400$$

$$Z = 1500 / 5 = 300$$

2) determine the repeating sequence by first determine the largest integer that divides evenly into the daily requirements of all the products. The largest integer divisor of the three is 100. Then, the ratio becomes 4:3:2. The sum of the ratio numbers is 9, so each repeating sequence will have 9 units: 4 products Ys, 3 products Zs and 2 products Ws. Note that this sequences must be repeated 100 times a day to produce the required amount for every product.

3) determine the product ordering within the repeating sequences. Batches as much as possible separate. In this case: YZWYZYZWY

In a pull production system, what is the relationship between the amount of WIP required between upstream stages of the process and the amount of leveling in the production schedule?

Pull production systems function well only when demand for materials at every stage is smooth and steady. For that demand to be level, production schedules must also be level. In pull production, working with small WIP is the modus operandi. Given that the size of the

batch at final assembly somewhat dictates the size of batches everywhere else in the production system, then to keep WIP small everywhere, the batch size at final assembly must also be small. The smaller the batch sizes and interval and the less the amount of WIP upstream, the more level the schedule and smoother the flow of materials.

For what reasons would a sequence other than the maximally mixed MMP sequence be employed?

If the takt time is very short and the changeover times between products are somewhat long. Or, if the products are packaged two to a container, then producing even numbers might be better because items could then be packaged as soon as they are made.

Describe the following three production philosophies: make to stock, make to order, assemble to order. In each case, where is the end item for production planning purposes?

Make to stock

MTS companies make products in anticipation of demand. Usually these products go into finished goods stock before being withdrawn to fill customer orders. Relatively few products (less than 100) are produced in large volume, and each product typically contains a large number of components. End item for production planning purposes: finished product or group of products that are identical except for minor features.

Make to order

MTO companies produce products in response to actual customer orders, so they carry little finished goods inventory. They can produce many kinds of products each in small quantity. It is impossible to forecast demand for products. When demand is sporadic or every order is somewhat unique, then level production is impossible. If, however, product demand is uniform and somewhat continuous, then level production is possible.

Assemble to order

ATO companies produce subassemblies according to forecast and then combine the subassemblies into unique combinations as requested by customers. A large variety of different products can be produced by combining different combinations of relatively few kinds of subassemblies. End item for production planning purposes: the option for a kind of subassembly.

Contrast the relative roles of the final assembly schedule (FAS) and the master production schedule (MPS)

MPS often portrays anticipated orders or forecasted demand, FAS usually portrays actual orders.

MPS: look far enough into the future so that material and capacity requirements can be anticipated, ordered, and on hand when needed. Result: production lead times are the determining factor in setting the time horizon.

FAS: the time horizon need cover only the time between when all components or subassemblies become available for production of an item and when the production of the item is completed.

Describe how a bill of materials and a modular bill of materials differ. How is each used? Why use one instead of the other?

A BOM is a detailed description of all the materials of an individual product. When a company makes numerous kinds of products, it is impossible to maintain a detailed BOM for each of them. A way to deal with the problem of too much variety is to sidestep it and instead deal with something for which there is much less variety: a modular bill of materials. A modular bill shows available options for a product family. Ordinarily the BOM for a product shows the particular combination of subassemblies used in a product, the modular bill shows all the possible options, but not particular combinations of them. Each box in a figure is a module and represents an option.

Explain the pros and cons of holding in stock higher-level subassemblies (assemblies of subassemblies) versus lower-level subassemblies (subassemblies or modules)

The holding in stock of higher-level subassemblies: less lead time but higher inventory costs.
The holding in stock of lower-level subassemblies: longer lead time but less inventory costs.

Explain what a planning bill is. How is it used?

When the number of possible final products is very large, a type of a modular bill called a planning bill is used for production scheduling. Planning bills greatly simplify production scheduling and improve the ability of production schedules based on forecast to satisfy actual customer demand. It is relatively easy to forecast the percentages of products that will involve different options from sales records and conversations with customers. These percentages are precisely what a planning bill provides. It specifies the amount of materials and subassemblies needed to fill actual orders in MTO and ATO factories, it does not specify the exact amount of each product to produce.

Discuss how current engineering efforts ultimately affect production scheduling procedures

Simplifying products to simplify planning requires the combined effort of people in marketing, engineering, production, and purchasing. Engineering determines ways to design the product to meet the range of wants. They discuss how to achieve the wants through possible combinations of options, then zero in on combinations that will simplify planning and scheduling, minimize production costs and lead times, and be feasible given constraints of production costs, capabilities, and lead times.

