UNIT-6

Manufacturing & Delivery Operations

Learning Outcomes

By the end of this unit the learner will be able to:

- ✓ Understand what production design is
- ✓ Identify Production Scheduling procedures
- ✓ Explore the Delivery Scheduling process

Unit 6

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Whenever a product is to be built, the design and components needed for its development depend upon the available technology and requirements for the product's performance.

Initially, less focus used to be given to product design and selection of its elements, though these factors affect the supply chain. If you are considering product design from the perspective of a supply chain, the objective focuses on designing the product with fewer parts, modular construction from generic sub-assemblies and simpler designs.

This way, the parts can be obtained from a smaller group of chosen suppliers. Inventory can be kept in the form of generic sub-assemblies at suitable sites in the supply chain. There will not be the requirement to hold larger finished goods in inventories, as customer demand can be fulfilled quickly by assembling finished products from generic sub-assemblies, as clients' orders arrive.

The supply chain needed to support merchandise is moulded by the design of the product. The more responsive, flexible and cost effective the supply chain is, the greater the likelihood is that the product will be succesful in the market. To demonstrate this point, consider the scenario outlined below:

A corporation designs an outstanding home entertainment system, offered with a widescreen TV and high quality sound. It performs to the highest standard and delivers superior results. But the key electronics behind this entertainment centre are produced with elements from 12 different vendors.

The company increases production when there is an increase in demand. Managing the functions of quality control and delivery schedules for 12 different suppliers is a challenge. More procurement staff and managers are hired. Assembly of the elements is complicated, but delays in the components' delivery from any of the vendors can slow the speed of production rates. So, additional stocks of finished products are kept to compensate. A number of new suppliers are needed to offer the required product components. One of them is causing the company to face quality control problems and needs to be replaced, while another supplier decides following several months to stop production of the component/s it supplies to the corporation. They launched a new part with similar features, but not an accurate replacement. The company has to delay production of the home entertainment system, while a team of engineers redesigns the element of the system that used the discontinued component, so that it can make use of the new component. During this time, buffer stocks run short in some locations and sales start to plummet as clients go elsewhere.

There is a natural tendency for procurement, design and manufacturing people to have dissimilar agendas, even though their actions are harmonized. Designers are anxious about meeting the requirements of customers. People who are involved in the procurement process negotiate the best

prices from a group of pre-screened and favoured suppliers. Those in manufacturing want to have trouble-free fabrication and assembly approaches and long production runs. Cross-functional design teams with representatives belonging to these three groups have the ability to bring together the best insights from every group. Cross-functional teams can re-examine the new product plan and discuss related issues. Can existing suppliers supply the components required? How many new suppliers are required? What prospects are there to make the design simpler and decrease the number of suppliers? What happens if a dealer stops producing a particular component? How can product assembly be made easier?

At the same time, they are checking product designs; this is a cross-functional team, which can assess current preferred suppliers and production facilities. What components can current suppliers provide? What are the quality levels of their services and technical support capabilities? How large a labour force and what type of skills are required to make the product? How much power is needed and which facilities must be used? A product design process that does a good job of organizing the three perspectives — design, procurement and manufacturing—will result in a product that can be maintained by an effective supply chain. This will give the product a faster time to market and a competitve cost.

Production Scheduling (Make)

Production scheduling assigns accessible capacity (equipment, facilities and labour) to the work that is required to be done. The objective is to use accessible capacity in the most well-organized and cost-effective manner. The production setup operation is a process of finding the correct balance between a numbers of competing objectives:

- **High Utilization Rates**—this often means long production runs, along with centralised production and distribution centres. The idea is to create and benefit from the advantages of economies of scale.
- **Low Inventory Levels**—this usually implies short production runs and just-in-time delivery of materialsm, in order to reduce both assets and cash used in inventory.
- **High Levels of Customer Service**— this often needs high inventory levels or a lot of short production runs. The priority is to provide the customer with fast delivery of products and not to run out of stock in any product.

