

Effects of Centerline Issues on Inserts

I have recently discovered many machinists and engineers don't understand the effect of tool alignment on tool performance, chip control, part dimensions, and surface finish. As a result, I feel the need to put together a paper to discuss "Indexable Tooling Alignment Effects".

What is Centerline for an Insert?

Centerline is when the insert cutting lip is neither above nor below the center of the part or bar. All indexable tools were designed to run slightly below centerline.

- Example: If you are turning a piece of bar stock to center, you will leave a *nib* on the stock. The only way to eliminate the nib is to be above centerline. The nib is left because the weight of material and pressure of the tool causes the material to separate before it reaches the part center. A tool that is at the exact centerline height will leave a minimum of .002" nib.

Where do you want your indexable tooling aligned?

Having a tool holder on centerline or slightly below is important to the life of the insert. The correct tool alignment will often resolve other problems you might be have including:

1. Smearred finish
2. Chatter
3. Size control
4. Chip control issues
5. Poor tool life or chipping/breaking inserts

6. Re-cutting chips resulting in chipped insert
7. Premature chip welding
8. Insert top flaking

Above Centerline Signs

- Smearred, torn, or dull finish
- No chip or minimal wash pattern on top of insert
- Side of insert discolored and non on top.
- Inconsistent size
- Offset size and size doesn't change but after several offsets size jumps
- Premature insert chipping or flaking
- Chip welding after 1 or 2 parts (short time in cut)
- Ceramic inserts have top chipped
- Chatter on part
- Long stringy chips (no chip control)
- Chips wrap part or chips form bird nest

How to improve your tool alignment

A nib of .002" to .005" will insure the insert will perform to how it was designed. The nib tells you the tool is set slightly below centerline. This will not cause any problems with part geometry or tool pressure.

The benefits will be:

1. Improved chip control

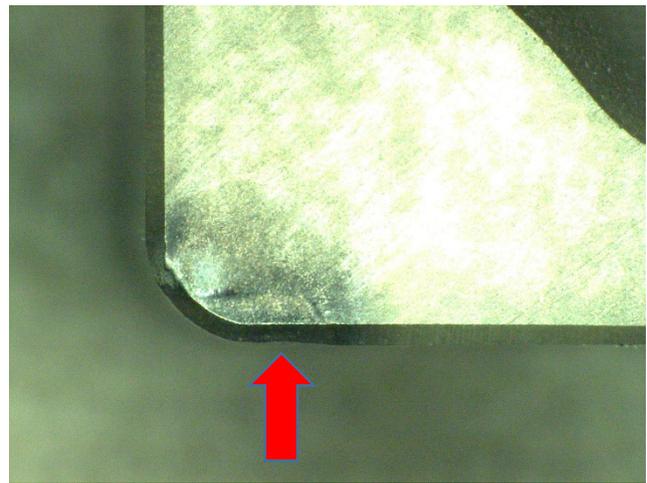
How to improve your tool alignment

(continued)

2. Better finish
3. Better size control
4. Elimination of premature chip welding
5. Reduction or elimination of chatter
6. Better part concentricity & TIR
7. Improved tool live (often increase by 30% or more)

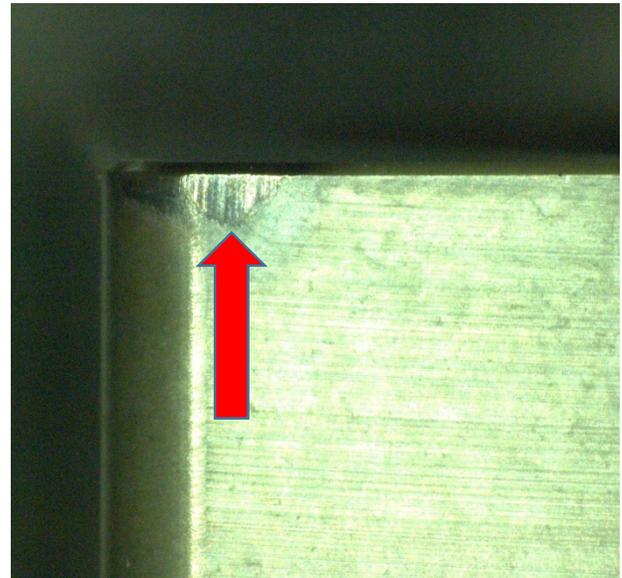
Observing Centerline on the Insert

This insert has minimal chip wash pattern on the top of the tool. Frequently, the insert top appears discolored or residue will form on the top and side of insert. You can see a slight indentation at the DOC area. All wear appears at bottom of cutting lip. These are typical signs of being above centerline.



