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SEDM5008 - AUTOMATED TECHNOLOGY

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Q1a)

The first stage of additive manufacturing is the generation of a solid model using CAD software. There are a number of CAD platforms available. CAD software packages generate the geometry in solid model format which allows material allocation to each of the sections drawn. Developments in CAD packages and scanning packages available from companies such as FARO who developed a probing system to scan components knowing their geometrical locations.

The second stage is the conversion of the solid model into a language which can be understood by the machine that will be used for printing the component. This file format is called .STL which is an abbreviation of Standard Tessellation Language. The STL file includes the x, y, z co-ordinates of the geometry of the solid model.

Stage 3 involves splitting the geometry into layers along their horizontal planes. These planes can be considered as horizontal cross sections of the geometry and allows the machine to calculate its geometry through the workpiece. The thickness or height of the layer is determined in the z -axis.

Stage 4 is the building of the model. This is the conversion of raw material into the printed geometry. The machine parameters will be set such as datums, layer thickness and printing speeds. The machine reads the .STL file and will begin its layer printing to create the geometry. The

machine will build the geometry and will also include the support structures to assist the building of complex geometries.

Stage 5 is the cleaning and finishing stage. The finished part can be removed from the machine and inspected. If happy there are normally some defects or spurs that will need removing. Some machines may use a water soluble ~~structure~~ support structure in which case this may need cleaning off. Flash on components or spurs may require a gentle sanding to remove. The part can then be rinsed or blown off to clean.

Q1b). Liquid based - liquid based systems ~~are~~ ~~break~~ can be broken into 2 categories. - SLA and MJP. SLA systems work by using a laser to cure a resin bath in a required geometry. As the laser travels around the geometry path in a tray of liquid resin it cures in the toolpath. The second is multijet printing. This layers liquid resin along the work surface and a following UV light cures the layer after its printed.

Solid based - solid based printing is based on a solid raw material being converted into its required geometry. FDM systems use a filament to be deposited onto a worktable by a heated nozzle. The filament is allowed to cool in the required geometry. This filament is printed in a constant flow or string. 3D printing is completed using drops of

thermoplastic to build up the required layers.

Powder based Systems - these systems can be broken into SLS and SLM. Sintering systems heat a layer of heat fusible powder and lay this to create the model slice. Melting processes create a stronger and more accurate model which can be made using a metal powder.

Q1c) The support structure is in place to help hold some complex geometries during their printing process. These geometries may be overhangs on the geometry, or hollows that need supporting ~~for~~ until layers further up the geometry can tie these in. Support may also be used to hold floating objects within a geometry. In 3D printing, PVA based support can be washed away. Liquid based systems will use a resin to create the support. This may require additional finishing work to remove at the end. Both powder processes do not require support as the non melted powder will provide the solid support.

Q1d). SLM is a process that can print metal powder into the required geometry. The powder is heated to melting point which allows the grains to join together. The process works by dispensing material across a layer and melting only the horizontal areas where geometry is required. The powder that is not melted remains to form the structure support for the rest of the geometry.

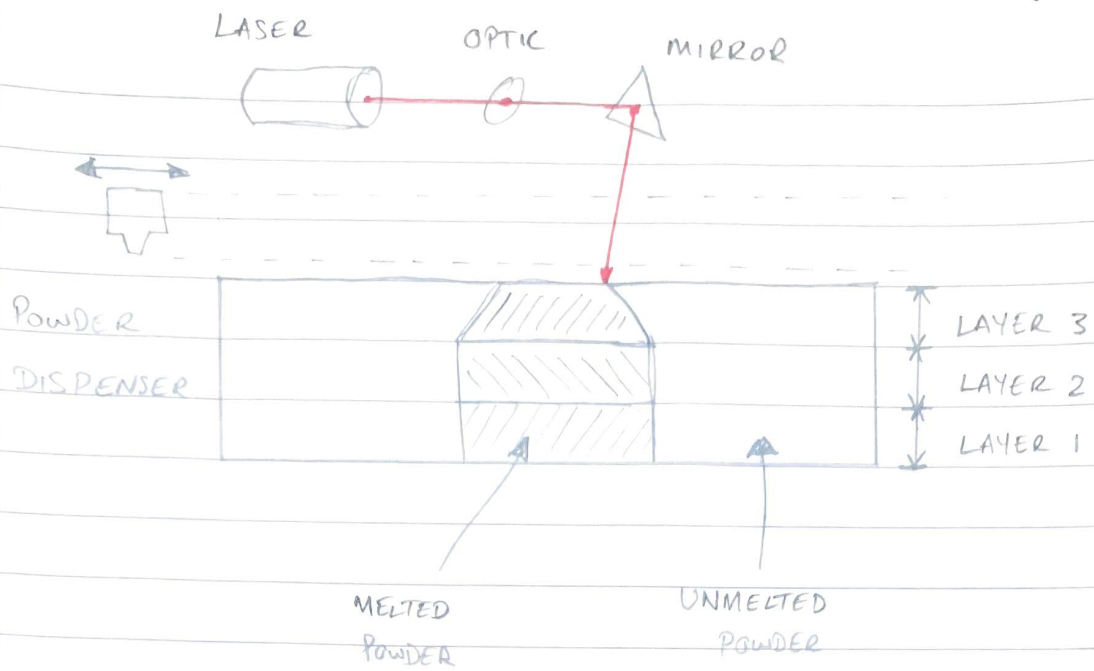


Figure of a SLM (selective LASER Melting) process.

