

Chapter 1

Introduction to Operations Management

- **Operations Mgmt:** Mostly performed by management and administrative employees.
 - Forecasting
 - Capacity Planning
 - Scheduling
 - Inventory management
 - Quality assurance
 - Employee training and motivation
 - Location of facilities
 - Purchasing materials/supplies
- Success depends on PLANNING.
- **Efficiency:** operating at minimum cost and time.
- **Effectiveness:** Achieving quality and timeliness.
- A large percentage of a company's expenses occur in the operations area (purchasing materials, salaries)
- Typical organization has **3 basic functions**, which must interact to achieve the company's goals and objectives (product and process design, forecasting, setting realistic schedules, quality decisions):
 - **Operations:** Manages all the activities DIRECTLY related to producing goods/ providing services.
 - **Finance:** Performs activities related to securing funds at favourable prices and allocating those funds throughout the organization.
 - Provision of funds
 - Economic analysis of capital investment proposals

- **Marketing:** Assessing customer wants and needs, and communicating those needs and feedback to **operations** and **product design**.
- **Other supporting functions:**
 - Accounting
 - Management Information Systems/BTM
 - Purchasing
 - Human Resources
 - Manufacturing engineering
 - Maintenance
 - Product design
 - Logistics
- **Goods-Service Package:** The goods-service package is a CONTINUUM.
 - Example: House painting (a service, using a good).
- **Value-Added:** The difference between the cost of inputs and the value/price of outputs. (aka Profit Margin)
- **Services:** “The greater the value added, the greater then efficiency of that operation”.
- **Goods:** “The greater the value added, the greater the amount of funds available for R&D, investment in new facilities/equipment, salaries, owners’ profits” .
 - p. 7 for goods-services continuum

Operations Decisions:

1. **Design:** capacity planning, product/process design, production capacity, location of facilities, arrangement of departments, placement of equipment, acquisition of equipment, work/job design.
 2. **Planning/Control:** quality planning and control, inventory planning and control, production planning, scheduling, project management.
- “Operations management has a vital stake in design because **design determines limitations of operations.**” (p. 9 for DESIGN & PLANNING/CONTROL DECISIONS)
 - Design decisions: strategic and long-term (1-5 years ahead)

- Planning decisions: Tactical and medium term (1-12 months ahead)
- Control decisions: Short-term (1-12 weeks ahead)
- **Production of goods VS performance of services differ in:**
 - The performance of a service usually occurs at the point of consumption (leaky roof); Goods are usually consumed away from the point of production.
 - **Customer contact, use of inventories, demand variability** (goods can be held as inventory when demand varies, whereas services are more sensitive to demand variability)
 - **Uniformity of input** (service input will vary depending on every specific problem; goods variability can be very carefully controlled)
 - **Labour content of jobs** (services require more labor than goods production)
 - **Uniformity of output** (goods production is less variable than services time-wise and performance-wise. *ATMs are an exception!!!*)
 - **Measurement of productivity**
 - **Quality assurance** (With goods production, errors can be corrected on a product before they reach the consumer)
- **Responsibilities of Operations Managers: P-O-C-D**
 - **Planning:** Capacity, location, mix of products, production process, layout
 - **Organizing:** Degree of centralization, departments, subcontracting, suppliers, staffing
 - **Controlling:** Inventory control, quality control, production pace, motivation, cost control
 - **Directing:** Scheduling, issuance of work orders, job assignments, purchasing, logistics
- **General approaches to decision making:**
 - **Models:** Ignore the unimportant details so that attention can be concentrated on the most important aspects of a situation. For each model, try to learn:
 1. its purpose
 2. how it is used to generate results

3. how these results are interpreted and used
 4. what assumptions and limitations apply
- **Quantitative Techniques:** Embody an attempt to obtain optimal solutions to the mathematical models of managerial problems. Are time-consuming.
 - Linear programming: widely used for optimal allocation of scarce resources.
 - Queuing techniques: Useful for analyzing situations in which waiting lines form.
 - Inventory techniques
 - Project scheduling techniques (aka **Project Evaluation and Review Technique**): Useful for planning, coordinating, and controlling large-scale projects.
 - Forecasting techniques: Used for forecasting demand.
 - Statistical techniques: Used in areas of decision-making, including quality control.