When a particular product is to be produced in a dedicated facility, scheduling means systematizing operations as economically as possible and running the resource at the level needed to meet the product demand. When a number of different products are to be completed in a single service or on a single assembly line, this becomes more complex. Every product will have to be produced for some span of time, after which it is necessary to switch over to the manufacturing of the next product.

The primary step in arranging a multi-product manufacturing facility is to decide the economic lot size for the manufacturing runs of every product. The calculation of economic lot size involves balancing the production set-up costs for a product with the cost of carrying that product in inventory.

If setups are completed frequently and manufacturing runs are done in small batches, the result will be low inventory level, but production costs will be higher because of enlarged set-up activity. If production costs are reduced by doing long production runs, then inventory levels will be higher and product inventory carrying costs will increase.

Once production quantities have been decided, the next step is to set the correct sequence of production runs for every product. The fundamental rule is that if inventory for a particular product is low when compared to estimated demand, manufacturing of this product should be pushed ahead of other products that have higher inventory levels, relative to their estimated demand. A general practice is to schedule production runs based on the notion of a product's "run out time." This is the time that represents number of days or weeks it would take to reduce the product inventory on-hand, given anticipated demand. The calculation for run out time for a product is expressed as

$R = P / D$

where:

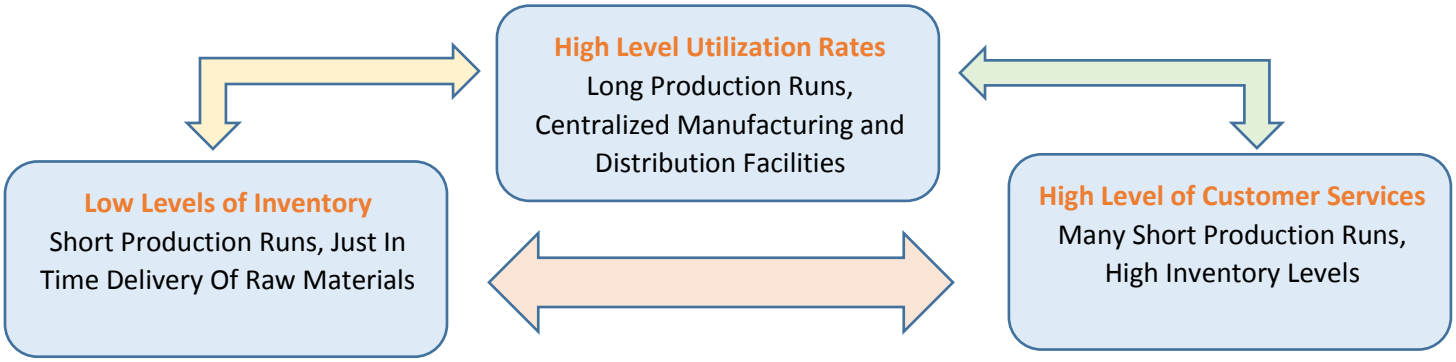
R = run out time

P = number of units of the product on hand

D = product demand in units for a day or week

The scheduling procedure is a repetitive process, which starts with a calculation of the run out times for all products—their 'R' values. The first production run is then planned for the product with the lowest R value.

Assume that the economic lot size for the product has been produced and then recalculate all product R values. Again, choose the product with the lowest R value, and schedule its production run next. Imagine the economic lot size is produced for this product and once more recalculate all product R values. This scheduling procedure can be repeated as often as necessary to create a production schedule going as far into the future as needed.



