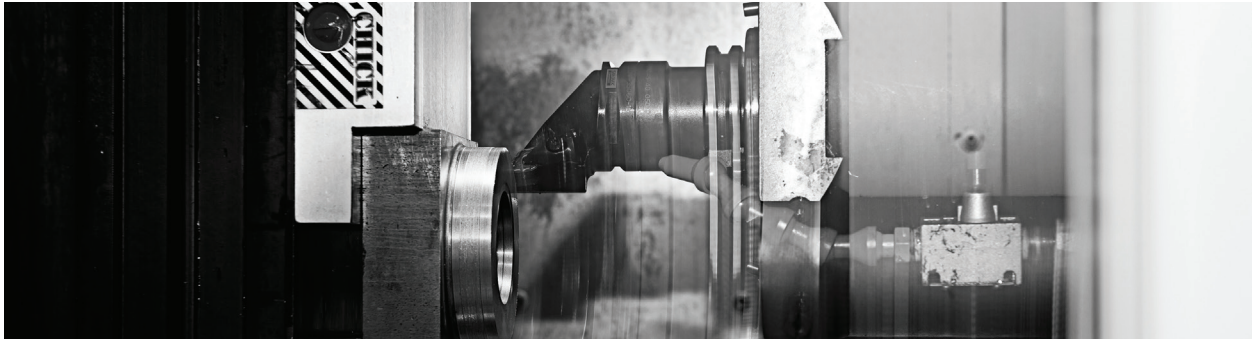




TURN-CUT ENABLES TURNING ON HORIZONTAL MACHINING CENTERS — ELIMINATES THE NEED FOR SECONDARY MACHINERY



TURNING FUNCTIONALITY IS
ENABLED ON A HORIZONTAL
MACHINING CENTER.

SUMMARY

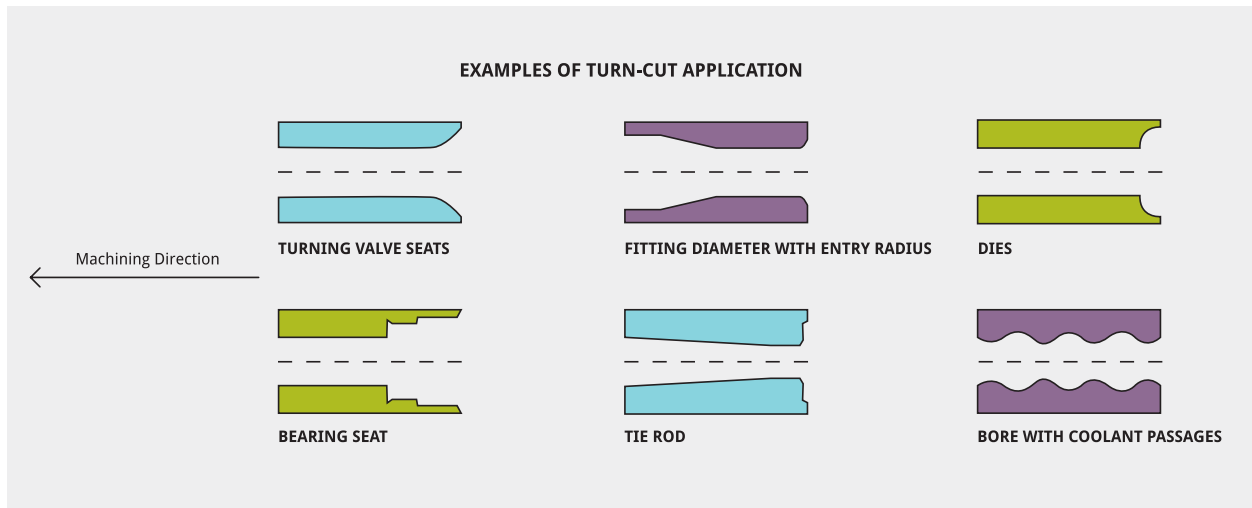
Turn-Cut is a programming option available on Okuma horizontal machining centers that allows the machine to create bores and diameters that include circular and/or angular features. It allows users to turn features on large, unbalanced parts on the same platform where standard CNC machining functions can also be performed. This eliminates the need to purchase special-purpose machines, tooling, fixtures or add-on components.

