stiles education Learning Online

TEACHING TOMORROW'S INDUSTRY LEADERS TODAY

Tech Tip # 14 July 2007 Written by: **Phil Rasey,** Stiles Education's Machining Center Specialist

Audience: Introductory **Machine \ Process:** CNC Machining Centers

Fixture Techniques

Manufacturing Small Parts on Machining Centers

Manufacturing small, individual components on large CNC machining centers which utilize vacuum pod systems has always been a challenge. Using one vacuum pod to secure small parts will not hold the piece firmly enough to prevent the part from moving or vibrating during machining. Furthermore, ineffectively securing small parts may cause damage to the finished product, the machine or the operator who are placed at risk for injuries from thrown materials and tooling. The creation of a fixture is necessary to ensure quality parts with minimal waste and to prevent dangerous situations for the operator and machine.

Creating spoil boards and fixtures greatly increases the machine's capabilities, allowing for increased productivity, decreased waste and a greater variety of designs for your company's product lines. The creation of fixtures requires safe practices, some basic parts and materials, a little knowledge of math and physics and above all − a creative mind.

Important Information

This module illustrates the steps to machine small parts on a large CNC machining center and does not contain specifics about each machine model or configuration.

Fixture Techniques

Terms and Definitions

First, let's review a few basic terms relative to this process on a CNC:

Closed Cell:
Gasket material which has very small air pockets within the material which restricts the air flow through the gasket. Door weather stripping is an OPEN cell material which allows excessive vacuum loss causing a part to shift during processing.

Edge Tape:
Material used to seal the edges of the spoil board or fixture to force vacuum through the face of the material preventing vacuum loss through the panel edges

Fixture:
A device designed to hold parts during the machining process possibly using fixed edges, mechanical or pneumatic clamps or gasket material.

In-Board Gasket:
A closed cell material designed to fit into a groove that has been provided inside the part's outer edges. See page 6.

On-Board Gasket:
A closed cell, self-adhesive gasket material placed on top of the spoil board or fixture to create a vacuum area surrounding the part's edge and inside the cutting edge. See page 5.

Spoil Board (a.k.a. waste panel, bleeder board):
MDF or LDF material used to create a flat surface to machine parts. Predominantly utilized on nested-based CNC machines, but may be utilized with vacuum pod machines under certain circumstances.

Z Axis Offset:
The value set in the CNC program or machine controls to compensate for the spoil board or fixture thickness. This value is very important for the proper positioning of the CNC tooling in the Z axis, router, drill and saw depth. See page 3.

Fixture Techniques

Z Axis Offset

The Z axis offset value is added to the CNC program to ensure the safety of the machine's surface or vacuum pods. Without the Z axis offset, the machine may place the tooling at the top of the vacuum pods instead of the top of the spoil board / fixture, thus possibly causing damage to the pod, pod gasket and the tooling itself.

Vacuum pod, spoil board and production panel offset

Damaged tooling

Damaged vacuum pod

Fixture Techniques

Spoil Board and Fixture Clamping

One method of fixturing is to use a mechanical clamp to hold the part to the spoil board or fixture. Some part designs require a mechanical clamping system to ensure the part does not move during machining. Many mechanical and pneumatic clamp designs are available and vary in operation and complexity. It is vital to ensure the CNC tooling will not collide or contact these clamping system units. You may want to run a test pattern before the clamps are in place to determine the actual tool path and to verify the proper placement of the physical clamps. If the clamps are positioned in the tool path a collision may occur, damaging the part, the router tooling and possibly the machine

Vacuum pod and mechanical clamp

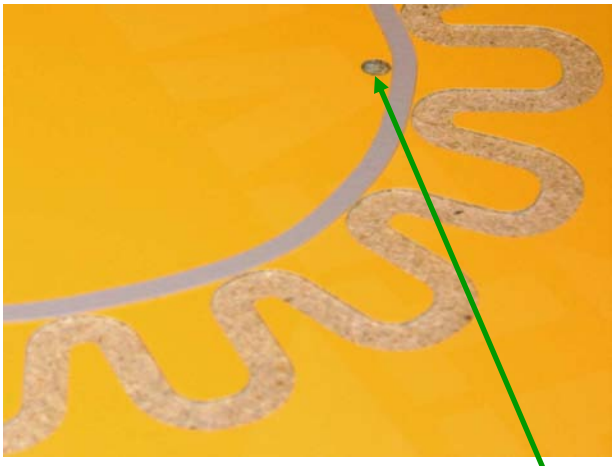
High production mechanical fixture utilizing vacuum and mechanical clamps

Evaluation of Gasket Materials and Types

On-Board Gasket

Another clamping method is to use gaskets to create a vacuum area. Comprised of a closed cell material, this self-adhesive gasket is placed on top of the spoil board or fixture to create a vacuum area surrounding the part's edge and inside the cutting edge. On-board gaskets have a glue backing and are used on the surface of the spoil board or fixture for simple or temporary designs and are available in many widths, thicknesses and materials. Common applications include temporary or single use fixtures, as it is easy to use and requires less time and machining to create the fixture.

