Profile Cutting

A Basic Guide to CNC and CAD/CAM Programming

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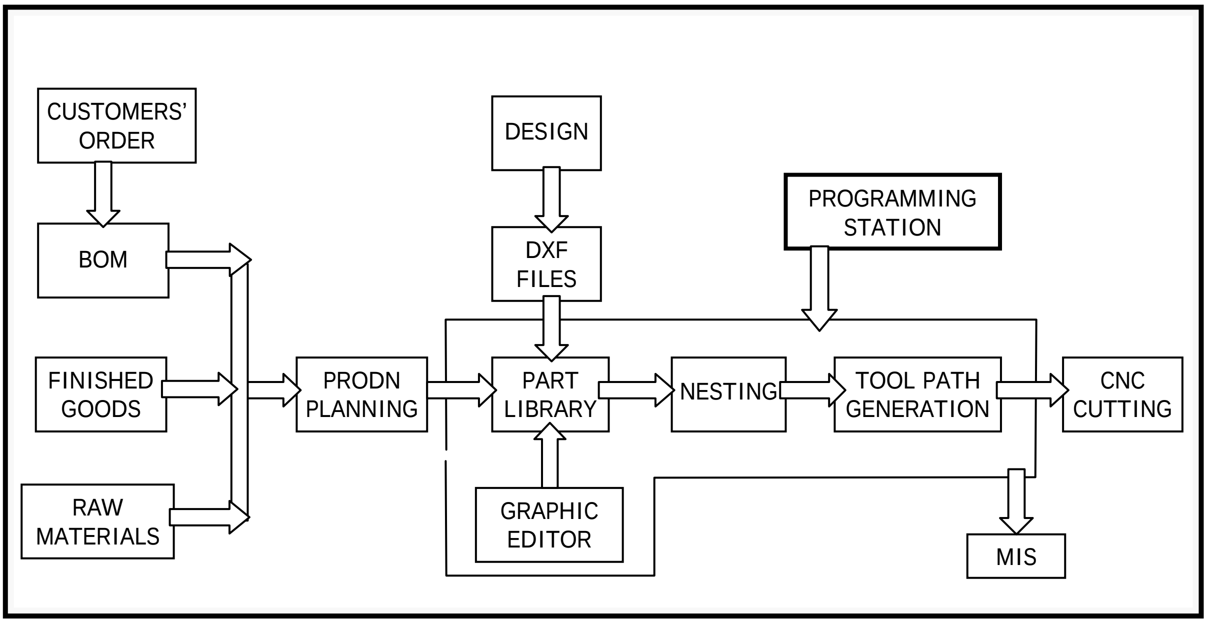
INTRODUCTION

A Computerised Programming Station is now nearly always used for the “off-line programming” of CNC profile cutting machines because it keeps the cutting machine 100% free for its main function -- cutting.

IBM–PC’s or compatibles, which now serve as an industry standard, are normally used and the programming is done through a simple graphical interface. A range of user friendly software is now widely available and can be operated without any special knowledge of computer programming.

Today, the investment in a programming station is now considered a necessity because of the plate savings gained from fast, efficient “nesting”, combined with the considerable savings in labor and working capital due to faster turnaround.

In this paper, the main features of a programming station and the major advantages have been described. A typical schematic flow diagram of a computerised programming station is shown in Figure-1.



The programming is done in three basic steps, which are part creation or drafting, nesting and toolpath generation. Thereafter, the nested program is transferred to the CNC machine. The steps involved are described here.

COMPUTER ASSISTED DRAFTING (CAD)

The first step towards part programming is to define the geometry of the shapes to be cut. Part description is done in the same way as is done on the drawing board by using the integrated CAD type software that normally comes with the software package. Pull down menus and prompts make life easy for the programmer. If any standard CAD system (such as AutoCAD) is already in use, the part drawings can be directly imported without having to create those parts all over again. Normally this is accomplished by an information exchange utility program, which can pick up the shapes as long the shapes are presented by the CAD system in standard IGES or DXF files. A direct AutoCAD (DWG) import facility is also often available.

Torch entry/exit (lead-in/lead-out) points on the contour, types and dimensions can be defined in a very user friendly way. To give an example, the lead–in is automatically inserted by the software once the type of lead–in (i.e., semi–circular or straight line, and the lead–in distance) is selected by the user. The "process" will also have to be defined if multiprocess software is being used.