Turn-Cut operates by leveraging Okuma's philosophy of manufacturing both control and machine, which allows for the perfect blend of mechatronics. It operates using standard tooling, which, in most cases, saves on tooling costs. Turn-Cut works without additional motors, servos, and heavy attachments, and integrates with tooling already developed and readily available. Turn-Cut enhances the use of the machine without adding components or weight that may restrict its use during normal CNC machining operations.

Turn-Cut does not affect the performance or longevity of the machine, and in fact enhances performance with the addition of abso-scales and chilled ballscrews. When heavy milling is required, the Okuma horizontal machining center equipped with Turn-Cut is still as capable as ever.

MOST IMPORTANTLY, TURN-CUT ALLOWS FOR PROCESSING WORK WITHOUT THE NEED TO USE A SECONDARY MACHINE FOR A TURNING APPLICATION.

Valves, pipes and manifold-type parts are ideal candidates for Turn-Cut.



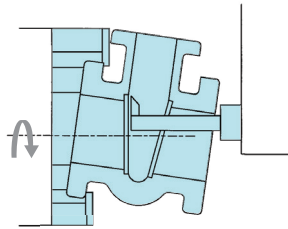
WHAT IS TURN-CUT?

Turn-Cut is a programming option that enables a horizontal machining center to create surfaces that taper, arc, or have any combination of varying diameter shapes along the Z-axis of a work piece. The surfaces created by Turn-Cut can be either on the outside or inside diameter of the machined part. Turn-Cut can operate using standard tooling and minimal fixturing.

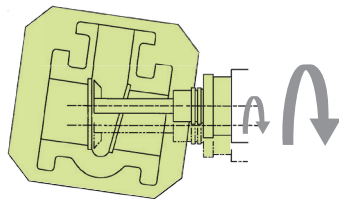
Turn-Cut is used in applications that would traditionally use a CNC lathe to turn a feature. In some cases, the part configuration (size, shape, weight) prohibits it from being set up on a lathe. With Turn-Cut, the part is stationary as the Turn-Cut programming creates the tool path.

Turn-Cut synchronizes the X & Y circular motion with the spindle angle to ensure the tool edge maintains its programmed path at all times. Turn-Cut is turned on by a G-code in the program and follows standard lathe programming convention to describe the desired path.

TURN-CUT FUNCTION ENABLES LATHE OPERATIONS ON THE HORIZONTAL MACHINING CENTER



Lathe Operation



Turn-Cut Operation

BENEFITS OF TURN-CUT

1. Turn-Cut provides process optimization capabilities without a large investment in specialized tooling, attachments, fixturing or even a specialized machine tool. Turn-Cut can be installed on Okuma horizontal machining centers while maintaining the original performance of the machine. In nearly all cases, the additional options of the Turn-Cut package will make the machine perform more consistently, even in applications not requiring Turn-Cut.
2. Turn-Cut simplifies fixturing and reduces set up time as well. Standard fixturing can be used with Turn-Cut instead of complex fixtures typically required to orient the part.
3. Setup time is reduced since the part does not have to be moved to another machine to perform the operation handled by Turn-Cut.
4. Expensive index chucks are no longer needed for manufacturing of small valves or tee's. Turn-Cut on a horizontal machining center can perform the same operation with less fixturing investment.
5. Complex heads or specialized tooling used to control tool path are not required with Turn-Cut. The use of these types of attachments typically adds complexity to the setup and also adds extra weight past the spindle taper. Standard spindle tooling can be utilized, reducing setup cost.

