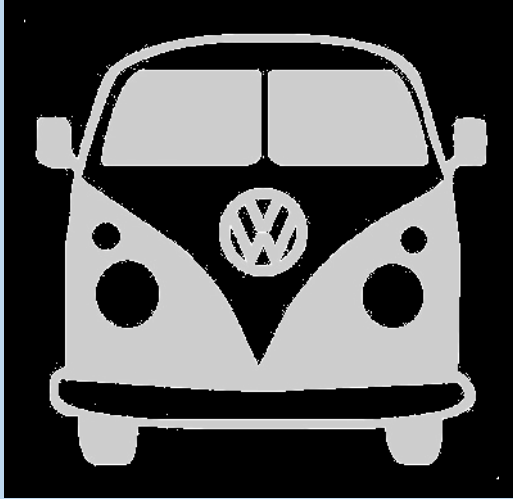


# CAD CAM KEY FOB PROJECT



You will be designing and making your very own key ring fob using CAD CAM. You will learn about the processes involved, as well as the materials you will be using. You will be using 2D design, the vinyl cutter and the CNC Micro Router.

*Wow! I really want to design and make my own Key Fob! How cool would it be if I could learn about the processes involved too!*



# POLYMERS – NATURAL / SYNTHETIC



**Natural polymers:** The polymers which are obtained naturally are called natural polymers. A natural polymer has its origin in plants and animals. Starch, cellulose, proteins, [natural rubber](#) etc. are the examples of natural polymers.

**Synthetic polymers:** The man-made polymers or the polymers which are synthesized in the laboratory are called synthetic polymers. Synthetic polymers find a large application in our daily life. Most of the things that we use are made up of synthetic polymers. Some of the typical examples of synthetic polymers are polyethylene, polyvinyl chloride, [Bakelite](#), nylon, synthetic rubbers.

# PROPERTIES OF POLYMERS



Performance characteristics of different materials have to be considered when choosing what products should be made of, you need to know the definitions of the following properties;

- **Hardness** – resist cutting and indentations
- **Toughness** – withstand shocks such as hammering
- **Strength** = 4 types include the ability to withstand...
  - Tensile Strength- pulled apart or stretched
  - Crushed or compressed
  - Twisted
  - Sheared as a result of sideways force like scissors
- **Elasticity** – can be stretched and then return to original length
- **Flexibility** – bend but not break and return to original shape
- **Ductility** – can be stretched into wire
- **Durable** – can withstand bad weather conditions
- **Malleability** – can be hammered, pressed into a shape

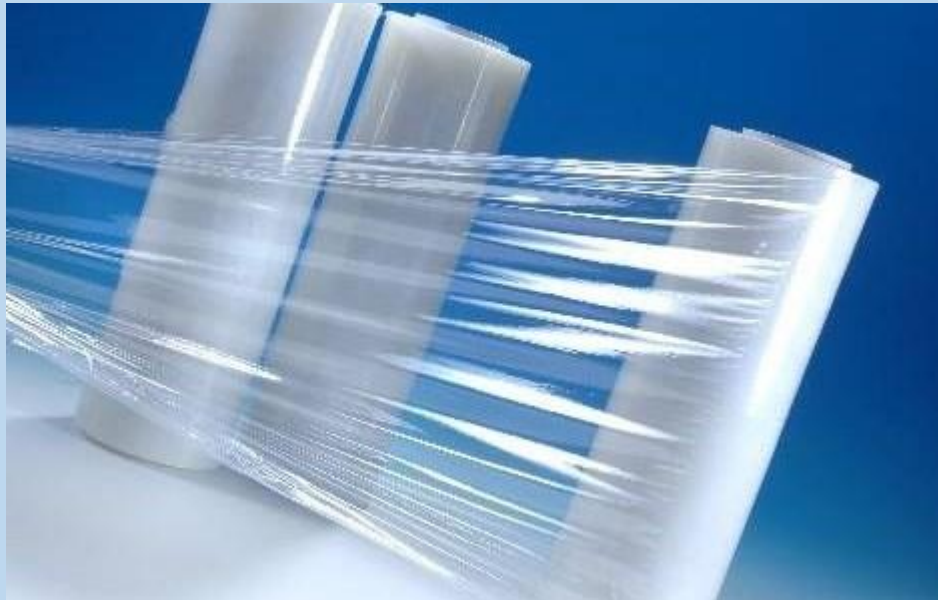
# HOW POLYMERS ARE SOLD



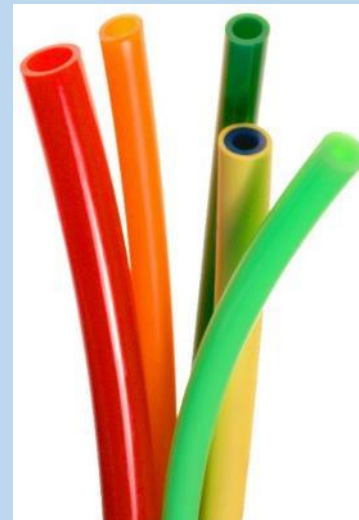
**Bar/Rod**



**Sheet**



**Thin film**



**Tube**

1

## POLYMERS



Complete the names in the boxes for the standard forms that polymers come in:










Connect with the straight line, the property with the definition:

- |                 |   |
|-----------------|---|
| 1: Hardness     | Can be hammered, pressed into a shape   |
| 2: Toughness    | Can be stretched into wire  |
| 3: Strength     | Can withstand shocks such as hammering  |
| 4: Elasticity   | Can be pulled apart or stretched, crushed or compressed, twisted, sheared as a result of sideways force |
| 5: Flexibility  | Can be stretched and then return to original length   |
| 6: Ductility    | Can bend but not break and return to original shape   |
| 7: Durable      | Can withstand bad weather conditions  |
| 8: Malleability | Can resist cutting and indentations   |

Put a **N** for Natural polymer or a **S** for Synthetic Polymer in the small box to the different polymers:

Nylon		Proteins	
Polyethylene		Cellulose	
Starch		Polyvinyl Chloride	

# SYNTHETIC POLYMERS



There are 2 'families' of plastics;


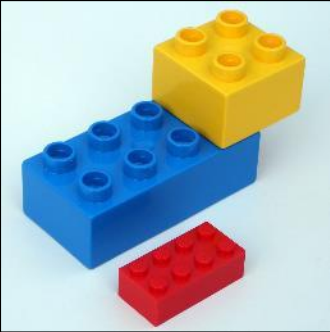

Key Terms;

- **THERMOFORMING PLASTICS** = such as acrylic, can be heated to make them soft so they can be shaped, this can be **repeated** many times.
  - **PLASTIC MEMORY** = is the ability of thermoforming plastics to return to their original state after reheating
- **THERMOSETTING PLASTICS** = such as epoxy resin, can also be heated to make them soft so they can be shaped, but this **can only be done once**. They are particularly useful for making plastic products that are resistant to heat
- **DYES** = can be added to plastics to make them a specific colour all the way through unlike woods or metals that can only be coloured on their surface.






# THERMOFORMING PLASTICS



Metal	Picture	Properties	Uses
Acrylic		Stiff, hard, clear, durable outdoors, easily machined and polished, good range of colours, does scratch easily	Illuminated signs, aircraft canopies, perspex sheet, car rear-light clusters, school projects
ABS		Tough, high-impact strength, lightweight, scratch-resistant, chemical resistance, excellent appearance and finish. <b>Good for injection moulding</b>	Kitchenware, safety helmets, car parts, telephones, food mixers, toys
Low-density Polythene		Range of colours, tough, flexible, good electrical insulator and chemical resistance	Washing-up liquid, detergent and squeeze bottles, bin liners, carrier bags

# THERMOSETTING PLASTICS



Metal	Picture	Properties	Uses
Urea-Formaldehyde		Stiff, hard, brittle, heat-resistant, good electrical insulator, range of colours	White electrical fittings, domestic appliance parts, wood glue
Epoxy resin		Good chemical and wear resistance, resists heat to 250°C, electrical insulator	Adhesives such as Araldite used to bond different materials such as wood, metal and porcelain
Polyester Resin		When laminated with glass fibre becomes tough, hard and strong, brittle without reinforcement	GRP boats, chair shells, car bodies



## 2

## THERMOPLASTICS & THERMOSETTING PLASTICS



Advantages of Thermoplastics	Advantages of Thermosetting Plastics



What plastic do you think the saucepan handle is made from?

Why do you think this?



Which plastic do you think the measuring jug is made from?

Why do you think this?



