1 Intro to OTM

1.1 What is Operations

- Part of business organization that is responsible for producing (tangible) goods and services
- It is a business function responsible for designing, managing and improving creation and delivery of products

1.1.1 Products vs Services

Characteristics of Goods	Characteristics of Services
Tangible product	Intangible product
Can be inventoried	Cannot be inventoried
Consistent Product Definition	Inconsistent Product Definition
Limited customer interaction	High customer interaction
Production (usually) separate from consumption	Produced and consumed at the same time
Easy to automate	Hard to automate
Many aspects of quality are easy to evaluate	Quality may be hard to evaluate
Goods produced at a fixed facility	Services dispersed
Often has some residual value	Reselling is unusual

- In most cases, products are a mix of both physical goods and service

1.1.2 Supply Chain

- Network of all entities involved in producing and delivering finished product to customer.

- Supply chain management integrates supply and demand management within and across companies. Without it companies faces:
  - Oscillating inventory levels (bullwhip effect → surge in retail causes large change in inventory down supply chain), inventory stockouts, late deliveries and quality problems

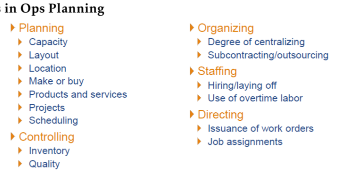
1.2 Functions of Business Organization

- **Marketing** (generates demand), **Operations** (create product/service), **Finance** (deals with money)
- Function overlaps:
  - Finance and Ops: budget, analysis of investments, provision of funds
  - Marketing and Ops: Demand data, product designs, competitor analysis, lead time data

1.3 Objectives of Ops Management

- **Cost** (productivity, inventory turnover), **Quality** (features, mean time between failures, scraps), **Dependability** (% of on-time deliveries, days late), **Flexibility** (setup times, time to market)

1.3.1 Decisions in Ops Planning



1.4 Productivity Calculations

$$\text{Productivity} = \frac{\text{Output}}{\text{Input}}$$

$$\%\text{ change in productivity} = \frac{1+Y\%}{1+X\%} - 1$$

$$\text{Multifactor Productivity} = \frac{\text{Output}}{\text{Labor} + \text{Material} + \text{Energy} + \text{Capital} + \text{Misc}}$$

$$\text{Relative Wage Rates} = \frac{\text{Foreign Wage Rate}}{\text{Exchange Rate}} \times \frac{\text{Home Productivity}}{\text{Foreign Productivity}}$$

- How to increase productivity in Services due to it being labor intensive, requires domain specific skills, difficult to automate

2 Operation Processes and Technologies

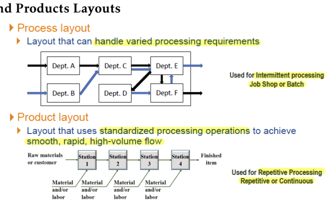
2.1 Process Selection

- refers to the way production of goods/services will be organized which impacts: capacity planning, layout of facilities, equipment and design of work systems

2.2 Types of Processes

	Job Shop	Batch	Repetitive/Assembly	Continuous
Description	Customized goods or services	Semi-standardized goods or services	Standardized goods or services	Highly standardized goods or services
Advantages	Able to handle a wide variety of work	Flexibility; easy to add or change products or services	Low unit cost, high volume, efficient	Very efficient, very high volume
Disadvantages	Slow, high cost per unit, complex planning and scheduling	Moderate cost per unit, moderate scheduling complexity	Low flexibility, high cost of downtime	Very rigid, lack of variety, costly to change, very high cost of downtime

2.2.1 Process and Products Layouts



2.2.2 Summary

Activity/Function	Job Shop	Batch	Repetitive	Continuous	Projects
Cost estimation	Difficult	Somewhat routine	Routine	Routine	Simple to complex
Cost per unit	High	Moderate	Low	Low	Very high
Equipment used	General purpose	General purpose	Special purpose	Special purpose	Varied
Fixed costs	Low	Moderate	High	Very high	Varied
Variable costs	High	Moderate	Low	Very low	High
Labor skills	High	Moderate	Low	Low to high	Low to high
Marketing	Promote capabilities	Promote capabilities; semi-standardized goods and services	Promote standardized goods and services	Promote standardized goods and services	Promote capabilities
Scheduling	Complex	Moderately complex	Routine	Routine	Complex, subject to change
Work-in-process inventory	High	High	Low	Low	Varied