THEORY OF OPERATION

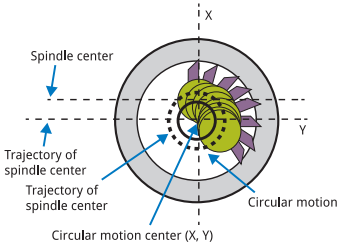
The Turn-Cut function performs cutting on a horizontal machining center by synchronizing the circular motion of the feed axis with the spindle's turning angle (tool tip position control).

1. The tool turns by synchronizing high-speed circular motion on the feed axes X and Y with the turning angle of the spindle. The position of the turning tool tip is synchronously controlled so it is kept perpendicular to the workpiece face.
2. The cross section configuration is commanded with Z-X as in a turning program. The X-axis is commanded with the radius of X-Y continuous circular motion.

The above features enable turning of cylindrical workpieces and inside/outside diameter tapers on the horizontal machining center. The program can be commanded in the very same manner as turning on a CNC lathe according to a turning program (Z-X).

With the center of the axes (0,0) as origin of the workpiece coordinate system:

- Continuous circular motion can be commanded in place of the spindle; and
- The feed axis dimension (Z) and the radius (X) can be commanded

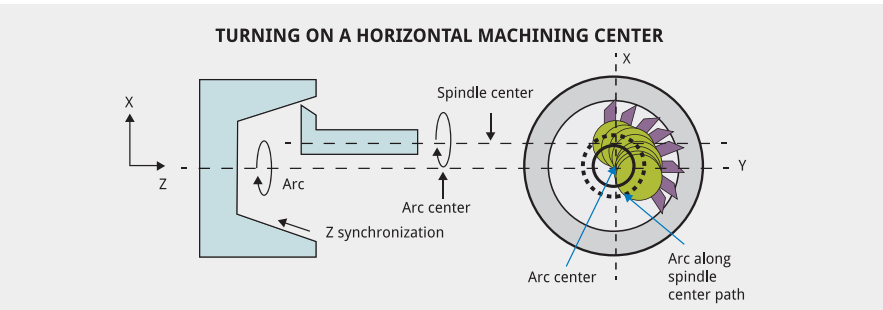
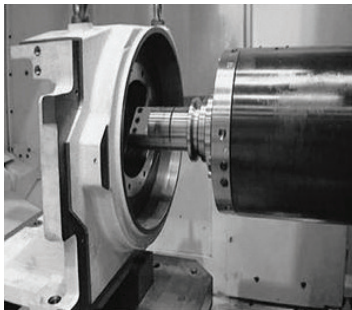


- Interpolation of up to (3) linear axis plus spindle orientation
- High torque spindle • Max. 200 rpm

Turn-Cut Enables ID/OD Turning, Facing and Grooving Operations on the Horizontal Machining Center, Eliminating the Need for a CNC Lathe

Turning is done through synchronized control of X-Y Axis and tool edge position of rotating spindle tool.

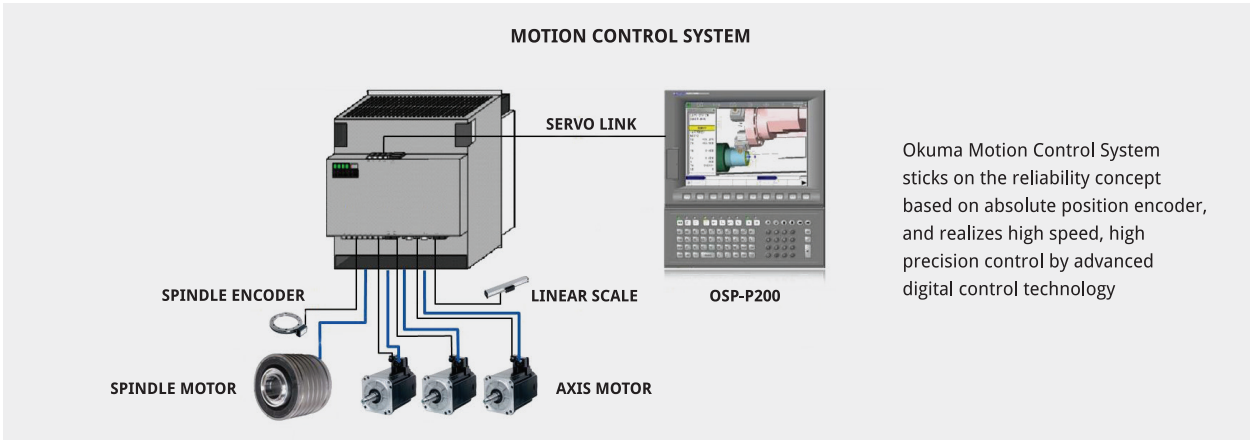
- Machining of tapered holes
- Machining of various diameters with a single tool
- Machining of ID/OD greater than largest tool diameter



