Comparison of NC Analysis & Optimization Strategies

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The VeritasCNC cncCheck™ and cncTune™ analysis and optimization products are based on tool forces, computed from a combined geometric and physics model of the cutting process. Why is this important?

Users know tool forces are important but aren't focused on them much as a typical driver may not know the details of what is going on under the engine hood. Drivers do care about performance and safety and – if they have to choose – normally put safety ahead of performance. An accident or engine malfunction may be a rare event, but one such event can ruin more than the driver's day. Similarly, the machining community cares about performance – they want to minimize production time -- but not if this means an increase in events such as broken tools or unacceptable surface quality.

Virtually all "optimization" products focus on performance - making the part in the least time – while offering the user little guidance on the inevitable costs of trying to go too fast. Sure, case studies of vastly reduced production times with acceptable part quality are available for carefully worked out examples arrived at by trial and error. But the user has only crude guidelines (left to do their own experiments??) in setting speeds for their tool, their material and their part program.

What are some of the deficiencies common across these optimization products?

- These products typically optimize based on the volume removed per tool cut. Often, this is sufficient as it makes sense to go faster for lighter cuts. But we have demonstrated ***there are important cases where volume removed alone can be woefully wrong as a criterion for tool forces*.** One example is the sort of tool cuts encountered in high speed machining. No user wants a product that works "most of the time" any more than they would buy a car whose brakes worked "most of the time."

- These products offer little or no guidance on the effects on the machining conditions important to end users when speeding up. Since they lack a physical basis for the modeling (using geometry only**), they are ill equipped to provide reliable answers to such user concerns** as to whether the spindle might stall out, a tool might break or part tolerances are exceeded. Even a single bad event can yield a scrapped part and a very unhappy customer.

- In fact, parameter setting with these optimization tools is an art based on guesses, not on science based on facts. Sure, they get reliable information on how much faster their program will run, but is the race necessarily 'won' by the quickest? A simple question to pose to the vendors of these products: **"How does a user know when fast is too fast?"**

What are some of the advantages for cncCheck and cncTune?

- Analysis and optimization is based on a **proven science-based model of the machining process**. Our results are backed up by 1000's of laboratory tests, including tool force measurements. All of the tool force computations are “under the hood” transparent to the user. The tool forces are converted into machinist-friendly vocabulary and reports.

- cncCheck provides an **easy to understand analysis of the user’s part program**, correlating an animation of the part being machined with plots of the spindle power, chip load, tool stress as a % of the tool breaking stress (We do NOT report raw tool stress as N/mm^2 or whatever. That is meaningless to virtually all users) and tool deflection as effecting part tolerance.

- cncTune optimizes the user’s part program, but only within the machining limits set by the user (e.g. maximum spindle power, maximum likelihood of the tool breaking, …). In practice, **cncTune may *slow the tool cutting* down from programmed feeds over particularly challenging tool cuts**. Part quality and tool health (staying within the machining limits set by the user) are our first concerns and, only then, do we speed up the cutting process.

Tool wear

All optimization products, including the present generation of cncCheck and cncTune, mostly ignore the effects of **tool wear**. An empirical fudge factor (“decrease the feed by X% for every minute of tool use”) might be proposed, but that is a shot in the dark. Tool wear is a highly stochastic process, that can vary considerably even for nominally the same tool, material and part program. Taylor tool life “laws” are at best guidelines and offer no information on how much the tool forces increase with tool wear.

Is this important?

You bet. Our experiments indicate that tool forces can double or more for a still serviceable tool. Imagine a car whose speed control is set to 60 mph but is wrong by a factor of two and is actually racing the car at 120 mph; an accident waiting to happen.

VeritasCNC has received generous funding from the National Science Foundation to solve this problem. Ever since Taylor’s pioneering work in 1906, researchers have sought ways to monitor and predict tool wear. Our breakthrough experiments clearly demonstrate that we can monitor and **predict tool wear**, just by capturing the spindle power (easily done with modern CNCs). Current tool wear monitoring systems are also based on spindle power, but operate blindly and so need extensive training (more experiments by the user) to determine safe levels of worn tool spindle power over the normal power variations with part geometry. By integrating our science-based model of the cutting process with the spindle power data, VeritasCNC can report on-going tool wear and predict remaining tool life, from the very first tool cut – all of this transparent to the operator with no onerous experiments.

Our integrated system cncPerformance™ will accurately report increases in tool forces with tool wear. This allows us to automatically and intelligently adjust the programmed feeds based on the actual tool wear status. This integrated system is patent protected and will provide a unique and lasting advantage over the competition. VeritasCNC is and will remain the industry leader in providing CNC analysis and optimization products.