On-board gasket tape

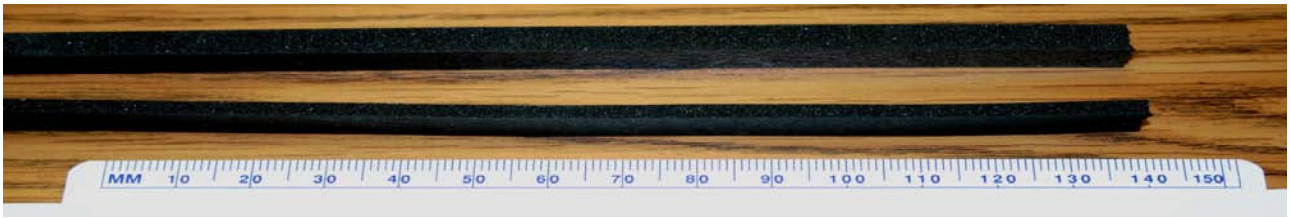


Hole through fixture base for vacuum

Evaluation of Gasket Materials and Types continued

In-Board Gasket

Comprised of a closed cell material, this design does not have a glue backing. In-board gaskets are much thicker in order to fit into the groove machined on the fixture base around the perimeter of the part. In-board gaskets are available in many widths, thicknesses and materials and are used for more permanent applications or heavily used spoil boards and fixtures. This gasket material is much more durable for longer life and more stable for extensively used fixtures and aggressive machining.



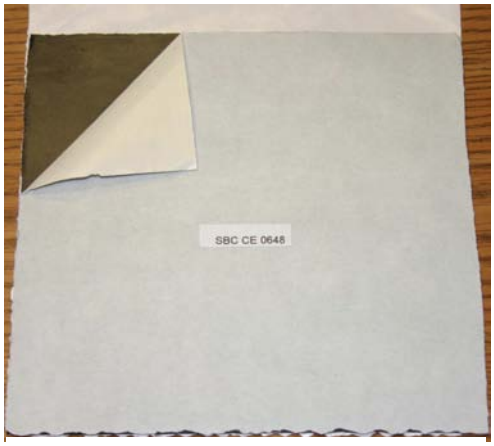
In-board gasket ribbon or strips

Hole through fixture base for vacuum

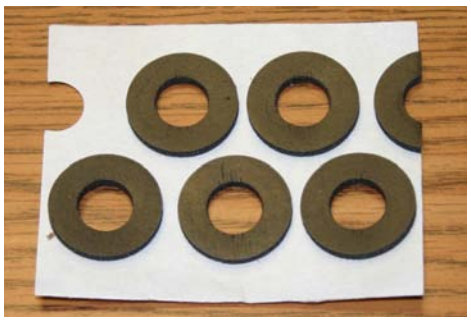
Evaluation of Gasket Materials and Types continued

Other Gasket Materials and Types

Manufacturers of CNC gaskets have a large inventory of gasket materials and types available for desired functionality of “fixture” needs. These include but are not limited to solid sheet materials, and gasket “O”-rings.



