Beckfoot

Engineering Manufacture

Unit R111: Computer aided manufacturing **LO1: Plan The Production Of Components On Computer Numerical Control (CNC) Machines**

Year 10 / 11

enjoy learn succeed

Factors to consider when producing plans for CNC machining operations in the production of components

1. Planning Of Operations

1	Sequence Of Operations	Step 1: Determine the machining operations to be performed. Step 2: Decide the machining order. Step 3: Generate the G & M Codes. Step 4: Consider the work holding device. Step 5: Consider the cutting tools. Step 6: Start the machining process.
2	**Tool Changes**	Some machines have **automatic tool changers** (ATC) which is used to improve the production and tool carrying capacity of the machine.

4. Tools Required

1	**Setting Tools** Spanners, Allen Keys, Clamps, Chuck Key.
2	**Machining Tools** Drills, Turning Tools, End-mills.
3	**Cutting Tools** Cutting Blades, CNC Router.

2. Scale Of Manufacture – Waste Minimisation

1	**One-off / Batch / Mass Production** **T**ransportation – Moving materials **I**nventory – What is in stock but not used **M**otion – Motion by a person or a machine **W**aiting – slowed or halted production **O**ver-processing – making of components which is unnecessary **O**ver-production – Making too much of a product that goes unused **D**efects – a product deviating from the standards of its design

5. Materials

1	**Speeds And Feeds For The Size And Type Of Materials** **Cutting speed** (also called surface speed or simply speed) is the speed between the cutting tool and the surface of the workpiece it is operating on. It is expressed in meters per minute (**m/min**). **Feed rate** is the relative velocity at which the cutter is advanced along the workpiece. The value of these is determined by; **The material being machined** (steel, brass, tool steel, plastic, wood) **The material the cutter is made from** High-Carbon Steel, high speed steel (HSS), Carbide, Ceramics, and Diamond tools) and the economical life of the cutter (the cost to regrind or purchase new, compared to the quantity of parts produced)

3. Type Of Machine

1	**Milling Machines** The process of machining using **rotary cutters** to remove material by advancing a cutter into a work piece.
2	**Turning Centres** Turning Centeres are really a generalisation of a numerically controlled, multi-axis machine or a vertical milling machine, a 3-axis / CNC machine, even a manual lathe is often referred to as a turning centre.
3	**Fabrication Machines** **Metal fabrication** is the creation of metal structures by cutting, bending and assembling processes. **Waterjets** an industrial tool capable of cutting a wide variety of materials using a very high-pressure jet of water, or a mixture of water and an abrasive substance. **Press brakes** a machine pressing tool for bending sheet and plate material, most commonly sheet metal. It forms predetermined bends by clamping the workpiece between a matching punch and die. **Laser systems** Uses a **laser** to slice through & shape materials. **Plasma systems** a process that cuts through electrically conductive materials by means of an accelerated jet of hot **plasma** **Plate Rolls** Plate rolls are designed to quickly and efficiently transform flat sheet metal into cylindrical or radius parts.

Beckfoot

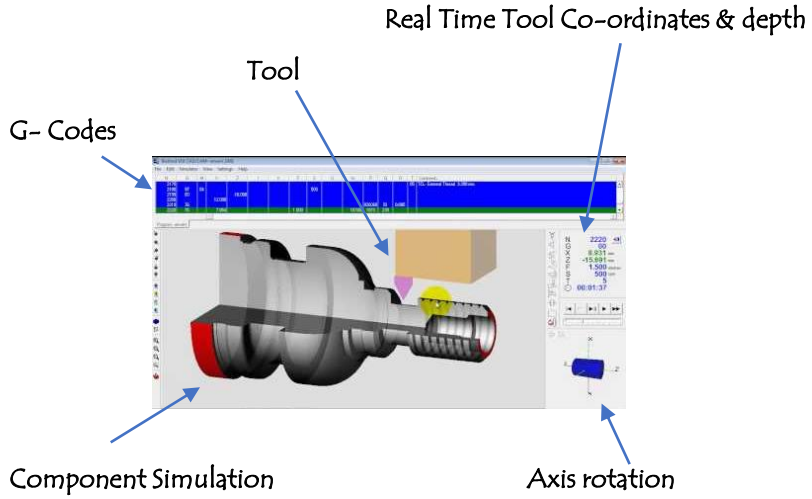
Engineering Manufacture

Unit R111: Computer aided manufacturing LO2: Be Able To Interpret Information From Computer Aided Design (CAD) To Manufacture Components On CNC Equipment