What are some rules for reducing waste and improving quality and service in make-to-order production environments?

Make to order: product variety is high and demand for each product is sporadic or one time. Reduce waste done in the following ways: simplify the BOM, use group technology and standard parts, make only what is needed, produce in lot sizes that are small and easy to count, use simple visual control systems, do not overload the shop or particular operations and use days or hours for planning lead times.

14. Synchronizing and Balancing the Process

Explain the concept of synchronization in a process. What is necessary to synchronize a process consisting of a sequence of operations?

Synchronization: aligning the production rates and sequences of all upstream workcenters so that everything arrives as needed at the final stage. Synchronization is achieved by setting the cycle times (CTs) at every upstream operation according to the FAS, MMP or bottleneck schedule (demand rate).

How is a process synchronized when the completion times per unit of the operations in the process are different?

After product CTs have been set, the operations at all upstream processes are structured to produce roughly at those times. The actual CT of each cell can be adjusted by assigning workers and refining tasks such that it does not exceed the required CTs.

Explain (a) the relationship between production rate and cycle time, and (b) their interpretation in synchronous production

CT implies regularity, uniformity, and periodicity in output - a leveled, uniform flow - whereas a production rate implies a quantity produced within a period of time without regard to uniformity. CT of 60 seconds means one thing: one unit of a finished product (or part or component) will be produced every 60 seconds, uniformly, throughout the day. In contrast, a production rate of 60 units/hr can mean many things, including 120 units/hr produced once every 2 hours.

Regarding the production capacity of all operations in a process, what is necessary to base the CT of those operations on the required CT at final assembly?

An assumption in synchronizing a process around the final assembly schedule is that all operations have adequate capacity to meet that schedule, otherwise the process would not be able to keep up with the required pace. In a process that is somewhat long running and stable, it is possible to adjust capacity everywhere such that, in fact, all operations are able to meet the requirements of final assembly with only minimal adjustments. When bottlenecks appear at places other than at final assembly, FAS is no longer the determinant of what flows through the system nor can it set the pace. Scheduling a process based upon the bottleneck constraint is called bottleneck scheduling.

Explain the meaning of the terms drum, buffer, and rope

Drum: setting the pace of the process according to the capacity of the bottleneck (CT of the process)

Buffer: ensuring that the bottleneck is never without work, a buffer of jobs should be maintained ahead of it.

Rope: pulling material into the process from the bottleneck

In bottleneck scheduling, why is it desirable to maintain a buffer of work ahead of the bottleneck?

To ensure that the bottleneck is never without work, If upstream operations are interrupted, the buffer will permit the bottleneck operation to continue working.

What does it mean for the workstations in a process to be balanced?

In a balanced process, every stage has about the same work content, and the work content time is equivalent to the required CT.

Discuss the meaning of the term line balancing as it applies to an MMP process

Line balancing refers to assigning tasks (elemental units of work) to a workstation or operations sequence such that the CT of the combined sequence of workstation satisfies the required CT, the tasks are assigned in the right order, and the assignment is as efficient as possible.

In MMP, more than one product is being produced, so for each product the time for a given task might be different. Unlike traditional line balancing, which considers the production of only one product, MMP balancing must consider simultaneous production of multiple different products. In general, MMP balancing requires assigning tasks to a sequence of workstations such that the CT time for each product at each workstation satisfied the required product CT, and the assignment for all products is as efficient as possible.

Comment on the following: a process has eight workstations in sequences; the workstation with the greatest work content takes 94 seconds; therefore the CT for the entire process should be set to 94 seconds per unit

It depends on the required CT. And the required CT = Operating time / demand. If the required CT is greater than 94 seconds per unit, the CT for the entire process should be the required CT. If it lies below 94 seconds per unit, then the CT of 94 seconds per unit is the bottleneck.

Discuss ways to reduce the effects of disruptions in a synchronized process

Andon lights or a signal board are used to display the status of operations. When a light for an operation flashes red, supervisors and adjacent workers rust over to resolve the problem. In a truly synchronized process, a red light at one operation is a signal for every operation to stop. Only after the problem has been resolved (green light) do all operations resume, and they all resume simultaneously.

Multiskilled operators, flexible operations, and short changeover times to enable quick adaption to changes in product demand and product mix.

Less than full-capacity scheduling to allow for delays or unanticipated demand changes.

