Conventional vs Climb Milling:

- Step overs of greater than ¾ times the cutter diameter, use Conventional milling to avoid a negative rake cutting condition.
- Use Conventional milling for old machines with backlash.
- Use Conventional milling for end mills less than 1/8" diameter.
- Use Conventional milling for non-rigid setups.
- Use Conventional milling for long end mills.
- Use Conventional milling on casting, hot rolled materials, flamed cut materials, forgings, or when the part is case hardened since the cut begins under the surface of the material.
- Tool deflection during Conventional milling will tend to be parallel to the cut.
- Use Conventional milling for thin wall finish cuts because the tool deflection will tend to be parallel to the cut.

https://www.cnccookbook.com/climb-milling-versus-conventional-milling/

Advantages of Conventional Milling (Up Milling):

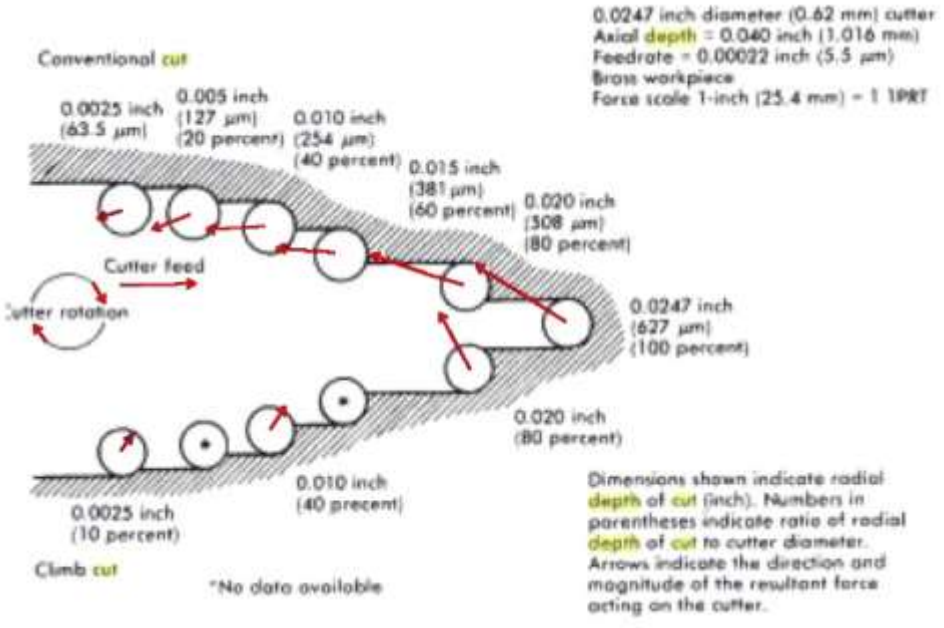
- The width of the chip starts from zero and increases as the cutter finishes slicing.
- The tooth meets the workpiece at the bottom of the cut.
- Upward forces are created that tend to lift the workpiece during face milling.
- More power is required to conventional mill than climb mill.
- Surface finish is worse because chips are carried upward by teeth and dropped in front of cutter. There's a lot of chip recutting. Flood cooling can help!
- Tools wear faster than with climb milling.
- Conventional milling is preferred for rough surfaces.
- Tool deflection during Conventional milling will tend to be parallel to the cut

Advantages of climb milling (Down Milling):

- The width of the chip starts at maximum and decreases.
- The tooth meets the workpiece at the top of the cut.
- Chips are dropped behind the cutter–less recutting.
- Less wear, with tools lasting up to 50% longer.
- Improved surface finish because of less recutting and the creation of a cleaner shear plane.
- Less power required.
- Climb milling exerts a down force during face milling, which makes workholding and fixtures simpler. The downward force may also help reduce chatter in thin floors because it helps brace them against the surface beneath.
- Climb milling reduces work hardening.
- It can, however, cause chipping when milling hot rolled materials due to the hardened layer on the surface.
- Tool deflection during Climb milling will tend to be perpendicular to the cut, so it may increase or decrease the width of cut and affect accuracy.

Tool Deflection and Cut Accuracy in Climb vs Conventional Milling

How does climb vs conventional milling affect tool deflection and accuracy? The following illustration contains small arrows (often called vectors) showing the direction of tool deflection as the cutter moves along the toolpath:



The arrows show where the cutting force is attempting to deflect the cutter. Conventional cut at top, climb cut at bottom.

Note how the deflection force vector is more nearly parallel to the cut with conventional milling (albeit the arrows are longer, showing there are higher cutting forces). With climb milling, the arrow is nearly perpendicular to the cut. If your cutter deflects 0.001″, wouldn't you prefer it to be nearly in the direction of travel? The alternative is for the cutter to plow deeper into the wall or pull away from the wall. Either case will introduce more error in the part being machined. The counterpoint is that the lengths of the vectors are longer when conventional milling. That's telling you that the cutting forces are heavier and the tool is more likely to deflect.

Try climb for roughing, because you can rough faster and the tool deflection effects on accuracy don't matter–the finish pass will deliver the accuracy. You can rough faster because cutting forces are lighter and the thick-to-thin chip profile carries the heat away on the chip. That thick-to-thin + carrying the heat away is particularly crucial for tough work-hardening materials like stainless. It also results in a nicer surface finish if you can afford to climb for the finish pass.

Consider Conventional Milling for Finish Passes

This one is counterintuitive for a lot of machinists who are trained for most of their careers that climb produces a better finish than conventional. All other things being equal, that's true, but all other things are seldom equal!

The problem is that deflection affects surface finish too. If the vector is nearly parallel to the path, you can consider that the portion of the vector that pushes it "off parallel" is very small. Therefore, the tool will have little tendency to deflect and put waves on the wall you're finishing. Note that this may be particularly important in thin wall work where the walls are weak!

Therefore, you should switch to conventional milling for the finish pass if you're at all deflection challenged. One should avoid too much depth of cut when climb milling to reduce tool deflection. When deflection is to be minimized, use no more than 30% of the diameter of the cutter for conventional milling and 5% for climb milling. Climbing to rough and conventional to finish is in line with the consensus over at Practical Machinist.

Properly managing deflection can help you avoid the need for an extra spring cut, which saves time and money.