Product variety:- In several product categories, such as eyeglasses, toys, apparel, and watches, firms offer a variety of products to satisfy diverse consumer needs. The competition among firms that offer such products often is nonlocal because consumers can purchase the products easily through online, Even if a sufficiently large variety of products is available, the preferred products of some consumers still may be unavailable. It is also conceivable that a consumer's preffered products may be available but the consumer may not be informed about them
Product variety is a class of business models that seek a competitive advantage by offering more variety than the competition.

Modular Design:- Modular design refers to designing products by organizing subassemblies and components as distinct building blocks (i.e., modules) that can be integrated through configurati to fulfill various customer and engineer requirement A modular system can be characterized by the following:

→ Functional partitioning into discrete scalable, reusable modules consisting of isolated, self-contained functional elements.

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→ Rigorous use of well-defined modular interfaces including object-oriented descriptions of module functionality

→ Ease of change to achieve technology transparency and, to the extent possible, make use of industry standards for key interfaces.

Design for manufacturability:

Design for manufacturability describes the process of designing or engineering a part in order to optimize the production process and reduce manufacturing costs. Design for manufacturability allows potential problems to be fixed in the design phase, which is the least expensive place to address them. The design of the part can have an enormous effect on the cost of manufacturing.

Design for manufacturability may start with the use of design tools such as computer aided design (CAD) to evaluate design alternatives, but the process is actually much more involved. Design for manufacturability requires the optimization of a given product design within the production environment, and includes suppliers, material optimization, material handling systems, packaging, manufacturing processes, labor force capabilities, and distribution/logistics systems. The end result of design for manufacturability is a part that maximizes cost savings while improving quality, safety, time-to-market, and overall customer satisfaction.

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Design for Manufacturing - Guidelines

Design for Manufacturing (DFM) and design for assembly (DFA) are the integration of product design and process planning into one common activity. The goal is to design a product that is easily and economically manufactured. The importance of designing for manufacturing is underlined by the fact that about 70% of manufacturing costs of a product (cost of materials, processing, and assembly) are determined by design decisions, with production decisions (such as process planning or machine tool selection) responsible for only 20%.

The heart of any design for manufacturing system is a group of design principles or guidelines that are structured to help the designer reduce the cost and difficulty of manufacturing an item. The following is a listing of these rules.[1]

1. **Reduce the total number of parts.** The reduction of the number of parts in a product is probably the best opportunity for reducing manufacturing costs. Less parts implies less purchases, inventory, handling, processing time, development time, equipment, engineering time, assembly difficulty, service inspection, testing, etc. In general, it reduces the level of intensity of all activities related to the product during its entire life. A part that does not need to have relative motion with respect to other parts, does not have to be made of a different material, or that would make the assembly or service of other parts extremely difficult or impossible, is an excellent target for elimination. Some approaches to part-count reduction are based on the use of one-piece structures and selection of manufacturing processes such as injection molding, extrusion, precision castings, and powder metallurgy, among others.

2. **Develop a modular design.** The use of modules in product design simplifies manufacturing activities such as inspection, testing, assembly, purchasing, redesign, maintenance, service, and so on. One reason is that modules add versatility to product update in the redesign process, help run tests before the final assembly is put together, and allow the use of standard components to minimize product variations. However, the connection can be a limiting factor when applying this rule.

3. **Use of standard components.** Standard components are less expensive than custom-made items. The high availability of these components reduces product lead times. Also, their reliability factors are well ascertained. Furthermore, the use of standard components refers to the production pressure to the supplier, relieving in part the manufacture's concern of meeting production schedules.

4. **Design parts to be multi-functional.** Multi-functional parts reduce the total number of parts in a design, thus, obtaining the benefits given in rule 1. Some examples are a part to act as both an electric conductor and as a structural member, or as a heat dissipating element and as a structural member. Also, there can be elements that besides their principal function have guiding, aligning, or self-fixturing features to facilitate assembly, and/or reflective surfaces to facilitate inspection, etc.

5. **Design parts for multi-use.** In a manufacturing firm, different products can share parts that have been designed for multi-use. These parts can have the same or different functions when used in different products. In order to do this, it is necessary to identify the parts that are suitable for multi-use. For example, all the parts used in the firm (purchased or made) can be sorted into two groups: the first containing all the parts that are used commonly in all products. Then, part families are created by defining categories of similar parts in each group. The goal is to minimize the number of categories, the variations within the categories, and the number of design features within each variation. The result is a set of standard part families from which multi-use parts are created. After organizing all the parts into part families, the manufacturing processes are standardized for each part family. The production of a specific part belonging to a given part family would follow the manufacturing routing that has been setup for its family, skipping the operations that are not required for it. Furthermore, in design changes to existing products and especially in new product designs, the standard multi-use components should be used.