Economics Lot Size (ELS)

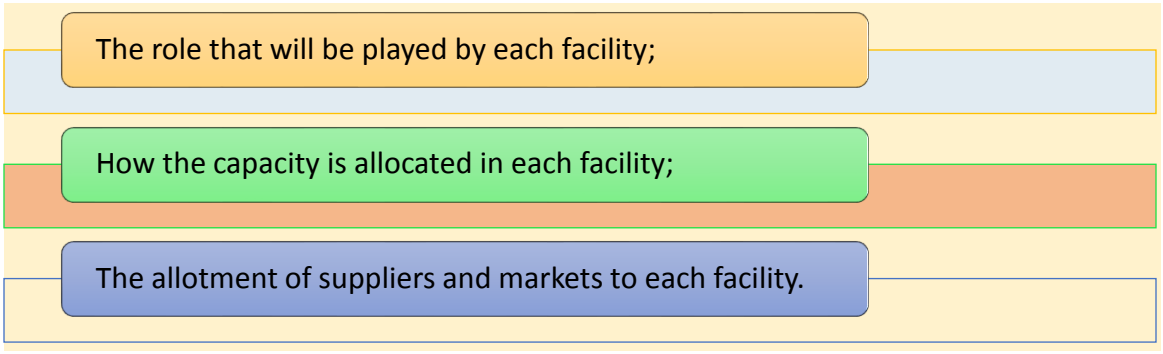
- Producing Products In ELS Balances Production Setup Costs Against Inventory Carrying Costs.
- Schedule Production So That Products With Shortest Run Out Times Are Made First.

After setting up is done, the resulting inventory must be constantly monitored against definite demand. Is inventory building up too quickly? Should the demand level be altered in the calculation of run out time? Reality hardly ever pans out as expected, so production schedules need to be constantly altered and reconsidered.

Facility Management (Make)

Location is one of the five supply chain drivers, as examined earlier. It is usually quite expensive to close a facility or to construct a new one, so businesses generally live with the decisions they make about where to situate their facilities. Ongoing facility administration sees location as an entity and pays attention to how best to make use of the capacity available.

This is carried out by making decisions in the following three areas:



The role that every facility will play is determined by decisions as to what activities will be carried out in which facilities. These decisions will have a big affect on the overall flexibility of the supply chain.

The decisions made help to define the ways that the supply chain can alter its operations to meet varying market demand. If a facility is chosen to carry out only a single function or supply only onesingle market, it generally cannot easily be altered to carry out a different function, or serve a diverse market if supply chain requirements change.

How capacity is assigned in each facility is based upon the role that the facility plays. Capacity allocation decisions determine the labour and equipment deployed at the facility. It is simpler to vary capacity allocation decisions than to modify location decisions, but still it is not cheap to make recurrent changes in allocation. So, once determined, capacity allocation powerfully influences supply chain profitability and performance. Allocating insufficient capacity to a facility leads to the inability to meet market demand and ultimately the loss of sales. Excessive capacity results in lower rates of utilization and higher overall supply chain costs.

The allotment of suppliers and markets to every facility is subjective to the first two decisions. On the basis of the role that a facility plays and the capacity assigned to it, the facility will need specifc kinds of suppliers, while the products and volumes that it can hold mean that it can support certain kinds of markets. Decisions regarding suppliers and markets to assign to a facility influence the costs for moving supplies to the facility, and transporting finished products from the facility to clients. These decisions also influence the general supply chain's ability to meet market demands.

Order Management (Deliver)

The procedure for passing information from customers back to the supply chain, from retailers to distributers to service providers and producers is called order management .This procedure also includes the distribution of information regarding product substitutions, order delivery dates and back orders *forwards* through the supply chain to consumers. This procedure has long relied on the utilization of telephone communication and paper documents like purchase orders, change orders, sales orders, pick tickets, packing lists and invoices.

A business generates a buying order and contacts a vendor to fill this order. The provider, who gets the call, meets the order from their own inventory or sources, which need products from other suppliers. If the vendor fills the order from its inventory, it turns the customer buying order into a pick ticket, a packing list and an invoice.

If products are obtained from other suppliers, the original customer buying order is turned into a buying order from the first supplier to the next supplier. That supplier will in turn either fill the order from its inventory or source products from other suppliers. The purchase order it receives is again turned into documents such as pick tickets, packing lists and invoices. This process is recurrent through the length of the supply chain.

