NC VERIFICATION, MACHINE SIMULATION AND NC OPTIMIZATION IN CAM SYSTEMS

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Abstract: *The expansion of the computer technique and new CA technologies gives very power tools to enhance quality of process planning. CAx systems contribute to the pre-production time shortening expressively. Computer utilisation in machining simulation, flow and working processes and production facilities is important in production. The article is centred on the possibilities of NC verification, machine simulation and NC optimisation in CAM systems.*

Key words: *CAM system, computer aided, verification, NCmachine,optimization*

1.INTRODUCTION

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At present time the goal of every manufacturer is to produce error-free parts on time and within budget. Imagine having the ability to simulate the machining process and verify the accuracy of your parts before they get to the machine. Today's CAM system are significantly faster and easier to use than ever before. CAM software has made the process of creating tool paths easier, but the need remains to test and verify part programs before production machining. After the tool path is created, it is converted into commands specific to a particular NC machine, either internally or through an external post-processor. A number of mistakes can occur at any time during this process. For example, the programmer can inaccurately input data or cause an error through incorrect use of the CAM system; the CAM system can produce errors in the tool path; or the post-processor can introduce errors or output code unsuitable for the machine's control.

2. VERIFICATION TECHNIQUES

There are a variety of tool-path verification techniques available to help manufacturers ensure that the part will be machined safely and correctly. The most rudimentary is to

manually scan the NC data to identify obvious errors. But this is time consuming and error prone, and other problems such as collisions between tools, the part, and fixtures usually cannot be detected until the actual machining takes place. The most sophisticated manufacturers take advantage of NC/CNC simulation and verification technology to verify the accuracy of the part program on the computer at the programming stage. While there is no complete substitution for production testing, verification software greatly reduces, if not eliminates, the many iterations of tool-path testing.

2.1.The Software Verification Process

NC verification software graphically simulates the material removal process by continuously updating the solid stock shape as the cutter moves along the tool path to produce the final part. The software accepts NC G code; APT-CL or other CAM tool path file formats as input and simulates the entire machining process. The "virtual machining" process is quite similar to setting up and running an actual prove-out on the machine tool. First, the user defines a block of stock from which the part will be cut. Then, the user defines the cutting tools and any fixtures (Fig.1) [7] that will be used, and finally inputs the tool path. The software then uses solid modelling technology to simulate the machining (Fig.1) [3].

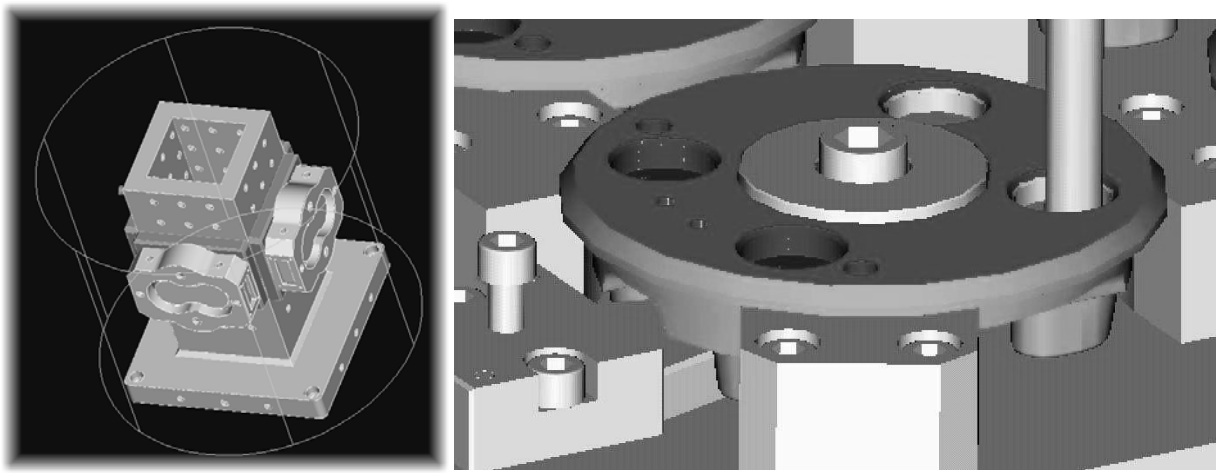

Fig.1 *Fixtures and Simulation of Machining Process*

Any errors detected during the process are highlighted so they can be easily identified and corrected before the part program is sent to the shop floor. There are different levels of sophistication in tool-path verification. Simple simulation is the most basic. 3-D simulation enables users to actually see "exactly" what will occur on the machine and how the part

"takes shape," rather than forcing one to imagine how each cut will affect the part. The next level of sophistication is actual verification, which enables users to detect problems in programming techniques. The final level of sophistication in the verification process is optimizing the tool path for the most efficient machining possible.

