Troubleshooting

Introduction

Troubleshooting should be performed in a sequential method to identify and solve your milling problems. These problems can be recognized as premature insert edge failure, part appearance, machine noise or vibration, and the cutter's appearance. Successful troubleshooting requires that we correctly identify the problem, then take the necessary corrective action one step at a time. The five key areas of concern are:

1. cutting tool material (grade)
2. cutter/adapter
3. machine
4. workpiece
5. set-up/fixturing

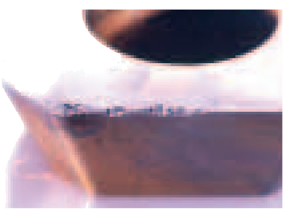
This section will discuss possible causes and will recommend corrective actions for each of the five areas listed. Remember, if more than one step is taken concurrently, the real cause of the problem may never be discovered. Always perform one corrective measure at a time.

Edge Condition Problems and Solutions

1. **chipping:** Appears like normal flank wear to the untrained eye. Actually, normal flank wear lands have a fine, smooth wear pattern, while a land formed by chipping has a saw-toothed, uneven surface. If chipping is not detected soon enough, it may be perceived as depth-of-cut notching.

   Chipping can also be caused by recutting of chips. A good example of this would be a slotting operation where chip clearance or chip gullet space does not allow the chips to evacuate cleanly. In this instance, packing of the chips also occurs.

   In most cases, by changing to a stronger grade and/or to a different edge preparation such as a larger hone or T-land, or from a 0° cutter geometry to a lead angle cutter geometry, will resolve the problem.

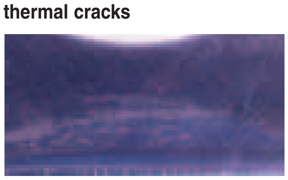
problem	cause	solution
chipping 	• chatter	• Check system rigidity for proper part clamping. • Correct worn gibs/bearings. • Check for improper cutter mounting.
	• edge prep	• Use largest hone or T-land possible.
	• grade	• Use a tougher grade.
	• built-up edge	• Increase speed.
	• feed	• Reduce feed per tooth.
	• recutting chips	• Choose cutter geometry with correct pitch for chip clearance. • Use air blast or coolant to remove chips.

2. **depth-of-cut notching:** Appears when chipping or localized wear at the depth-of-cut line on the rake face and flank of the insert occurs. Notching is primarily caused by the condition of the workpiece material. Material conditions prone to depth-of-cut notch include: an abrasive workpiece skin of scale, abrasive properties of high-temperature alloys like Inconel, a work-hardened outer layer resulting from a previous machining operation, or heat-treated material above 55 HRC.

problem	cause	solution
depth-of-cut notching 	• cutter geometry	• Change to a lead angle cutter.
	• grade	• Use a more wear-resistant grade of carbide.
	• feed	• Reduce feed per tooth.
	• speed	• Reduce speed.
	• edge-prep	• Use honed or T-land inserts.
	• programming	• Vary depth of cut on very abrasive materials.

3. **thermal cracks:** These cracks run perpendicular to the insert's cutting edge and are caused by the extreme temperature variations involved in milling. In one revolution of a milling cutter, the insert starts to cut and the temperature quickly rises as the insert enters the cut. The varying chip thickness also changes the temperature throughout the cut. When the insert comes out of the cut, air or coolant flow rapidly cools the insert before it reenters the cut.

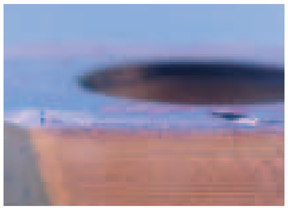
   These temperature variations create heat stresses in the insert which can result in thermal cracks. To the untrained eye, advanced thermal cracking could appear as chipping.

problem	cause	solution
thermal cracks 	• speed and feed	• Reduce cutting edge temperature by reducing the cutting speed and possibly the feed per tooth.
	• coolant	• Shut off coolant.
	• grade	• Use coated grade designed for wet milling.

Technical Information

Edge Condition Problems and Solutions (cont'd.)

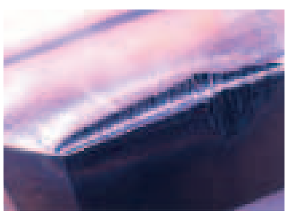
4. built-up edge: This condition involves the adhesion of layers of workpiece material to the top surface of the insert. Hardened pieces of the adhered material periodically break free, leaving an irregularly shaped depression along the cutting edge. This causes damage to the part and insert. Cutting forces will also be increased due to built-up edge.

problem	cause	solution
built-up edge 	• speed	• Increase sfm.
	• feed	• Increase feed per tooth.
	• coolant	• Use mist or flood coolant to avoid chips sticking to the insert when machining stainless and aluminum alloys.
	• grade	• Use sharp edge PVD inserts.
		• Higher speeds require diamond-tipped inserts or diamond coated inserts on certain non-ferrous alloys.
	• edge-prep	• Use sharp edge, positive rake PVD inserts, or polished (J-polished) inserts.

5. crater wear: A relatively smooth, regular depression is produced on the insert's rake face. Crater wear occurs in two ways:

1. Material adhering to the insert's top surface is dislodged, carrying away minute fragments of the top surface of the insert.
2. Frictional heat builds up resulting from the flow of chips over the top surface of the insert. Eventually, this frictional heat buildup will soften the insert behind the cutting edge and carries minute particles of the insert away until such time as a crater becomes noticeable.

Crater wear is rarely encountered in milling, but can appear when machining certain steel and cast iron alloys. If crater wear becomes severe, there is a risk that the cutting edge will break, destroying the insert.

problem	cause	solution
crater wear 	• grade	• Use a more wear-resistant grade.
	• speed	• Reduce cutting speed.
	• edge-prep	• Use smaller T-land or increase feed to proper range for T-land.