The plastic used for the thin rods needs to be flexible, name a thermoplastic suitable:

The plastic used for the outer shell of the headphones needs to be scratch resistant, name a thermoplastic suitable:

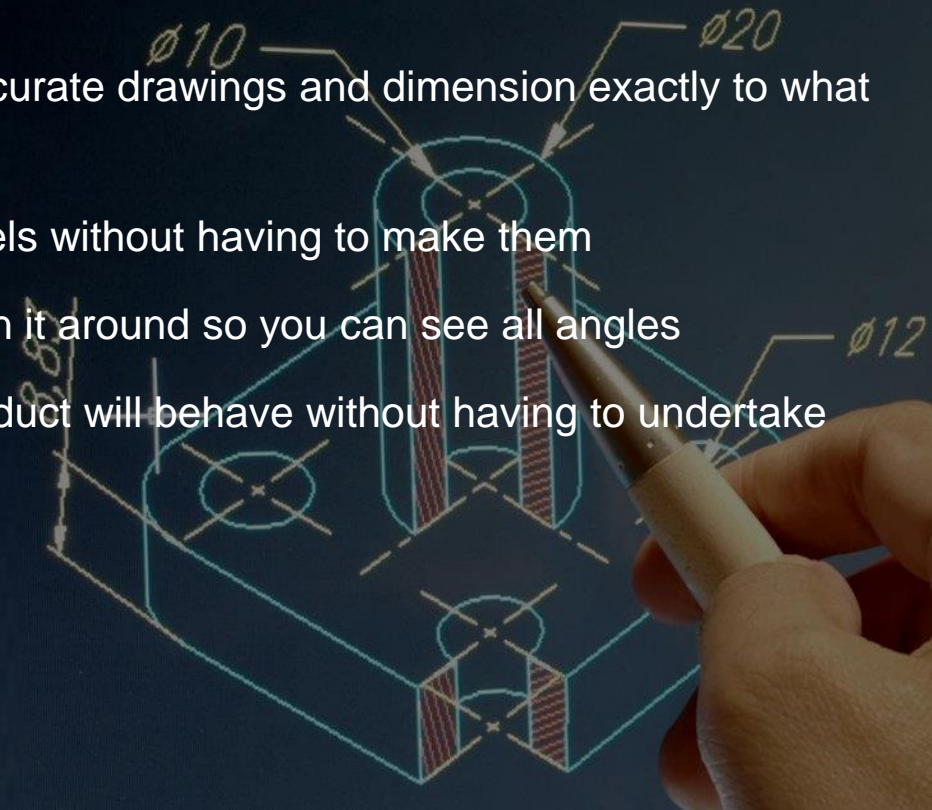
What is a disadvantage to these headphone components being made from thermoplastics instead of thermosetting plastics?



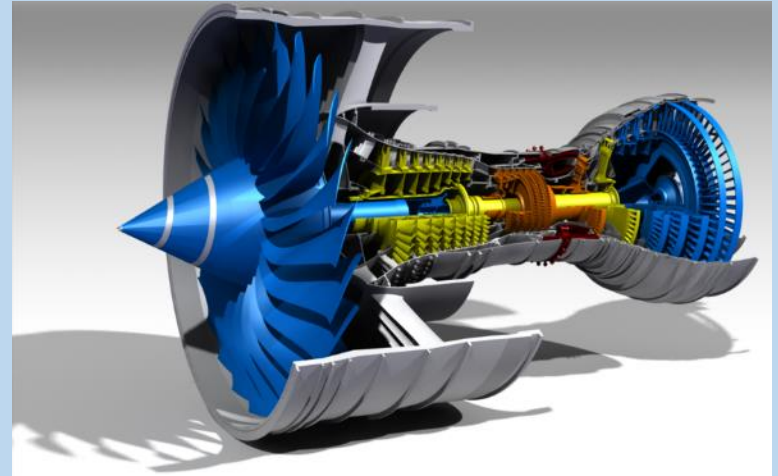
CAD software is used to create precision 2D or 3D drawings, models or technical illustrations. It is commonly used by designers, architects, engineers and artists.

Designers can use computer packages like 2D Design, Autocad, Google SketchUp to design, Model and Test ideas before they go into production. It is particularly useful because;

- Computers can be used to make changes to a design and edit it without having to redraw it.
- Computers can be used to produce very accurate drawings and dimension exactly to what is drawn.
- Computers can produce photorealistic models without having to make them
- You can see what it will look like in 3D – spin it around so you can see all angles
- Computers can show or simulate how a product will behave without having to undertake expensive testing.



# EXAMPLE OF CAD DESIGNS WHICH HAVE BEEN RENDERED



# ADVANTAGES AND DISADVANTAGES



Advantages of CAD	Disadvantages of CAD
Designs can be created, saved and edited easily, saving time	CAD software is complex to learn
Designs or parts of designs can be easily copied or repeated	Software can be very expensive
Designs can be worked on by remote teams simultaneously	Compatibility issues with software
Designs can be rendered to look photo-realistic to gather public opinion in a range of finishes	Security issues - Risk of data being corrupted or hacked
CAD is very accurate	
CAD software can process complex stress testing	

# COMPUTER AIDED MANUFACTURE / CAM



- Automated machinery is controlled by software to manufacture physical parts
- CAM uses Computer Numerical Control (CNC) and CAD files to generate 3D tool paths for the machinery to follow
  - CAM machinery includes laser cutters, embroidery machines, CNC milling machines, routers and lathes
  - Where is CAM currently used?