Between the main benefits of NC verification process belong:

- Detect NC program errors and bad or rapid cuts
- Machine parts correctly the first time
- Eliminate expensive and time consuming dry runs and proofing
- Reduce material scrap and overall cost

2.2. Machine Simulation

A lot of CAM software allows machine tool simulation. This verification uses 3D graphical technologies to model and animate the complete NC machine and its environment on the computer [4]. The software processes the actual machine input and simulates all movements of the machine components, including the axes, heads and tools, to detect collisions between any moving or stationary components (Fig.2).

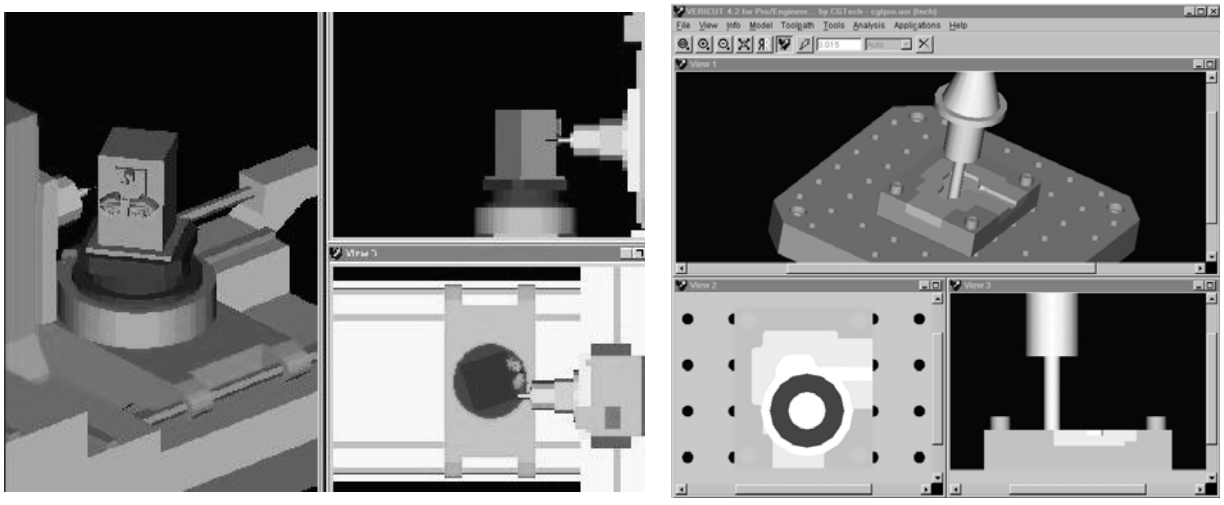

Fig. 2 *Illustration of Machine Simulation* [7]

Between the important factors in selecting a machine simulation product belong:

1. **Multi-window viewing capability**: -important for visualization and checking the machine movements with respect to the current machined stock shape. Without this, the collision detection will be incorrect.

2. **Easy and non-programmatic interface**: -the machine modelling capabilities should be simple and flexible. Software must accept standard 3D CAD models as the machine components or which provides a non-programmatic interface for machine definition.

3. **Fast and smooth animation**: - for a realistic simulation of the machine tool, the software should support smooth animation using advanced 3D graphics capabilities.

Between the main benefits of machine simulation process belong :

- Detect collisions between all machine components (heads, axes, pallets and tables)
- Preview machining operations by simulating movements of all machine components
- Train new programmers and operators
- Validate post processor configurations
- Use as a presentation and demonstration tool

2.3 NC Optimization

Verification software enables the user to send CNC programs to the shop floor that are not only proven, but are optimized with the best possible feed rate information.
The software analyzes machining parameters such as depth of cut, width of cut, volume of material removed, tool area of contact and tool sizes to determine optimum feeds and speeds (Fig.3).

The software does this by automatically analyzing the machining conditions and the amount of material removed by each cut, and then assigning the best feed rate for that particular cut. NC optimization software analyzes NC programs to adjust the feeds and speeds, reducing machining time by up to 50% or more (Fig.4).

