QuickCAM 3D Appendix

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QuickCAM 3D CNC Manufacturing Materials

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The sections below list general information on manufacturing materials used with CNC machines.

To order any of the materials listed below, or other ancillary items such as cutting tools, collets and work holding systems for your Denford CNC machines, please click here for details.

A list of feedrates and spindle speeds when using 2mm and 6mm diameter cutting tools with common materials on Denford CNC machines can be accessed by clicking here.

Your QuickCAM 3D models can be rendered in the Denford materials listed below. To access the image tiles required, please click here.

High Density Urethane Foam

General Information:
A rigid, closed cell, high density foam, suitable for most 3d prototyping applications. The higher durability and density, compared to lighter foams, makes it the ideal choice for rapid production of good quality "painted" models holding plenty of surface detail. Commonly used as moulds for low melting

point alloys and vacuum forming.

Denford Ordering Information:
Code BI03508 - High Density Foam - Billet dimensions 150 x 110 x 45mm
please note - all dimensions are approximate

Styrofoam

General Information:
A rigid, closed cell, low density foam. The low cost and easy machining properties make it particularly suitable for quick 3d realisation of your design ideas.

Denford Ordering Information:
Code N/A - Syrofoam - Billet dimensions 150 x 110 x 45mm
please note - all dimensions are approximate

Jelutong

General Information:
A light, close grained timber, which allows machining of high definition details on 3d models. Easy and quick to machine, with minimal tool wear.

Denford Ordering Information:
Code N/A - Jelutong - Billet dimensions 150 x 100 x 21mm
please note - all dimensions are approximate

MDF

General Information:
MDF (medium density fibreboard) featuring no grain and high definition capabilities. When machining, dust extraction must be employed. Commonly used in working areas as a (disposable) temporary machine table, onto which billets can be attached.

Denford Ordering Information:

Code BI03509 - MDF - Billet dimensions 205 x 205 x 25mm
Code BI03509A - MDF - Billet dimensions (b) 205 x 115 x 16mm
please note - all dimensions are approximate

High Impact Polystyrene Sheet

General Information:
Rigid, easy cutting, thermoplastic, used for 2d jobs and 3d photographs. Can be quickly "layered" in different colours, to produce low cost nameplates etc. Easily held on temporary machine tables using vinyl double sided tape.

Denford Ordering Information:
Code BI03509 - High Impact polystyrene - Billet dimensions 160 x 90 x 2mm
please note - all dimensions are approximate

Aluminium

No picture available (same as aluminium billet below minus anodised surface)

General Information:
Free cutting aluminium billet, easily polished, to yield professional looking component parts. Ideal for producing quick prototypes of metallic components.

Denford Ordering Information:
Code BI03511 - Aluminium - Billet dimensions 100 x 100 x 12mm
please note - all dimensions are approximate

Aluminium (anodised red surface)

General Information:
Free cutting aluminium billet, easily polished, to yield professional looking component parts. Features a red anodised surface finish, making it ideal for etching, bases and nameplates.

Denford Ordering Information:
Code BI03511A - Aluminium Anodised Red - Billet dimensions 100 x 100 x 12mm
please note - all dimensions are approximate

Ordering materials from Denford Limited

For further information, regarding current pricing, availability and ordering of CNC manufacturing material packs and equipment, please contact the Denford Sales Team.
Telephone Denford Sales: 01484 717282
Fax Denford Sales: 01484 718229
E-mail: sales@denford.co.uk

Sales Department Hours: Monday to Friday 8.30am - 5.00pm GMT
For international dialing: +44 and remove first 0 from each city code.

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QuickCAM 3D Spindle Speeds & Feedrates

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Selecting spindle speeds and feedrates can be difficult, particularly if you're not used to working with CNC machines. Although you can't beat years of experience, we've compiled a short list of recommended spindle speeds and feedrates to get you "up and running" as quickly as possible. The most commonly used materials are listed, then divided according to the Denford CNC machine type. All values are modeled around the use of 2mm and 6mm diameter cutters and in most cases should suffice for most jobs.

If you want to calculate your own spindle speeds, click here for more information

If you want to calculate your own feedrates, click here for more information

However, do remember that these spindle speeds and feedrates are only approximate values, so they do not take into account factors such as tooling material types, diameters and profiles. With this in mind, we recommend performing a test cut, then changing the values according to any factors that may affect the machining of your design.
Click here for more...