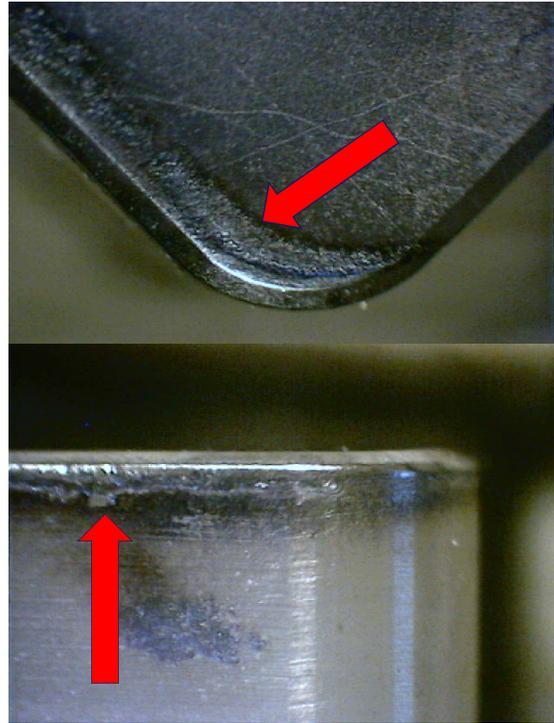
Flank Wear

Next look at the side of this insert. This picture has extreme flank wear for the minimum amount of land wear (previous picture was insert top). This wear pattern on the side of the insert shows an above centerline issue, and if it is run much longer, the top of the insert will show a defined fracture point from the side of the insert across the top of the insert. Signs on the part could be chatter or chip welding.



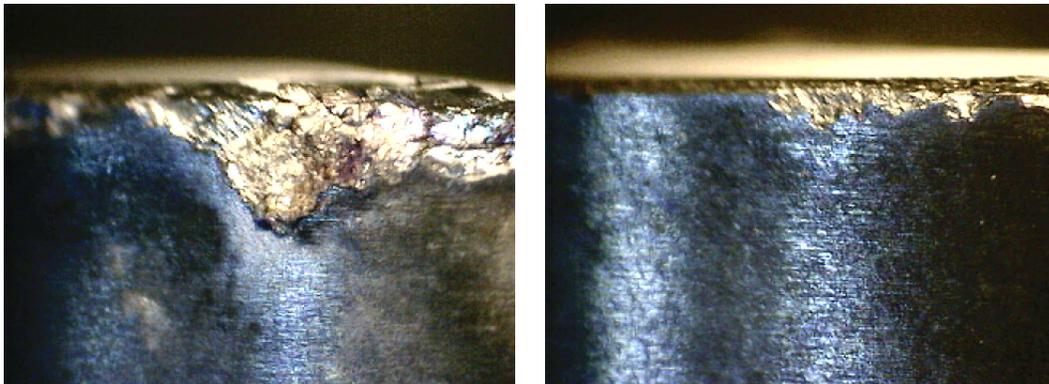
Above Centerline Wear

Note how the top of this insert shows minimal chip wash and has a residue build up. The side shows a shelf beginning to develop. The shelf will grow as the time in the cut increases. The top of the insert will chip from tool pressure.