ONLY FROM OKUMA

A Motion-Control System from a Single-Source Provider

Okuma is uniquely capable of offering Turn-Cut because of the solid build quality of the machine coupled with use of its own CNC and motion control system. Okuma utilizes their own motion control system to drive their machines. This sets Okuma apart from other CNC machine manufacturers who need to purchase motion control systems from other manufacturers. Each Okuma CNC machine utilizes drives and parameters designed specifically for each model, which are tuned specifically for optimum results. The items pictured below are designed and manufactured by Okuma.



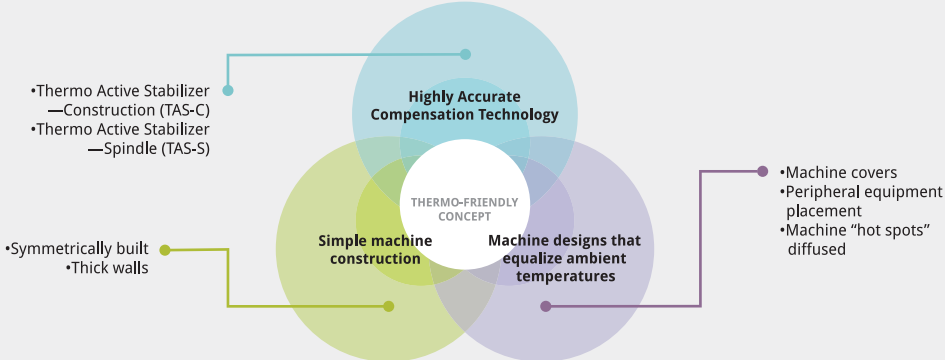
Okuma Motion Control System sticks on the reliability concept based on absolute position encoder, and realizes high speed, high precision control by advanced digital control technology



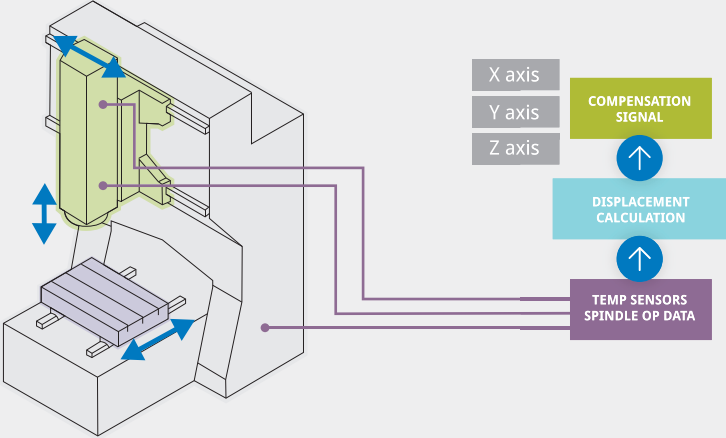
TAS: Thermal Active Stability

Okuma utilizes a concept called Thermal Active Stability (TAS). Okuma builds machines to the highest standards to provide a rugged yet highly accurate CNC machine tool. However, all machines are subject to thermal growth as a result of the CNC machining process or ambient temperature variations. TAS has been engineered to monitor temperature fluctuations at key areas of the machine and make minute adjustments to maintain accuracy.