*BUT: Sometimes a **heuristic approach** may be the only practical solution technique.*

- **Trade-off analysis:** deciding how much inventory to stock by evaluating the trade-off between the increased level of availability that the additional inventory would yield and the increased costs required to stock that inventory, or choosing a machine by evaluating the merits of those extra features relative to the cost of those extra features, or deciding whether to schedule overtime based on the value the increased output against the higher costs of overtime.
- **The Systems Approach:** emphasizes interrelationships among all the parts of a system. It is essential whenever something is being designed, redesigned, implemented, improved, or otherwise changed, because it is important to take into account the impact on all the parts of the system.
- **Establishing Priorities:** Enables managers to to direct their efforts to where they will do the most good and to avoid wasting time and energy on insignificant elements. A manager should examine each situation, searching for the few factors that will have the greatest impact, and give them the highest priority.
 - **The Pareto Phenomenon:** Some things (a few) will be very important for achieving an objective or solving a problem, and other things (many) will not.
 - **The 80-20 Rule:** Approximately 20% of factors will impact approximately 80% of the results achieved.

- **Ethics:** Managers must consider how their decisions will affect shareholders, employees, customers, suppliers, the community at large, and the environment.
 - Worker safety: provide adequate training, maintain equipment in good working condition, maintain a safe working environment.
 - Product Safety: provide products that minimize the risk of injury to users or damage to property or the environment.
 - The environment
 - Closing facilities: taking into account the impact on the community, and honouring commitments that have been made.
- **Craft production:** highly skilled workers using simple, flexible tools to produce small quantities of customized goods. (Long time ago, before machinery was invented)
 - Production was slow and costly, and production costs did not decrease as volume increased. “There were no economies of scale, which would have provided a major incentive for expansion.”
- **Total Quality Management (TQM):** Emphasizes quality and continuous improvement, worker teams and empowerment, and achieving customer satisfaction.
 - Similar to TQM: Lean Production System and Just-in-Time (JIT) manufacturing.
- **Lean Production:** Uses much fewer resources than mass production systems (less space, inventory, and fewer workers) to produce a comparable amount of output. Uses a highly skilled workforce and flexible equipment.
 - High volume, low cost (mass production)
 - High variety, flexibility (craft production)
 - HIGH quality (higher than in mass production)
 - The skilled workers are more involved in the system: they stop production if a defect is discovered and they work together to find and correct the cause of that defect. (cuts down on the need for end-of-the-line inspection)
 - This means more is expected of the workers: anticipate problems before they occur, quick resolution of problems, work in teams, active roles in operating and improving the system, generally higher responsibilities (thus higher pressure and anxiety).

- Unions oppose conversion from traditional system to lean system because they view the added responsibility and multiple tasks as an expansion of job requirements without comparable increases in pay.

- **World Class Manufacturing (WCM):** a combination of TQM and just-in-time manufacturing.

	Craft Production	Mass Production	Lean Production
Description	High variety, customized output, one or few skilled workers responsible for and entire unit of output.	HIGH volume of standardized output. Capitalizes on division of labour, specialized equipment, and interchangeable parts.	Moderate to high volume of output, more variety. Less inventory, emphasis on quality, empl. involvement and teamwork v important.
Examples of goods and services	Landscaping, portrait painting, surgery.	Sugar, steel, movie theatres, airlines, hotels, paper, mail sorting.	Cars+parts, electronics, industrial equipment.
Advantages	Wide range of choice, output is custom tailored	Low cost per unit, mostly low-skill workers.	Flexibility, variety, high quality of goods.
Disadvantages	Slow, requires skilled workers, few economies of scale, high cost, low standardization.	Rigid system, difficult to change output volume, product/process design, Volume over quality.	No safety net for breakdowns, flatter org. structure=less opp. for empl. advancement, more stress, requires skilled workers.