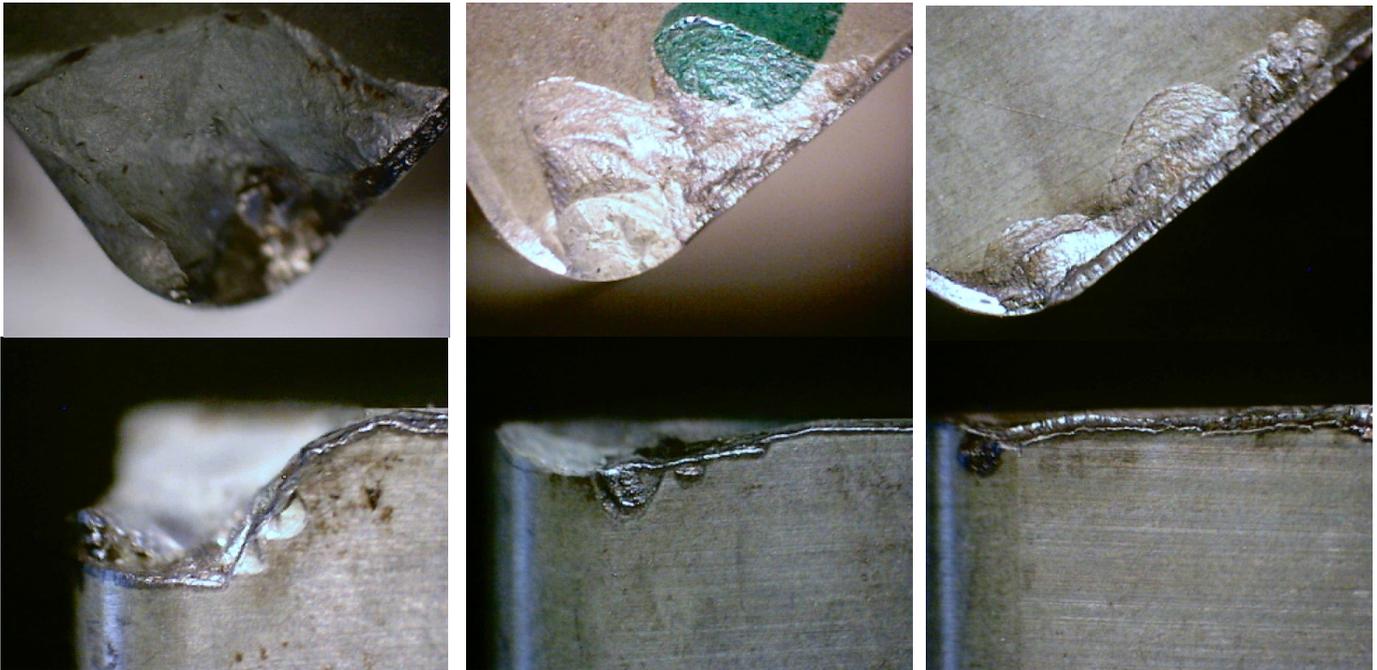


Above Centerline Wear

Chatter Fractures



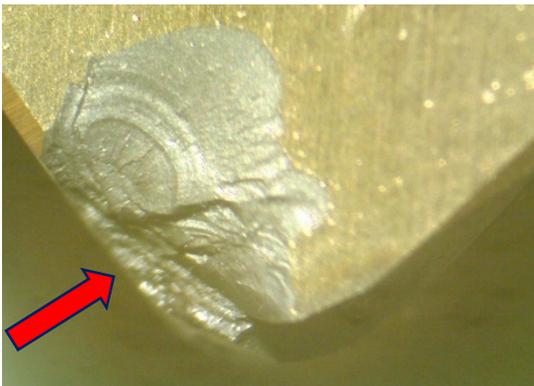
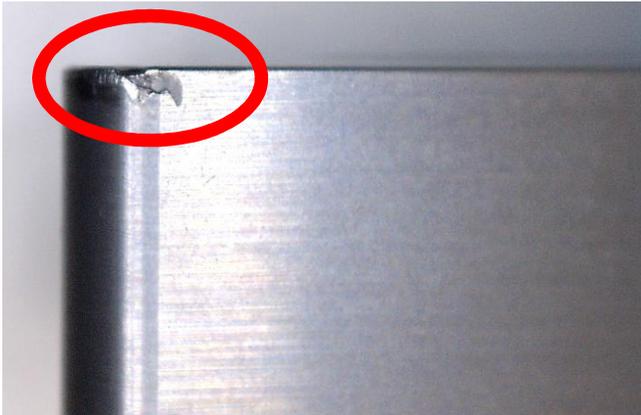
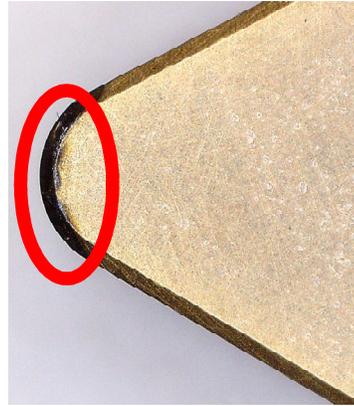
Chatter can be seen on the part finish. Frequently, you will be able to hear a chattering noise when the part is being machined. While this can be caused from many conditions, it is most frequently caused by the tool being above centerline.