Q2a) A robot is a reprogrammable device that can be used to transport and manipulate parts using pre programmed sequences and operations. Robots can have numerous implements or end effectors to undertake a number of tasks.

Cobots are a collaborative robot to be used for working with people. They are designed and utilised for working around human operators where a robot or human may not be able to undertake a task ~~fast~~ quick enough or is too complex.

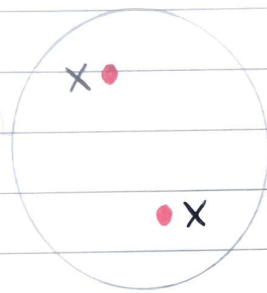
Advantages of cobots include the removal of some human interaction with components that could be done by the machine. They do not need to have breaks and can work for longer periods than humans. Unlike Robots, cobots can be moved around to different workstations if required.

Q2b) Companies have seen benefits to robots in manufacturing by utilising them and their functionality in workplaces. Reasons for companies to invest would include -

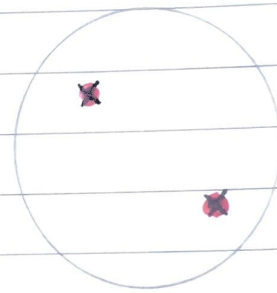
- Safety - Removing humans from danger or harm in some tasks.
- Repeatability - Due to the programmed process, the ~~more~~ Robot will repeat a process to the same standard every time.
- Efficiency - Robots can work 24/7 with some maintenance at intervals. They do not require breaks or welfare facilities.

- Improve quality - all parts are made to the same standard. The removal of human error.
- Reduce waste - with improved quality and repeatability there is a reduction of rework required.

Q2c) The accuracy of the robotic system means the machine is in the correct location in respect to the geometry. Any deviation to this could affect the end product.



Inaccurate



Accurate.

The repeatability of a machine is the ability to maintain the accuracy detailed above on a number of jobs for a duration of time.

Q2d) Robots are being integrated into additive processes in a number of fields, this includes material loading and job unloading. The robots save human interaction in places which may be too hot for humans or to save the interaction. Future Additive manufacturing methods include using end effectors that can make parts. Such as changing the effector to an extrusion nozzle to allow complex geometries.

Q4a) when tools are inserted into the carousel, the first task to be done is to advise the machine about where the end of the tip is. There are 2 ways of doing this. -

The first is to measure and adjust. Using the manual function of the machine, a cut is taken. This can then be measured. This dimension is added to the tool ~~offsets~~ data in the machine. For accuracy, this should be checked after the roughing cycle.

The second method is using a probe. The probe uses pressure sensors to detect the button being depressed. This data is automatically fed into the tool data.

When tool setting, the radius of the tool is an important data input for allowing the machine to follow the correct geometry. These offsets are included in a tool call line. -

T0303
 ↗ ↖
Tool I.D. OFFSET I.D.

Q4b) Utilising canned cycles is important for improving the efficiency of a program. The canned cycle described is for the stock removal. It can be broken down as follows.

G71 - Multiple repetitive cycle for stock removal.

U3 - max depth of cut (Radial)

R1 - Retraction of the tool at the job

P70 - Geometry line start

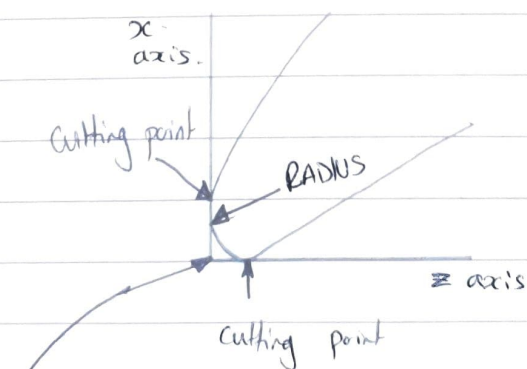
Q130 - Geometry line end

U1 - Finishing allowance x-axis

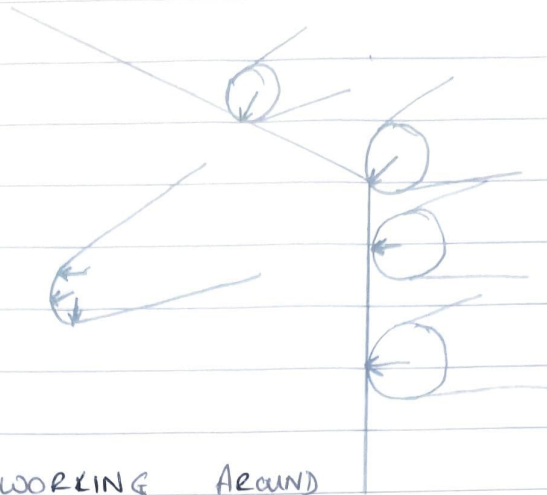
W0.5 - Finishing allowance z-axis

F0.3 - Roughing feed rate.