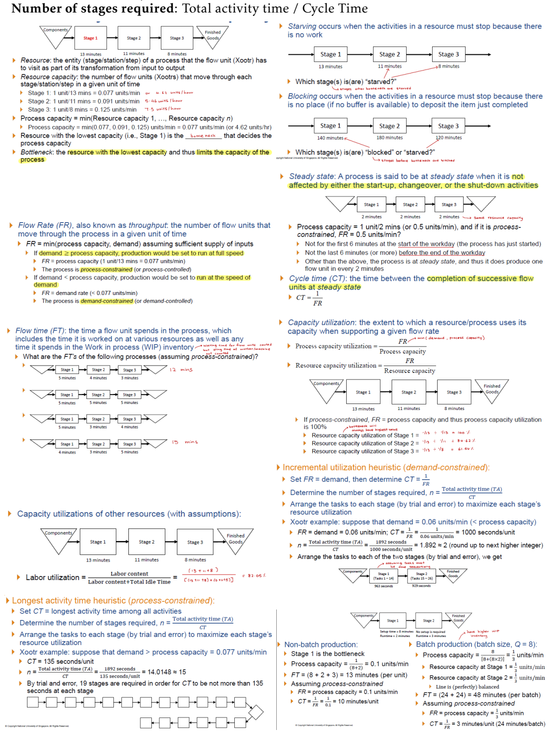
2.3 Technology

- Technology refers to application of scientific knowledge to development and improvement of goods and services
  - **Hard Technologies** are equipment or deceives like actuators, computers and sensors
  - **Soft Technologies** are application of the internet, software and information system like databases, AI, and voice recognition software
- 3 types of Automation:
  - **Fixed automation**: use high cost specialized equipment for fixed sequence of ops, suitable to produce large volumes of goods but minimal variety (e.g. automated car park system, machining transfer lines in automobile)
  - **Programmable automation**: use general-purpose equipment controlled by a program, suitable for batch operations where for each batch, the equipment has to be reprogrammed. Production rates lower than fixed automation (e.g. CAD and CAE)
  - **Flexible Automation**: use equipment more customized that that of programmable automation, suitable when variety is sufficiently limited. Reprogramming typically done off-line and allows for mixture of different products to be produced one after another.

3 Process Flows

3.1 Process Analysis

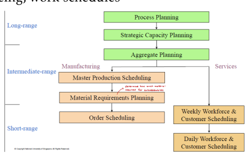
- **Flow unit**: basic unit of analysis
- **Activity/Process Time**: amount of time spend on activity, including setup and run time
- **Process Capacity**: maximum number of flow units that move through the process
- **Inventory**: average number of flow units that are in the process
- **Buffer**: storage area between stages where the output of a stage is placed prior to being used in a downstream stage. Should contain enough units to prevent starvation and used to improve throughput
- **Little's Law**: Inventory = Flow Rate × Flow Time
- **Number of stages required**: Total activity time / Cycle Time



4 Aggregate Planning

4.1 Planning Horizons

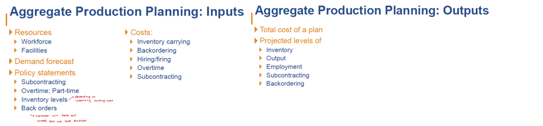
- Aggregate planning: Intermediate-range capacity planning, usually covering at least **one seasonal cycle (2 to 12 months)**
- **Long-range planning**: > 1 year, yearly increments. Planning for things like Long-term capacity; location; layout; product design; work system design
- **Intermediate- range planning**: 1 seasonal cycle, monthly or quarterly increments. Planning for things like: Employment; output; finished-goods inventories; subcontracting; backorders
- **Short-range planning** (reliable planning): 1 day to < 6 months, weekly increments. Planning for things like: Production lot size; order quantities; machine loading; job assignments/sequencing; work schedules