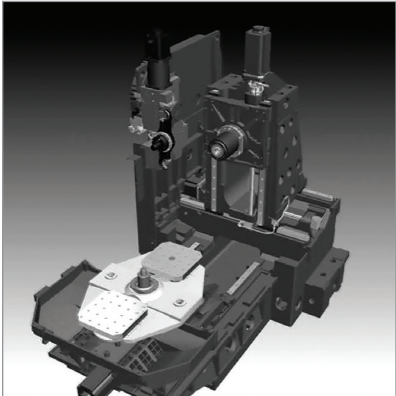
COMBINING MACHINE TECHNOLOGY AND CONTROL TECHNOLOGY



TFC THERMO-FRIENDLY CONCEPT



- OSP**
Compensating for thermal deformation to achieve extremely high machining accuracy
- TAS-C**
Corrects thermal deviation of the machine's structure due to environmental temperature changes
- TAS-S**
Corrects the spindle's thermal deviation which is caused by the heat of the spindle



Build Quality

Okuma uses advanced electronic control to supplement build quality, not replace it.

- Ribbed castings for strength
- Large base casting with three-point leveling
- Ballscrew mounts are integrated with base casting to ensure rigidity
- Cantilevered column to reduce weight and resist bending forces
- All cast mating surfaces hand scraped for superior flatness and contact
- Work area enclosed in sheet metal to eliminate hot chips and coolant from contacting castings; minimizing thermal influences

TURN-CUT MARKETS AND APPLICATIONS

<p>OIL PATCH</p> <ul style="list-style-type: none"> → Refinery valves → Frac pumps → Re-work 	<p>MUNICIPAL WATER TREATMENT</p> <ul style="list-style-type: none"> → Gate Valves → Strainers 	<p>AGRICULTURE/ HEAVY EQUIPMENT</p> <ul style="list-style-type: none"> → Heavy equipment drive train
<p>AUTOMOTIVE</p> <ul style="list-style-type: none"> → Disc brake 	<p>AEROSPACE</p> <ul style="list-style-type: none"> → Air Frame → Pumps, ACM (air cycle machine) 	<p>PLUMBING</p> <ul style="list-style-type: none"> → Residential Fixtures
<p>MOLD/DIE</p> <ul style="list-style-type: none"> → Bottle mold 		

- CURRENT MODELS INCLUDE:**
- MA-400H • MA-500H
 - MA-600H • MA-800H
 - MA-500HII • MA-600HII
 - MB-4000H • MB-5000H
 - MB-8000H • MB-10000H

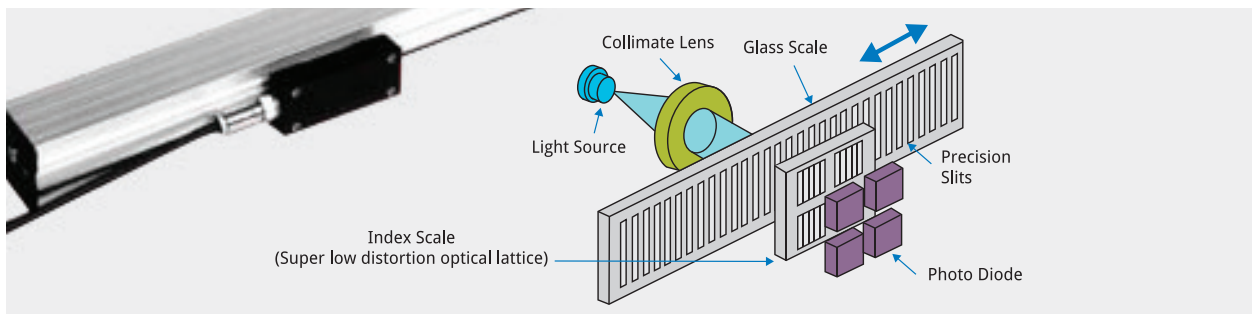
OKUMA PRODUCT APPLICATION

Okuma offers Turn-Cut as a simple programming option, available on the entire horizontal machining center product line. Turn-Cut can be included at time of order on a factory-built machine or can be field retrofitted on certain model/control combinations. Okuma should be consulted when considering a field retrofit solution.