Q4c) Tool nose radius compensation needs to be considered when picking tools and profiling geometries. When the tool is setup it is assuming a pointed corner as detailed below:-



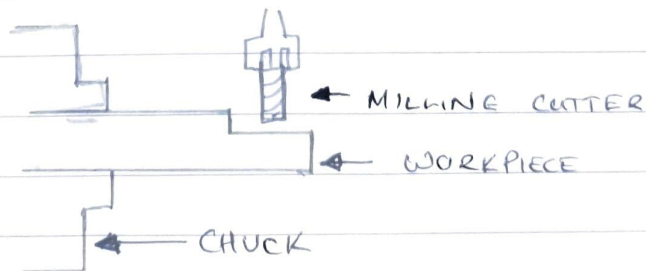
This point here is the fixed geometry assumed corner. When machining corners or tapers, the cutting edge moves around the radius as it follows the toolpath.



TOOL RADIUS WORKING AROUND
TAPERS.

Q4D) With a ~~new~~ C-Axis machine, the Spining lathe chuck can be controlled in conjunction with the tooling held in a live holder ~~carried~~^{turret}. The C axis of the chuck is controlled through 0° - 360° and the position of the turret. The turret remains mobile in X+Z. Application can include -

Machining flat Surfaces - using a milling cutter flat sides can be given to a geometry.



Specialist Drilling through the diameter can also be completed using this method.

Q5a) Value Engineering is the process of improving the value of a product by reviewing its function. This does not mean cutting costs, but looking at what is required, how its made, and how it can be redeveloped. Value is defined as the ratio of function : cost. If performance can be maintained and the cost of the product reduced, this can be good value.

Introduction of 4.0 Industry is very quickly using data tracking in the review of product performance. The technological advancements mean that computers can be used to monitor parameters such as tool wear, or force used for cutting. Manufactures are then in the Spotlight when data can be presented to show where their product engineering needs to be developed.

Q5b) Fast diagrams provide a graphical representation of the important factors and functions that give the product its edge.

The FAST Diagram can be broken down as below

OBJECTIVE → FUNCTION → PERFORMANCE → EXTRAS

what it is
required to
do.

How it
does
this.

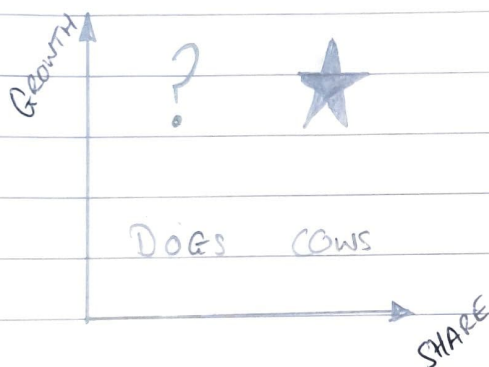
Actions required to
get to function.

Any other
tasks

- Products which have benefitted from this form of development include -

LONDON - NEW YORK FLIGHTS - Reducing flight costs.
LAPTOPS - Reducing costs and providing more performance.

Q5c) The Boston Matrix can be broken down and categorised as a form of investment and development portfolio. It determines the options for products to be deemed as successful or where they may require further thought.



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- LOW MARKET SHARE + HIGH MARKET GROWTH

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- NEED CASH INVESTMENT

- UNSURE POTENTIAL.

★

- HIGH GROWTH + HIGH SHARE

- ARE SUCCEEDING IN REVENUE + GROWTH

DOGS - LOW OR DECLINE MARKET

- NEGATIVE LABEL FOR COMPANIES PROFILE

COWS - HIGH MARKET BUT SMALL GROWTH

- HIGH CASH

- LOW INVESTMENT.

The Boston matrix categorises the products and allows the companies to observe where they may need to make improvements. Some companies with various ranges may utilise the matrix to see where their products can be seen in the future.

Q5d) Internet of things have led to a significant development on how products can be seen as advancements in real time. The ability to connect to a number of softwares allows data monitoring of performance by operators and manufacturers to see where their products fall in performance.

Traditionally, a fault would develop until it stopped, it was repaired and go again. Now engineers can track the fault development and can plan maintenance before it becomes a problem. This also means that foresight can mean cost savings for companies.

This costs tracking can allow companies to monitor the lifecycle of the machine accurately and determine the ~~value~~ cost : functionality ratio for the value of the machine.