

## **CAM STRATEGIES USING VISUALMILL SOFTWARE**

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**ABSTRACT:** CAM software market continues to be highly fragmented and competitive. Therefore, even if there are leading vendors, like Dassault Systèmes, providing CATIA V5, and UGS PLM Solutions, it is wise to investigate manufacturing strategies offered by other CAM programs, less known, but considerable cheaper than the previously mentioned. This approach, also assures a good practice for almost all CAM software utilization, due to the similarity of programming methods involved and their user-friendly interface. Thus, the facilities of VisualMill, which is a general-purpose machining program, suitable for machinists with sophisticated manufacturing requirements, are reviewed.

**KEYWORDS:** CAD-CAM, CNC milling, material removal simulation, post-processing

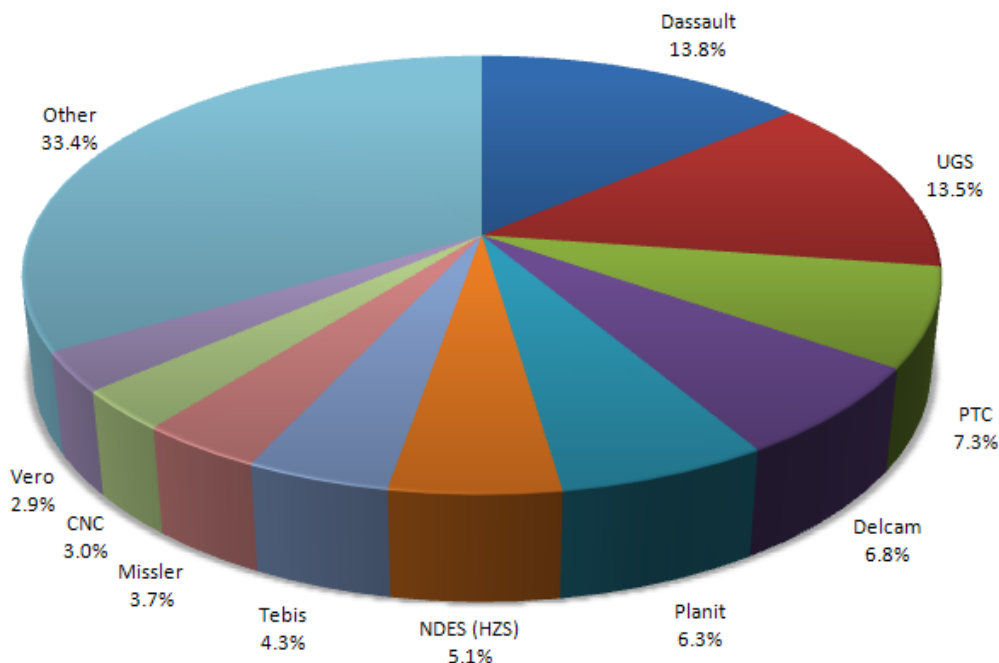
### **1. INTRODUCTION**

Even though there have been a number of recent mergers and acquisitions, the CAM software market continues to be highly fragmented and competitive. There is no single vendor or small group of vendors that dominate the worldwide market.

For example, the 2006 leading vendors on the basis of CAM revenue received were

Dassault Systèmes and UGS PLM Solutions, with nearly identical revenues and a combined market share of 27.3%. The remaining eight vendors in the top 10 had a combined market share of 39.3% and the remainder of the vendors below the top 10 had a combined market share of 33.4%.

This data is shown in the following chart (figure 1).



**Fig.1. Market Share of the Largest NC Vendors at the Vendor Level in 2006**

Since the CAM software market remains extremely divided, even if there are leading vendors, like Dassault Systèmes, providing

CATIA V5, and UGS PLM Solutions, it is wise to investigate manufacturing strategies offered by other CAM programs, less known,

but considerable cheaper than the previously mentioned. VisualMill is a general-purpose machining program, ideal for the rapid-prototyping, general machining, hobby and educational markets.