Major Trends: Organizations must take these into account when developing strategies and operations.

1. **Internet and E-Commerce:** efficient and has changed the way organizations interact with suppliers and customers.
2. **Technology:** has led to vast array of new products and processes, has revolutionized how companies operate.
3. **Globalization:** has had a growing impact on the strategies and operations of organizations around the world. The General Agreement on Tariffs and Trade (TAFF) has reduced the tariffs and subsidies in many countries, expanding world trade.
4. **Supply Chains:** Many beneficiaries on the chain (raw material producers, truck delivery companies, factory workers, shops that sell the output, and more)

5. Sustainability: Concerns of global warming and pollution have an increasing effect on how businesses operate (stricter government regulation, customers' pressure to reduce carbon footprint, etc).

- Mainly affected: Product design, Purchasing/Supply chain management, production process, disaster preparation/response.
- Sustainability: Reduced use of resources and reduced harm to the environment so that future human existence is not threatened.
- Green initiatives: reducing packaging/materials/water and energy use, and buying locally.

Chapter 2

Competitiveness, Strategic Planning, and Productivity

Competitiveness

Competitiveness: The ability and performance of an organization in the market compared to the organizations that offer similar goods or services.

- Depends on the capabilities and performance of the company in its market
 - Capabilities can be developed over time by focusing on limited range of goods/ services, and/or a technology, (core competencies) using teamwork and rewards.
- An organization's performance also depends on the expectation of customers for the purchase. (Key Purchasing Criteria)

Key Purchasing Criteria: price, quality, variety, timeliness, other.

- **Price:** The amount a customer must pay for the G or S. All factors equal, customers will choose the G or S with the lowest price.
 - **Quality:** Characteristics of a G or S determined by its design, material, workmanship, performance, and consistency. Most customers want high quality, but are willing to settle for G or S that serve their intended purpose (specification) as long as quality is consistent.
 - **Variety:** The choices of models and options available to customers. The more variety, the wider the range of potential customers.
 - **Timeliness:** The availability of G or S when they are needed by the customer.
 - **Other:** Customer service (easy/fast returns, warranty repairs, response to requests, etc) and convenient location.
- **Value = (Quality, timeliness, etc)/Price**
 - **Order Qualifiers:** purchasing criteria that customers perceive as minimum standards of acceptability for purchase. (but may not be sufficient to get the sale)
 - **Order Winners:** purchasing criteria that cause the selling organization to be perceived as better than competition.

Competitive priorities:

- **Cost:** The unit production cost of a good or performance of services to the organization.
- **Quality**(organization's perspective): Determining customers' quality requirements, translating these into specifications for G or S and consistently producing goods or performing services to the specifications. The goal of all organizations is to produce products free of defects.
- **Flexibility:** Being able to produce a variety of G or S. Includes customization. Can also be quantity flexibility (ability to easily increase or decrease production quantity).
- **Delivery Reliability and Speed:** Ability to consistently and promptly meet promised due dates and producing/delivering goods of performing services on time and quickly. This is achieved by using faster and more reliable resources/processes.

Strategic Planning

- **Strategic Planning:** The managerial process that determines a strategy for the organization, and implementing it through allocation of resources and action plans.
 - **Balanced Scorecard:** An analysis concerning the competitiveness of the organization.
 - **SWOT Analysis:** Strengths, Weaknesses, Opportunities, Threats

Mission, Vision, and Values statement

Can help build consensus with the organization. Important to be clear and simple. (see p. 32 for examples!)

- **Mission:** Where the organization is going now, its product, its markets.
- **Vision:** Where the org desires to be in the future. Has to be realistic.
- **Values:** The shared beliefs of the org's stakeholders that should drive everything else such as culture, mission/vision, strategy.

