4 CAPACITY PLANNING
OBJECTIVES

When you complete this section you should be able to:

- have defined capacity and understood what decisions have to be taken in determining capacity.
- explored options which a company has for increasing capacity.
- examined the approaches to capacity planning and the factors which need to be taken into.
- have taken a brief look at forecasting demand including qualitative approaches and time series forecasting.
- understand the application of some decision-making processes involved in capacity planning.
4.0 INTRODUCTION

One of the key decisions a company must make on contemplating a new site, or a new operation at an existing site, is its capacity. The site will attract a mix of fixed and floating costs dependent upon throughput. Fixed costs will be related to optimum throughput and any reduction will attract a relative increase in costs per unit. Floating costs are usually directly related to throughput and might include: waste; energy; overtime; transport; materials.

Capacity planning is the long-term strategic decision which determines a company’s capability to supply products or services. In this section we explore the components of capacity planning and differentiate between utilization and capacity. Capacity planning is usually undertaken using sophisticated computer software and we explain the process which enables integrated capacity planning to be undertaken.
4.1 TYPES OF PRODUCTION SYSTEMS

Three types of production system can be identified certain features of which influence the actions of production managers.

- Small batch and unit production.
- Large batch and mass production.
- Continuous process production.

Woodward compared the affect of these on the span of control of the first line supervisor and levels in the management hierarchy. She drew conclusions on how different approaches to operational systems design affect management control over work done. The importance of information is paramount.

A few points to note are:

- Products can be divided into those a customer regards as single items or multi-component assemblies. Few companies produce single item products n.b. packaging is a product in itself. Subcontractors may produce single components for someone else to assemble (note bulk chemicals also).

- Most production in engineering, electronics, furniture, etc, is concerned with assemblies of manufactured internally or ‘bought in’ components. “Make or buy” decisions are important and considerable cost information is required.

Production system are often split between the part that produces components and the part that assembles them and certain basic organization structures can be identified in a production plant:
Activity

What type of production system does your organization use?
Functional
- Production facilities grouped by function e.g. all furniture drilling machines together, all sanding and finishing machines together. Orders are routed through the functional departments where each operation is performed. The benefits of ‘collective expertise’ are obtained but the operators are ‘task specialists’. This can result in motivational and attitudinal problems. Functional organization is flexible but needs much close control and information on the progress of ‘batches’ between shops.

Line
- Materials flows through the manufacturing facilities are uni-directional and any product flowing along the line usually require all the facilities on the line. With computer control of materials movements far more flexibility vis a vis exactly what components go into each product as it passes down the line can be built in. This is a feature of the modern computer controlled car assembly line where so long as the car is a Micra different versions (E, L, GLS, Turbo etc) will sit side by side on the line.

This type of approach needs a well trained, flexible workforce with supervisors and workers on the shop-floor possessing up-to-the-minute information. When the product type is changed - complex resetting is necessary.

Continuous Process
- Is a special form of line organization that is - plant dominated. The operation of the system is defined almost completely when the plant is designed (chemical plant, nuclear power station etc) Constant control of the process is needed for efficient control operations e.g. to adjust temperatures.

Group Organization
- is similar to LINE except that a group or cell of facilities
processes a range of items with similar facility requirements. All items (not physically similar necessarily) produced by the group won’t need all the facilities. Different facilities within the group will be working on different items. Again material flows should be uni-directional as possible and immediate information on work flows and priorities is needed by the supervisors and workers.

These modes of production have substantial implications in terms of ability to control stocks, supplier-customer relationships and the sophistication of purchasing systems.
Activity

Using the organization in which you work for identify which options it might have for increasing capacity and the factors that would influence its choice.
4.2 COMPARING PHYSICAL ORGANIZATIONS

Manual assembly of products for stock in high volumes is usually line organization because of use of semi-skilled staff, size of work-in-progress inventories, training time and the efficiency of the work design. However unit assembly by small group or individual is more likely to be MtO or jobbing work. Component manufacture (medium volume) is usually batch or functionally organized because of the need for machine stations and the inflexibility of machine cycle times. Low utilization of facilities is a problem. The flexibility of functional organization has a cost of high work-in-progress inventories to stabilize uneven workflow. Line organizations (inflexible) have efficient throughput rates with low inventories. The use of computers to minimize the inefficiencies of each is therefore obvious.
Example: Functional Organization

An order requires 10 operations with a total batch work content time of 20 hours only. However work in progress queues may involve 2 days waiting at each work centre. Thus an order would take 3 weeks (10 operations * 2 days) to have only 20 hours work done on it.