If a programme is being made for cutting a single part, then the toolpath and cutting sequence also need to be defined at this stage.

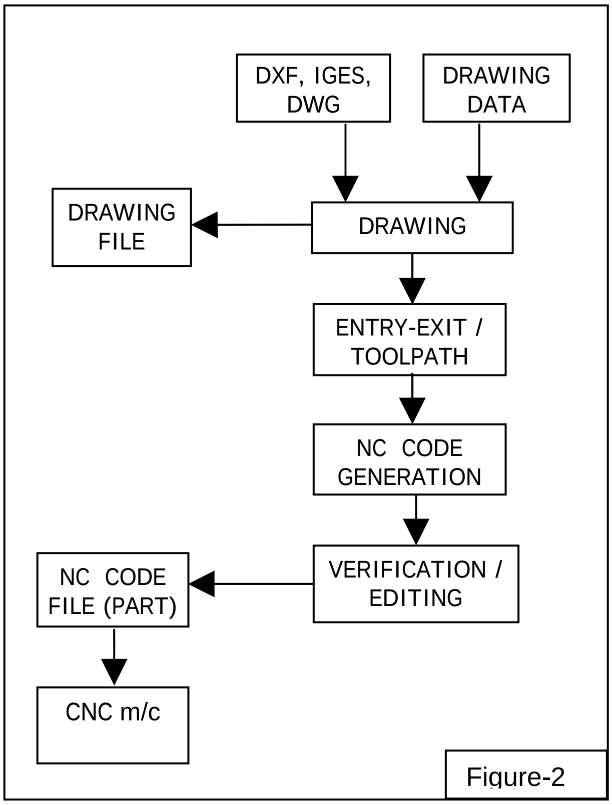


Figure-2

Figure-2 shows the logical sequences of these basic activities carried out by a part programming module, in the form of a flow diagram.

MARKING

Most profile cutting machines are equipped with a marking device. Line marking is frequently used for marking the reference lines for subsequent operations such as bending, welding, etc. Centre points for drilling are also marked on the machine itself. Text marking is used for part identification. The purpose of marking on the cutting machine is to reduce cycle time and improve relative dimensional accuracy of the different operations.

Plasma marking is very popular because of its simplicity. Powder marking, punch marking, ink jet marking, and many other processes are available. In view of this, a marking facility becomes an essential feature in any programming software.

Programming for marking is done in a way similar to part definition using the integrated CAD facility. When text marking is used, the software should have the facility to convert the text fonts to machine movements automatically.

NESTING

Nesting is the next critical step of programming. The purpose of nesting is to place and interlace various shapes of same thickness on a given plate in such a way that the utilisation of the plate is maximized whilst the scrap is minimized.

Nesting is a process of trying combinations of parts like a jigsaw puzzle. The most common understanding of 'nesting' is regular nesting, where each part is enclosed by a rectangle and then the rectangles are stacked next to each other. There is shape nesting, where C-shaped and L-shaped parts are allowed to interlock. Advanced shape (True Shape) nesting allows unlike parts to be nested together as well as nesting one part inside the cutout of another part. All these options must also consider the various rotations of the parts. The shapes are then laid out in an optimal pattern (nest).

Before nesting can be done, a nest requirement file is created with list of parts and quantities against each. Priorities of various degrees, (such as from 1 – 9 and “must nest”) are assigned to individual parts. Permission for rotation, flipping, mirroring, etc., can also be assigned to individual parts. Minimum part separation , permission for placing small parts in hole, number of torches to be used, plate size, etc., are also defined.

Most nesting systems take the approach of finding a near perfect solution within a reasonable time frame vs. an absolute exhaustive process. In general it is good practice to always check nesting results because even with an optimum layout, there may be some process related problem such as distortion, piercing etc., which will need operator intervention.

Consequently, ‘Interactive nesting’ or semi-automatic nesting is a valuable feature because it allows the ability to ‘jostle’, rotate, move, etc., which makes part manipulation easy. The software should also ideally allow the bridging of parts. This is often necessary for controlling distortion and maintaining accuracy of cut-parts.

The output from the nest gives a cut-list of how many parts could be placed on the plate against the requirement, so a decision can be made if a second plate is needed.