- **Strategy:** The long-term plans that determine the direction an organization takes to become/remain competitive. The strategy is determined during the strategic planning process.
 - Examples: Branding, growth, niche market, product differentiation, first-to-market, innovation, e-commerce, low cost, global selling, global operations, partnership, sustainability.
- **Tactics:** Medium-term plans used as components of a strategy. More specific in nature than a strategy, and provide guidance for determining policies and carrying out **action plans**.
- **Action Plans:** medium or short-term projects to accomplish specific objectives, assigned to individuals, with deadlines and resources needed.

Example: David is a high school student. He would like to live comfortably. A possible scenario for achieving his mission/vision might look something like this:

- Mission/vision: Live a good life.
- Goal: Successful career, good income.
- Strategy: Obtain a college/university education.
- Tactics: Select a college/uni and a major; decide how to finance the education.
- Action Plans: Register, buy books, take courses, study.

Operations Strategy

Comprises a set of well coordinated policies, objectives, and action plans, directly affecting the operations function, which is aimed at securing a long-term sustainable advantage over the competition. In order to formulate an operations strategy, the operations function has to cooperate with all the other functions of the business to collectively monitor the external markets. (marketing and engineering and technologies and etc)

9 Strategic Decision Categories: operations policies, objectives, and action plans. (pp. 35-36)

1. **Facility:** Number and location of facilities influences the operations and marketing strengths of the organization. A major operations decision for multi facility organizations is how to specialize or focus each facility: by market, product group, or production process type.

2. **Capacity:** Longterm capacity decisions relate to size of plants and major equipment (which add economies of scale and unit production costs). The main issue is whether and how to change the capacity in anticipation of future demand. Capacity underutilization/shortage affect operation/opportunity costs.
3. **Vertical Integration/Outsourcing:** Vertical Integration is ownership of a major part or the whole of the supply chain. Outsourcing is letting a supplier perform some of production/service. Cost, coordination, and control are the important decision factors.
4. **Supplier Relationship/Partnership:** The 2 extremes are using competitive arm's-length or cooperative close relationships. The decision also determines how the quality of purchased goods will be assured: either work with a supplier to assure/control its production processes or inspect the incoming parts. The Purchasing Agent's knowledge and effective performance are important for operations' strength.
5. **Product Mix and New products:** The challenge of operations management increases as the variety of products and the rate of new product introduction increase. These require flexible production systems. Products designed for easy manufacturing and assembly and effective product development process increase operations' strength.
6. **Process Types and Technology:** Four generic process types: job shop, batch flow, assembly line, and continuous flow. The "Product-Process Matrix" can be used to relate product characteristics to process characteristics/technologies. The process type determines the appropriate technologies and degree of process automation. In-house process-technology knowledge, using new/efficient technologies and good facility layout are important for operations' strength.
7. **Human Resources:** Workers/staff are appraised, selected, developed/trained, motivated, promoted, and rewarded to work as a team to achieve the company's goals. Organizational learning and flexible organizational structure play an important role in gaining competency.
8. **Quality:** Product quality is determined during the design and production. Tools that can be used include statistical process control and continuous improvement/ Six Sigma. A major decision is whether to assign the responsibility of quality control to the workers.

- 9. Operations Infrastructure and Systems:** These decisions include effective planning and control (forecasting, material requirements planning, scheduling), using a software program for planning and control, whether to use just-in-time production, operations policies, and the type of production/delivery system used (make-to-stock or make-to-order).

