This is an **integrated** approach to manufacturing that is centered around a **computer system**. The move towards digital manufacturing has become essential with the improvement of computer systems in manufacturing plants and capitalist drive to reduce costs and increase profits.
As more **automated tools** have become used in manufacturing plants (**AGV's, Robotic Arms** etc.) it has become necessary to **model**, **simulate**, and **analyse** all of the machines, **tooling**, and input materials in order to optimise the manufacturing process.
Digital manufacturing can be seen sharing the same goals as **computer-integrated manufacturing (CIM)**, **flexible manufacturing**, **lean manufacturing**, and **design for manufacture** (3.1.11).

1. Computer Aided Design (CAD)

1

Advantages
CAD (Compared To Manually Generated Alternative)

Better Quality Designs:
They produce designs with high accuracy and the scope for errors is much lower when compared to hand drawing. The higher accuracy will lead to better designs and these better designs helps in manufacturing faster. Manual design not only takes more time but the errors caused will delay the process.
Easy Saving and Sharing: All the designs and drawings created with the help of CAD can be easily saved and preserved for future use and reference. These saved drawings can also be edited and printed whenever required. Some components from the drawing can also be standardized for future uses. The CAD drawings require less space and can be stored in hard drive, USB pen drive or cloud and can be shared easily.
Modify and Reproduce Faster: Modifying the CAD geometry is easy. Correcting any errors is much quicker when compared to using a pencil and paper. Earlier the draughtsmen used to take days to complete a drawing by manual drafting, and reproducing the drawing meant recreating the drawing from the scratch. But, in case of the CAD drafting, you can reproduce the drawing in no time and make as many copies as you want.
Ability to Create 3D CAD Models: CAD has the capability to transform an idea into a visible sketch in a matter of minutes. Creating 3D CAD models manually is a very difficult and tiresome job. CAD models are logically connected, or in other words you cannot create a CAD model which is not possible practically.
Template and Database Creation: You can create any number of CAD templates with basic details that can be used and reused any number of times. These templates can save time by providing basic information. The CAD files can be used to create a database as well. Once created, the CAD templates and CAD database can be accessed through a wide area network. The drawings created by manual drafting can only be stored locally.

1. Computer Aided Design (CAD)

2

Disadvantages
CAD (Compared To Manually Generated Alternative)

Work Done is Original: In the past, drafters sat at drawing boards and used pencils, pens, compasses, protractors, triangles, and other drafting devices to prepare a drawing by hand. When doing manual drafting, most of the drafting work is done by technical people like the architect / engineer / diploma holders making their work to be genuine. The ability to bring creative style and expression to drawings is higher in manual drafting.
Low Cost of Drawing Equipment: In manual drafting, all you need is a drafting table or a drawing board, pencil/eraser, a straightedge, a t-square, triangles, French curves, a mini-drafter, and a compass. A drawing board, mini-drafter and pencils/eraser are much cheaper than a CAD package.
No high-tech and Cutting Edge Technology Required: Like in the CAD system, you do not need state of the art technology, systems engineer(s), IT engineer and expensive air conditions and AC technicians to maintain a pencil and paper. Whereas you have to have systems engineers, IT Engineers and AC technicians to keep the CAD system running.
No Training Required: Apart from the training that we get when we study, there is no need for the designers to be taught the CAD package being used. The Architects and Engineers would draw their sketches and later developed by assistants who are diploma holders or architectural and engineering draughtsmen in their respective trades. Even in the modern days Engineering, Architectural and Design majors are taught manual drafting techniques alongside digital software at most colleges.
No Yearly Subscriptions: Unlike the CAD systems, there are no software update costs or operator training. With the CAD systems, you would need yearly subscriptions for the CAD software, operating systems and other supporting software applications. Sometimes with yearly updates, the CAD operators would need additional training on the updated CAD software.

2. Computer Aided Manufacture (CAM)

How CAM Is Used In The Manufacture Of Products

1	**Laser**	Works by directing the output of a high-power laser most commonly through lenses
2	**Routing**	A **computer numerical control** (**CNC**) **router** is a computer-controlled cutting machine used for cutting various hard materials, such as wood, composites, aluminium, steel, plastics, glass, and foams. A CNC router is very similar in concept to a CNC milling machine. Instead of routing by hand, tool paths are controlled via computer numerical control. A CNC router typically produces consistent and high-quality work and improves factory productivity. Unlike a jig router, the CNC router can produce a one-off as effectively as repeated identical production. Its benefits include automation, precision, reduction of waste and errors, and the time the finished product takes to get to market.
3	**Milling**	The process of machining using **rotary cutters** to remove material by advancing a cutter into a work piece.
4	**Turning**	A material removal **process**, which is used to create rotational parts by cutting away unwanted material.
5	**Plotter Cutting**	A **cutting plotter** works like a **plotter**, except that it moves a knife instead of the pen. Depth of the blade is adjusted to the material. "**Cutting plotter** knives **cut** into a piece of material (paper or vinyl) that is lying on the flat surface area of the **plotter**.