Throughput Efficiency = 20 hours ——> 3 weeks

Thus a typical functional organization will have a T.E. of 10-20% rarely higher.
Activity

Calculate the TE of your organization assuming your organization is a functional organization.
4.3 PROBLEMS IN MtO AND MfS

Controllable

1) capacity (output rate).
2) Finished stock levels (inventory investment).
3) Customer delivery times.

The OPS Mgr needs data on these to manipulate efficiency to the best.

For examples:

- poor quality control at Jaguar Cars in the 70’s led to considerable employee alienation. The company’s high quality standards now and emphasis on employee excellence (participation and training) are reaping dividends.

- a restaurant chain decides to re-design its franchise outlets so that only a limited range menu is offered (for fast, efficient service). Any change in eating habits or in the cost structure of the menu will render the design partial.
Activity

Identify the controllable in your organization and the values and then discuss how best to improve production.
4.4 MAKE/BUY DECISIONS

The modes of production (batch/unit, flow process etc) have substantial implications in terms of ability to control stocks, supplier-customer relationships and the sophistication of purchasing systems.

Make-for-stock or Make-to-order
The link between the manufacturer/supplier and the customer (direct or indirect) is a key variable affecting production systems and control over materials required by production.
Activity

Identify types of product that are typically MfS and MtO.
Make to Customer Order (MtO)
A work-in-progress order can be identified as exclusively for one customer. An order document is attached to the work-in-progress. Components may be made for stock (MfS) with MtO identified at the assembly stage.

Systems include JOBNING (small orders for a wide range of customers. Each order has its own design features. Order Quantities small and few components are common to more than one order. Little work can be carried out prior to order receipt.

CONTRACT WORK - customer design specified in broad outline. Much design work is attached to the order. Products are usually large, expensive (although printing fits in here).

REPEAT ORDER OR BATCH PRODUCTION - a standard range of products is offered (often combinations of standard modules). Components are made or bought for stock and assembly schedules are based on either forecast order mix or on firm orders only. Promised delivery date depends on order loading and backlog and customer allocation from production plans. If the sales forecast is erroneous some finished goods stocks can result. This not only applies to a factory but can include catering etc.

CALL-OFF SCHEDULES - the customer specifies quantities to be delivered over future periods (product is often specific to customer.

Make for Stock (MfS)
An off-the-shelf service - production geared to replenishment of finished goods stocks based on a forward plan with modifications based on market demand. Many companies operate a mixture of MtO and MfS.
4.5 CAPACITY PLANNING

Involves analysis and decisions to balance capacity at a production or service point with demand from customers (orders, visitors etc). In this sense it is useful to think of information flows and constraints in a client-server relationship. The production or service point has a given capacity and may or may not have the flexibility to expand this or reduce it in response to demand. Operations managers must:

- have sufficient production or service capacity (machines, space, staff skills and hours, stocks, vehicles etc) to be able to supply the right quantity at the right time. Thus must optimize the utilization of resources.

Order flows and customer arrivals can be unpredictable and capacity inflexible. The sales team may desperately want to take the order but do operations have the actual capacity to produce and deliver?

Capacity planning methods vary according by industry or service yet many of the principles are similar.

- **A long-term** view may cover months to years. An operations strategy/policy is needed covering overall organizational capacity (production sites, hotels, hospital wings (rooms and beds), warehouses, production lines/machinery, computer up-grades and investment in new facilities, etc.

- **Medium-term** forecasting demand then scheduling available capacity to best meet or balance that demand. This typically involves manufacturing or requirements planning, machine scheduling, staffing rotas and materials requirements planning. These plans reflect different levels of aggregation.

- **Short-term day-to-day adjustments** are typical of capacity management. Our aggregate plans help in assigning production/service capacity to accommodate the demand but many details are only revealed in operation. Unforeseen contingencies occur by the hour, day or week. Local staffs need the expertise, discretion
and some “slack” for flexibility to make locally identified adjustments - without upsetting the objectives of the aggregate plans.
Activity

What approach does your organization use in capacity planning, long-term, mid-term or short-term and why?
Capacity planning provides an operational framework and ensures the coordination of supplies and scheduling of resources. The starting points are:

1) market information - do we know what the demand is and by when? Can we forecast (predict) it?