Formulating an Operations Strategy

1. Link the organizational goals (ex: becoming a leader in a sector) to the operations strategy: determine operations requirements of the organizational goals.
 2. Categorize/segment the *customers* into types (ex: 'Major Customers' vs 'Other'). For each category, determine which of the four competitive priorities (Cost, Quality, Delivery, Flexibility) should be emphasized.
 3. Group *product lines* into types. (Ex: 'Low Volume', 'High Volume')
 4. Conduct an operations audit to determine the strengths and weaknesses of the current operations strategy in each of the 9 strategic decision categories. Also, for each *customer category* assess the relative standing of products (by competitive priority) against those of most relevant competitors.
 5. Assess the degree of focus at each plant. A focused plant is more efficient. Use the product-process matrix to detect the degree of congruence between a product line and its "natural" process.
 6. Develop an operations strategy and reallocate product lines to plants if necessary. For each of the 9 strategic decision categories, state the objectives, policies, and action plans. Deploy these policies and action plans.
- See page 37 for full example of the formulation of an operations strategy.
 - **Generic Operations Strategies** are **operations improvement programs**, not actual strategies (although they are commonly considered so). If every company in an industry pursues the same generic strategy, every company becomes more efficient/effective, without gaining competitive advantage. Some have been used since WW2.
 - Low labour-cost strategy, scale-based strategy, focused factories strategy, flexible factories strategy, continuous improvement strategy, business process reengineering (BPR), enterprise resource planning (ERP) software.
 - **Quality-based strategies:** Focus on maintaining or improving the quality of an organization's G or S. This strategy can be motivated by many factors: an effort to overcome an image of poor quality, a desire to catch up with competition, a desire to

maintain an existing image of high quality, etc. Also: cost reduction, increased productivity, time reduction, etc. Recently, some organizations use a quality improvement initiative called Six Sigma.

- **Time-based strategies:** Focus on reducing the time required to accomplish various activities (develop new products, market them, respond to change in customer demand, etc). Organizations seek to improve service to the customer and gain competitive advantage over rivals. Costs are generally less, productivity is higher, and quality tends to be higher. (Note: just-in-time is a special case)