Micromill (all versions)

	Spindle Speed (RPM)	Feedrate (mm/min)
Foams	2,500	300
Woods	2,500	300
Plastics	2,000	150
Free Cutting Aluminium	3,000	2mm slot cutter @ 1mm deep Sinking - 20 Profiling - 45
	3,000	6mm slot cutter @ 2mm deep Sinking - 35 Profiling - 70

Novamill (all versions)

	Spindle Speed (RPM)	Feedrate (mm/min)
Foams	2,500	300
Woods	2,500	300
Plastics	2,000	300
Free Cutting Aluminium	3,000	2mm slot cutter @ 1mm deep Sinking - 20 Profiling - 45
	3,000	6mm slot cutter @ 2mm deep Sinking - 35 Profiling - 70

Triac (all versions)

	Spindle Speed (RPM)	Feedrate (mm/min)
Foams	2,500	2mm carbide cutter @ 2mm deep - 600
	2,500	6mm carbide cutter @ 6mm deep - 900
Woods	2,500	2mm carbide cutter @ 2mm deep - 600
	2,500	6mm carbide cutter @ 6mm deep - 900
Plastics	Acrylic -1,600 High Density Polystyrene - 1800	2mm carbide cutter @ 1mm deep - 300
	Acrylic -1,600 High Density Polystyrene - 1800	6mm carbide cutter @ 3mm deep - 400
Free Cutting Aluminium	4,000	2mm HSS cutter+coolant @ 1mm deep - 75
	2,500	6mm HSS cutter+coolant @ 3mm deep -150

Triton (all versions)

	Spindle Speed (RPM)	Feedrate (mm/min)

Foams	2,500	2mm carbide cutter @ 2mm deep - 600
	2,500	6mm carbide cutter @ 6mm deep - 900
Woods	2,500	2mm carbide cutter @ 2mm deep - 600
	2,500	6mm carbide cutter @ 6mm deep - 900
Plastics	Acrylic -1,600 High Density Polystyrene - 1800	2mm carbide cutter @ 1mm deep - 300
	Acrylic -1,600 High Density Polystyrene - 1800	6mm carbide cutter @ 3mm deep - 400
Free Cutting Aluminium	4,000	2mm HSS cutter @ 1mm deep - 75
	2,500	6mm HSS cutter @ 3mm deep -150

Microrouter (all versions)

	Spindle Speed (RPM)	Feedrate (mm/min)
Foams	20,000	2,000
Woods	20,000	2,000
Plastics	5,000	1,000 @ 1mm deep 500 @ 2mmdeep

Please Note - Metals cannot be machined on the Microrouter series.

Factors to consider when selecting speeds & feeds

If your CNC machine is used with incorrect spindle speeds and feedrates, your work may be machined with a poor surface finish or the workpiece or cutter could be damaged. There are many factors that would effect the decision you make to set or calculate these values, including:

- The maximum and minimum speeds and feeds available on the CNC machine.
- The condition of the CNC machine.
- The type of material being machined.
- The clamping method used to secure the billet in the CNC machine.
- The type of cutting tool used.
- The diameter of the cutting tool.
- The type of material used in the cutting tool.

- The condition of the cutting tool.

Troubleshooting with speed and feed values

Fault.	Solution.
Machine loses position, ie, some parts of the design are misaligned.	Lower the feedrate.
The billet material melts or fuses to cutter tip.	Lower the spindle speed or increase the feedrate.
The cutting tool tip becomes worn, blunt or burnt.	Lower the spindle speed.
The machine spindle keeps stalling (caused by low torque).	Increase the spindle speed.
Marks are produced across the surface of the design (cutter vibrates).	Increase the spindle speed.

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QuickCAM 3D
Calculating Spindle Speeds

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What is spindle speed?

A milling cutter needs to be spinning, so that it can cut the material. The rate at which the cutting tool rotates is called the "spindle speed", measured in Revolutions per minute, or RPM. The spindle is the part of the milling machine that holds the cutter.

Each cutter has its own spindle speed, depending on the type of material being cut and the size (diameter) of the cutter. When cutting the same type of material, the smaller the cutter is, the faster it must rotate. This is because every material has an "Ideal speed". This is the optimum speed at which the material can be cut

safely, in order to obtain a good quality of finish. These ideal speeds are calculated on the assumption that the material is cut with just one blade and that the blade moves in a straight line.