There are two major classes of machining operations, essential in any industrial fields, that can be created in VisualMill: milling – categorized as 2½ axis, 3 axis, 4<sup>th</sup> axis and 5<sup>th</sup> axis milling – and drilling.

## 2. TYPICAL CAM STRATEGIES FOR SURFACES MILLING

The manufacturing process aims to successively reduce material from the stock model until it reaches the final shape of the designed part.

To accomplish this, the typical machining strategy consists of:

- using initially large tools to perform bulk removal from the stock (*roughing operations*);
- using progressively smaller tools to remove smaller amounts of material (*pre-finish operations*);
- using a small tool to remove the uniform stock layer achieved in previous operations (*finish operations*).

This machining strategy must be programmed using VisualMill. In addition, by simulating material removal the image of the stock mode at any time during the process, can be visualized. This provides valuable feedback for choosing the most appropriate machining strategy (*figure 2*).

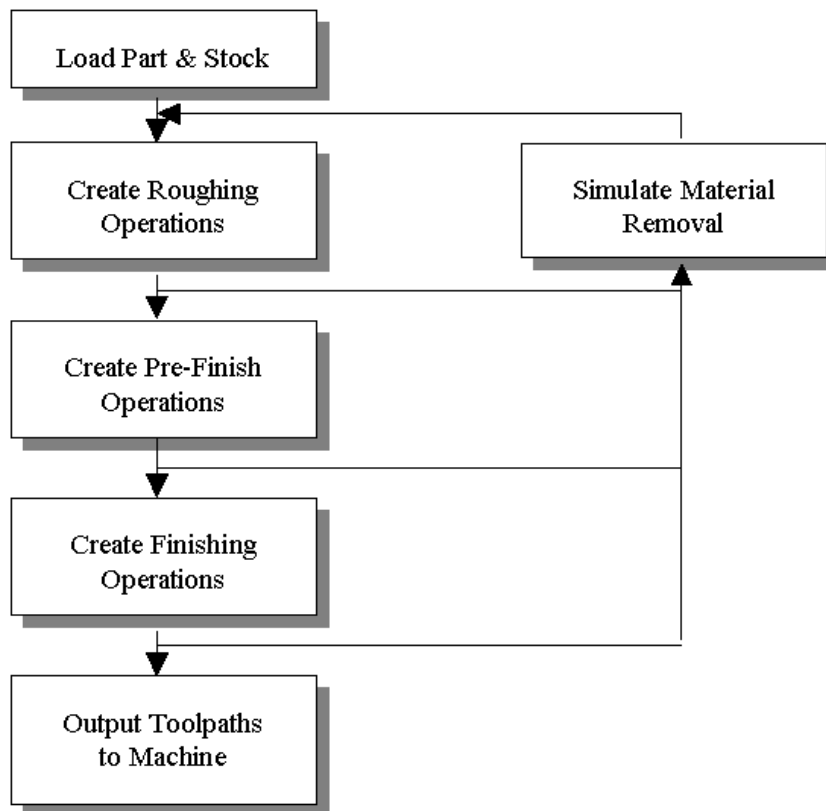


Fig. 2. VisualMill Workflow

### 2.1. Part Loading

The workpiece 3D model can be designed using *Geometry Bar* tools, featured by VisualMill CAD module, which is a relatively competitive one. In addition, it is possible to import ready-made parts into VisualMill, such as Rhino, STL, IGES, DXF/DWG, VRML, and Raw Triangle files. An add-on module enables to import Parasolid geometry data from the native design files of

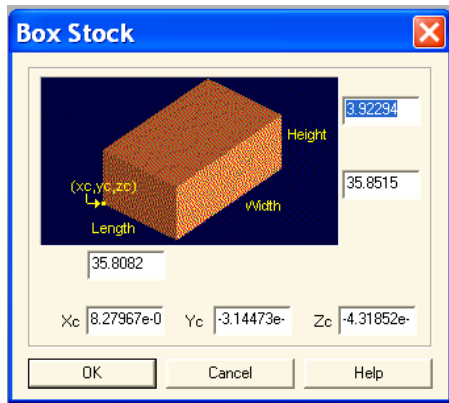
any Parasolid-based CAD system, as well as SolidWorks, Solid Edge files.

