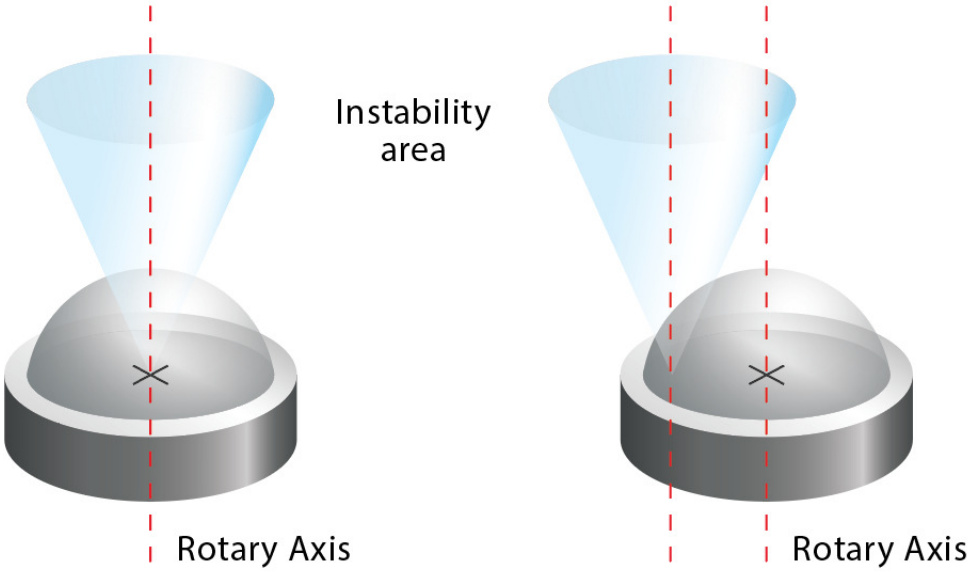
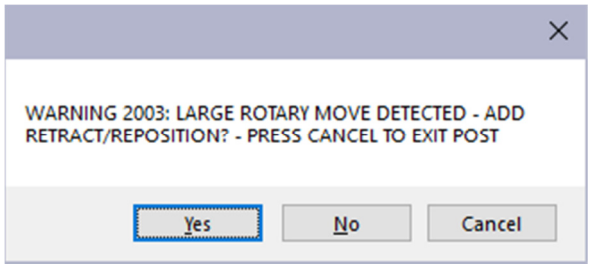
Instabilities

This document will explain how instabilities are caused and will cover some solutions to prevent or reduce the number of instabilities. It is important to note that instabilities are neither a Mastercam issue nor a post processor issue and is solely due to the physical limitations of 5-axis machines.

Instabilities occur in 5-axis toolpaths when the tool vector is parallel to the rotary axis vector. Generally, this occurs when the machine has a C-axis about the Z-axis and the tool vector is parallel to the Z-axis. When the tool vector is parallel to the rotary axis there are an infinite number of solutions (ways to approach) that point as the rotary axis can be at any angle. When the tool vector is parallel or near-parallel to the rotary axis vector, instabilities can occur as small movements can result in large rotary or tilt movements. This can cause chatter resulting in a poor surface finish or even gouging. IKE posts compare the current rotary/tilt angle to the next rotary/tilt angle and if the difference is greater than a preset limit (generally set at 45 degrees) then an instability is triggered and the programmer will be prompted. The prompt will ask if a retract and re-approach move is wanted. To avoid instabilities, program your toolpath so the tool axis lie outside of the instability areas (cones) usually this is away from vertical.



When prompted there are 3 options:



1. **Yes** This will result in an additional pop-up asking for a retract distance and will continue to post out code with a retract and reposition move added in to the point of instability

2. **No** This will continue to post out without a retract and reposition move and may result in poor surface finish, gouging, and/or crashes. IKE posts will output a comment in the code mentioning that instability was detected.

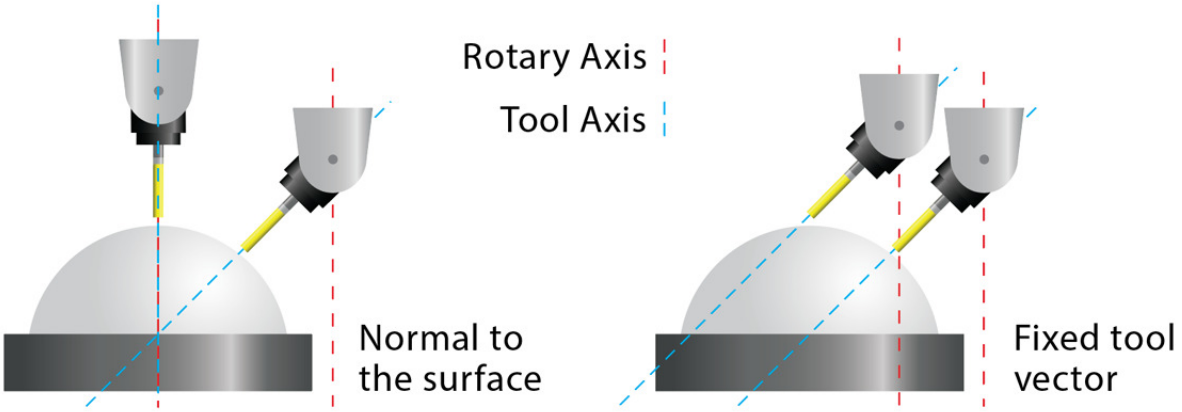
3. **Cancel** This will exit the post and cancel the posting of code

How to Avoid Instabilities

The best ways to avoid instabilities are:

1. Manipulating the tool axis
    a. Add a lead/lag/side tilt angle
    b. Lock the tool axis to a plane that is not perpendicular to the rotary axis
    c. Lock the tool axis to or from a point so it is not aligned to the rotary axis
2. Manipulating the tool path
    a. Changing the cut pattern constraints such as the line/angle/curve that the toolpath is parallel to
    b. Changing the toolpath type i.e. swarf, parallel, curve, etc. to cut axially instead of radially or vice-versa or cut with a combination of both
3. Changing your machine fixtures to machine on a different plane

Example:



The toolpath on the left may have an instability as the tool axis and rotary axis are parallel. The toolpath on the right has a lag angle thus keeping the tool axis away from the rotary axis.

Special Case – Going Over the Top

A special case is when a tool crosses the vertical position when going from one side to another. By default the post attempts to keep the same tilt solution which generally results in a C180 move. If an alternate tilt solution is preferred after crossing the vertical point you can contact us at postdev@inhousesolutions.com for that logic to be added in.

Removing Prompts

In most cases instabilities can be avoided by re-programming the toolpath. If that is not the case you can always opt to press "No" and the post will output the code as programmed or "Yes" and the post will retract and reproach the unstable point(s). As a last resort you can remove the instability prompt by increasing the rotary and/or tilt limits. This however, does not mean your machine will not reach a point of instability it only removes the warning and the option to retract "Yes" or cancel. In other words this does not fix the issue it only ignores it and is equivalent to selecting "No" when prompted which can cause poor surface finish, gouges, and/or crashes. We highly recommend leaving the limits unless you have tested your machine for large rotary/tilt moves.