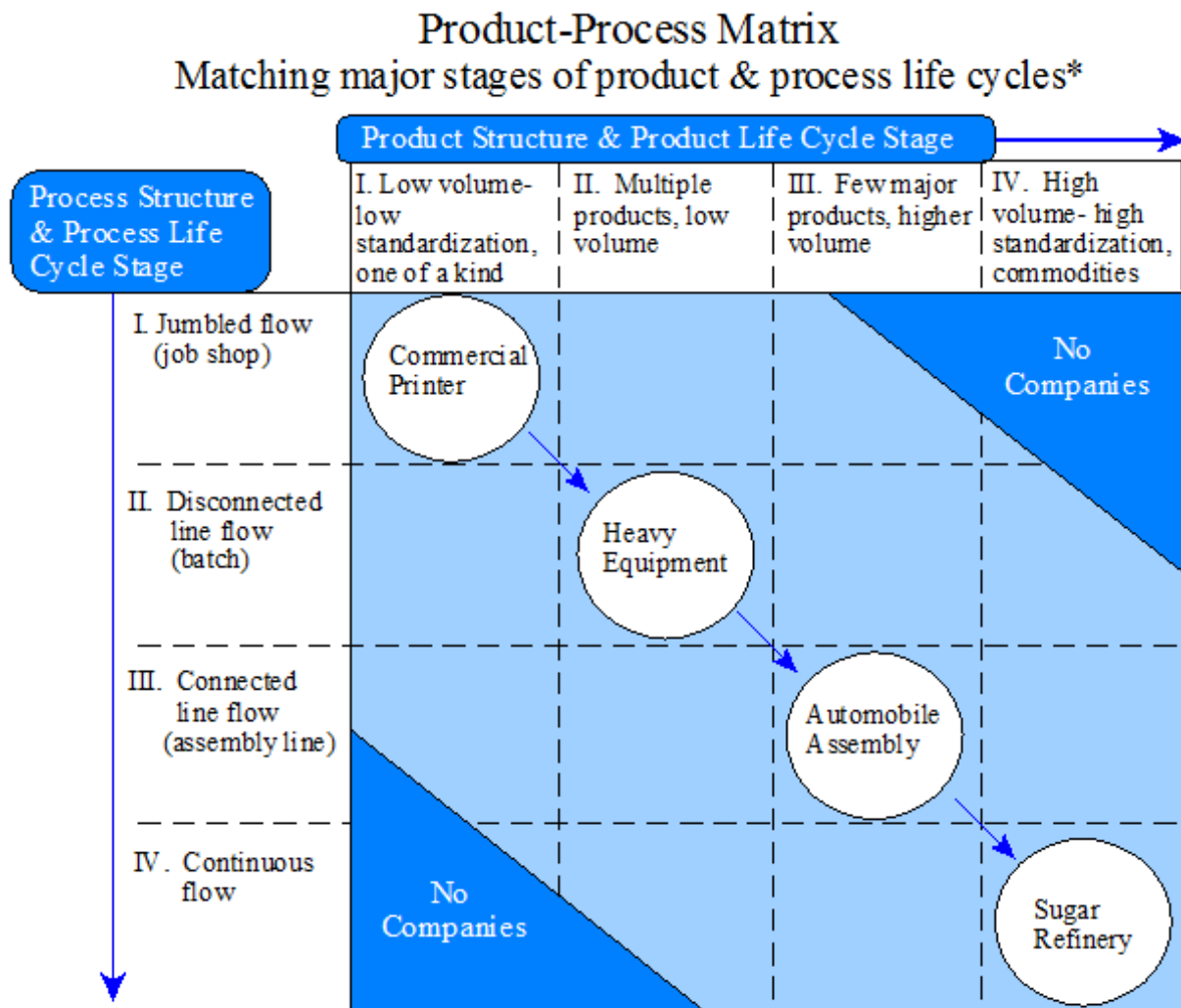
Productivity

- **Productivity:** A measure of how efficiently resources are being used.
 - Output (good and services) per unit input (machine, labour, materials, energy)
 - Output / Input
- **Productivity growth** = $(\text{Current period productivity} - \text{Previous period productivity}) / \text{Previous period productivity}$
 - Productivity increases (in a country) add value to the economy while keeping inflation in check.
 - Partial vs Total Productivity (p. 40)
 - Different Productivity measures (p. 40-41)
- Total productivity and profit of a company are directly related.
 - Total productivity = revenue/total cost
 - Profit = revenue-total cost.
- If 2 companies have the same level of output, but one requires less input because of higher productivity, that one will be able to charge a lower price and consequently increase its share of the market, or it might elect to charge the same price, thereby reaping a greater profit.

Service Productivity Measurement

- Difficult in situations where a service has no goods component, because it is intangible, involves intellectual activities, or the output has a high degree of variability.
- Sometimes measures of output used in services could result in misleading conclusions about productivity growth.

Product-Process Matrix (not part of chapter, but good to know)



* Adapted from Hayes & Wheelwright, Exhibit 1, p. 135.

Chapter 17

Project Management

- **Project:** A unique, large, one-time operation designed to accomplish a specific objective in a limited time frame.
- **Program:** A set of projects.
- **Performance Goals:** to be completed within time/schedule, cost/budget, and quality guidelines.
 - Projects must be authorized, their objectives and scope must be established, a project manager should be appointed, and the project must be planned. Activities/ tasks must be identified and time estimates made. Resource requirements must also be estimated and budgets prepared. Once underway, the project's progress must be monitored to ensure that project's performance goals will be achieved.
- **Project Phases:**
 - Project initiation (conception, feasibility study/selection)
 - planning and scheduling
 - execution and control
 - closeout
- **Project Portfolio Selection:** Involves budget, availability of personnel with appropriate knowledge and skill, cost-benefit considerations, financial benefits, and how the project will contribute to the company's strategy.
 1. Establish a project council.
 2. Identify some project categories and criteria.
 3. Collect project data.
 4. Assess resources.
 5. Prioritize the projects within categories.
 6. Select projects to be funded.

7. Communicate the results to stakeholders and provide the reasons for selection or non selection of each project.

- **Work Breakdown Structure (WBS):** Breaking down the job into smaller components
- Most organizations use a **matrix organization** that temporarily groups together specialists from different departments to work on special projects.