### 2.2. Stock Creating

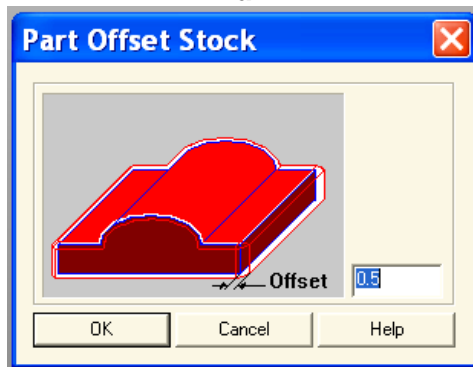
Stock geometry can either be created within VisualMill or imported from an external file. There are two main modalities of defining stock 3D model:

- by setting its prestablised coordinates for box or cylinder shape (*figure 3.a.*);

➤ by specifying offset values, which establish the position of its bounding surfaces (figure 3.b.).



a



b

Fig. 3. Modalities of creating stock model

### 2.3. Tools Selection

VisualMill supports numerous types of milling and drilling tools (figure 4). For each tool, standard APT parameters, like diameter, corner radius, taper angle, flute length (cutting length) and tool length can be specified. Also, a set of tools can be saved to an external folder that can be loaded in other files.

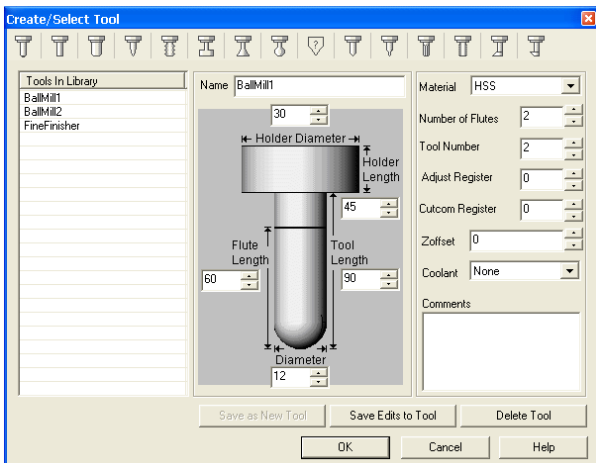


Fig. 4. Tools selection and parameters specification

### 2.4. Speed and Feed Parameters Set Up

The default values of different working or positioning motions can be customized by user (figure 5).

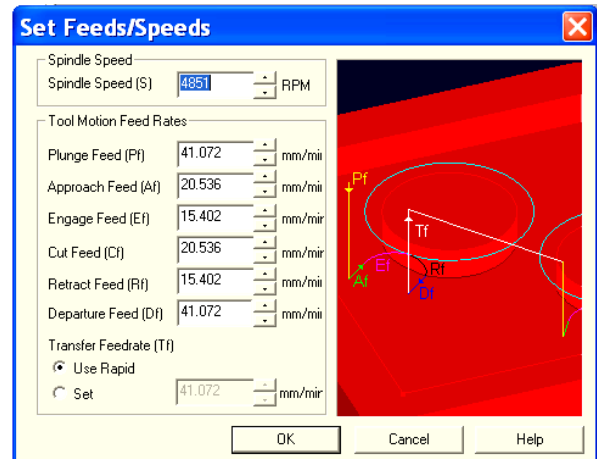


Fig. 5. Speeds and feeds setting up

### 2.5. Creating Roughing Operations

Rough machining can be done by *Horizontal Roughing* (3 axis) or *Pocketing* (2½ axis) operations. *Horizontal Roughing* is VisualMill's main method of roughing, also called *waterline* or *constant Z* cutting, meaning that the material is roughed out in horizontal layers. This type of machining is very efficient for removing large volumes of material, and is typically performed with a large flat end mill or an end mill with a corner radius.