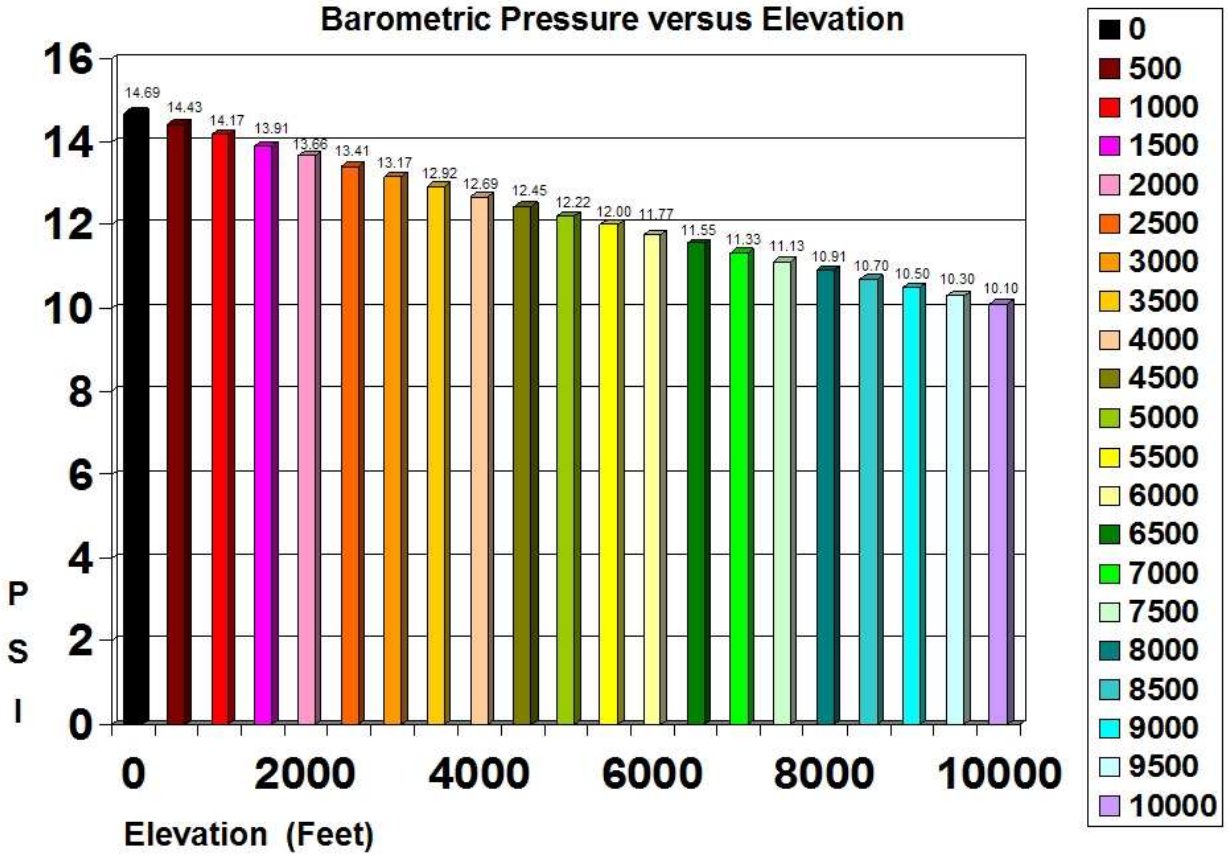
Solid rubber sheet with adhesive



Closed cell ring gaskets

Now for some *Physics*!

Securing parts on the spoil board or fixture requires the creation of a vacuum area. Although we cannot create an actual vacuum, but we can create an area of decreased atmospheric pressure. The geographical location of the manufacturing facility will determine the amount of down force available.



A manufacturing facility located near sea level may experience atmospheric/barometric pressure of approximately 14.7 pounds per square inch (psi) or 1 bar, while a facility located in the Rocky Mountain region may only experience a pressure of 10.1 psi or .68 bar. A value of zero bar would be equal to outer space. Why is this important?

Fixture Techniques

Vacuum Gauge

The vacuum gauges on most CNC machines display barometric pressure (bar) as sensed within the vacuum system and do not indicate the holding force on the panel. These internal gauges usually display a value between 0 and 1 bar. The elevation of your facility will determine the absolute "best" barometric pressure your machine can achieve. Obtaining a reading of 1 bar using the vacuum system on the machine would mean a "perfect" vacuum situation which is impossible to obtain. The machine requirements will determine the necessary lower vacuum (bar) value for machine operation.

Optimal Gauge Reading

The photograph above is an example (.96 bar), of an optimal fixture configuration utilizing the largest surface area formed by the gasket type and material. If the area of vacuum was reduced to the holes drilled through the board approximately 2 square inches, the amount of force decreases to a total force of 27.93 pounds at sea level and 23.218 pounds at 5000 feet of elevation. At these pressure settings, it takes minimal side pressure to move the panel during machining. The machine exerts extreme side pressure or force to the panel material during machining and the part will move during processing, and may become released from the spoil board if the holding force is inadequate.