OPTIONS REQUIRED FOR TURN-CUT

Abso-scale

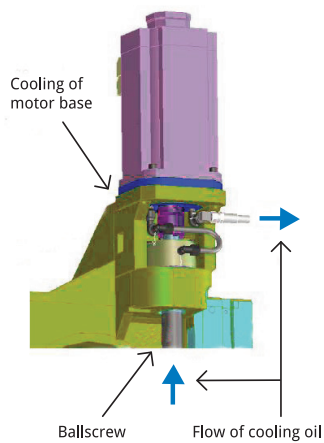
- High precision accuracy and quality machining
- High precision detection (.05 μm: Logical Value) by Okuma original super low distortion optical system
- Non-touch detection mechanism eliminates lost motion
- High speed performance: 150 m/min



Ballscrew Cooling — All-axis

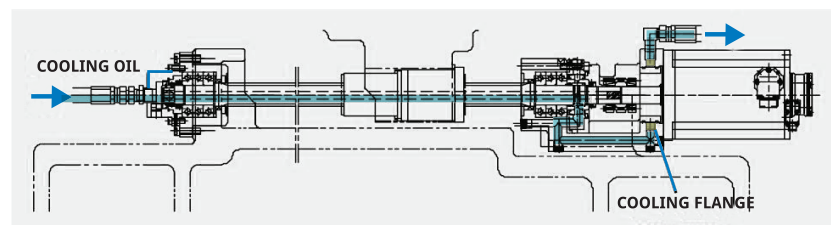
INCREASED RIGIDITY FOR HIGHER FEED-RATE: COOLING OF BALLSCREW AND COOLING OF MOTOR BASE (OPTION)

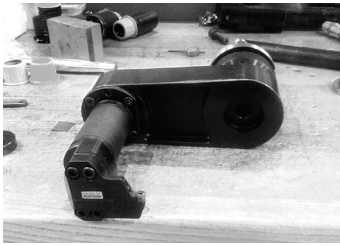
If an axis is fed at the high average continuous feedrate including rapid traverse, the feed axis decreases its rigidity due to thermal expansion of the ballscrew, resulting in deteriorated machining accuracy.



*Drawing shows y-axis

The ballscrew cooling is recommended when it is necessary to perform contour generation or shape machining with high accuracy and at an average feedrate of 3 m/min (118.11 ipm) or over. (Ballscrew center cooling is necessary if the average continuous feedback exceeds 10 m/min (393.70 ipm).)