Project Manager: Person responsible for planning, scheduling, executing, and controlling a project from inception to completion, meeting the project's requirements, and ensuring completion on time, within budget, and to the required quality standards. Bears the ultimate responsibility for the success or failure of the project.

- Must possess skills such as: Ability to motivate and direct team members and build a team, make trade-off decisions in project performance goals, expedite the work when necessary, deal with obstacles and team conflicts, put out fires and solve problems, handle failure or fear of failure, and monitor time/budget/and technical details, employ strong leadership skills (ability to adapt to changing circumstances that may involve changes to project performance goals, technical requirements, and project team composition), recognize the need for change, decide what changes are necessary in consultation with stakeholders.
- Is responsible for managing each of the following:
 1. **Time** (to be completed on schedule)
 2. **Quality** (to realize specific objective)
 3. **Cost** (to complete project within budget)
 4. **Communication:** internal (all the info they need to do their work) and external (the customer/sponsor is well informed). Good to keep logs of actions, issues, risks, and project history.
 5. **Human Resources** (in order to keep workers well directed and motivated)
 6. **Work** (broken down into steps/activities, so that activities are completed in proper sequence and performance goals are met)

Project Planning: risk management planning, estimating the required resources for the activities, cost estimation, budgeting, human resource planning, project scheduling, quality planning, communications planning, and purchase planning.

- Quality Planning: Determine how product quality will be assured and controlled.

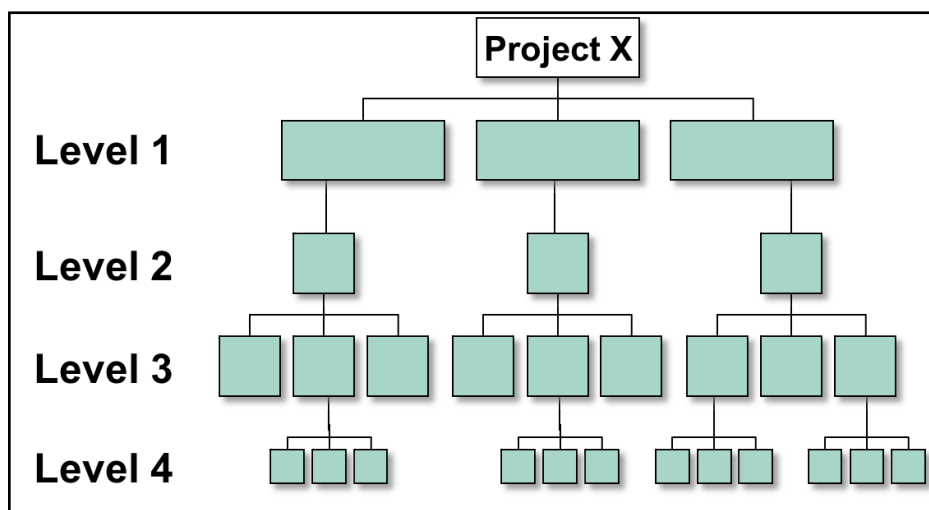
- Communications Planning: determine the nature of info needed by stakeholders.
- Purchase Planning: Determine what to purchase, specification of the item, supplier evaluation and selection, and the award of contract. (only planning components. delivery and monitoring/controlling are part of Execution and Control)

Risk Management Planning: Good risk management entails identifying as many potential risks as possible, analyzing and assessing those risks, and planning a response to avoid, transfer, or mitigate the risk. (Examples of risk response p. 678)

- Delays (Example: suppliers)
- Increased costs
- Technical specs (difficult to meet)
- Project termination (Budget has a big impact on this)

Work Breakdown Structure (WBS): A logical hierarchical listing of what must be done during the project. (“Project structure tree”)

1. Identify the major components of the project (Level 2).
2. Identify the major subcomponents for each of the major components (Level 3).
3. Break down each major subcomponent into a list of the activities needed to accomplish it (Level 4).