2) Shall we make goods to order only (MTO) or, being able to rely on a steady flow of orders with additional predictions of demand make to stock (MTS)? Trends for both MTO and MTS must be predicted to ascertain capacity implications and generate plans.

### 4.5.1 Capacity planning considerations

**Operations and Forecasting**

Operations managers engaging in planning require information systems to enable them to manage demand variations. If demand exceeds available capacity, then crudely:

- extra capacity can be made available, or
- customers will wait.

If demand for products exceeds capacity and capacity constraints are real (excess demand will be lost), we can use linear programming to ascertain the best mix of demand that can be accommodated.

### 4.5.2 Demand Forecasting

#### 4.5.2.1 Dependent demand

- driven by known advance orders. A manufacturer obtains an order to supply 2,000 of a component in six months’ time. If the materials supply and production lead-times are less than six months, then they can be produced in six months. Materials can be ordered for use when required. Demand for finished goods is dependent - it depends on orders. Demand for materials depends upon demand for finished products.
4.5.2.2 Independent demand

- here demand is unpredictable, (required delivery time is less than the production lead-time). Demand is independent, driven by forecasts which ascertain production output.

In production, even though demand for materials is dependent on orders (planning targets required finished product output), if supply lead-times are long compared with process lead-times e.g. 3 days to make but 20 weeks to obtain supplies, it is likely that demand for raw materials is frequently treated as if it were independent.
Activity

Identify the products in your organization that is dependent and independent demand and why.
4.5.3  Forecasting - Quantitative And Qualitative

Demand forecasts can be subjective or objective. A forecasting method should give results that are accurate, cheap, reliable and quick enough.

Three forecasting approaches are common:

1) time series - moving average, exponential smoothing, seasonality and cycles.
2) causal methods - build mathematical models.
3) subjective / qualitative methods.
Activity

Discuss the pros and cons of subjective and objective forecasting.
4.5.3.1 Time series

This involves taking past quantitative data on demand and extend this into the future. There are many time series techniques. Each tries to differentiate trends in the data from random-ness or ‘noise’.

The techniques find it difficult to differentiate between random variations and changes in trend. One figure off a main trend line may be a blip (noise); two in succession may be a change. We have to be aware of the sensitivity of the technique:

- techniques sensitive to change are sensitive to noise.
- those offering a smooth forecast may be slow to respond to a trend change.

Moving average

The simplest forecasting technique. We deal with trends and random variations by averaging order data over the immediate past and taking the average as the forecast.
Activity

The table shows a 3-month moving average. Fill in the blanks.

<table>
<thead>
<tr>
<th>Month</th>
<th>Actual Demand</th>
<th>Forecast 3-mth Moving Avg.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apr</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>May</td>
<td>213</td>
<td></td>
</tr>
<tr>
<td>Jun</td>
<td>256</td>
<td></td>
</tr>
<tr>
<td>July</td>
<td>266</td>
<td>223</td>
</tr>
<tr>
<td>Aug</td>
<td>358</td>
<td>245</td>
</tr>
<tr>
<td>Sept</td>
<td>160</td>
<td></td>
</tr>
<tr>
<td>Oct</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td>Nov</td>
<td>145</td>
<td></td>
</tr>
<tr>
<td>Dec</td>
<td></td>
<td>152</td>
</tr>
<tr>
<td>Jan</td>
<td>148</td>
<td>165</td>
</tr>
<tr>
<td>Feb</td>
<td></td>
<td>165</td>
</tr>
<tr>
<td>Mar</td>
<td>189</td>
<td>164</td>
</tr>
</tbody>
</table>
**How to calculate?**

Sum the previous 3 months’ sales and divide by 3. We drop the oldest monthly figure and add the newest so rolling forecast.

A 6-month average takes the previous six months and divides by 6.

The moving average gives equal weight to the oldest and newest figures and disregards data older than moving time span. We can see also from the figures in the table above that the November moving average of 223 will be misleading for production planning purposes. The factory may be thrown by the August high level of demand which is adding too much weight to the average.