In this type of toolpath, both part and stock geometry are used to determine the regions that can be safely machined.

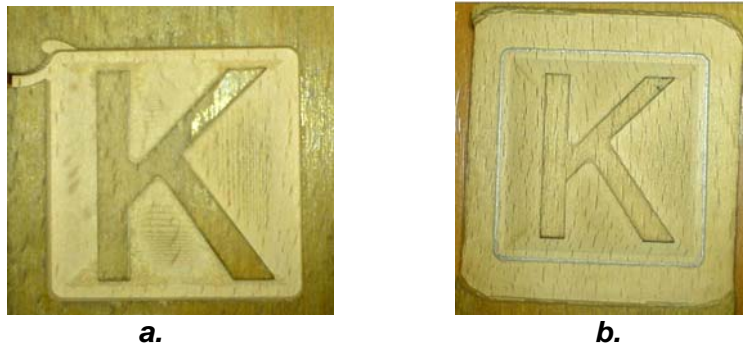
Three types of cutting patterns are available:

- *Linear* – parallel, zigzag lines;
- *Stock Offset (Pocketing)* – spiral pattern within stock and part (figure 6.a.);
- *Part Offset (Facing)* – spiral pattern outside the stock and outside the part (figure 6.b.).

### 2.6. Creating Pre-finishing and Finishing Operations

The part can then be pre-finished by using *Parallel Finishing* or *Horizontal Finishing* (3 axis) or *Profiling* (2½ axis). Pre-finishing and finishing operations typically use ball end mills, with or without a side angle.

For complex 3D parts, additional finish operations may be necessary. For example, *Parallel Finishing* operation can be defined using a small ball tool with a fine stepover value.



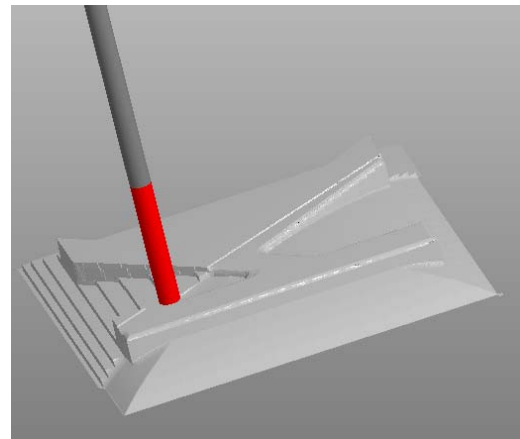
**Fig. 6. Comparison between Pocketing (a) and Facing (b)**

### 2.7. Toolpath Simulation

Simulation is valuable in order to catch errors, reflecting the model look after machining. Moreover, the cut stock can also be visually compared with the part model to indicate any areas of uncut or overcut material.

### 2.8. Post-Processing

After the toolpath generating, it can be post-processed to a specific machine controller, chosen from a wide set of post-processors, including those more often used like HeidenHain, Fanuc, Isel. The code programs obtained, having over 20 000 lines for a medium complexity workpiece, obviously can't be realized by manual programming.



**Fig. 7. Toolpath simulation**

The samples presented in *figure 8* were obtained using Isel CNC Machining Centers.



**Fig. 8. Processed wood samples**

## 3. CONCLUSIONS

VisualMill is an advanced CAM product, suitable for machinists with sophisticated manufacturing requirements especially for mold, die and tool making, woodworking, and other complex applications.

This approach, also assures a good practice for almost all CAM software utilization, due to the similarity of

programming methods involved and their user-friendly interface.

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