Edge Condition Problems and Solutions (cont'd.)

6. flank wear: Uniform flank wear is the preferred method of insert failure because it can be predicted. Excessive flank wear increases cutting forces and contributes to poor surface finish. When wear occurs at an unacceptable rate or becomes unpredictable, the key elements that must be investigated are speed, feed, grade, and insert/cutter geometry.

NOTE: Inserts should be indexed when: roughing (.015 to .020 flank wear is reached) finishing (.010 to .015 flank wear or sooner).

problem	cause	solution
flank wear 	• speed	• Check this area first. Recalculate sfm to assure correctness. • Speed should be reduced without changing feed per tooth.
	• feed	• Increase feed per tooth (feed should be high enough to avoid the pure rubbing which occurs with small chip thickness).
	• grade	• Use more wear-resistant grade. • Change to a coated grade if you are now using an uncoated grade.
	• insert geometry	• Inspect insert to determine if proper style is being used in the cutter.

7. multiple factors: When wear, chipping, thermal cracking, and breakage all occur at once, the machine operator must look beyond the normal feed, speed, and depth-of-cut adjustments to find the root cause of the problem. Speed, feed, and depth-of-cut parameters should be re-examined for accuracy, but the system's rigidity should also be closely inspected for loose or worn parts as well.

problem	cause	solution
multiple factors 	• system rigidity	• Check system for loose cutter mounting. • Improve fixture and cutter rigidity. • Check for worn hardware or improper insert installation. • Reduce the gage length of the cutter and arbor assembly.
	• feed	• Reduce feed rate to relieve cutting forces.
	• cutter geometry	• If possible, use a lead angle cutter to redirect cutting forces away from the insert nose.
	• insert/grade	• If possible, use a larger nose radius. • Use T-land insert. • Use a tougher grade of carbide.

Troubleshooting Matrix for Advanced Cutting Tool Materials

This matrix explains the specific areas where advanced cutting tool materials perform differently from uncoated and coated carbide grades during the troubleshooting identification process.

cutting tool material	problem	solution	comments
cermets KT530M	• chipping	• Reduce feed per insert. • Turn off coolant. • Apply hone or T-land insert.	• Excellent resistance to built-up edge • Dry milling grades, do not use coolant • KT530M is noted for maximum toughness and edge chipping resistance at moderate speeds and medium chip loads
	• breakage (fracture)	• Reduce depth of cut and chip load. • Increase speed. • Apply hone or T-land insert.	
ceramic K090	• chipping and breakage	• Check system rigidity. • Increase hone or T-land. • Switch to thicker insert. • Increase speed. • Reduce feed from heavy to moderate/ light feed range. • Change to grade Kyon 2100 for nickel-base alloys. • Change to Kyon 3500 for cast iron alloys.	• Coolant is not recommended when used for milling operations • Use lead angle cutters where possible
	• wear	• Reduce speed	
sialon Kyon 1540 Kyon 2100	• depth-of-cut notch	• Reduce hone or size of T-land edge preparation. • Use a lead angle cutter, if possible. • Pre-chamfer part to eliminate stress points on cutting edge of insert. • Vary depth of cut.	• Excellent for machining nickel-base materials over 35 HRC • Available in positive rake inserts. • Run dry – no coolant. • Works well on PH stainless steels. • Use KY1540 at less than 2000 sfm.
	• minor chipping	• Minor chipping is normal, especially on Inconel.	
	• flank wear	• Use .060 as indexing criterion.	
	• fracture	• Use thicker inserts. • Do not over-torque clamping.	
silicon nitride Kyon 3500	• flank wear	• Reduce speed. • Increase feed.	• Use without coolant. • Will provide optimum combination of increased toughness and wear resistance in high-speed machining of cast irons. • Wide range of sfm • Kyon 3500 is your first choice for maximum toughness and edge chipping resistance at high-speed and heavy-to-moderate feeds.
	• chipping	• Change edge preparation. • Reduce chip load.	
	• breakage	• Reduce doc. • Use thicker inserts.	

Troubleshooting Matrix for Advanced Cutting Tool Materials (cont'd.)

cutting tool material	problem	solution	comments
polycrystalline diamond (tipped) KD1410 KD1415 KD1405	• chipping and breaking	• Check system rigidity. • Reduce chip load. • Increase sfm. • Edge prep	• Excellent wear resistance for improved size control and surface finish • Unsurpassed tool life when machining aluminum alloys, non-ferrous and non-metallics at high sfm's • Can be used with coolant • Regrindable/resettable
diamond film coating KDF300	• burrs and finish	• Use a KD1410 tipped insert in one or two pockets as a wiper insert.	• Roughing to semi-finishing grade • Excellent tool life when machining aluminum alloys that have 12% or less silicon content • Multiple cutting edges versus single-edge on tipped PCD • Less expensive than ground, PCD-tipped KD1410
KD120 cubic boron nitrides (tipped) and KD200 (solid) CBN's	• chipping and breaking	• Check system rigidity. • Additional edge preparation may be required (hone or T-land).	• Use on hardened tool steels, cast irons, and some high-temperature alloys (Ni-base) • Applications on: Ni-hards, high-chrome irons, chilled cast irons, hard alloys, and hardened tool steels (50-65 HRC) • KD120 tipped CBN for finishing only one cutting edge • Regrindable/resettable • KD200 solid CBN with high thermal conductivity and a low thermal coefficient; excellent for milling hardened materials • Regrindable • Multiple cutting edges versus single-tipped CBN • Use with coolant

Inserts
Face Mills
End Mills
Die and Mold
Slotting
Thread Milling
Widia Cutters
Vintage Cutters
Accessories
Technical Data
Mat'l Database
Index