A milling cutter differs because it not only has more than one blade, it also cuts in a circular line. The speed at any point on the periphery (outside edge) of any size of cutter must always be equal to the ideal speed for the material, for it to work at its optimum performance.

How to calculate a spindle speed

Assuming that the CNC machine you are going to use is in good working order, there are ways of calculating the spindle speed for a cutter. On a milling cutter it is the speed of any point on the periphery (outside edge) of the cutter that should be equal to the ideal speed for the material. In order to work out the Revolution per Minute that a cutter should rotate at, we use this simple formula:

Spindle RPM =
[Ideal Cutting Speed (Metres/Minute) x 1000] / [Diameter of the Cutter (mm) x PI]

where PI=3.142

The only information we don't have at the moment is the ideal speed for any material. The table below shows a list of common materials and their cutting speeds, when using a H.S.S. (High Speed Steel) Cutter.

Table showing approximate cutting speeds for common materials when using a H.S.S. (high speed steel) cutter.

Free cutting mild steel	38 m/min
Low carbon steel	32 m/min
Brass or bronze	55 m/min
Aluminium or alloys	200 m/min
Plastics	250 m/min
Woods	500 m/min

Example

To calculate the correct spindle speed for a 10mm diameter slot cutter machining plastic, the equation would be as follows:

Spindle RPM =
[Ideal Cutting Speed (Metres/Minute) x 1000] / [Diameter of the Cutter (mm) x PI]

where PI = 3.142

Spindle RPM =
[250 m/min x 1000] / [10mm x 3.142]

Spindle RPM =
7956 revs/min.

If you want to calculate your own feedrates, click here for more information

A list of feedrates when using 2 - 6mm diameter cutting tools with common materials on Denford CNC machines can be accessed by clicking here.

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QuickCAM 3D
Calculating Feedrates

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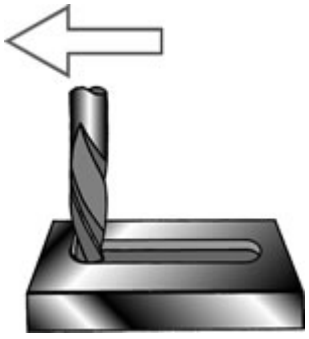
What is feedrate?

When the cutting tool moves through the billet material, it is important that the speed at which it moves is controlled. The speed of the cutter's movement is
called the "feedrate". The feedrate depends on many factors, including the type of material being cut, type of cutter used and the condition of the CNC machine.



How to calculate a feedrate

Assuming that the CNC machine you are going to use, is in good working order, there are ways of calculating the feedrate for a cutter. Every material has an ideal feedrate, measured in Millimetres per minute. Feedrates can vary, even if two cutters look the same size. One cutter might have twice as many cutting blades (called teeth) as the other, so its feedrate would be greater. More teeth cutting means it would be able to cut faster through the material.

In order to work out the feedrate, we need to know the proposed spindle speed of the cutter in RPM, the number of teeth on the cutter and a figure representing how much force we can put on each tooth, called tooth load. These figures can then be transferred into this simple formula to give the feedrate, in Millimetres per minute:

Feedrate (mm/min) =
Tooth Load (mm). X Number of teeth. X Spindle Speed in RPM.

Table showing approximate tooth loads for common materials when

using a H.S.S. (High Speed Steel) cutter.

Material	Slot cutter	Endmill cutter	Ballnose cutter	Facemill cutter
Low carbon steel	0.17mm	0.15mm	0.17mm	0.30mm
Brass or bronze	0.20mm	0.17mm	0.20mm	0.35mm
Aluminium or alloys	0.32mm	0.27mm	0.32mm	0.55mm
Plastics	0.22mm	0.17mm	0.22mm	0.36mm

Example

To calculate the correct feedrate for a 2 tooth, 10mm diameter, slot cutter, machining plastic, the equation would be as follows:

Feedrate (mm/min) =
Tooth Load (mm). X Number of teeth. X Spindle Speed in RPM.

(The RPM figure was calculated in the Spindle Speed section).

Feedrate (mm/min) =
0.22mm X 2 X 7956revs/min

Feedrate (mm/min) = 3500 mm/min

If you want to calculate your own spindle speeds, click here for more information

A list of feedrates when using 2 - 6mm diameter cutting tools with common materials on Denford CNC machines can be accessed by clicking here.