3. Virtual Modelling

Be Able To Describe, How **Virtual Modelling/Testing** Is Used In Industry Prior To Product Production

1	**Simulation**	**Simulation methods** are ways to imitate of the operation of real-world systems. It first requires that a model be developed representing characteristics, behaviours and functions of the selected product. It is carried out using computers making changes to variables and performing predictions about the behaviour of the product.
2	**Computational Fluid Dynamics (CFD)**	This is the **modelling** of fluid flow problems using **Computational Fluid Dynamics** (**CFD**). Flow simulation through an engine. A river. A water system. Modelling using a computer simulation can save time, money and prevent costly mistake.
3	**Testing Aerodynamics And Wind Resistance, And Flow Of Liquids Within/ Around Products**	Manufacturers are moving away from wind tunnel testing and opting to use virtual simulation techniques instead as they try to reduce aerodynamic drag. Engineers can model a car's aerodynamics without even building one. Virtual simulation techniques are not only **quicker** and **less costly** than using a wind tunnel but also give better results.
4	**Finite Element Analysis (FEA)**	This is a **computerised** method for predicting how a product reacts to **real-world forces, vibration ,heat.** This is the modeling of products and systems in a **virtual environment**, for the purpose of finding and solving potential structural or performance issues. Used by engineers and scientists to mathematically model and numerically solve **complex structural, fluid and other real world problems**.

Key Terms

Computer Integrated Engineering (CIE)	**Computer-integrated engineering** (CIE) is the engineering approach of using **computers** to control the entire manufacture process
Computer Integrated Manufacture (CIM)	This is the **complete** automation of a manufacturing facility such as a factory. All functions are under computer control. This starts with **computer aided design**, followed by **computer aided manufacture**, followed by **automated storage and distribution**. One integrated computer system controls all that happens.

4. Rapid prototyping processes

Rapid prototyping is a group of techniques used to quickly make a scale model of a physical part or assembly using three-dimensional computer aided design (CAD) data. – Including 3D Printing.

Why Rapid Prototype?

- **Concept models** provide designers with the opportunity to **validate** both their ideas and the assumptions they make. A physical concept model is an ideal way to **explore** a concept, **demonstrate** its validity to stakeholders and/or create **communication** surrounding it.
- Functional prototypes enable designers and developers to grasp the details that provide an accurate representation of the finished product before it moves onto the next stage. **The fit, design, manufacturability and function** of the product can be **tested** prior to moving it into full production mode.
- Proving that a **workable prototype** is also going to be economically feasible to manufacture is another application of rapid prototyping. Having a fantastic prototype that achieves a satisfactory balance of functionality and aesthetics while also being cost-effective is possible with rapid prototyping.

Advantages of Rapid Prototyping

- Explore and realise concepts quickly. This **efficiency in time and cost** allows teams to move beyond the mere visualisation of a product, making it easier to grasp the properties and design of a product.
- Apply **repeated designs** and incorporate **changes** that allow for the evaluation and testing of the product. This **iterative process** provides a roadmap to developing and **refining** the final product.
- Being able to **communicate** concepts concisely and effectively. Rapid prototyping takes ideas, images and concepts from flat and 2 dimensional visuals to hands-on products that clients, colleagues and collaborators can then see in action.
- The ability to **thoroughly test and refine** a concept. Being able to minimise design flaws with a small volume rapid prototype run helps **eliminate costly design flaws** that might not be evident during an early assessment.
- **Save time and money** since setup and tooling aren't necessary. Because the same equipment can be used to produce prototypes with different properties and materials, the costs and time outlay are kept to a minimum.

5. Electronic Data Interchange

Describe, The Use Of Electronic Point Of Sales (**EPOS**) For Marketing Purposes And The Collection Of Market Research Data;

An electronic point of sale (EPOS) system connects back-office, shop-floor operations and manufacture / inventory to create a streamlined system.

The Maintenance Of Stock Levels	Every time a customer purchases a product, the inventory records on the system are **updated immediately**. A good EPOS system provides an **accurate** picture of your stock levels at any given time.
The Capture Of Customer Data, Eg Contact Details	**Improve the customer experience**. ❑ Increasing the transaction speed will make for a quicker and improved experience. ❑ Modern EPoS systems can also help provide product information and recommendations for additional sales, and ensure that the products customers want are always in stock. ❑ EPoS systems can drive the marketing throughout the year. By providing data capture opportunities, this can enable customers to understand more about their customers and improve communications.

6. Production, planning and control (PPC) networking

Defined as a **work process** which seeks to **allocate human resources, raw materials, and equipment/machines** in a way that **optimises** efficiency. PPC helps manufacturers work smarter in allocating resources of people, materials, and machines in order to meet the demands of customers.

Availability Of Materials – Raw materials, finished parts and bought out components should be made available in required quantities and at required time.

Scheduling Of Machines And People – Detailed analysis of available production facilities, equipment down time, maintenance policy procedure, schedules, and equipment availability.

Coordinating Suppliers And Customers. – The idea here is to get suppliers and customers using the same system to improve logistics & other information systems. This can lead to faster responses to changes in the market place and patterns of demand.