The conventional order management process has longer lead and interval times built into it, because of the slow movement of data back and forth in the supply chain. This sluggish movement of data is sufficient in some simple supply chains, but in multifaceted supply chains, faster and more precise movement of data is essential, in order to attain the responsiveness and competence required. Contemporary order management focuses on systems to enable faster and more correct movement of order-associated data.

Additionally, the order management process needs to incorporate exemption handling, offering people ways to quickly spot problems and give them the details they need, in order to take the necessary action. This means the handling of routine orders should be automatic, while orders that need special handling due to issues such as inadequate inventory, missed delivery dates or altered requests from the buyer need to be brought to the attention of those who can tackle such issues.

The following represents four key rules for effective order management -

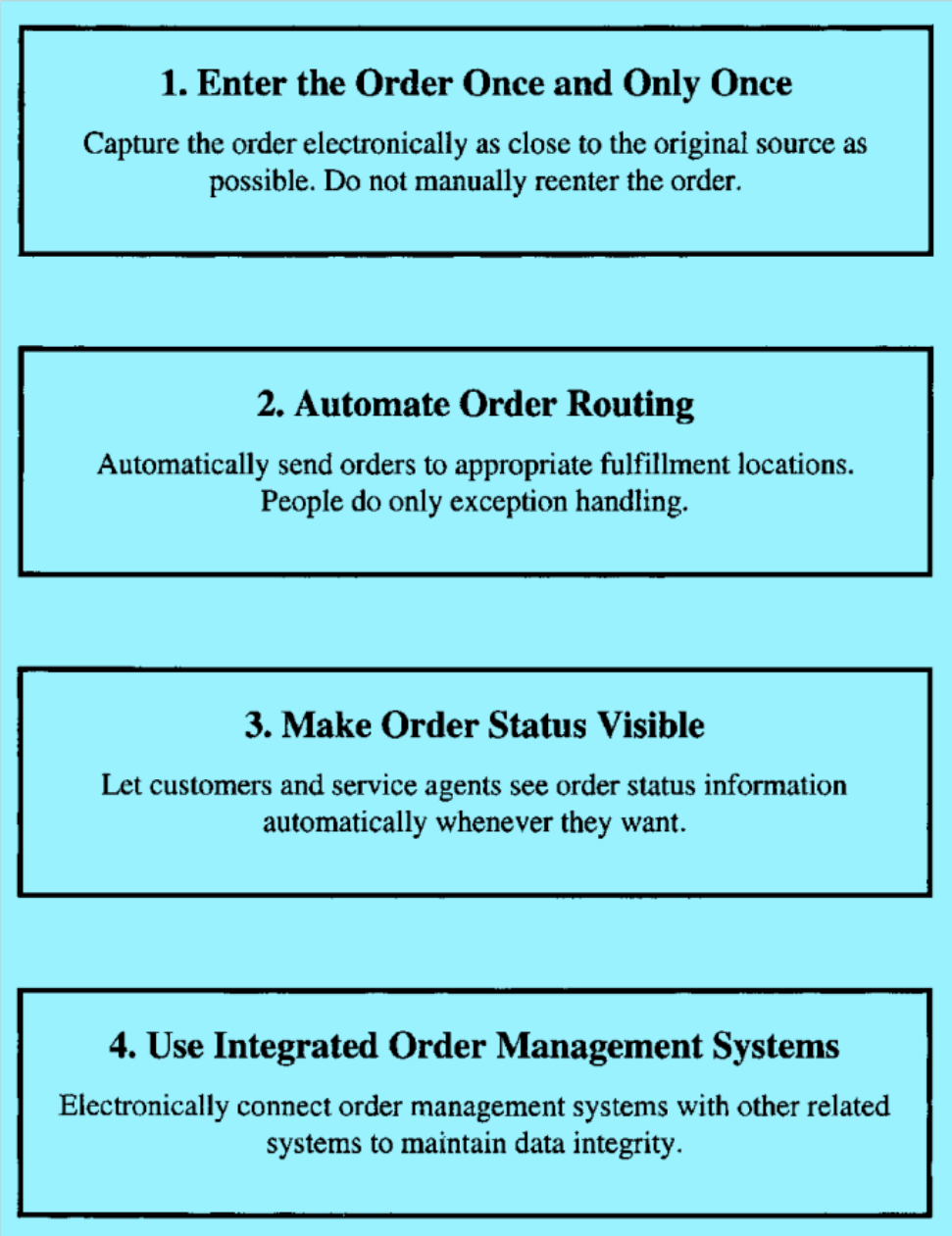


Fig: 6.2

Because of these requirements, order management is beginning to overlap and combine with another function called Customer Relationship Management (CRM). This is typically considered to be a marketing and sales function. Due to supply chain challenges and shifting market demands, order management is a procedure that is evolving rapidly.

However, there are several essential principles that direct this operation:

- **Enter the Order Data Once and Only Once**—Track the data electronically as close to its original source as possible and do not by-hand re-enter the data as it progresses through the supply chain. It is typically best if the consumers themselves put their orders into an order entry system. This system should then move the most important order data to other systems and supply chain participants as required, for the generation of purchase orders, pick tickets, invoices and so on.
- **Automate Order Handling**—Manual interference should be kept at the lowest possible level for directing and satisfying routine orders. Computer systems should transmit the required data to the required locations to complete routine orders. Exception handling must identifyany orders with problems that require the attention of specialist individuals to address them.
- **Make Order Status Visible to Customers and Service Agents**— Let consumers track their own orders through all phases, right from entry of the order to delivery of their desired products. Customers must be able to view their order status on demand, without having to enlist the help of other people. When an order runs into trouble, the order should be brought to the attention of service agents who can address the problems.