4.2 Aggregate Production Planning

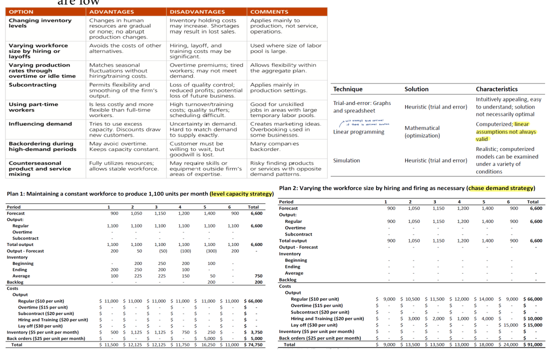
Aims to specify the **production rate** (units produced), **employment level** (# of workers), **inventory on hand** (carried from previous period), in order to meet the varying demand pattern over seasonal cycle. Ultimately want to **reduce cost**, **maintain service level** and **minimize workforce fluctuations**

4.2.1 Inputs and Outputs



4.2.2 Strategies

- Demand Management
  - Influence demand through promotion (however there will be a lag between promotion and demand); pricing; backorders
  - Create new demand for complementary products
- Supply management
  - Level capacity strategy
    - Maintain a level workforce/steady output rate
    - Use inventory/backorders to absorb variations in demand
    - Works best when inventory-carrying and backlog costs are relatively low
  - Chase demand strategy
    - Match demand period by period; hire/fire; OT/Slack time; part-timers; subcon
    - Works best when inventory-carrying costs are high, and costs of changing capacity are low



4.2.3 Aggregate Planning in Services

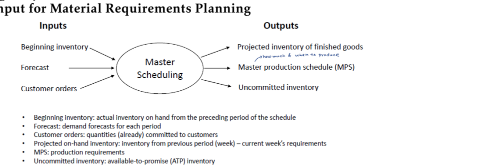
Difficulties faced when doing aggregate planning for services:

- Services occur when they are rendered - cannot be inventoried
- Demand for services highly variable and unpredictable
- Capacity availability hard to predict - labor intensive and service task requirements highly variable

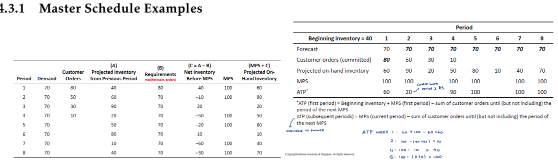
4.3 Master Schedule

Result of **disaggregating** an aggregate plan - shows quantity and timing of specific end items for a schedule horizon

- Master Production Schedule
  - Indicates the quantity and timing of planned production, taking into account desired delivery quantity and timing as well as on-hand inventory
- Production Planning and Control (PP&C)
  - Determines the quantities needed to meet demand
  - Interfaces with marketing, capacity, production, and distribution plannings
  - Enables the senior management to determine whether the business plan and its strategic objectives will be achieved
- Used as **input for Material Requirements Planning**



4.3.1 Master Schedule Examples



4.3.2 Time Fences

- **Frozen phase**: near-term phase (1-3 periods) that is so soon that delivery of a new order would be impossible, or only possible using very costly or extraordinary options such as delaying another delivery (no adjustment to master schedule)
- **Slushy phase**: next phase, and its time fence is usually a few periods beyond the frozen phase (4-5 periods). Order entry in this phase necessitate trade-offs, but is less costly or disruptive than in frozen phase
- **Liquid phase**: farthest out on the time horizon (>=6 periods). New orders or cancellations can be entered with ease

5 Inventory Management

5.1 Major Objectives of Companies

- Maximise customer service level
- efficient low-cost operations
- minimize investment in inventory

5.2 What is inventory?

- Raw materials and purchased parts
- Partially completed goods, called work-in-process (WIP)
- Finished-goods inventories (manufacturing firms) or merchandise (retail stores)
- Maintenance, repairs, and operations (MRO) inventory (e.g. drill bits, cleaning products)
- Goods-in-transit to warehouses, distributors, or customers (pipeline inventory)

5.2.1 Functions/Purpose of Inventory

- Manage **Production**: permit ops (pipeline stock), smooth production requirements (seasonal stock), decouple ops (buffer stock)
- Manage **Demand**: meet anticipated demand, protect against shortages (safety stock)
- **Control costs**: take advantage of order/production cycles, hedge against inflation, take advantage of quantity discounts (economic of scale)

5.2.2 Cons of Inventory

- Higher costs: ordering/setup costs and holding costs
- Difficult to control: determining optimal amount, record keeping, storage and maintenance (e.g. wine cellar)
- Handling inventory is a non-value-added activity
- Reduces cash availability
- Product might become obsolete
- Hides production problems (e.g. overprocessing, poor process capacity, breakdowns)