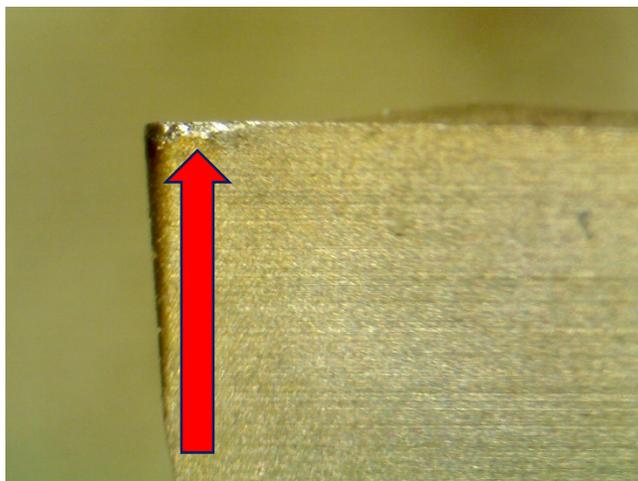
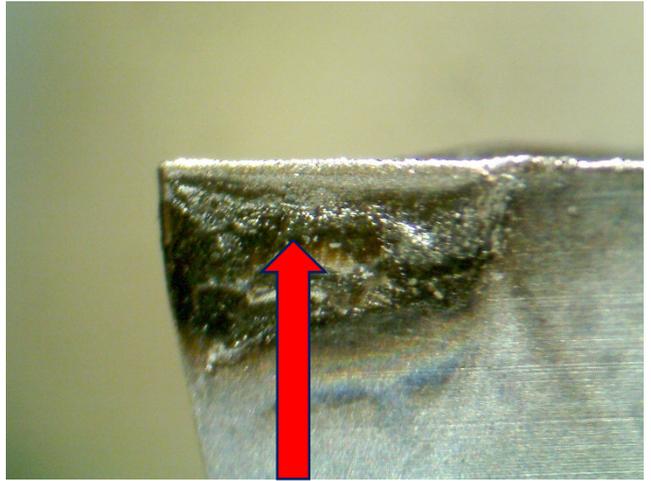
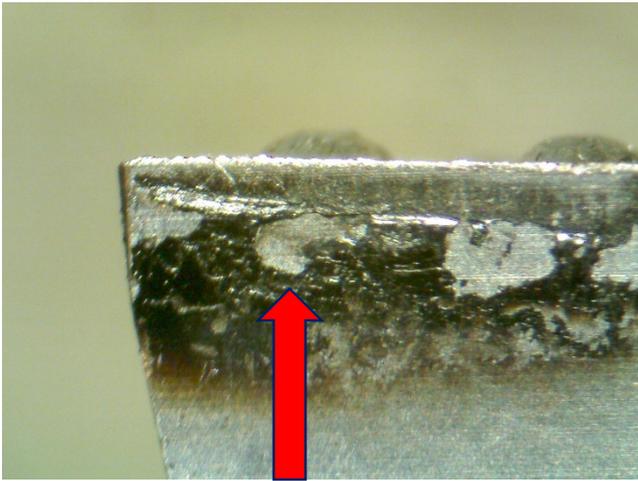
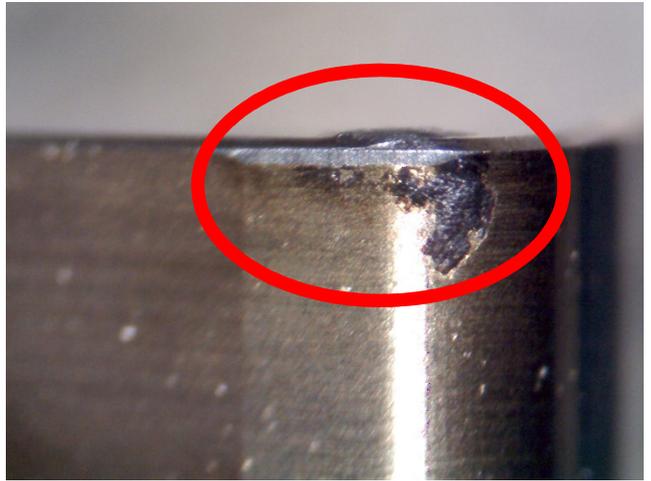
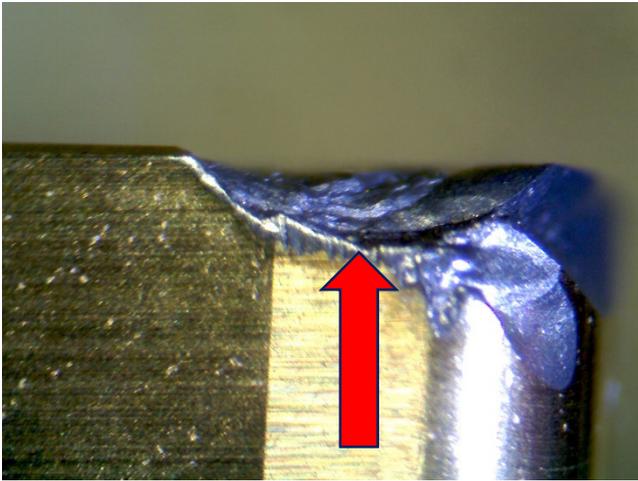