**Exponential smoothing**

We can weigh the moving average exponentially to reduce the effect of older figures on the forecast giving recent data the greatest weighting. The formula is:

\[
F_{t+1} = e \cdot A_t + (1 - e) \cdot F_t
\]

- \( F_{t+1} \) = forecast for period \( t +1 \)
- \( F_t \) = forecast for period \( t \)
- \( A_t \) = actual figure for period \( t \)
- \( e \) = exponential coefficient \( 0 < e < 1 \)

The larger \( e \) is then the more weight is given to last month’s actual demand. The forecast is more sensitive to recent actual data and the forecast may be therefore less smooth. To dampen a forecast (less emphasis on most recent data) will might keep \( e \) below 0.1.
Activity

Apply exponential smoothing with coefficients of 0.1 and then 0.2 to the above table of data and compare the results.
Time series is useful in forecasting only if variations are random. Factors such as rising /falling trends or seasonality must accommodate.

Demand patterns may repeat daily (electrical power and public transport has regular peaks/troughs daily), weekly (general consumer demand on Fridays/Saturdays) or annually (half time in the Cup Final etc.).

4.5.3.2 Seasonality and Cyclical Patterns
Can we separate an underlying trend from seasonal effects? “Seasonal” relates to annually repeating patterns. In the table data above - the up-surges for August and December may repeat annually. The time series needs to be weighted to account for this.

“Cyclical” involves patterns which repeat over other time periods. Extraction of trend and seasonality (decomposition into component parts) requires data over several cycles.
Activity

Identify products in your organization that are seasonal and cyclical.
4.5.3.3 Operational Research and Causal Methods

Here we build mathematical models that seek to relate causes to effects on operations.

If we can identify measurable factors that consistently influence demand - we can model the situation - e.g. by using regression analysis. For such forecasting to be useful - the time lag needs to be sufficient between creating and running the model acting on our interpretation of its results.

Interest rates influence demand for consumer durables. There is a time lapse between interest rate changes and an up-surge/downfall in demand. However other complex influences will affect the model’s forecasting accuracy ability thus causal forecasting are used little in day to day operations.

4.5.3.4 Subjective methods

Without hard data, operations planners must make best judgments - based on intuition, opinion, experience, market awareness. We use our insight/opinion (perhaps to inform our use of quantitative data) and make informed assumptions e.g. demand will be 5% more than the same period last year. More detailed market research - a survey of customers or suppliers - may be tried. The sales team, overseas agents or trade associations may be canvassed.

Operations planners e.g. in high-value, low-volume capital goods manufacturing, may attempt scenario construction (what-if analysis, contingency planning). Opinion is gathered and evaluated in structured ways by a panel that creates various scenarios. They assess the probability of a scenario occurring and its possible effect. This scanning and imagining of different contingencies - enables the preparation of alternative outline plans and contingency measures e.g. agreeing purchase options with suppliers.

4.5.4 Pros And Cons Of Chasing Demand Or Producing To A Level Capacity

Managing Demand Variations
Operations managers, once forecasting has been done, seek to manage demand in relation to capacity.
We can have variation in demand between products which, if total demand remains roughly constant, can be managed by use of scheduling systems.

If variation in total demand causes difficulty we may try to smooth demand by:

- marketing to even-out seasonal effects.
- finding complementary products (greetings cards for all occasions).
- differential pricing of services (off-peak tariffs).

These help but the operations manager may still face problems and can try one or a mixture of the following.

1) Working to a level capacity

If customers will wait, or we use stock to buffer operations e.g. in a seasonal market (August car sales, Christmas build-up). We can try to ignore demand variations, set total system capacity at the average demand, (plus a small contingency surplus) and maintain steady output.

We make for stock in the off-peak period and sell from stock at peak (if it materializes). Note: difficult to do with ice-cream or cream cakes! Products need a long shelf-life.

The key to make for- and sell-from stock in peak periods lies with:
• efficient use of operations resources and thus low costs.
• managing cash flow.
• costs of promotion and discounting.

If disadvantages are greater than advantages, we can try a chase demand strategy.

2) Chase demand
If operational costs reduce as capacity is reduced (down-sizing) we might:
• vary capacity quickly in line with demand.
• maintain high utilization without stockholding or demand management penalties.

Capital-intensive operations largely have fixed capacity. In the short term it is difficult to vary capital capacity. Increasing/reducing the full-time staff (hiring and firing policy) incurs penalties (redundancy payments, recruitment, training costs). Lay-offs are expensive (continue basic payments) and add to staff unrest.