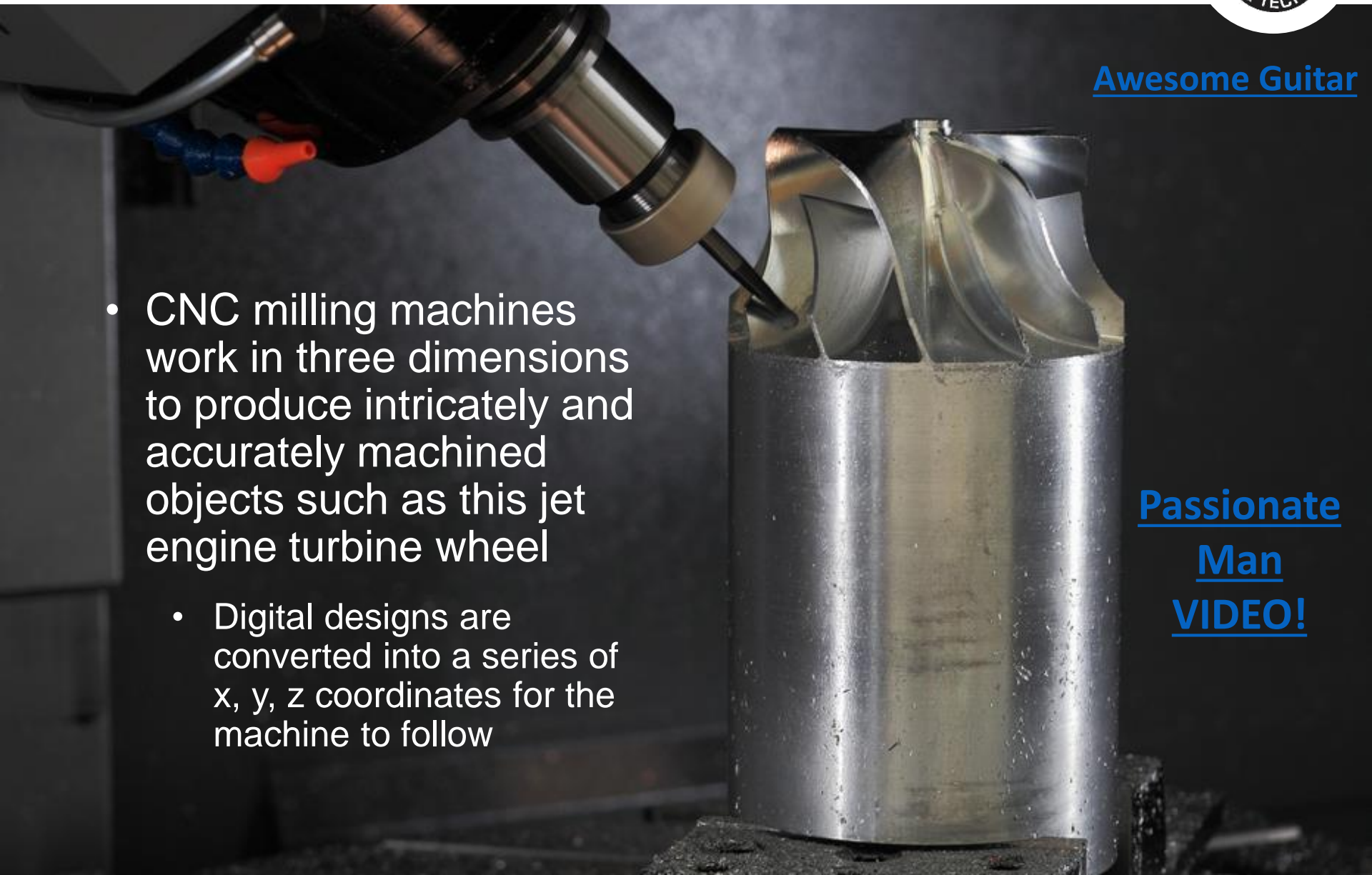
# CNC MILLING MACHINES



[Awesome Guitar](#)

- CNC milling machines work in three dimensions to produce intricately and accurately machined objects such as this jet engine turbine wheel
  - Digital designs are converted into a series of x, y, z coordinates for the machine to follow

[Passionate  
Man  
VIDEO!](#)





# CNC LASER CUTTING



- By cutting at different speed rates, laser cutters can burn through or etch the surface of a material
- They can cut complex shapes in a wide range of materials including:
  - Paper
  - Polymers
  - Timber
  - Metals and
  - Textile based materials



**Laser cutting fidget spinner design VIDEO**

# VINYL CUTTING



A vinyl cutter is a type of computer-controlled machine. Small vinyl cutters look like computer printers. The computer controls the movement of a sharp blade. This blade is used to cut out shapes and letters from sheets of thin self-adhesive plastic (vinyl).