CUTTING SEQUENCE AND TOOLPATH GENERATION

After the nesting is done, the toolpath generation can be done automatically. Pre-conditions like "minimum rapid traverse" etc., can be defined for generating the toolpath. However, in order to keep distortion to a minimum, consideration must be given to the process related inputs, namely the cutting sequence, before finalizing the toolpath. This is a stage where the operator may choose to make some minor adjustments.

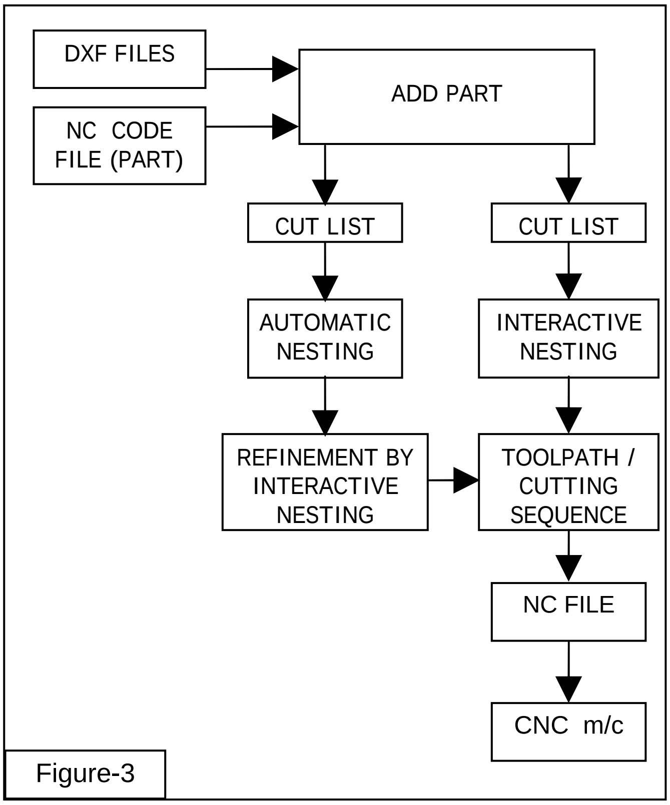


Figure-3

It is best to optimize the toolpath in order to minimize the total cutting cycle time. However, it must be noted that minimizing the cycle time is not the only goal and due considerations must be given to the process related problems such as distortion control etc, which often affects the toolpath. The toolpath generated by the computer is not always the optimum toolpath from a practical point of view so the operator needs to check.

Various cutting methods other than oxy–cutting, such as plasma, laser, water jet, router, etc, each have their own characteristics and the software should have the facility to generate programmes for any of these processes. This is normally done by selecting the appropriate cutting process during programming. It is often the practice to use marker, plasma and oxy-cutting on the same machine at the same time. The software would generally have the facility for switching and sorting the processes at appropriate stages so that the programme can take care of the multiple processes and the machine operator is not required to intervene during cutting.

Figure-3 shows the logical sequences of these basic activities carried out by a nesting and toolpathing module, in the form of a flow diagram.

PROGRAMME TRANSFER

The software automatically converts the nested toolpath into a series of machine-readable codes in the desired format. The most commonly used format for CNC flame cutting is ESSI, which uses only numerics. However, word address format (EIA 274), more commonly known as M & G codes, is also often used. Word address is actually a generalised format for all machine tools application. This format uses both alphabets and numerics. The program can then be transferred to the CNC machine.

One way is to download the program to the CNC machine from the computer almost instantaneously without any loss of accuracy through the RS232 communication port, using suitable wire or RS422 converter, depending on distance. Punched paper tape, which was the standard of the earlier generation of CNC machines, is now obsolete.

A DNC link is another concept that is used widely. This allows downloading and distributing jobs from one centralised programming station to more than one CNC cutting machine.

The only limitation of direct communication is the distance and coordination between the programming station and the CNC machine. In such cases a floppy or a CD can be used provided that the CNC has the facility. A current facility is the USB port where the programmes can be loaded on to the CNC using a pen drive.