- **Integrate Order Management Systems with Other Related Systems to Maintain Data Integrity**— Order entry systems require product descriptive data and prices of the products, so that the consumer has a guide while making choices. The systems that hold this product data must be in direct contact with order management systems. Order data is required by other systems to revise inventory status, calculate delivery schedules and produce invoices. Order data should automatically flow into these systems in a precise and timely way.

Delivery Scheduling (Deliver)

The delivery preparation operation is of course directly affected by the decisions made regarding the modes of transport that will be used. The delivery scheduling procedure works within the limitations set by transportation decisions. For most modes of transportation, there are two kinds of delivery methods: direct deliveries and milk run deliveries.

Direct Deliveries

Direct deliveries are made from a single originating location to a single receiving location. With this means of delivery, the routing is just a matter of selecting the shortest direct path between those two locations. Scheduling this kind of delivery involves decisions regarding the quantity to deliver and the frequency of deliveries to every location. The benefits of this delivery method are the ease of operations and delivery synchronization. Since this means products are moved directly from the location where they are completed or stored to a site where the products will be consumed, it eliminates any middle operations that combine different smaller shipments into a single, larger joint-shipment.

Direct deliveries are considered well-organized if the delivery location makes economic order quantities (EOQs) that are similar in size to the shipment quantities required, in order to make best use of the form of transportation being employed. For example, if a delivery location gets deliveries by truck and its EOQ is a similar size to the truck

load (TL), then the direct delivery process is effective and efficient. If the EOQ does not equal TL quantities, then this delivery method becomes less desirable. Receiving charges incurred at the delivery location are high because this location handles separate deliveries from a diverse rane of supplier to obtain all the products it requires.

Milk Run Deliveries

These are the deliveries which are routed to bring products from a single originating location to multiple receiving locations. Scheduling milk run deliveries is a much more complex task than scheduling direct deliveries.