We can add to capacity and chase demand by:

• **Overtime working**
  Five hours overtime on a basic 40-hour week gives e.g. a 12% increase in output without employing extra staff. We may have to pay overtime premiums but we get better capital utilization. What are the other pros and cons?

• **Flexible and casual labour**
  With a front-shop and back-office service, back-room staff can be assigned to boost front-shop capacity. Backroom work can be put on hold. In a department store, non-selling staff may work on the shop floor as sales assistants for the first, busy days of the sales. Larger short-term variations e.g. Christmas or a large new order may need part-time staff rather than overtime which may be too much for permanent staff. Service operations e.g. catering functions, hotels typically rely on staff working up to eighteen hours weekly. In the
hotel situation, part-time staffing enable split shifts to be managed with flexible roots.

Holiday resorts with their seasonal demand variations depend upon seasonal casuals - of which there is usually a reliable supply (students, people who want summer work with live-in-accommodation in particular).

- **Make-or-buy and sub-contracting**
  Buying in components that are normally made in-house is an option provided the source can offer the right quality and delivery. The make-or-buy decision thus focuses on capacity as well as price. Bought in components may cost more than those made in-house. There is an additional problem of dependency on a supplier and the latter’s reliability.

  Civil engineering subcontract in very efficient ways. A main contractor will be the project co-coordinator who hires sub-contractors, workers and plant as required.

  In clothing manufacture, out-workers (self-employed, home-working, subcontractors) may be used. The sub-contractor has the premises, expertise and equipment. A window installation company may vary its order fulfilling capacity quickly with fewer cost penalties by using its list of reliable sub-contractors.

3) **Hybrid Strategies**

At the end of the day a company may use stock, overtime, part-timers and demand/marketing management and still not have maximum utilization. Services rely on queues or appointment systems at peak times and have off-peak, unused capacity. The balance between demand and capacity is a target which operations managers strive towards - recognizing inevitable compromises on the way.
Activity

Discuss the benefits of chasing demand or producing to level capacity in relation to products in your organization.
4.5.5 Planning Systems Capacity Planning Systems

Medium-term (aggregate) planning e.g. a weekly/monthly plan or schedule tries to match demand with capacity as such the units of measurement for both need to be defined. For demand these might be:

- volumes to be shipped by day/week etc.,
- number and type of customers to be served etc.

If we are making one product e.g. strawberry jam tarts, demand can be measured as gross or tonnes output/week or production hours required per week (given a standard quantity of production per hour).

For capacity we need to know:

- machine and vehicle capacity,
- staff skills and hours, and
- material/component stock availability.

A bakery of mixers, ovens, preparation tables, packaging machines etc. has a design capacity to produce tarts at a given rate and to a maximum capacity (working flat out 24 hours a day, each week and all year) - assuming you have the staff who can withstand the stress.
Activity

Discuss the capacity planning system that your organization uses.
Complexity (output/capacity relationships)
..must be managed in a multi-product situation. Each product may make different time/process demands. Do we have the ability to properly co-ordinate all operations to meet existing orders let alone squeeze in a new order with its knock on effect on the rest? Will managerial breakdown result? Sales staff may wish the company to accept the order. Operations staffs despair at the pressure.

If the order/product mix and processes are stable, a multi-product firm may:
- assume that the overall mix (aggregate demand) for the product is roughly constant.
- on this basis we can draw up our aggregate plan (our manufacturing resources plan) on the basis of “total” figures.

Master Production Schedules
- Start with anticipated demand for individual products over the planning horizon - up to the due date of the plan.
- Map expected demand against available capacity.
- Identify over/under-capacity problems.
- Take action to amend the schedule or adjust capacity.
- When actual orders roll in they can be compared against plan and the MPS (a continuous rolling plan) up-dated.

With our overall estimate, accommodation of slight, short term variations in the product mix is akin to fine tuning. The overview and aggregate allocations provide predictability and ease in seeing where the gaps are.

Data for manufacturing resources planning
...we need process time and availability data in order to allocate capacity across our planned products and required processes. Plant capacity depends on:
- required times for each operation/process on each product.
- machine speeds, set up times and availabilities.
• work patterns and operator availabilities e.g. a 37 hr week plus controlled overtime per operator or shift working possibilities.