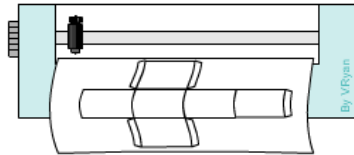


## INPUT



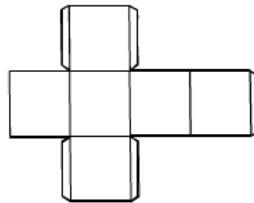
COMPUTER AIDED DESIGN (CAD) SOFTWARE IS USED TO DESIGN THE DEVELOPMENT / NET OF A SIMPLE PACKAGE.

## PROCESS



THE SOFTWARE CONVERTS THE DESIGN INTO COORDINATES. THE CUTTER FOLLOWS THE COORDINATES, CUTTING OUT THE PACKAGING SHAPE.

## OUTPUT



THE WASTE CARD IS REMOVED, REVEALING THE FINAL DEVELOPMENT / NET. THIS IS THE OUTLINE OF THE PACKAGE. THE FLAT DEVELOPMENT IS FOLDED ON PERFORATED LINES, ALSO CUT BY THE VINYL CUTTER.



# 3D PRINTING



The action or process of making a physical object from a three-dimensional digital model, typically by laying down many thin layers of a material in succession.



**The future of 3D printing**  
**3D Printed engines to show working models VIDEO**

# PRINTING BODY PARTS



- 3D bioprinting is being used to create new, living organs
- Skin tissue, livers, and joint cartilage have already been 'printed' and successfully transplanted
  - A solution for more complex organs is probably only a couple of decades away

**3D Printing organs VIDEO**





# THE DANGERS OF 3D PRINTING



- In 2013, the 3D print file required for all the parts of a working gun was created and distributed online
  - Who would be able to print a gun using these files?
  - What implications could this have?
  - How would a plastic gun affect barrier security?



# WHY USE CAM?



- Why are CAM systems becoming increasingly used in industry?
- What are the drawbacks of using CAM to:
  - The organisation/ company?
  - Staff within the organisation/company?



# ADVANTAGES AND DISADVANTAGES



Advantages of CAM	Disadvantages of CAM

# ADVANTAGES AND DISADVANTAGES



Advantages of CAM	Disadvantages of CAM
Computers do not make mistakes if programmed properly	CNC Machines can cost a lot of money, more than manual machines
Computers give reliable and consistently high standards of manufacture	Specialist knowledge is needed to programme computers
Computers achieve quicker production times	May lead to rise in unemployment (less workers needed)
Complex shapes and designs can be created easily	
Production can run 24 hours a day, 7 days a week, so more efficient	
Designs can be produced quickly to gather public opinion in a range of finishes	

## 4

## CAM WORKSHEET



Advantages of CAM	Disadvantages of CAM

Write about the different machines and explain which would be better at cutting out the acrylic back to your keyring and why:

<b>Laser Cutter</b> 	<b>VERSUS</b>	
<b>Micro Router</b> 		

Discuss the different methods and the benefits of both when it comes to cutting out your vinyl sticker for the front of your keyring. Which would be best and why?