The benefits of this mode of delivery come in the fact that better use can be made of transportation, while the price of receiving deliveries is lower as receiving locations get larger but fewer deliveries. If the EOQs of various products required by a delivery location are less than truck load (LTL) amounts, milk run deliveries allow orders for different products to be combined until the resultant quantity equals a TL amount. If there are numerous delivery locations where each needs lower quantities of products, they can all be served by a solo truck that begins its delivery route with a full TL amount of products.

There are two major methods for routing milk run deliveries.

Every routing technique has its benefits and drawbacks and every method can be more or less successful, depending on the circumstances in which it is used *and* the accuracy of the data that is accessible.

Both of these techniques are supported by software packages.

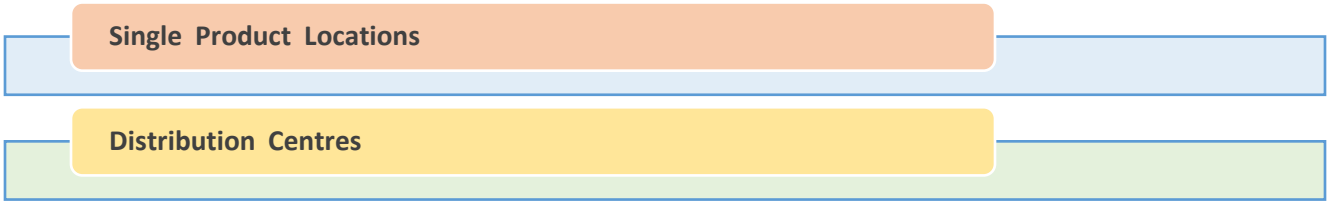
These two techniques are:

The Savings Matrix Technique is the easier of the two techniques. It can be utilized to allocate customers to vehicles and to plan routes, in which there are delivery time windows at delivery locations and other limitations. This method is versatile and can be tailored to take into account many different constraints. It provides an efficient routing solution that can be put to effective use.

Its flaw lies mostly in the fact that it is easier to find cost-effective solutions using the second of the techniques. This method is best used when there are a lot of different constraints, all of which must be fulfilled by the delivery schedule.The Generalized Assignment Technique is more sophisticated and usually provides a better solution than the Savings Matrix technique, when there are no restraints on the delivery schedule other than the carrying capacity of the delivery vehicle. The challenge with this technique is that it is harder to make workable delivery schedules due to the higher volume of restraints. This practice is best employed when delivery constraints are restricted to vehicle capacity or to overall travel time.

Delivery Sources

Deliveries are made to customers from two sources:



Single product locations include facilities like factories, warehouses or anywhere a single product or limited range of related items are accessible for shipment. These facilities are suitable when there is an expected and high level of demand for the products they offer, and where shipments will be made only to customer locations that can accept the products in larger quantities. They offer high economies of scale when used efficiently.

Distribution centres are there facilities where mass shipments of products enter from single product locations. When there is a long distance between suppliers and customers, the utilization of a distribution centre allows for economies of scale, using long-distance transportation to carry large quantities of products to a site closer to the final customers.

The distribution centre might warehouse inventory for potential shipment, or it might be used mainly for cross docking. Cross docking is a method, first pioneered by Wal-Mart, where truckload shipments of single products enter and are then unloaded. While these trucks are being unloaded, their mass shipments are split into smaller lots and are joined with small lots of other products, to be loaded immediately back onto other trucks. These trucks then deliver the products to their destinations.

Distribution centres that utilize cross docking benefit from multiple advantages. The first is that products flow quicker in the supply chain, given that small levels of inventory are held in storage space. The second is that handling expenses can be reduced as products do not have to be put away and then recovered from storage later. The advantages of cross docking are maximized when there are large expected product volumes and when economies of scale can be achieved on both inbound *and* outbound transportation.