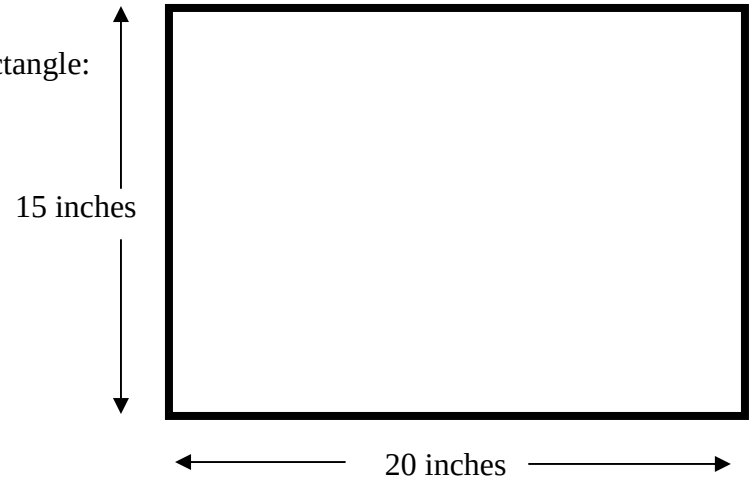
Let's try some Mathematics

Once the vacuum system bar value has been verified, we can use mathematics to calculate how many pounds of force are actually pressing the production panel into the spoil board or fixture. **The barometric value (bar) is multiplied into the total surface area in square inches to evaluate the holding pressure during the processing of the panel.**

To calculate the holding pressure for a fixture design, calculate the square area of the vacuum surface using the formulas: **Length x Width** for rectangles or **Pi (∏) x (Radius Squared)** for circles.

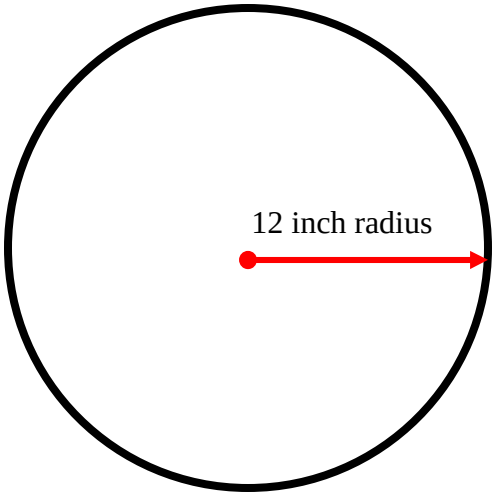
With this example, calculate the area of a rectangle:

Length = 20 inches
Width = x 15 inches
Square area = 300 inches



With this example, calculate the area of a circle:

Radius squared (12 x 12) = 144.00 inches
Value of Pi = x 3.14
Square area = 452.16 inches



Mathematics continued

When the spoil board and production panel are placed on the machine, and the vacuum is activated, the vacuum gauge will display the ***sensed vacuum*** value. What percentage of sea level pressure is applied to the vacuum system?

The barometric value (bar) is multiplied into the total surface area in square inches to evaluate the holding pressure during the processing of the panel.

Gauge display .95 bar at sea level = 13.965 pounds of force over each square inch of the design.

Gauge display .95 bar at 5000 foot elevation = 11.609 pounds of force over each square inch of the design.

A panel design covering 144 square inches (1 square foot) would be held to the spoil board with **2010.96** pounds of force at sea level and **1617.696** pounds of force at 5000 feet of elevation.

144 square inches x 13.965 psi = 2010.96 pounds total force

144 square inches x 11.609 psi = 1617.696 pounds total force

Fixture Techniques

Spoil Board Examples

An important element in creating a proper spoil board or fixture is being an artist! The fixture designer must implement safety procedures, capitalize on available materials and techniques, use calculations to properly design the fixture and have a thorough knowledge of the capabilities of their CNC machining center.

Here are some examples of spoil board design to illustrate the versatility and benefits of various spoil board layout options:

Vacuum holes, no gasket

Holds part but does little to prevent part movement.

Vacuum holes, on-board gasket

Creates a vacuum area and provides friction preventing movement of the part, however, thin gasket materials may compress against the panel surface of the board, decreasing the surface area.

Fixture Techniques

Spoil Board Examples continued

Vacuum holes, in-board gasket

Creates a vacuum area and provides friction preventing movement of the part, however, gasket material may still compress against the panel surface of the board, decreasing the surface area. In-board gaskets are used for more permanent applications or heavily used spoil boards and fixtures.

Vacuum holes, in-board gasket with center area removed

Machining the center portion of the fixture, to a depth of a few millimeters, greatly increases the surface area. This technique works with on-board gasket tape and in-board gasket strips.

Fixture Techniques

Final Comments

Vacuum pods are not a limitation to the abilities of your CNC machining center. Creating spoil boards and fixtures greatly increases the machine's capabilities, allowing for increased productivity, decreased waste and a greater variety of designs for your company's product lines. The creation of fixtures requires safe practices, some basic parts and materials, a little knowledge of math and physics and above all − a creative mind.

Next Step

Stiles Education provides fixture information and guidance in a variety of CNC machining center courses for operators and programmers.

For information regarding Stiles Education courses or to register for classes, call 616-698-7500 ext 1237 or visit

www.stilesmachinery.com/SE

Stiles Education
3965 44th Street SE
Grand Rapids, MI 49512
p 616 698-7500
f 616 698-7524