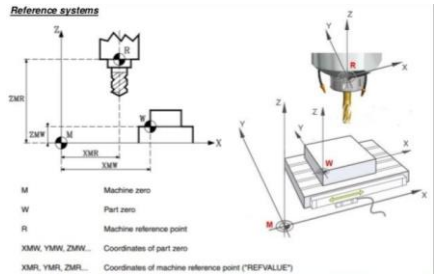
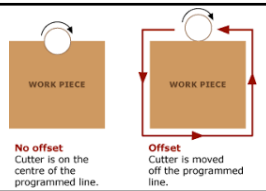
Year 10 / 11

enjoy learn succeed

1. Use Of Computer Aided Design (CAD) Packages

1	Export Drawing Information To CNC Machines	1. **Export** your CAD models. 2. **Import** them into a computer-aided manufacturing or machining (CAM) program. 3. Use the CAM program to **convert** your design into "instructions" called **G-codes.** . **G-codes calculate the necessary movement (toolpath) and operation of the tool head to put together the end product.** Basically, they instruct a computer numerical control (CNC) machine how to build the physical CAD model . 4. Feed the G-code into the CNC machine controller. 5. The CNC machine creates your models by cutting. Note that CNC machines are usually compatible with the following CAD formats: **2D**: AI, PDF, DXF, and DWG **3D**: STL, OBJ, DXF, STEP, IGES, DWG, and 3DM
2	On-screen Simulation	

2. Factors To Consider When Performing CNC Machine Programming Operations

1		**Setting Datum Points** In engineering a **datum** is a reference **point**, surface, or axis on an object from which measurements are made.
2	Co-ordinates (Absolute And Incremental)	Imagine your workpiece is on a graph **Absolute** coordinates are defined as each position on the work piece. With **incremental** coordinates, the last point traveled to becomes the **new reference** point on which the operator bases his **next move**. 
3		**Tool Change-over** Required when a **different product** (a new batch of one item or more) needs to be processed. Change-over might also be required to replace tooling as required, as the machine's tool becomes **worn**.
4	Tool Offsets	
5	Language (G & M Codes)	**G-code** is a programming language for CNC that instructs machines where and how to move. **G stands** for geometry, **M codes:** an M code in CNC programming controls **miscellaneous** machine functions, including starting and stopping.

1. Procedures For Setting Up CNC Equipment

1	Tooling	Tooling, also known as **machine tooling**, is the process of getting the **components** and **machines** needed for production. The common categories of machine tooling include jigs, gauges, moulds, dies, cutting equipment (drill bits / milling bits / lathe tools). If the tools don't work properly, products are not manufactured correctly.
2	Work Holding	If you do not have a means to hold the material during your process, you outcome will fail. These involve; **Vice, Clamps, Vacuums, Custom-built, Three Jaw Chucks, *Four Jaw Chucks, Collet Chucks (Drills), Faceplate, Angle Plate, And Many More.***
3	Computer Interface	The **exchange** of information between the computer CPU and the hardware (**CNC Lathe, Keyboard, Mouse, Screen**). A good interface makes it easy for users to tell the computer what they want to do, for the computer to request information from the users, and for the computer to present understandable information.

1. Procedures For Setting Up CNC Equipment

4	Safety Procedures	You should never work with a CNC machine without the proper training. Features available; ❑ **An emergency stop button.** ❑ **A soundproof casing (if necessary)** ❑ **Guards (**to shield the machine operator from fragments.) ❑ **Fence. (Outline safe working areas)** ❑ **The contact mats (operator may need to stand on this for machine to function)** Do: •Wear proper ear protection and a good pair of safety glasses when operating a CNC machine. •Ensure that you wear suitable footwear such as safety boots at all times. •If you have long hair, ensure that you keep it covered when you operate the cnc machine. •Keep your hands away from any moving parts during machining processes. •Stand clear of the machine whenever it is operational. You should also warn any other people near the risk of being too close to it. •Whenever you are handling or passing tools, avoid touching the cutting edges. •Ensure that you turn the machine off completely and clean it whenever you have finished using it. **Don'ts:** •You should never wear gloves while operating the CNC machine. •You should never wear jewelry or any loose clothing. •You should never try to reach into the machine while it's running •You should never put your hands anywhere near the spindle when it's revolving. •Never leave the machine when it's not completely powered down

2. Procedures To Produce Products To Required Specification

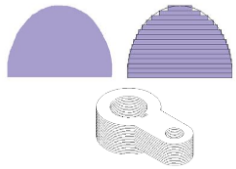
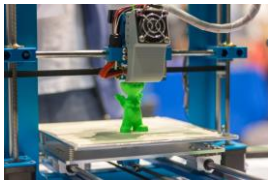
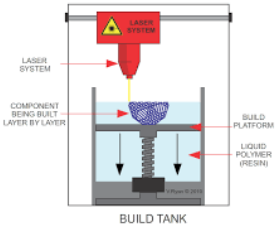
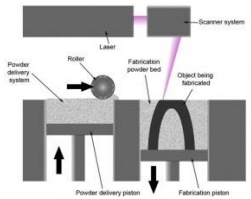
1	Initial Setting	**1 Clean Machine Table and Other Surface** **2 Load Tools** **3 Set Tool Length Offsets** (make sure tools stick out correct length.) **4 Install Work** (Clamp / Vice / Chuck) **5 Load Program Onto the Machine** (G & M Codes) **6 Check Coolant** (If necessary for cooling of the component to reduce wear & tear on the tool)

3. Methods Used To Compare Items Manufactured By Manually Controlled And CNC Production

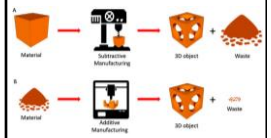
1	**Visual**	Standard Of Finish
2	**Dimensional – measure using appropriate tool**	Accuracy – component tolerance
3	**Cycle Time**	Total **time** from the beginning to the end of your process
4	**Consistency**	**Batch Tolerance** – Measure & check components regularly when producing a number of identical parts depending on the batch size and tolerance required.

