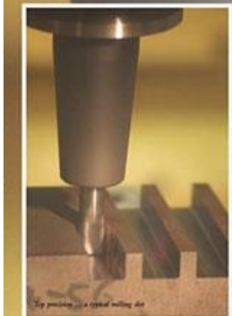
What's new in industry tooling

How to get that winning edge



Top precision … a typical milling slot

Machinery expert James Abbott, the Managing Director of Challenge Engineering, recently co-ordinated a Society of Manufacturing Engineers (SME) event hosted by SECO Tools Australia. Held at the SECO Technical Centre at Huntingwood in Western Sydney, the event focussed on the development of new technologies in metal cutting. This is James Abbott's report ...

Tooling is technical. To stay competitive you must be aware of the latest developments. The machinist needs to be aware of all the variables and how to manage tools well. Unless the machinist is aware of the many variables, serious problems can arise during the machining process.

These include:

- Chip forming and evacuation
- Tool wear and heat

By smart tool selection, correct tool usage and milling processes, you can manufacture products straight off the machine and increase productivity.

To stay in touch, industry professionals should attend the latest, relevant industry events.

Challenge Engineering has been involved in the manufacturing sector for several years and actively promotes special industry events and awareness of new technology – with a special focus on Lean Manufacturing.

Below is an outline of the technology demonstrated and discussed at a recent Society of Manufacturing Engineers (SME) event.

CNC Machining

Many years ago, an experienced machinist was someone who could grind a HSS tool with the appropriate cutting geometry to suit the material they were machining. Today, an experienced machinist is someone who can apply the appropriate cutting parameters to available tooling to cut any material.

Chip forming and evacuation

Chip forming and evacuation really needs to be fully under control. If not, long chips can cause production stoppages and damage to work pieces, machine tools and cutting tools – as well as operators. Cutting forces acting on the tool need to be completely understood. If control is lost, there is a risk of broken tools, broken cutting edges and vibrations during the operation. All of these will cause production stoppages and a poorly finished product.

Tool wear

Today's machinist needs a solid understanding of chip formation and tool wear. Contrary to popular belief, short 'C' shaped chips are not necessarily desirable. They require an extra 20 per cent of force to produce and reduce tool life.

In fact, short spiral chips are more desirable because they do not require as much machine power.

To understand tool wear is the key to a safe and predictable machining process as it's an excellent gauge for productivity. But what should you look out for? Tool wear that occurs suddenly like "breaking" or "edge chipping" should be avoided.

Flank and crater wear are what you should strive for in tool wear, because they are measurable.

Example: if you're getting 0.3mm flank wear every hour, or 100 parts, then each time you change that insert on that job, you will get the same amount of tool life and insert wear over and over again.

It's measurable, and of all the tool wear variations you can get, flank and crater wear are the most desirable.

On the other hand, "plastic deformation" is an undesirable tool wear. Basically, you're melting the cobalt binder in the cemented carbide insert as you're placing too much heat into the cutting edge, making it unpredictable.

But without enough heat at the cutting edge, you will have "built up edge" where friction welds small deposits of metal during the cutting process onto the cutting edge that will deliver an uncontrollable cutting action resulting in poor swarf control and surface finish.

Heat and Temperature

Machining metal generates intense heat. If not evacuated by the chips, this heat will concentrate over a period of time in the cutting tool or in the work piece surface, jeopardizing the quality of the finished work piece.

The high temperature in the cutting process can cause changes in the cutting properties of the cutting material with loss of tool life as a logical consequence.

Heat can make it difficult to finish work pieces with the correct quality in terms of dimensions, shape, surface roughness and surface structure.

It's an accepted fact that plenty of heat is generated during the cutting process.

Heat can be used to our advantage, but temperature is what we need to avoid. Why? It's a function of pressure from the cutting forces on the cutting edge.

However, you don't want to generate too much heat as it will build temperature into the insert and the work piece. Interestingly, under normal machining conditions, if you are machining steel, 80 per cent of heat is evacuated through swarf.

Understanding the cutting process

Are you familiar with the flow zone? It's a term that explains the microscopic deformation of material at the cutting edge.

Long chipping materials have a flow zone on the underside of the chip. The thickness of the flow zone is influenced by the work piece material, the machining angle and the cutting speed.

To avoid heat problems, the cutting process and the interaction between the different elements need to be carefully considered.

A key element is the cutting method. We can choose between traditional machining, high speed machining, high feed machining or high performance machining. Each offers advantages as well as constraints.

This means not every method – in a given situation – offers the same operating security. A well-selected cutting edge – in terms of cutting material and geometry – in relation to the selected cutting method is of the highest importance in making the cutting process reliable.

The cutting material needs to be adapted to the work piece material with cutting speed as the linking element. The cutting edge geometry has to be well selected to serve the purpose of the operation eg. roughing or finishing.

The linking elements here are the feed(s) and the depth(s) of cut.

Then there is the correct selection of the cutting data combination to consider – high cutting speed combined with low feed, or high feeds with moderate cutting speeds? Each cutting condition needs to be selected correctly.

Cutting speed needs to be high enough to avoid built-up edge wear. But, the cutting speed should not be so high that the wear process is mainly governed by thermo-chemical wear patterns.

The depth of cut and feed, have to be selected so that chip formation and mechanical impacts on the cutting edge (cutting forces) are under control.