These inserts shows breakage across the top of the inserts from the cutting point.

Other signs: chatter, smeared finish, fluctuating size (prior to fracture).

More Examples





IMPORTANT NOTE

Part Sag

- Long parts will sag. The result will be lowering the centerline when doing any (ID or OD) cut.
- Facing long shafts or parts with long length to diameter ratio can't use facing to determine proper centerline. The only way to determine is to check an insert after cutting.
- The wear pattern on insert is the only way to determine if a tool has proper centerline height. It will only help determine if tool is above centerline.
- If tool is too low on these parts, the part geometry will be off. Size will fluctuate, and intermittent cutting often occurs.

How to Fix Alignment

To fix this problem, the following information is needed:

- The wear measurement from the bottom of the cutting edge to the fracture, wear point, or size of nib after facing part, or the size of the nib.
- If machine has Y-axis programmability or adjustable block, change offset or adjust block.
- Holders with shim seats can have the seat ground down to lower centerline height.
- OD holders can have the bottom of the shank ground down.
- Boring bars can be turned if the set screw doesn't turn the bar back. If the bar has a shim seat, it can be ground down. (It is best to use a split boring bar sleeve where set screw can't turn the bar. **SPLIT SLEEVES ARE BETTER TO REDUCE HARMONICS**).

Establishing Alignment

Facing

It is recommended to make a .010" to .015" deep facing cut.

- After cut is made, check size of nib.
- If no nib, begin dropping centerline by .005" until you leave a .002" to .005" nib.
- For programmable Y-axis or adjustable block machine, drop by .005" until you leave a nib .002" to .005".
- If nib is greater than .005", and part diameter is under .125" raise centerline to ensure correct part geometry.
- Parts $>.125$ " and up to 1", nib can be up to .008" before part geometry would be affected.
- Parts 1" to 10", nib can be up to .015" before part geometry would be affected.
- Parts great than 10" can have nib up to .025" before part geometry would be affected.
- Larger parts can even be lower.

The faced bar can use the nib to line up the balance of OD tools insuring they are at or below the nib.

Castings

Establishing Alignment

Many castings have holes preventing facing to centerline. It is suggested that a piece of a soft inexpensive material like aluminum or plastic plug be placed in chuck (workholding) to face. Follow the face procedures to establish centerline.

Summary

Establishing and maintaining proper centerline is crucial. The benefits are numerous. Reduction of part cost, chip control, and quality of parts are the main reasons to ensure the proper cutting tool height.

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