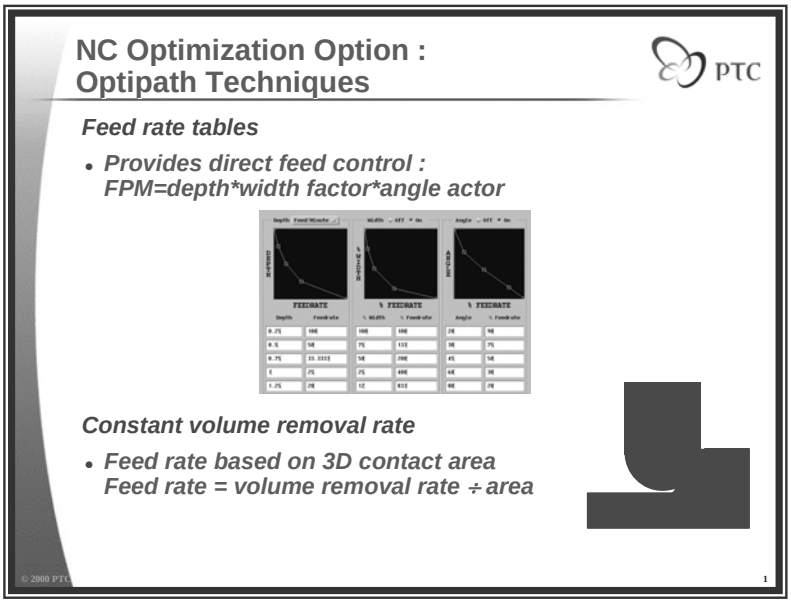

Fig. 3 *Illustration of NC Optimization Software* [8]

Between the important factors in selecting an NC Optimization product belong:

1. **Standard plug and play libraries**: - standard CNC controllers as well as feed and speed libraries should be included to enable immediate operation of the software.
2. **Speed and reliability**: - optimization be performed quickly and accurately to ensure optimum improvements to the manufacturing process.
3. **Other optimizations**: - possibilities to optimize other parameters such as: tool wear, tool life and inefficient tool movements.

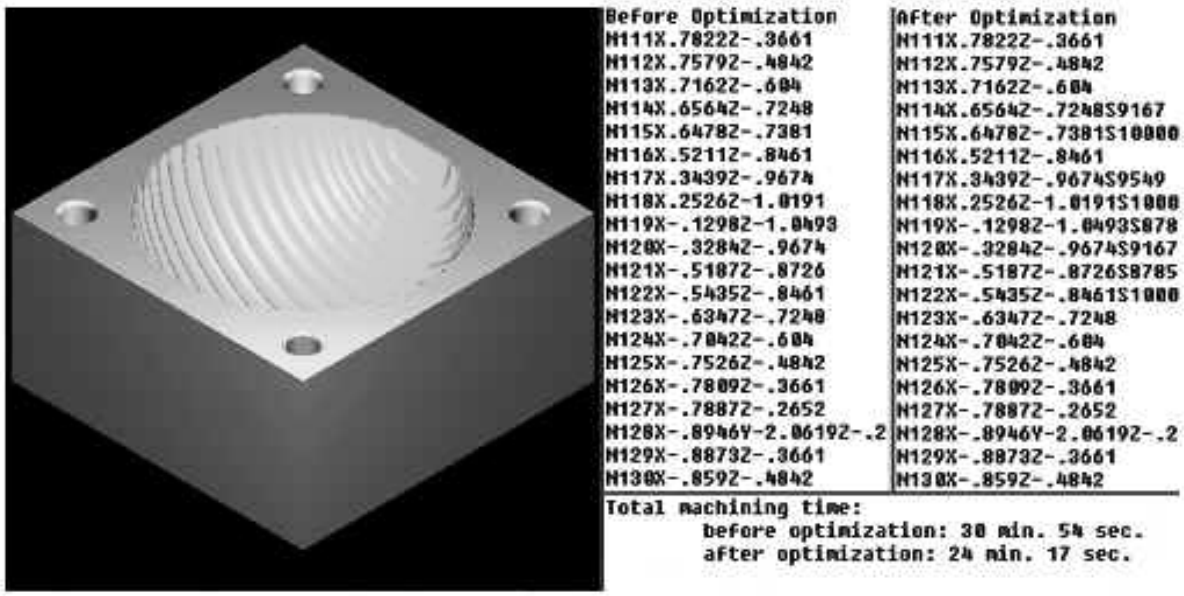

Fig.4 *Illustration of Optimization Software with amount of reducing machining time* [4]

Between the main benefits of NC Optimization process belong:

- Substantially reduced total machining time
- Better machine tool utilization and more efficient NC programs

3. CONCLUSIONS

Imagine having the ability to simulate the machining process and verify the accuracy of machining parts before they get to the machine. Verifying part programs on the computer reduces or eliminates the cost of machine-tool crashes, rework, scrapped parts, and damaged tooling, fixtures, and clamps. The part programs can be created that properly control feeds, speeds, and coolant during the programming phase.

Quality is also enhanced, because tool paths verified and optimized on the computer produce better surface finishes, do not leave dwell marks on the part, and place less wear and tear on the machines. Verification software also acts as a valuable training tool for programmers, operators, and students without risking a collision, or using valuable machine-tool time. Screen captures and playback animation files can be used to create documentation that enables operators, trainees, and managers to visualize the process before machining.

4. REFERENCES

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