<b>Vinyl Cutter</b> 	<b>VERSUS</b>	
<b>Craft Knife</b> 		

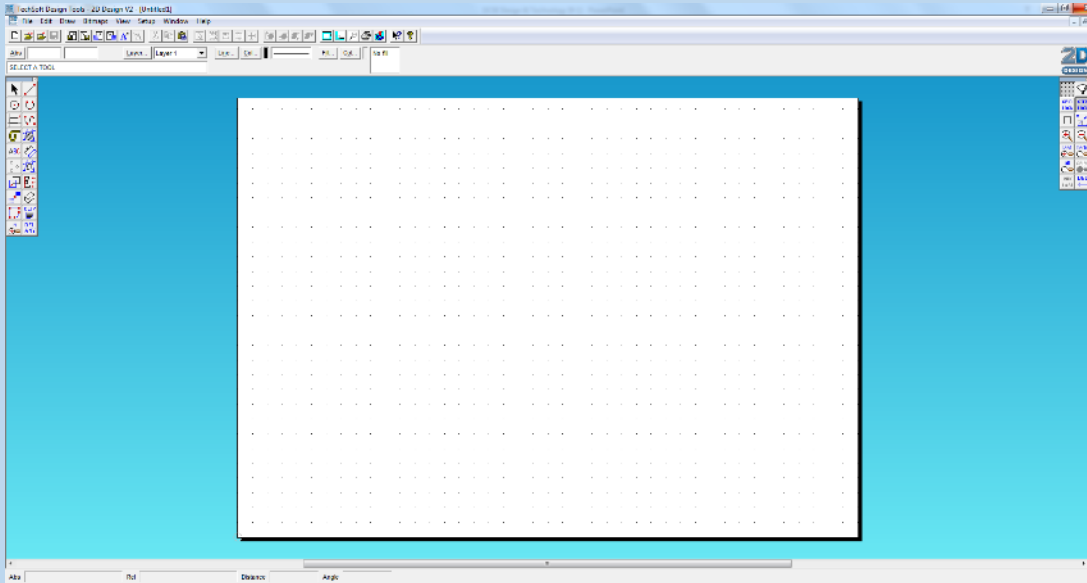
What are the drawbacks to using CAM to an organisation and the staff working within the organisation?

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# HOW TO USE 2D DESIGN TO CREATE YOUR DESIGN



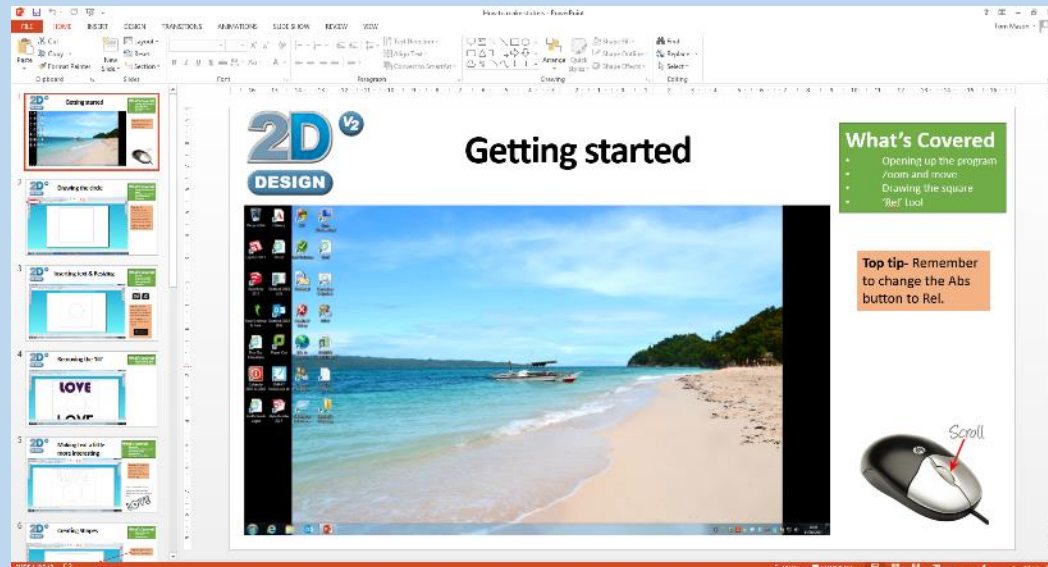
2D Design V2 can be found on your computer by searching for its name. When a grey box appears, just click on it to make it disappear and get started.

There are also videos in the shared area to help you with getting started and drawing simple shapes.

These videos can be found at:

Computer > Student Resources (R:) > Resistant Materials > Year 7

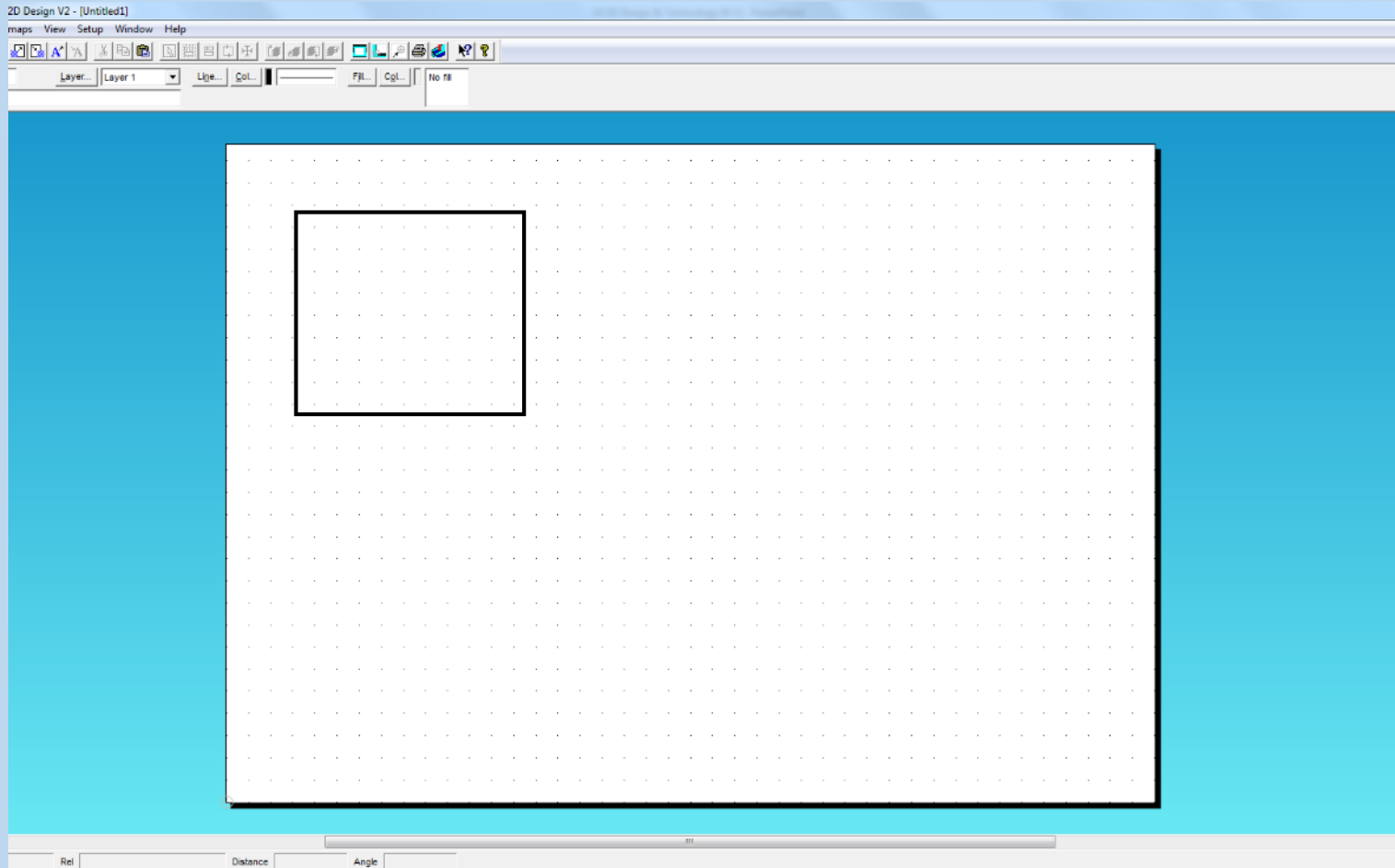
In a folder called "How to make stickers"