5.3 ABC Analysis

Idea is to manage the 20% of item that contributes to 80% of the total inventory costs

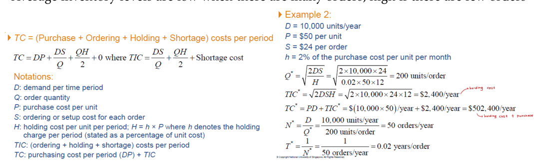
- **Class A**: 15-20% of total inventory items and represent 70-80% of total dollar usage
  - Intensive control, constant management attention, requires sophisticated forecasting
- **Class B**: 30% of total inventory items and represent 15%-25% of the total dollar usage
  - Moderate control using computer whenever possible
- **Class C**: 50%-55% of total inventory items and represent 5% of the total dollar usage
  - Minimize control and transaction cost, use of simple manual control

5.4 Types of Inventories

- **Dependent** (end product sold) vs **Independent** (component used in end product)
- **Deterministic** (demands known with certainty) vs. **Stochastic** (demands are uncertain)
- **Static** (Stationary) (expected demand does not change over time) vs. **Variable** (expected demand changes over time)

5.5 Economic Order Quantity (EOQ)

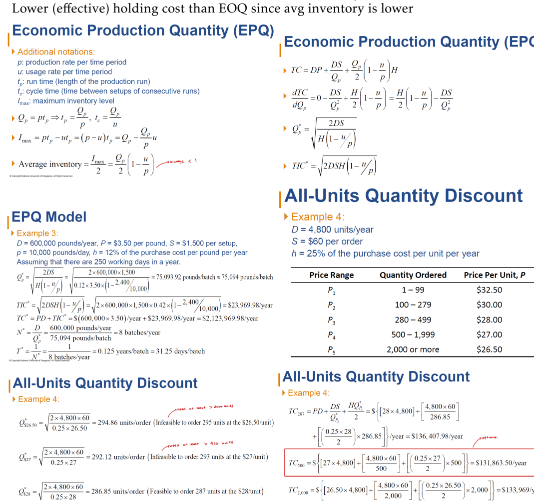
- Total Cost: Purchase + Ordering + Holding + Shortage cost
- To determine how much of a given item to order, we can use EOQ to get a good estimate
- Assumptions of EOQ model:
  - Annual demand is known and is evenly spread throughout the year
  - No stockouts are allowed
  - Lead time is known and constant
  - One-batch delivery (instant delivery)
  - No quantity discount (**Purchase cost is ignored in EOQ**)
  - All other costs remain unchanged
  - Order quantity can be a fraction
- Average inventory levels are low when there are many orders, high if there are few orders



- $Q^* = \sqrt{\dfrac{2DS}{H}}, TIC^* = \sqrt{2DSH}$
- Ordering cost = holding cost when $Q = Q^*$
- Number of optimal order per period = $N^* = D/Q$
- Time between optimal order = $T^* = Q^*/D$

5.6 Economic Production Quantity (EPQ)

- Assumption is now that firms receive their inventories over a period of time instead of instantaneous delivery
- Suited for production environment where units are produced at a faster rate than they are used (sometimes also called Production Order Quantity (POQ)
- Lower (effective) holding cost than EOQ since avg inventory is lower



6 Inventory Management II

6.1 Reorder Point Under Certainty

$$ROP = d \times LT$$

where

d : Demand rate (units per unit time)

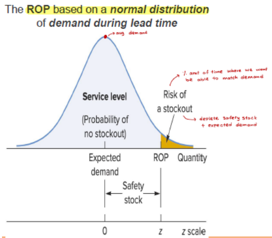
LT : Lead time (same units as d)

6.2 Fixed-Quantity Reorder Point

- Safety stock: Difference between the maximum probable demand during lead time and expected demand during lead time
- ROP = Expected demand during lead time + Safety Stock

6.2.1 How much safety stock?

- Stockout risk: Risk of having a stockout that is determined by the ops manager, decreases when we increase stock which improves customer service level
- Service level: probability that demand will not exceed supply during lead time, calculated as 100% - stockout risk