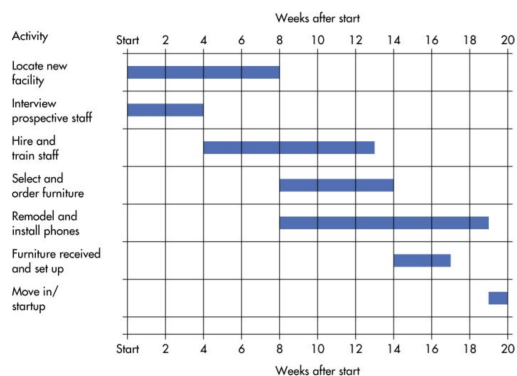


- The WBS is the basis for developing time and cost estimates.
- Progressive elaboration can be pursued as the details of work packages become known (aka **rolling wave planning**).

Project Scheduling: involves determining the timing of activities of the project, then identifying any sequential dependencies of every pair of activities, then identifying the resources needed for each activity, then estimating the duration of each activity using info on the availability of resources (the risk register could possibly add on some contingency time to the duration). Finally, develop the schedule using PERT or CPM technique.

- **Gantt Chart:** A visual aid for scheduling and controlling activities of a *simple* project.

- Good for its simplicity, bad because it does not indicate relationships between activities (or the delay one activity might have due to another, or not).



Program Evaluation and Review Technique (PERT) / Critical Path Method (CPM):

Tools for scheduling and controlling large-scale projects. Managers are able to obtain:

1. A graphical display of project activities and their sequential relationship.
2. An estimate of how long the project will take.
3. An indication of which activities are most critical to timely project completion.
4. An indication of how long any activity can be delayed without delaying the project

- **Precedence Network:**

- **Critical Path= the longest path** = the project’s duration! = zero slack time

- “**No.**”: Activity number/designation
- “**Dur.**”: Activity duration
- “**ES**”: Earliest Start, “**EF**”: Earliest Finish
- “**LS**”: Latest Start, “**LF**”: Latest Finish

- **Slack Time= LF-EF or LS-ES.**



Deterministic vs Probabilistic

Deterministic activity durations: Durations are fairly certain. In CPM, path time durations are deterministic.

Probabilistic activity durations: Durations are subject to variation.

- Path Probabilities (3-Point Estimates method):

- **Optimistic duration (o):** Length of time under best conditions.
- **Most Likely duration (m):** Most probably length of time.
- **Pessimistic duration (p):** Length of time under worst conditions.

Formulas:

- t_e (expected time) = $(t_o+4t_m+t_p)/6$
- $\sigma^2_{act} = [(t_p-t_o)/6]^2$ or $\sigma^2_{act} = [(t_p-t_o)^2]/36$
- **path mean = sum of (expected duration of all activities on the path)**
- **σ_{path} = square root of sum of (variances of activities durations on the path)**
- **$z = (\text{specified length of time} - \text{path mean}) / \text{path standard deviation}$**

Determining Project Probability:

1. Calculate the expected times of each activity (t_e formula)
2. Calculate the variance (σ^2) for each activity
3. Calculate the expected times (t_e) for each path
4. Sum all the activity variances (σ^2) for each path and take the square root of the sum.
5. Calculate the z-score for each path
6. Use the z-table to determine the Probability for each path
7. Find Probability for the whole project

Project Crashing

1. Obtain estimates of regular and crash durations and crash cost per period for each activity, and indirect project costs per period.
 2. Determine the lengths of all paths.
 3. Determine the critical activities.
 4. Crash critical activities, starting from the cheapest, as long as crashing cost per period does not exceed the benefits of crashing.
- Must crash on the CP.
 - Choose least costly common activity on CP or least costly combination of both least costly activities on both CP's.

Formulas:

- **Marginal Crashing cost per week = (Crash Cost-Normal Cost)/(Normal Time-Crash Time)**
- **Allowable Crash Time = Normal Time - Crash Time**