Discuss the ramifications (relative pros and cons, ease or difficulty) of adapting production to schedule changes by (a) altering the length of the workday and (b) altering the production rate

Two ways to meet changing demand requirements are to alter the length of the production workday and to alter the rate of the production process. The latter is inherently more difficult since it involves changing the required CT, and, potentially, rebalancing tasks everywhere in the process. Thus altering the length of the workday is the favored method, at least in the short run, and modern union contracts often specify a range of times, say, 7 to 10 hours, as a normal workday. However, it can cause hardship for workers, and thus should be somewhat infrequent and only follow advance notice. Long-term shifts in demand can initially be handled by changes in the workday or by overtime; through continuous improvement, the CTs should be adjusted so that, eventually, the workday can be brought back to normal

15. Planning and Control in pull production

- 13. Explain the procedure of preparing tentative production plans for pull production. Describe what happens as these plans become more firm and, eventually, fixed. What are the purposes of longer-range flexible plans versus shorter-range plans? What role does ERP/MRP II serve in all of this?**

In a pull production a decentralized planning and control system is used. First an initial capacity planning is made each month. Second, as late as 1 or 2 weeks before production begins, the plans for work cells and departments might have to be revised to incorporate the most recent demand information. Lastly, daily scheduling and control is generated and displayed by the visual management system. The plans become more based on recent information when they become more fixed. The purpose of the longer-range plan is to give all departments an indication of what is expected. ERP can be used to create a forecast. MPS II is used for planning the number of predicted workdays and the required average daily production level.

- 14. Explain the procedure for setting daily schedules based upon initial production plans and incoming customer orders.**

The MPS for the current month is broken down into weekly schedules, then into daily schedules, incorporating in each week the most recent information on forecast demand and customer orders. Such information is used to develop, first, an average daily production level and then eventually a final, fixed daily production schedule for the final stage of the process.

- 15. What is the purpose of sharing tentative production plans and schedules with suppliers?**

So that they can prepare for the orders to come. With the sharing of production plans the suppliers can deliver JIT. This is especially useful for specialized parts. At Nissan, for example, the suppliers receive tentative production plans for specialized parts a month ahead to prepare for this.

- 16. For each of the following kinds of procurement systems, discuss applications and relative advantages and disadvantages:**

a. Supplier Kanban links

Useful for a predictable demand. Advantage is that it eliminated any human handling from the production organization. Disadvantage is that the variation must be small and the Kanban needs to be adjusted every week to reflect demand for the upcoming week.

b. MRP systems for daily (or more frequent) order releases

Useful for JIT. Advantage is that the supplier receives the orders always 10 days in advance from the MRP system. Disadvantage is the loss of flexibility.

c. MRP systems for less-than-daily order releases

Useful for special parts. Advantage is that specialized parts can be supplied relatively fast. Disadvantage is that this is only done in low-volume.

17. Discuss the relationship between preparing the MRP and shop-floor control. What role does the agility on the shop floor have in this relationship? How is such agility achieved?

The MRP is used in more stable, centralized environments. Shop floor control uses visual management to collect data so that frontline workers can schedule and control their work.

18. Describe the purpose of the visual management systems on shop-floor control. Review the ways that such visual management is achieved.

Visual management is achieved when people on the work floor know the status of the system and know what to do simply by looking at Kanban carts, containers, and workplace signals. With a visual management system it is not necessary to look hard or look far to see what needs to be done.

19. What effect does pull production have on the product BOMs? Why do product made in pull systems need fewer-level BOMs than the same products produced in MRP-type push systems?

The fewer records an pull production MRP system must maintain, the lower the recordkeeping cost and the easier it is to maintain record accuracy. Since a pull system controls work and materials throughout the process by delimiting the number of containers, any other form of control mechanisms at stages other than the final one is unnecessary.

20. Explain the purpose of phantom records.

A phantom record represents a material that never actually goes into storage, but is in a momentary transitional state (a component or subassembly) and is en route to the next stage of the process. Phantom records are used to simplify the BOM of an end product without altering the basic structure of the BOM. Figure 15.9, page 424 shows a BOM using phantom records.

21. Explain the concept of postdeduct (backflushing). What is a deduct point? What is a deduct list?

Even in pull production it is necessary to keep track of the quantities of completed end items and of procured parts and materials that need replenishment. This tracking and updating is done through a procedure called postdeduct or backflushing. The postdeduct procedure occurs everywhere in the process designated as a deduct point. At each deduct point, the inventory records to be updated are specified on a deduct list. As items move past a deduct point, the inventory records of items listed are automatically updated.

22. Explain the difference between a typical MPS and a rate-based production schedule. Why in a pull production system is one preferable over the other?