- Safety stock will depend on:
  - Average demand rate and average lead time
  - Demand and lead time variability
  - Desired service level
- Updated ROP equation:

$$ROP = \text{Expected demand during lead time} + z\sigma_{dLT}$$

z : Number of std dev (found in z table)
σ_{dLT} : std dev of lead time demand

6.3 Only demand Uncertainty

$$ROP = \bar{d} \times LT + z\sigma_d\sqrt{LT}$$

$\bar{d}$: avg demand per period
σ_d : std dev of demand per period

6.4 Only Lead Time Uncertainty

$$ROP = d \times \overline{LT} + zd\sigma_{LT}$$

d : Demand per period
σ_{LT} : std dev of lead time
$\overline{LT}$: Avg lead time

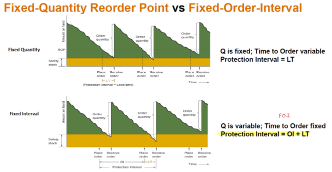
6.5 Both Demand and Lead Time Uncertainty

$$ROP = \bar{d} \times \overline{LT} + z\sqrt{\overline{LT}\sigma_d^2 + \bar{d}^2\sigma_{LT}^2}$$

6.6 Fixed-Order-Interval Inventory Model

- Orders are placed in fixed time intervals dictated by suppliers (consumers only vary order qty)
- Reasons for using FOI
  - No need for continuous tracking of inventory (do inventory count just prior to placing order)
  - Grouping orders from the same supplier yield savings in ordering/packing/transport costs
  - Supplier's policy may encourage its use

Fixed-Quantity Reorder Point vs Fixed-Order-Interval



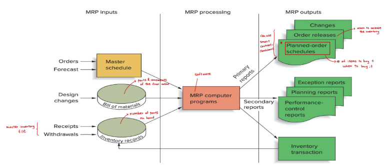
$$ROP = \bar{d}(OI + LT) + z\sigma_d\sqrt{OI + LT} - A$$

OI : Order interval (length of time between orders)
A : Amount on hand at reorder time

7 Materials Requirements Planning (MRP)

7.1 Inputs, Processing & Outputs

- MRP is a computer based system to order & schedule dependent demand items
- Dependent demand items are items that are subassemblies; raw materials; component parts that are used in production of finished goods



- Bill of Materials/Product Structure Tree: List of materials, parts, subassemblies needed to produce end items
- Inventory Records: status of each item by time period (gross requirements, schedule receipts, expected amount on hand)

Master schedule for shutters:

Week number	Beg. Inv.	1	2	3	4	5	6	7	8
Quantity					100				150

Shutters: LT = 1 week

	Beg. Inv.	1	2	3	4	5	6	7	8
Gross requirements					100				150
Scheduled receipts	0	0	0	0	0	0	0	0	0
Projected on hand	0	0	0	0	0	0	0	0	0
Net requirements					100				150
Planned-order receipts					100				150
Planned-order releases				100				150	

1 frame need 2 times 2 | times 2

Frames: LT = 2 weeks

	Beg. Inv.	1	2	3	4	5	6	7	8
Gross requirements				200				300	
Scheduled receipts									
Projected on hand									
Net requirements				200				300	
Planned-order receipts				200				300	
Planned-order releases		200				300			

2 week lead time | times 4 | times 4

Wood sections: LT = 1 week

	Beg. Inv.	1	2	3	4	5	6	7	8
Gross requirements				400				600	
Scheduled receipts		70							
Projected on hand		70	70	70					
Net requirements				330				600	
Planned-order receipts				330				600	
Planned-order releases			330				600		

7.2 Updating MRP

- MRP is **not a static document** and have 2 approaches to deal with changes
  - **Regenerative** MRP - update MRP periodically by batching/compiling all changes and periodically updating system
  - **Net-change** MRP - update MRP continuously to reflect changes as they occur, only changes are exploded through system

7.3 MRP Considerations

7.3.1 Safety Stock

- Theoretically no need safety stock for dependent demand items but there are variability due to bottleneck process, varying scrap rates and late completion
- Use **safety time** to account for variable lead time and schedule orders to arrive/complete earlier than needed