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Your 3D models can be rendered in realistic materials from stage six of the QuickCAM 3D process (tooling setup) onwards.

How to apply material texture tiles to your 3D model

To apply a material texture using the QuickCAM 3D software, click the "Options" menu, followed by "Select Material". The "Materials Selector" window is displayed, allowing you to load "Custom" materials - textures that may have been captured via a digital camera, scanned in, or created yourself using a computer paint package.

How to use the tiles available on this page

This tiles featured on this page can be saved and used as tiled "Custom" texture images in the "Materials Selector" window. Two versions of each tile are available, low resolution (these are the images you can see in the table below) and high resolution.

To save the low resolution version:

1. Position your cursor over the required tile and click the right mouse button.
2. A pop-up menu is displayed. Select the "Copy" option - this copies the tile to Windows clipboard.
3. Paste the tile into your favourite paint software package.
4. Save the new image file. We recommend that you save custom materials in your "QuickCAM3D" folder, using the "JPEG" file format.
   Tip: If you don't think you have any paint packages installed on your computer, try using the standard "Windows Paint" package. From the Windows startbar, click "Start | Programs | Accessories | Paint", then select "Edit | Paste" to paste the image.

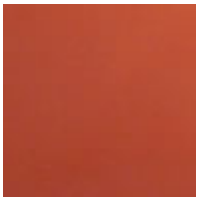
To save the high resolution version:

1. Left click on the required tile.
2. The high resolution version will open in a new window.
3. Right click on the larger high resolution tile, copy the image and paste it into a paint package.

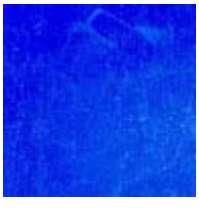
Denford Materials Image Tiles

The table lists texture tiles for materials commonly used in CNC manufacturing and modelling. All the materials shown in the table can be ordered directly from Denford Limited - please click here for details on how to order.

Plain Brushed Aluminium



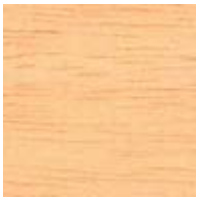
Red Anodised Aluminium



Modelling Wax

Low Density Styrofoam

High Density Urethane Foam



Jelutong Wood

Balsa Wood

MDF Board

More material and pattern tiles...

Further low resolution tiles featuring different and unusual (!) materials, textures and patterns can be accessed by clicking here.

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QuickCAM 3D Glossary of Terms

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AXIS (AXES) :
: The planes of movement for the cutting tool, usually referred to as X (horizontal left and right, parallel to the front of the machine), Y (horizontal forward and backwards, parallel to the side of the machine) and Z (directly vertical). Combinations of all 3 allow precise co-ordinates to be described. Axes are also referred to as slides or slideways.

BILLET :
: The actual material being machined, sometimes referred to as the "workpiece" or "stock".

BLOCK :
: A collection of program words that collectively describe a machining operation. A single program line in the CNC file.

CAD :
: Computer Aided Design; using a computer to help the process involving the design of your part.

CAM :
: Computer Aided Manufacture; using a computer to help the process involving the machining of your part.

CHARACTER :
: A number, letter or symbol as entered into a CNC program.

CONTEXT SENSITIVE :
: When the type of input signal of an event automatically changes the output signal.

CO-ORDINATES :
: Positions or relationships of points or planes. Co-ordinates are usually described using three numbers referring to the (X,Y,Z) axes, e.g. the co-ordinate (23,35,45) means X axis = +23 units, Y axis = +35 units and Z axis = +45 units.

CNC :
: Computer Numerical Control.

CNC FILE :
: The sequence of commands describing the manufacture of a part on a CNC machine, written using G and M codes, also called the CNC program.

CUTTER SPEED :
: The velocity of the cutting edge of the tool relative to the workpiece. With circular tools, the cutting speed is related to the tool when new (maximum cutting diameter). Usually the effect of feedrate is ignored.

CYCLE :
: A sequence of events or commands.

DATUM :
: The zero point (co-ordinate) from which a series of measurements are taken.

DIRECTORY

An area of a disk containing the names and locations of the files it currently holds.