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[1]Information taken from *Computer-Aided Manufacturing*, Second Edition, Tien-Chien chang, Richard A Wysk, and Hsu-Pin Wang. Pages 596 to 598. Prentice Hall 1998

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6. **Design for ease of fabrication.** Select the optimum combination between the material and fabrication process to minimize the overall manufacturing cost. In general, final operations such as painting, polishing, finish machining, etc. should be avoided. Excessive tolerance, surface-finish requirement, and so on are commonly found problems that result in higher than necessary production cost.

7. **Avoid separate fasteners.** The use of fasteners increases the cost of manufacturing a part due to the handling and feeding operations that have to be performed. Besides the high cost of the equipment required for them, these operations are not 100% successful, so they contribute to reducing the overall manufacturing efficiency. In general, fasteners should be avoided and replaced, for example, by using tabs or snap fits. If fasteners have to be used, then some guides should be followed for selecting them. Minimize the number, size, and variation used; also, utilize standard components whenever possible. Avoid screws that are too long, or too short, separate washers, tapped holes, and round heads and flatheads (not good for vacuum pickup). Self-tapping and chamfered screws are preferred because they improve placement success. Screws with vertical side heads should be selected vacuum pickup.

8. **Minimize assembly directions.** All parts should be assembled from one direction. If possible, the best way to add parts is from above, in a vertical direction, parallel to the gravitational direction (downward). In this way, the effects of gravity help the assembly process, contrary to having to compensate for its effect when other directions are chosen.

9. **Maximize compliance.** Errors can occur during insertion operations due to variations in part dimensions or on the accuracy of the positioning device used. This faulty behavior can cause damage to the part and/or to the equipment. For this reason, it is necessary to include compliance in the part design and in the assembly process. Examples of part built-in compliance features include tapers or chamfers and moderate radius sizes to facilitate insertion, and nonfunctional external elements to help detect hidden features. For the assembly process, selection of a rigid-base part, tactile sensing capabilities, and vision systems are example of compliance. A simple solution is to use high-quality parts with designed-in-compliance, a rigid-base part, and selective compliance in the assembly tool.

10. **Minimize handling**. Handling consists of positioning, orienting, and fixing a part or component. To facilitate orientation, symmetrical parts should be used when ever possible. If it is not possible, then the asymmetry must be exaggerated to avoid failures. Use external guiding features to help the orientation of a part. The subsequent operations should be designed so that the orientation of the part is maintained. Also, magazines, tube feeders, part strips, and so on, should be used to keep this orientation between operations. Avoid using flexible parts - use slave circuit boards instead. If cables have to be used, then include a dummy connector to plug the cable (robotic assembly) so that it can be located easily. When designing the product, try to minimize the flow of material waste, parts, and so on, in the manufacturing operation; also, take packaging into account, select appropriate and safe packaging for the product.

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vendor: vendor means a person (company) who sells and supplies him(its) products.

An intelligent purchasing involves the rational selection of sources from which materials can be obtained. Considerable efforts are needed in identifying, developing and evaluating the prospective suppliers. It is also essential to continuously appraise the performance of current suppliers.

vendor development involves four stages:

→ First stage — survey stage
→ second stage — enquiry stage
→ Third stage — negotiation & selection stage
→ fourth stage — experience & evaluation stage

vendor rating:

→ categorical method
→ weighted point method
→ cost ratio method

→ categorical method: The buyer prepares a list of factors, which are considered necessary for evaluation.

At periodical intervals, once in three months, the buyer prepares a performance report.

factors	Always	Usually	Seldom	Never
	9 8 7	6 5 4	3 2 1	0
1. Supplies as per quantity specified				
2. Deliveries are as per schedule				
3. Rigorous follow up are not necessary				
4. Solves his raw material problem on his own				

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5. Willing to accomodate when production schedules are suddenly	9	8	7	6	5	4	3	2	1	Never
6. Helps in emergency										
7. Behavior is courteous and considerate										
8. Reasonable in Pricing										
9. Miscellaneous										

Each supplier is evaluated and a number score is calculated. Then, it is converted into word rating. The conversion of scores is as follows:

Point	Remark
80-100	Excellent
70-80	Good
60-70	Average
50-60	very Poor

→ weighted Point method: This type of evaluation involves a point rating based on the quality of goods received, the promptness of deliveries made and the quality of the service rendered by the vendor.