1. Applications Of Computer Control

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.

1	Rapid Prototyping	**Laminating** Laminated object manufacturing (LOM) is where layers of plastic or paper are cut into the desired shape with a computer-controlled laser or blade then laminated together using heat and pressure to create a 3D object. **3d Printing** 3D printing, or **additive manufacturing**, is the construction of a three-dimensional object from a CAD model **Stereolithography** Stereolithography is a form of 3D printing technology used for creating models, prototypes, patterns, and production parts in a layer by layer fashion using photochemical processes by which light causes chemical monomers and oligomers to cross-link together to form polymers. **Laser Sintering** Selective laser sintering is an additive manufacturing technique that uses a laser as the power source to sinter powdered material, aiming the laser automatically at points in space defined by a 3D model, binding the material together to create a solid structure.	   BUILD TANK 

1. Applications Of Computer Control

2	Manufacturing Processes	**CNC machining** **Computer Numerical Control** is the automated control of machining tools and 3D printers by means of a computer. A CNC machine processes a piece of material to meet specifications by following a coded programmed instruction and without an operator. **Additive manufacturing** They key difference between 3D printing and **CNC** machining is that 3D printing is a form of **additive manufacturing**, whilst **CNC** machining is subtractive. This means **CNC** machining starts with a block of material (called a blank), and **cuts away material** to create the finished part.	 
3	Robotics	**Welding** https://www.youtube.com/watch?v=ebX5hU_MDAY Robot welding is the use of mechanized programmable tools, which completely automate a welding process by both performing the weld and handling the part. **Riveting** https://www.youtube.com/watch?v=KpV_jFR4XYM&feature=youtu.be A **riveting** machine is used to automatically set (squeeze) rivets in order to join materials together. The **riveting** machine offers greater consistency, productivity, and lower cost when compared to manual **riveting**. **Pick-and-place assembly** https://www.youtube.com/watch?v=1fojHo9cVOk **Pick** and **place robots** used in **assembly** applications grab incoming parts from one location, such as a conveyor, and **place** or affix the part on another piece of the item. The two joined parts are then transported to the next **assembly** area.	  

Beckfoot

Engineering Manufacture

Unit R111: Computer aided manufacturing LO4: Know About Applications Of Computer Control Processes Used To Manufacture Products

Year 10 / 11

enjoy learn succeed

2. Computer Controlled Processes Used For Different Scales Of Manufacture

1	One-off/Job Production	Involves producing **custom work**, such as A one-off product for A **specific customer** or A small batch of work in quantities usually less than those of mass-market products

Birthday cake, F1 Car, Specialist jewellery, Large Buildings / Towers, Wedding Dress, Prosthetics for limbs.

Skilled workforce, Specialist machines, High quality products manufactures, Expensive to buy / make, High standard of quality control, Made for a specialist client / market.

2	Batch Production	A method of manufacturing where the products are **made to specified amounts**, within a time frame.

Flat packed furniture, Special edition cars, Baked goods, Clothing, Computer chips, Computer software, Electrical goods, Newspapers/magazines

A production line is set up (one task for each stage) semi-skilled / unskilled workers (Flexible – can be redeployed to make another product), Production lines run for a limited period of time.

3	High-volume Manufacturing	Also known as **flow production** or **continuous production**, is the production of large amounts of standardized products on assembly lines.

Recycling centers, Paper production, canned goods, over-the-counter drugs, some household appliances.
The emphasis in mass production is on keeping manufacturing costs low by producing uniform products using repetitive and standardised processes.

Automated production line, Unskilled / skilled workforce, Production line runs **24/7/365**, A **very high level** of **investment** in machinery & equipment, **Quality control** at every stage of production.

How It's Made

https://www.youtube.com/channel/UCELt4nocnWDEnYJmov4zqyA/videos

One-off

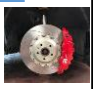
Jewellery – 4 axis mill turn lathe.- https://www.ringtech.com

Custom running trainers –
https://www.youtube.com/watch?v=fOo-FVbGbF8

Plastic injection moulds –
https://www.youtube.com/watch?v=NILOZ_36j70

Batch

Brake Discs – https://www.youtube.com/watch?v=ag7mu22qCA4



Diving regulator (0 – 2 mins) –
https://www.youtube.com/watch?v=fLH6ziMNcsY

Batch Produced ornaments (sterolithography) –
https://www.youtube.com/watch?v=hVGwjX8baX8

Robotic Arm – https://www.youtube.com/watch?v=FsaxLGX3D-8

Other suggestions;
PPE – Goggles, Visors, Shoes…

Mass

Pills – https://www.youtube.com/watch?v=NVW_Xkwd5RA

Recycling Plastic –
https://www.youtube.com/watch?v=w7UKafu4_4M

Other suggestions;
Mass produced cars
Pens / pencils
Toilet Roll