We can be swamped with data and not see the wood for trees. Aggregate planning systems must be workable and user friendly for those who refer to them. If users find that the plans are inaccurate or make too many assumptions - then they come to disbelieve the plans and ignore the figures. Chaos beckons. A heuristic for planners is to:

• group products e.g. by the similarly of demands made on equipment, staff, facilities.

• use larger units, e.g. weekly outputs rather than daily.

A Gross of Vans
A van may have three engine types, four levels of trim and eight paint options i.e. 96 permutations for customers. Yet in assembly - equipment needs (provided we have equipment flexibility) and staff skill requirements are similar. Demand can be aggregated into a plan for 96. Data on engine supply, paint availability and trim stocks requirements however is required in more detail.

Bills of Materials
With standard products, information from the product specification is used with production data to provide a bill of materials. This is an essential record in scheduling production of specific quantities of the product and the components that make it up. BOM data covers:

• raw materials and component quantities.

• processes used, sequences and throughput capacities.

• standard times for each process stage (work measurement data).

BOM e.g. for a packet of 24 vitamin tablets allows machine and staff requirements, raw material and component quantities from an order. With cost data we can then calculate the product’s standard cost.
### Bill of Materials

**Bottles of 500 mg tabs, 1000 bottles per batch**

<table>
<thead>
<tr>
<th>Process</th>
<th>Plant</th>
<th>Standard time</th>
<th>Material</th>
<th>Quantity</th>
<th>Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weigh</td>
<td>Scales</td>
<td>4</td>
<td>Vitamin</td>
<td>65 mg</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Binding agent</td>
<td>30 mg</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Shine agent</td>
<td>5 mg</td>
<td></td>
</tr>
<tr>
<td>Mix</td>
<td>Blender</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Set up press</td>
<td>Tab Press</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Press operation</td>
<td>Tab Press</td>
<td>12</td>
<td></td>
<td></td>
<td>96%</td>
</tr>
<tr>
<td>Inspection</td>
<td>Inspection slot</td>
<td>1.2</td>
<td></td>
<td></td>
<td>95%</td>
</tr>
<tr>
<td>Pack</td>
<td>Bottler</td>
<td>1.8</td>
<td>Plastic bottle</td>
<td>1</td>
<td>99.5%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Foam insert</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Plastic lid</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Label</td>
<td>Auto labeller</td>
<td>0.5</td>
<td>Label</td>
<td>1</td>
<td>99%</td>
</tr>
</tbody>
</table>
**GIGO**

Garbage in equal’s garbage out. A sound plan needs sound up-to-date information. The bill of materials file must be up-dated with any changes to product specifications, processes, standard times and yields.

The “yield” column reflects a process where there may be quality problems. A BOM must reflect re-working possibilities.
Activity

Identify a product in your organization and produce a detail BOM for it.
4.5.6  Job Shop Planning (Realistic Data, Proactivity and Planning-Job Shop Relationships)

Realistic Data
Capacity data must be realistic - reflecting what can actually be done - not the planner’s dreams. Well-grounded standard times are important including:

- work times, relaxation allowances, sickness, training courses, absences and holidays.
- contingencies e.g. supplier difficulties, work not available from up-stream operations and machine breakdown.
- planned maintenance times/schedules.

Medium-term plans and Short-term Pressures
Plans are imposed upon working facilities. The people who perform the operations usually find short-term scheduling and rescheduling involves more pressures than medium term aggregate planning. In shop floor terms therefore - the proactive manager anticipates the medium term demands in resolving immediate day to day problems. He/she keeps the longer term in view rather than being overwhelmed by the fire-fighting behaviours of the shorter term panic.

Project/job shop planning
One-off jobs/projects involve substantial uncertainty and planning depends on subjective estimating. Some repetitive operations may enable use of measured standard times but many tasks/times are unique to the order/project.

It is usually the case that the job-shop teams have the ability to undertake their own day-to-day planning. If operations planners do this it is essential that they have prior experience with “the kind of job that is involved”.

They have to be able to:
- research the project requirement properly consulting with the shop floor.
- rely on the expertise and ability the team in the job shop.
facilitate the flexibility that people in the job shop need. It is unlikely that neither work measurement data nor standard bills of materials are useable.

not irritant the job shop staff further by continually changing plans with little or no notice or harassing for work-in-progress updates.