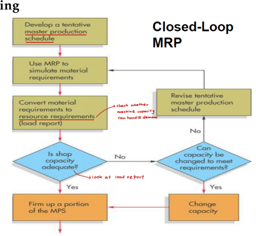
7.3.2 Lot-sizing

- Accounts for Order vs Holding cost
- **Lot-for-lot ordering** - order size = demand for time period, results in variable order qty, low holding cost, high order cost
- **Economic Order Qty** - can lead to minimum cost if usage of item is fairly uniform, mostly applicable for lower-level items that are common to different parents, not suitable for lumpy demand
- **Fixed period ordering** - order qty = predetermined number of periods of demand

7.3.3 Planning Horizon

- MRP should cover at least the **Cumulative Lead Time** (sum of lead times of phases from procurement to assembly)

7.3.4 Capacity Planning



7.4 MRP Benefits and Challenges

7.4.1 Benefits

- low levels of in-process inventories
- track material requirements
- evaluate capacity requirements
- help to allocate production time
- can determine inventory usage via backflushing (use end item's BOM to determine qty of each component to make the item)

7.4.2 Challenges

- Inaccurate data - missing parts, order incorrect qty of items, unable to stay on schedule

8 Operation Scheduling

Scheduling is constraint by higher level decisions in areas such as capacity, product/process design, equipment selection and PP&C cycle (aggregate plan, master schedule and MRP)

8.1 Scheduling for High-Volume Operations

- Goal of assembly lines is to smooth rate of flow and have high utilization of labor and equipment and is achieved by doing flow scheduling by adjusting rate of output (cycle time) and balancing assembly line

8.2 Scheduling for Mid-Volume Operations

- Utilizes intermittent scheduling that produces schedule for production in batches
- Economic run size/time (EPQ model) is key

8.3 Scheduling for Low-Volume Operations

- Difficult to schedule due to variety of processing task, time, sequence nad materials used
- Utilizes Job-Shop Scheduling which involves
  - **Loading** - assign jobs to processing workstations according to MRP
  - **Sequencing** - deciding order of jobs to be processed

8.4 Sequencing Priority Rules

All rules aims to meet some objectives such as meeting due dates (minimize lateness), minimize lead time/makespan, setup time/cost, work-in-process inventory, or maximizing machine utilization

Assumptions of priority rules:

- Set of jobs is known and no new jobs arrive/cancelled
- Processing times deterministic
- Setup time deterministic
- Setup time is independent of processing sequence
- No interruptions in processing (machine breakdowns; accidents)

8.4.1 Performance Metrics

- Job Flow Time - Time from when a job arrives until it is completed; includes waiting time
- Lateness - Time by which the job completion time exceeds the job due date
- Makespan - Time to complete a group of jobs from start of first job to completion of last
- Average number of jobs - Average number of jobs (WIP inventory) of a group of jobs that are in the shop (= [Total Flowtime] / [Makespan])

8.4.2 Smaleest Critical Ratio (CR)

- Uses the heuristic of ratio of time remaining till due date to processing time remaining

8.4.3 Smallest Slack per operation (S/O)

- Uses heuristic of (Time remaining till due date - Remaining processing time) / (# of remaining operations)

Job	Remaining Processing Time	Due Date	Remaining Number of Operations
A	4	14	3
B	16	32	6
C	8	8	5
D	20	34	2
E	10	30	4
F	18	30	2

Job	(1) Remaining Processing Time	(2) Due Date	(3) (2) − (1) Slack	(4) Remaining Number of Operations	(5) (3) ÷ (4) Ratio	(6) Rank
A	4	14	10	3	3.33	3
B	16	32	16	6	2.67	2
C	8	8	0	5	0	1
D	20	34	14	2	7.00	6
E	10	30	20	4	5.00	4
F	18	30	12	2	6.00	5

The indicated sequence (see column 6) is C-B-A-E-F-D.

8.5 Johnson's Rule

- Technique for minimizing completion time (Makespan) for a group of jobs to be processed on two workstations
- Steps of algorithm
  1. Select job with the shortest time
     - if shortest time is at first workstation, schedule that job **first**
     - if the time is at the second workstation, schedule the job **last**
  2. Eliminate the job from further consideration
  3. Repeat above steps, working toward the center of the sequence, until all jobs are scheduled

8.6 Challenges of Service Scheduling

- Cannot store or inventory services
- Customer service demand is random
- Scheduling service operations involves customers arriving at random time, workforce (scheduling to meet peaks?), equipment