When security is important during the metal cutting process (while maintaining the highest possible productivity), the preference should be for high depths of cut and feeds coupled with moderate cutting speeds (economical cutting).

Cutting speeds can be further increased if circumstances allow and if productivity weighs more than production costs in the total picture. But higher cutting speeds will also involve more "risk for the unforeseen" during the process.

But back to the importance of tool selection and the right strategy … Lead times these days are becoming shorter and parts, more complex.

We need to be thinking more about finishing straight off the machine. Post operations, such as grinding, are a thing of the past.

By utilising the correct parameters, you should be able to get good chip evacuation without the need for coolant.

Milling technologies

Now let's consider new technologies in milling. It all comes down to depth and width of cut (average chip thickness). High-speed milling is all about big depths of cut. High feed milling on the other hand is all about small depths of cut.

It's about getting the most out of your tooling as possible.

There are numerous milling techniques, such as ramping, helical interpolation, drilling, Z-levelling, plunge milling and even trochoidal milling. SECO is actually recognized as the developer of plunge milling.

There is a specific technique for each of these strategies. For example, plunge milling sends the cutting forces back up the spindle. Or if you are machining components with thin walls, you need to maintain rigidity in the work piece.

And then there is high speed machining. It's not all about rpm, but m/min. Obviously, a 1mm ball nose end mill isn't going to be very effective at 10,000rpm.

Now let's examine trochoidal (peel) milling.

This process is a constant circular interpolation to produce a keyway in a shaft, for example, using a multi axis CNC lathe. It does this using circular interpolation movement's, using a cutter that is smaller than the keyway, which allows for brief contact with the work piece as the reduction of the arc of contact to limit temperature development, followed by an air movement that allows for the cutting tool to cool down, or removing the temperature. It's based on a "small arc of engagement" strategy.

By simply adjusting the tool wear offsets, you have complete control over the width of the keyway, within microns.

Take the trochoidal (peel) milling process for example. You can rough and have your component semi finished with a single tool.

This potentially maximises tool life, because the same tool could be side milling and contour milling at a speed of 200m/min in material that could be as hard as 55Rockwell C. If the material is harder, say 63 to 75 Rockwell C, then consider using negative geometry to the extent where your tooling is almost blunt.

High feed milling, on the other hand, is all about small depth of cut using high feeds with at least 1mm per tooth. This makes for a very high rate of material removal using the right insert geometry to generate bigger chips.

Bending the rules

Traditionally, you'd machine a part and send out for heat treatment and grind to finished size.

These days it can be more viable to heat treat first and then machine to size. This is what technology is allowing us to do these days – bend the rules to make us more competitive.

But often we are stuck in a mindset of: "this is the way we do things around here."

This means we get mental blocks and can't think outside the square.

Our main overseas competitors have access to cheap labour. To counter this we must utilise our access to education and sound machining principles as our primary defence against inferior imports.

If you have something specific, it often pays to visit your tooling supplier's website for more information.

For example, www.secotools.com has valuable speed and feed calculators. It also has programming sequences for ramping and trochoidal milling – and it's free.

For more information on the SECO Tools/Challenge Engineering event visit:
www.challengecnc.com.au

High tech … lead times are shorter and parts, more complex

David Mort, Technical Centre Manager of SECO Tools Australia (left) with James Abbott, Managing Director of Challenge Engineering

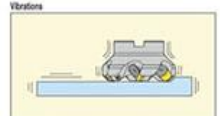
Tool life problems

Rapid flank wear	• Reduce the cutting speed. • Increase the feed rate. • Climb milling.
Rapid notch wear	• Reduce the cutting speed. • Increase the feed rate. • Increase the depth of cut. • Climb milling. • Change cutter positioning.
Chipping	• Increase the cutting speed. • reduce the feed rate. • Conventional milling. • Improve chip evacuation. • Change cutter positioning. • Minimize tool overhang. • Improve stability.

Comb cracks	• Reduce the cutting speed. • Reduce the feed rate • No coolant. • Change cutter positioning.
Built up edge	• Increase the cutting speed. • Increase the feed rate • No coolant. • Climb milling. • Change cutter positioning.

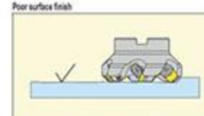
Common problems encountered with poor tool life and their remedies

Vibrations



- Improve the stability of cutter and workpiece.
- Change cutter positioning.
- Minimize tool overhang.
- Reduce the cutting speed.
- Increase the feed rate.
- Reduce the depth of cut.

Poor surface finish



- Improve the stability of cutter and workpiece.
- Minimize tool overhang.
- Reduce the feed rate.
- Increase the cutting speed.
- Use a coolant.
- Use wiper inserts.

Common problems encountered with poor setup and their remedies

Controlling stock levels is vital

In some work shops, it is not uncommon to have a multitude of inserts at individual work stations, in tool boxes, or at machines.

With so much variation in the market today, it can be difficult at times to inventory inserts and tool holders – particularly for larger facilities with numerous machines.

And with inserts priced about $10 each, this "lost inventory" can become very expensive.

Therefore, considerable savings can be made by efficiently maintaining insert inventory.

One solution is the SecoPoint Smart Drawer from SECO Tools Australia, a leading supplier of carbide to the manufacturing sector.

This is an insert dispensing system that can control stock levels of inserts and tool usage either at the console or remotely over the Internet.

It can automatically order tooling and generate necessary reports.

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