DISK :

A computer information storage device, examples, C: (drive) is usually the computers hard (internal) disk and A: (drive) is usually the floppy (portable 3.5" diskette) disk.

DRIVE :

The controller unit for a disk system.

FEEDRATE :

The rate, in mm/min (metric) or in/min (imperial) at which the cutting tool is advanced into the workpiece. For milling and drilling, the feedrate applies to the reference point on the end of the axis of the tool.

FORMAT :

The pattern or way that data is organised.

FLUTE :

The channels, spiralling up the side of the tool, that allow machined waste material to be removed from the cutting tip.

FNC :

FANUC Miller file, extension ".fnc". Contains G and M codes describing the machine and cutting operations.

G CODE :

A preparatory code function in a CNC program that determines the control mode.

HARDWARE :

Equipment such as the machine tool, the controller, or the computer.

M CODE :

A miscellaneous code function in a CNC program used to indicate an auxiliary function (ie, coolant on, tool change etc.).

MACHINE CODE :

The code obeyed by a computer or microprocessor system with no need for further translation.

MACHINE DATUM :

A fixed zero reference point set by the machine manufacturer. The machine datum is used to define the co-ordinate based grid system of the CNC machine. All machining co-ordinates originate from this point. However, this point can be temporarily moved using the machine offset facility.

MDI :

Manual Data Input - A method used for manually inserting data into the control system (ie, Desktop Tutor, qwerty keyboard etc.).

OFFSET :

Combination of two types of file, the workpiece offset and the tool offset. Used to describe the workpiece datum, a zero reference used on the CNC machine to ensure machining occurs in the correct place on the billet. Offsets are used to shift parts of the three dimensional co-ordinate based grid system, used by the CNC machine.

PART DATUM :

Used as a zero reference point in a CNC file. All machining co-ordinates originate from this point.

PART PROGRAM :

A list of coded instructions which describes how the designed part, or component, will be manufactured. The part program is also referred to as the CNC file, program, or G and M code program.

PC :

Personal computer.

PROGRAM :

A systematic arrangements of instructions or information to suit a piece of equipment.

RPM :

Revolutions per minute (rev/min) - a measure of spindle speed.

SPINDLE SPEED :

The rate of rotation (velocity) of the machine head / cutting tool, measured in RPM.

SOFTWARE :

Programs, tool lists, sequence of instructions etc...

TOOL OFFSET :

When machining, allowances must be made for the size of tools being used, since they all differ in length. The tool offset is the amount the Z value must be moved (or offset), so that all the different

cutting tool tips used line up with each other, so they can all be used by one CNC file. Sometimes referred to as the tool length offset. See OFFSET.

TXT :
Standard Windows text only file, extension ".txt".

WORK (WORKPIECE) :
The actual material being milled. The work is sometimes referred to as the billet or stock.

WORKPIECE DATUM :
Used as a zero reference point on the real billet. All machining co-ordinates originate from this point, when offset files are used.

WORKPIECE OFFSET :
A file containing X, Y and Z values that can shift the entire three dimensional co-ordinate based grid system, used by the CNC machine. See OFFSET.

WORD :
A combination of a letter address and digits, used in a CNC program (ie, G42, M04 etc.).

VIRTUAL REALITY :
A fully interactive, three dimensional, computer based simulation of a real world object or event.

Z TOOL OFFSET :
See Tool Offset.

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Denford Limited provides unlimited telephone and e-mail Technical Support on this software to registered users. On-site visits by our software engineers may be chargeable. Please refer to any warranty pack, your local Denford agent or Denford Customer Services for specific details and queries.

Before contacting technical support, please read the documentation in your software helpfile and check the Denford websites for support.
Internet (access technical support and FAQ sections):
Denford UK: http://www.denford.co.uk
Denford USA: http://www.denford.com

When you request technical support, please be at your computer workstation, with your hardware and software documentation to hand. To minimise delay, please be prepared to provide the following information:

1. Registered user's name / company name.
2. The QuickCAM version number (found in the menu option "Help|About").
3. The wording of any error messages that appear on your computer screen, if applicable.
4. A list of the steps that were taken to lead up to the problem

Contact Details:
Denford Customer Services,
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Specific comments and requests can be sent to our authoring team...

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We welcome any feedback on this product but please note that due to project commitments, we may not be able to respond immediately to your comments and requests.

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