8.7 Hungarian Method

1. Subtract smallest number in each row from every number in the row (row reduction); enter results in a new table
2. Subtract smallest number in each column from every number in the column (column reduction); enter results in new table
3. Test whether optimum assignment can be made: cover all zeros with minimum number of lines; if this is equal to number of rows, optimum is reached and make the assignment; otherwise, continue with next step
4. Subtract the smallest uncovered number from every uncovered number; add this number to the numbers at intersections of lines; leave other numbers as they are; enter results in new table
5. Repeat steps 3 and 4 until optimal assignment can be made
6. Make assignments; begin with rows or columns with only one zero; match only one row with one column; eliminate row and column after each match

9 Lean/JIT Operation Paradigm

9.1 Lean/JIT Definition

- Lean operation focuses on cutting away "fat" (unproductive resources or activity). These includes excess inventory, overproduction, waiting time, unnecessary transporting/processing, inefficient work methods, product defects and uncapitalized people
- JIT refers to parts being moved through operations/ services being performed just as they are needed and are only produced according to customer demand

9.2 Benefits and Risks of Lean System

- Key benefits: reduced waste, lower costs, increased quality and reduced cycle time
- Critical risks: few resources available if problems occur (no safety stock), disruptions halt operations, increased stress on workers

9.3 Building Blocks of Lean

9.3.1 Product Design

- Design and use standard/existing parts
- Modular design (module as a cluster of parts)
- Design-in quality to avoid disruptions (e.g. produce as single piece to avoid "jam defects")
- Concurrent engineering

9.3.2 Process Design

- Produce in small lot sizes (reduces holding, setup and ordering cost)
  - **allows for problems to surface** and allows people to take notice and solve it
  - Also provides benefits of low rework cost, more flexibility in scheduling, reduces time to market for new products
  - Small lots forces companies to reduce setup times with systems like **Single-minute exchange of die** (SMED)
  - Ideal lot size for lean is 1
- Use manufacturing cell that processes family of parts with similar requirements
- Use of CI (continuous improvement), autonomation - act of stopping production and correcting defect the moment a defect is detected
- Design for little inventory space

9.3.3 Personnel/Organization

- Workers are assets and should be **crossed-train**, adopting continuous improvement, and have leadership/project management skills
- Aims to break barrier of brains vs brawn, remove self-imposed functional/class barrier

9.3.4 MPC

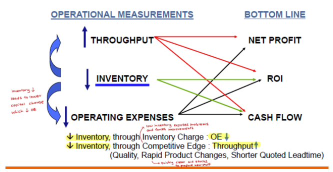
1. **Level Loading** - spread load evenly over time leads to lower inventories, flexibility and responsiveness to market requirements, certainty and learning. Uses **Mixed model sequencing** - instead of scheduling AAABBBBCCC always, mixing it up could save time
2. **Pull system**- pulls output from preceding stations as needed instead of having preceding station push output when done (traditional MRP)
3. **Kanbans** - communicates demand/cancellation of outputs or materials from preceding station, downstream has authority to pull/produce
   - # of kanbans = Demand × Avg waiting and production time × (1+ Safety stock) / Container size (Always round up)
4. **Close supplier relationship** - Lean systems have long term relationship with small number of suppliers, typically use tiered supplier network
5. **Preventive maintenance and housekeeping** - maintain machines in good operating conditions and adopt Sort, Straighten, Sweep, Standardize, Self Discipline (5s)

10 Theory of Constraints

10.1 3 Perspective of The Goal

- Managerial - make money in the present as well as in the future (on-going-improvement)
- Logistical - focus on work/material flow through system
- Behavioral - focus on on-going improvement process/attitude

10.2 Bottom Line and Operational Measurement



10.3 Synchronized Manufacturing (Drum-Buffer-Rope System)

- Bottleneck dictates the pace based on demand and capacity
- **Only put inventory before bottleneck** so that it is ALWAYS working
- Schedule for succeeding operation uses **Forward Scheduling** from bottleneck
- Schedule of preceding operation should use **Backward scheduling** from bottleneck

10.4 ToC Summary

- Focuses on improving operation processes
- Focuses on bottlenecks (calculated by utilization) to improve throughput
- JIT vs ToC:
  - JIT puts inventory at every station, ToC put only at bottleneck
  - Both uses Continuous improvement but ToC only focus on bottleneck