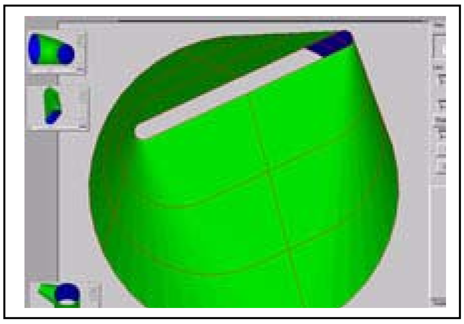
MIS

After nesting is complete, it is possible to get useful data about the job. Information such as cycle time, cutting time, gas consumption, and a print out of the nest can help the operator in planning his work. Costing of parts, weight, etc can be useful for many other purposes such as quotation and design.

OPTIONS

Many automation tools are now available to make complex fabrication jobs easy. For example, developing thick shapes for construction and infrastructure is an exacting process requiring specific skills. However there is a software program to assist in the creation of a range of heavy shapes such as pipe joints, space frame joints, lobsters, pipe transformations, bifurcate, etc. Most shapes are covered. Once the user puts in the basic parameters, the programme automatically does the calculations, modeling and all the weld and manufacture details. It also nests the pieces and outputs a cutting list! The operator still has to have fabrication knowledge but the process is not only so much faster it also more accurate. So important when you're dealing with expensive steel plate.

There are many features that are either built in or can be added to programming systems, depending on your needs. Font conversion, automatic pathing, DXF nesting, remnant plate nesting and management, part or drawing digitization, etc., and even nest-based quotations programs are all worth considering.



CONCLUSION

Developments in fabrication technology have delivered vastly improved production efficiencies and NC profiling has been one of the most significant. Cutting speeds and quality with new Plasma Technologies means few components are cut today via the old manual methods and the software in use is robust and mature. There are methods to automate and improve nearly every aspect of profile cutting.

However the value of an experienced operator should not be under-valued. He is still an essential element because of the need to intervene in any process-related problems, such as distortion.

With nesting, the key point is to understand that any improvement of the layout can potentially result in large savings of material and considerably reduce production costs, maximizing the material utilization and hence minimizing the [wasted] area. Today, the nesting technology is better and faster than ever before resulting in shorter lead-times, improved production services and better quality of output.

If possible, it is worthwhile to integrate a programming station with a CAD system in the design office. This further reduces the machine down time between jobs. Instead, where appropriate, the shapes can be imported from the design office CAD system. Torch entry/exit, marking lines, and text markings can also be defined at this stage if required.

It is strongly recommended that users look for a programming system that contains most of the features they need in the original purchase. The most expensive is not always the best. There needs to be a balance in only buying what is required and getting maximum buying value. Most suppliers will give better pricing if you purchase multiple programs at once. Users should check what other programs or modules the supplier offers and see whether or not the company provides printed operator manuals as well as online documentation. It is expensive and disruptive to change entire systems if your business needs grow.

About FastCAM

FastCAM are early pioneers and inventors of CAD/CAM software and introduced the first interactive CNC programming and nesting system in 1982. This was a revolutionary system at the time and significant commercially because it made computing affordable for manufacturers cutting parts from steel plate.

Although the hardware and operating systems have changed dramatically the original concept is as valid today as it was back then. The original code is still running! The FastCAM® System has of course been updated to reflect current processing capabilities however the fundamental features of the system have not changed. The main needs people had then are the same. The people who operate and service the machinery need to be able to use the system with absolute ease.

FastCAM has been supplying PC-based software for Burning, Shearing and Sawing/Drilling machines for over 25 years. The flagship product FastCAM® offers unique integrated postprocessors, NC verification and NC code nesting that still sets it apart from other CAM and CAD/CAM Systems. There are currently over 40 trademarked products offering "Best Fit, Best Value" for Metal Fabricators and the new generation of FastCAM® software is used in many countries, in many languages and in many different environments.

FastCAM is located in three locations: FastCAM Inc. in Chicago, USA, FastCAM Pty. Ltd, Melbourne, Australia and FastCAM Shanghai, in China. Personnel in FastCAM Research & Development combine years of software development and database experience with a unique understanding of day-to-day business practices in fabrication. FastCAM engineers are either qualified to a PhD. Level and/or have at least ten years of software programming experience.

For more information

Please contact us for a full color brochure on the FastCAM® System. For pricing information and/or a written quotation please email us at fastcam@fastcamusa.com or locate one of our sales offices worldwide at www.fastcam.com