A typical MPS system generates weekly schedules for every operation. For a pull production only daily schedules are used and only for the end-item. A conversion can be made from the monthly MPS into a daily production rate. This is appropriate for a pull production system.

16. Lean production in the Supply Chain

1. In 10 words or less, define what constitutes the supply chain.

The customer-supplier network, from raw materials to finished goods.

2. What role does the supply chain play in the competitive position of any one company?

Lean production acknowledges the importance of the supply chain to competitive advantage and stipulates that improvement effort must not be confined to a company, but must be extended to its suppliers and distributors.

3. What is the role of suppliers and supplier relationships in the Toyota Production System and concurrent engineering? To answer this question, review chapters 1 and 4.

The role for suppliers transitions from a traditional customer-supplier relationship, where the contract usually goes to the lowest bidder and multiple supplier per part are kept, to a partnership where suppliers are trained in ways to reduce setup times, inventories, defects, machine breakdowns, and so forth.

4. Discuss the trade-offs facing a manufacturer in deciding between designing and producing a product itself versus outsourcing design and production.

A manufacturer could gain from outsourcing design and production of simple items, so it can focus solely on the more difficult parts. Downside of this, it that the manufacturer loses control over quality and development of these parts.

5. Describe briefly the philosophy of supply chain management (SCM)

SCM is the coordinating the activities of suppliers to meet the requirements of the customer above them in the supply chain.

6. What is the role of supplier-customer teamwork in SCM? How is this teamwork manifested?

The purpose of this teamwork is to create the best product for the customer. Working with suppliers means many things, but especially means joint problem solving, practicing quality at the source, and exchanging information.

7. Discuss how the following aspects of customer-supplier relationships change when parties move from being adversaries to being partners: criteria for purchase decisions, responsibility for design, number of suppliers, nature of contracts, and working relationships.

8. Discuss significant differences between customer-supplier partnership agreements and traditional purchase contracts with regard to the following: time period of agreement; mutual expectations about price, quality, delivery, and ordering; and expectations about interaction between customer and supplier.

	TRADITIONAL	PARTNERSHIP
Purchase Criteria	Lowest bid	Competency, ability, capacity, and willingness to work with customer to improve price, quality, and delivery.
Design Source	Customer	Customer and Supplier
Number of Suppliers	Several for each item	One or few for each item or commodity group
Customer Business Volume per Supplier	Limited: multiple suppliers share business	High: one or few suppliers get all of the business
Type of Agreement	Purchase order; contracts to meet immediate requirements	Contract plus agreement about working relationship
Term of Agreement		
Duration	Short term; or as needed by customer	Long term, multiple years
Price/cost	Lowest bid, inefficiencies, and waste keep prices/costs high	Negotiated price/cost savings from supplier improvements shared with customer
Quality	Variable; customer relies on incoming inspection	High; quality at the source; suppliers uses SPC, TQM, etc.
Shipping: Frequency/Size/Location	Infrequent/large/dock or stockroom	Frequent/small/point-of-use
Order Mechanism	Mail or phone	FAX, phone, EDI, or Kanban
Customer-Supplier interaction	Formal information exchange, limited to customer requirements; no teamwork; supplier service limited to minimal requirements	Frequent formal and informal exchange of plans, schedules problems, ideas; teamwork and mutual commitment based on trust; cooperation to resolve problems and improve supplier's products and processes

9. What is vendor-managed inventory?

The supplier keeps track of the customer's on-hand quantity and to determine the amount to ship each delivery. Then the supplier manages the customer's inventory.

10. Discuss the process of evaluating suppliers for selection and ongoing performance assessment. Besides the usual criteria of price, what should a company look for in selecting among suppliers?

Criteria's that should be used for the evaluation of suppliers are: performance, problems, opportunities, and areas needing improvement. These evaluations can be done quarterly, monthly, or sooner if the supplier has problems.

11. Discuss the role of the purchasing function in managing supplier relationships.

The role of the purchasing function lies in three areas: specifying requirements, selecting suppliers, and managing supplier relationships. Purchasing is the major information conduit between the customer and suppliers. It provides suppliers with production schedules so they are able to plan deliveries, it assesses supplier performance, and works with suppliers about areas in need of improvement. In many companies purchasing also evaluates the suppliers' processes and capabilities and certifies suppliers.

12. Give examples of how the continuous improvement concept can be applied by a team of customers, suppliers, and carriers.

A team of customers, suppliers, and carriers can focus their improvement on the processes in between of each other. Especially the exchange of information is an important aspect here.