11 Strategic Management of Operations

11.1 Levels of Strategy

- **Corporate Strategy** - define businesses to be in, acquire & allocate resources
- **Business Strategy** - define scope of business, identify competitive advantage (cost leadership, product differentiation and/or market segmentation)
- **Functional Strategy** - Marketing, Operations, Financial strategies which supports business strategies, sets direction resulting in a consistent pattern of decisions

11.2 Operation Strategy elements

- **Mission** - defines role of operations, provides priority among operations objectives
- **Distinctive Competence** - what operations intended to excel in relative to competitors
- **Operations Objectives** - heuristics for performance: cost, quality, delivery and flexibility
- **Strategic Decisions** - guidelines for making strategic decisions in terms of Process, Quality, Capacity, Inventory and Supply Chain

11.3 Operations Strategy Process

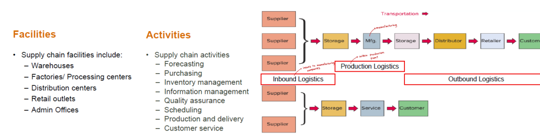
- Links Operations to Business Strategy
- Business strategy alternatives
  - Product Imitator - Order winner = Low Cost, Order Qualifiers = flexibility, quality, delivery
  - Product Innovator - Order Winner = flexibility (intro of new products), Order Qualifiers = cost, delivery, quality

12 Supply Chain Management

12.1 Supply Chain & Supply Chain Management

- Supply Chain is a sequence of organization (facilities and activities) that are involved in producing and delivering a product or service
- Supply Chain Management is the coordination of activities within the business and its supply chain to match supply and demand

Typical Supply Chains



12.2 Need for SCM

- Competitive pressures - Supply chain vs Supply chain
- Increasing globalization - Complex-Global SCs
- Growth of digital & e-Commerce
- Increasing levels of outsourcing
- Rising transportation costs
- Match supply chains to products

	Functional Products	Innovative Products
Efficient Supply Chain	Match	Mismatch
Responsive Supply chain	Mismatch	Match

- Manage bullwhip effect - variability and inventory (safety stocks) increases downstream

12.3 Role of Supply Chain Manager

- Responsible for managing supply and demand both within and across organizations
- **Economics**: supply products & services to meet demand efficiently
  - planning & coordinating activities
  - Sourcing and procurement of materials and services
  - Transformation activities
  - Logistics - transportation, warehousing & inventory, order fulfillment, distribution & returns
- Legal - laws/regulations of where supply chain is
- Ethical

12.4 Procurement in SCM

- Identifying sources, maintaining database of suppliers, negotiating contracts, obtaining goods/services, managing supplier
- Focus on core competencies; increase in outsourcing
- Changing globalization trends: near-sourcing & on-shoring, sourcing and deliveries globally
- Conversion to lean; frequent deliveries of smaller (local) lots

12.4.1 Types of Procurement

- **Centralized procurement** - Lower prices by combining orders, Better service from suppliers due to larger volumes, Better handling of special items
- **Decentralized Procurement** - Departments know their needs better, Quicker response time, Dealing with local suppliers may save money

12.5 Supplier Management

- Choose suppliers based on price, quality, reputation & service
- Supplier audits: Keep current on supplier's capabilities & policies
- Supplier certifications: verifies the supplier meets requirements for long term relationship
- Partnerships: CPFR - joint Collaborative Planning, Forecasting, and Replenishment, VMI - Vendor Managed Inventory in return for long-term commitment

Aspect	Adversary	Partner
Number of suppliers	Many; play one off against the others	One or a few
Length of relationship	May be brief	Long-term
Low price	Major consideration	Moderately important
Reliability	May not be high	High
Openness	Low	High
Quality	May be unreliable; buyer inspects	At the source; vendor certified
Volume of business	May be low due to many suppliers	High
Flexibility	Relatively low	Relatively high
Location	Widely dispersed	Nearness is important for short lead times and quick service

12.6 Supply Chain Enablers

- Logistics facilitated by Bar codes, EDI & RFID
- Efficient consumer response (ECR): initiative in the retail industry to achieve quick response using EDI and bar codes
- Distribution requirements planning (Kind of opposite of MRP, acts like reverse funnel)
- E-commerce, B2B Market Places, ERP, Blockchain (allows for security, decentralization, programmability, efficiency, verifiability, consensus, immutability and transparency)