4.5.7 Linear Programming

This section will be expanded substantially with illustrations over the next few months.

Linear programming is a technique used for optimizing the use of resources when:
- operating under resource constraints; and
- when the relationships between the factors are linear.

In operations management it is typically used in blending industries to optimize the mix of ingredients or product mix when faced with capacity constraints. If constraints are difficult to overcome some demand may be left unsatisfied. We can thus determine the feasible mix of output which maximizes the contribution.

The technique involves setting up simultaneous equations that represent the constraints, and then solving to maximize contribution. With only two variables i.e. two products sharing the same resources the solution can be identified graphically. With more than two variables computer software would be use to resolve the equations.

4.5.8 Predictability And Contingencies

To do capacity planning and scheduling planners must understand the limitations of the technology in use, staffing policies, the scope for contracting out, the implications of the organization’s size and structure etc. Plans can fail through staff illness, jobs hitting unforeseen problems etc. Overtime may ease matters or a hire car may be offered to the customer - increasing costs - the
customer may not be prepared to pay.
Activity

What are the contingencies plans does your organization adopt in capacity planning. Discuss
Consider the capacity difficulties in relation to perishables (newspapers, airline seats and meals, Belgian pate). Overbooking by hoteliers can work to their advantage but can upset holiday-makers!

- Bus companies or airlines use fixed schedules - if planes are not filled at standard fares then bucket shops sell surplus seats.

- People stand in trains or wait angrily in the freezing cold for the next one. They will miss their connection and be late again for work.

- A garage will book cars in for servicing according to equipment and staff availability - “Sorry sir it will be Tuesday of next week at the earliest...”.

A telephone company or Internet Service Provider needs capacity to fit maximum demand (and growth) - office/college hours and weekend demand. Operational changeovers and line repairs need to respond to existing demand. Fast operator/help desk systems may be needed at peak times. Public transport needs enough capacity for peak traffic. At other times buses and trains are idle.
4.6 SUMMARY

Capacity planning is one of the key facets of operations management as it determines the amount of goods or services (outputs) which can be produced within a given time period. Too little capacity means that customers will not be satisfied and too much capacity means that the operation is being under-utilized with resultant high fixed costs and consequential effects on break-even and profitability. When a company needs to increase capacity it has several options to consider ranging between working overtime to building a new site or a plant. Forecasting demand is critical to capacity planning and companies can adopt different capacity strategies i.e. lead, lag or average, to ensure customer satisfaction and maintain operations within their budget and other constraints.
Case study

The case study discusses the merits of bulk freight shipments by different types of ships.

Case Synopsis

Conventionally, shipping companies have invested in large ships to achieve economies of scale. More recently, high speed ships have been proposed as a means of achieving timely service for customers and improving shipping performance. Yet another solution offered here is to boost the cargo handling speed at port allowing for a higher number of annual round trips.

Both the cost efficiency and timeliness of shipping service can be improved. The economic trade-offs between the investments in cargo handling and ship propulsion technologies are formally analyzed by taking the round trip frequency as the key to performance. The theoretical analyses as well as the practical cases studied indicate that investments in cargo handling technology, such as automation of container terminal operations and hatch less self-loading ships, have indeed considerable profit-making potential for shipping companies. Other technology investment opportunities appear less promising: ship propulsion due to energy consumption and environmental concerns; and larger ships due to low customer responsiveness and risks of low capital productivity.

The case also makes use of analogies from manufacturing i.e. internal and external setups and some of the issues facing the transportation of goods at sea may also hold true for transportation, particularly by barge or lorry.

Please note that some of the original accompanying documents have not been included with the case, but we consider there is sufficient information within the body of the text for you to enhance your learning.
Questions

After reading the case, check your understanding by answering the following questions.

i) What has previously been the traditional means of increasing revenue / decreasing costs of sea freight?

ii) What are the drawbacks of high speed ships?

iii) What are the drawbacks of operating large ships on shorter routes?

iv) What is the ‘blind spot’ in shipping?
Test Questions

1) Define and discuss capacity planning and its importance.

2) How does planning the operational processes for an organization involves capacity planning and facilities planning.

3) Is it always more economical and efficient for companies to buy components from outside suppliers then to make them? Discuss the pros and cons.