However, cross docking is a difficult technique and it requires a substantial degree of synchronization between inbound and outbound shipments. Transporting and delivering goods is costly, so capabilities in this area are directly associated with the actual needs of the market that the supply chain serves. Highly responsive supply chains generally have high transport and delivery costs, because their consumers expect fast delivery. This results in a lot of smaller shipments of products. Less responsive supply chains can combine orders over a period of time and make fewer larger shipments. This results in lower transport costs and enhanced economies of scale.

Returns Processing (Deliver)

All supply chains have to deal with the returns. This procedure is also called “reverse logistics” and is often a tricky and unproductive process. In the Supply-Chain Council’s SCOR model, a whole class of

activities has been associated with this procedure. End customers, distributors, retailers and manufacturers all return products under various circumstances. The most general circumstances are:

- The wrong products were delivered
- The products that were delivered were broken in transit or were faulty from the factory
- Too many products were delivered than initially required by the customer
- All of these conditions arise from supply chain inefficiencies, resulting in the need to return products

Companies and supply chains, as a whole, need to keep a log of all returns. Specifically, their occurrence rate and if the return rates are increasing or decreasing. Returns processing should be resourceful, plus it is important keep in mind that if other supply chain activities are handled efficiently, there will not be a high need for returns processing.

Optimizing the returns procedure can turn out to be an exercise in addressing the inefficiency of a procedure that should not be happening in the first place. If return rates are growing, it is far more proactive to find and fix the sources of the troubles than to process heavy returns volumes.

Returns are a value added action for the whole supply chain where product recycling takes place. In this instance, returns occur at the end of the product life cycle when the final user sends the product back to the producer, or another business that will either recycle or securely dispose of the product. As environmental awareness increases, companies in growing numbers have adopted green policies – in turn spiking a surge in recycling activities. The recycling companies themselves will consider this activity not as returns processing, but rather as a sourcing activity. This is the approach by which they obtain their raw materials.

Supply Chain Operations Can Be Outsourced

After learning about the 10 fundamental supply chain operations in this unit and the prior unit, which of these operations are handled by internal staff in your company? How many of these operations are central competencies? How many of these operations bring money into your business and how many of them consume money?

The persistent pressure on revenue margins, which free markets produce, is the driving force behind the expansion of outsourcing. What might be considered as an overhead for Company A might be a service that Company B can offer and make a profit doing so. Company B might be able to provide this service for a price lower than it costs Company A to do it in-house. Company A would therefore be wise to think about outsourcing.

The standard participants in supply chains are producers, distributors, logistics providers and retailers. How many of the 10 supply chain operations can be termed as core competencies of any of these

organizations? There are certain operations, such as credit and collections, order management and product design, which might not be a core competency of any of the conventional participants. This creates opportunities for new service providers to handle these operations and take control of them for the other supply chain participants. All 10 of these operations need to be completed for the supply chain as a whole to work, but they do not all need to be done by any single company. Certainly, they cannot all be done *well* by any single company.

The other factor that encourages outsourcing is the increasing sophistication of the markets, which are served by the supply chains. The days when the Ford Motor Company could run a vertically integrated business that did it all - from mining iron ore to creating steel to designing and constructing automobiles – are long gone. That structure was only possible becasue the markets it served were satisfied to buy bulk quantities of standard products.

Henry Ford stated the following when he was asked about what colours his consumers could choose from:

"They can have any colour they want as long as it's black."

Markets today require - and have to pay for - all kinds of innovations, tailored features and services. This creates challenges for the participants of the supply chain, along with those who focus on specifc areas to offer the proficiencies and efficiencies that are necessary to handle this complexity.

Further Reading:

- ✓ **Ken Boyer, Rohit Verma, (2010), Operations and Supply Chain Management for the 21st Century**
- ✓ **Kenneth D. Lawrence, Ronald K. Klimberg, Virginia M. Miori, (2011), The Supply Chain in Manufacturing, Distribution, and Transportation**
- ✓ **F. Robert Jacobs, William Berry, D. Clay Whybark, Thomas Vollmann, (2011), Manufacturing planning and control for supply chain management.**