Performance	points
Quality	50
Delivery	30
Price	20
Total	100

~~Quality rating~~

Quality rating = Number of lots accepted x rating points

Delivery rating = Number of lots delivered in time x rating points

Price = least offer received x rating points

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→ cost-ratio method: It is an intricate system of determining the actual costs incurred in purchasing, follow up, transportation, packing, duties, receiving etc. Based on these costs, the unit cost incurred by the buyer is calculated, the higher the cost, the lower the supplier's comparative rating.

For example, costs relating to quality works out to be Rs 2,000 and the total worth of material purchased is Rs 200 lacks per year Quality cost ratio = 2000: 200000 (i.e. 1%) similarly, when the cost of delivery is Rs. 1000 then delivery cost ratio = 1,000: 200000 (i.e, 0.5%)

Similarly all types of costs can be calculated. These ratios must be maintained as minimum as possible.

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Just in time manufacturing:

Just-in-time (JIT) manufacturing, also known as Just-in-time Production or the Toyota Production System (TPS), is a methodology aimed primarily at reducing times within production system as well as response times from suppliers and to customers.

JIT is a Japanese management philosophy which has been applied in practice since the early 1970s in many Japanese manufacturing organisations. It was first developed and perfected within the Toyota manufacturing plants by Taiichi Ohno as a means of meeting consumer demands with minimum delays. Taiichi Ohno is frequently referred to as the father of JIT.

Toyota was able to meet the increasing challenges for survival through an approach that focused on people, plants and systems. Toyota realised that JIT would only be successful if every individual within the organisation was involved and committed to it. If the plant and processes were arranged for maximum output and efficiency, and if quality and production programs were scheduled to meet demands exactly.

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JIT manufacturing has the capacity, when properly adopted to the organisation, to strengthen the organisation's competitiveness in the market place substantially by reducing wastes and improving product quality and efficiency of production.

Kanban System

Kanban is one of the lean tools designed to reduce the idle time in a production process. The main idea behind the kanban system is to deliver what the process needs exactly when it needs it.

In Japanese, the word "Kan" means "visual" and "ban" means "card". So kanban refers to visual cards. Lean uses visual cards as a signaling system that triggers an action to supply the process with its needs either from an external supplier or from a warehouse.

It was originally invented as a part of the famous Toyota Production System. It is associated with the design of pull systems and the concept of delivering just-in-time goods.

A pull system is where processes are based on customer demand. The concept is that each process manufactures each component in line with another department to build a final part to the exact expectation of delivery from the customer.

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Because your Production Process is designed to Produce only what is deliverable your business becomes leaner as a result of not holding excessive stock levels of raw, partly finished, or finished materials.

Six rules for an effective Kanban system.

1. customer (downstream) Processes withdraw items in the precise amounts specified by the Kanban.
2. Supplier (upstream) Produces items in the precise amounts and sequences specified by the Kanban.
3. No items are made or moved without a Kanban
4. A Kanban should accompany each item every time
5. Defects and incorrect amounts are never sent to the next downstream Process.
6. The number of Kanbans is reduced carefully to lower inventories and to reveal Problems.

The four core Principles of Kanban

1. Start with what you do now
2. Agree to Pursue incremental, evolutionary change
3. Respect the current Process, Roles & Responsibilities
4. Encourage Acts of Leadership at all levels

The six Prectices of Kanban

1. visualise the workflow
2. Limit work in Progress
3. Manage flow
4. Make Process Policies explicit
5. Feedback loops
6. Improve Collaboratively

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Agile manufacturing:

Agile manufacturing is a term applied to an organization that has created the process, tools, and training to enable it to respond quickly to customer needs and market changes while still controlling costs and quality.

Agile manufacturing embraces the use of technology and tools that allow marketers, designers and engineers to share data on production capacities and problems in the manufacturing process, specifically where problems can lead to other and more serious issues downstream.

key elements: four key elements are

1. Modular Product design (design products in a modular fashion that enables them to serve as platforms for fast and easy variation)
2. Information technology (automating the rapid dissemination of information throughout the company to enable lightning fast response to orders)
2. Corporate partners (creating virtual short-term alliances with other companies that enable improved time-to-market for selected product segments).
4. knowledge culture (investing in employee training to achieve a culture that supports rapid change and ongoing adaptation).

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