# HOW TO USE 2D DESIGN V2 TO CREATE YOUR DESIGN



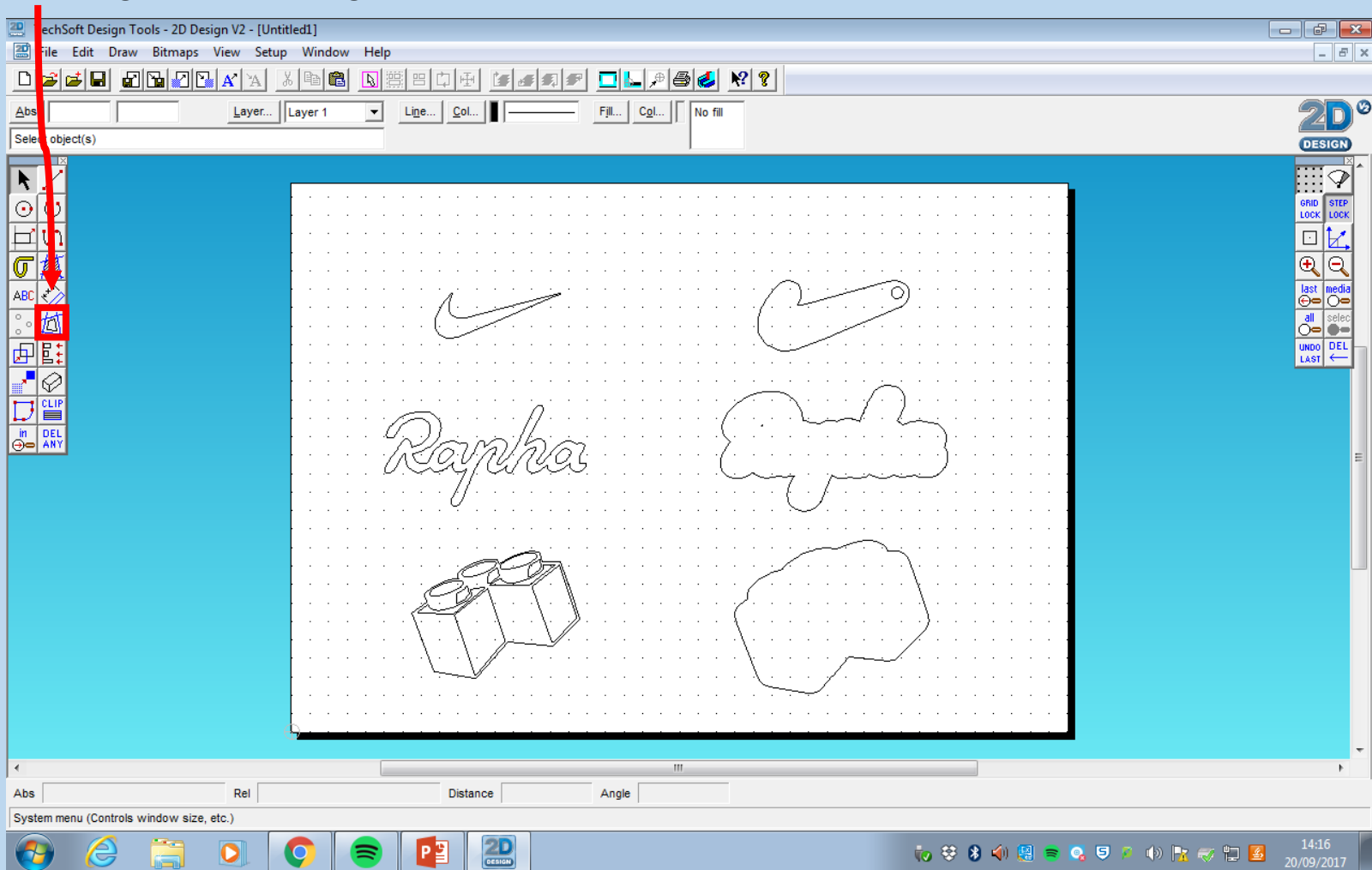
To get started, draw a rectangle on 2D Design which is 90mm by 90mm. This will be the max size for your keyring.



# CREATING THE TWO PARTS FOR YOUR KEYRING



Select the contour tool and change the size to 7mm. Next you need to click on the outside of your shape / design. Move the outside shape to the right of the page and then add the small hole!

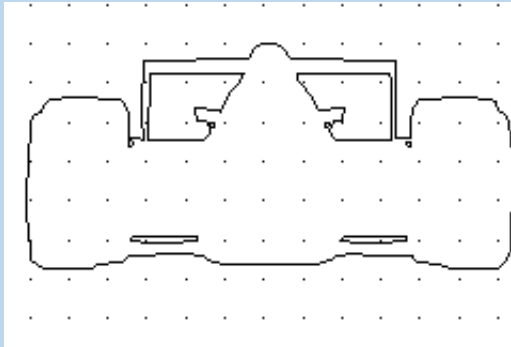




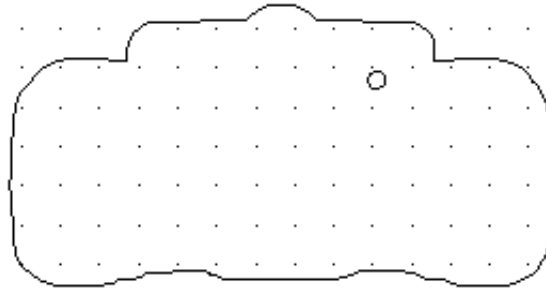
# CREATING THE TWO PARTS FOR YOUR KEYRING



This is the part the  
vinyl cutter will cut out



This is the part the  
Micro Router will cut out





# THE DENFORD MICRO ROUTER (CNC / CAM)

Here you can see the Micro Router cutting out some key ring design in time lapse



# THE DENFORD MICRO ROUTER (CNC / CAM)



The Micro Router has a chuck which holds a cutting tool. The cutting tool spins quickly and takes away material as it is moved along three different axis (X, Y & Z). The material that is being cut has to be held securely in place so that it is not moved by the spinning tool. The tool cuts slowly in layers, so the thicker the material, the longer it will take to cut.