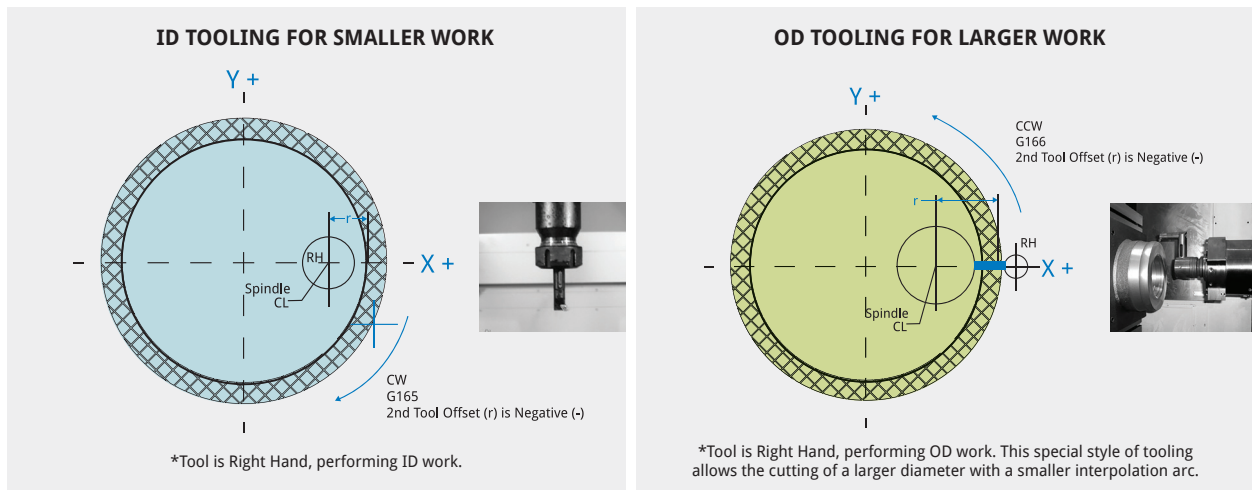




SANDVIK TOOL APPLIED IN TURN-CUT APPLICATION

TOOLING CONSIDERATIONS

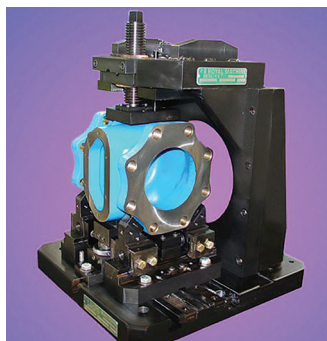
Because Turn-Cut maintains a standard spindle connection (CAT, HSK, etc.), tooling for Turn-Cut applications is readily available. Pictured to the left is an example of a tool used on a Turn-Cut application. Sandvik Coromant has been involved in Okuma's Turn-Cut research and has developed a line of products to work in many Turn-Cut applications. Sandvik Coromant is a longtime partner in Okuma's Partners in THINC initiative.



FIXTURING CONSIDERATIONS

Chain Fixture

Chain fixtures have been used for years and offer the simplest method of clamping valve bodies. They are used predominately on parts with large flange surfaces or similarly shaped parts. As their name suggests, chain fixtures use a chain and a cam mechanism to force the part into the fixture's cradle. Chain fixtures will mar the part's surface, so care should be taken in their application.



Clamp Fixture

Clamp fixtures offer more flexibility than chain fixtures as they are more flexible to accommodate non-flange type parts. Clamp fixtures are often outfitted with quick change mounting and clamping surfaces. This makes them adaptable to a wide variety of parts and sizes. They are often designed with a window for machine access on all four sides.

Fixtures can be sourced from a variety of vendors. Companies such as Busche Workholding in Indiana and Royal Machine & Tool Corporation in Connecticut can assist with fixturing needs.

*IMAGES PROVIDED COURTESY OF ROYAL MACHINE & TOOL

COMPETITOR OFFERINGS FALL SHORT

U axis

U axis heads are spindle mounted units with an internal gear set that is driven by a separate motor through the spindle shaft. The gear set moves a table mounted on the face of the U axis. A boring tool is then mounted on the table with its diameter being controlled by the motor as the spindle rotates.

- Typically a separate motor control and software must be added to the CNC machine in order to drive the U axis and synchronize its movements to the machine's linear axis.
- Care must be taken when using a U axis head as there are weight and mass considerations to account for before using the automatic tool changer.
- U axis heads add weight to the rotating spindle and cause part interference issues.
- Additional maintenance is required which may cause the unit to be sent back to the manufacturer for rebuild.
- U axis heads may not be compatible with spindle coolant as the drive mechanism occupies the area normally used for coolant delivery.

Externally Driven U axis Head

Externally driven U axis heads work on the same principle. They are similar in design to the U axis head but have their drive mechanism external to the spindle. They require a separate motor and controller like the U axis head. The motor is often attached to the spindle cartridge and is directly connected to the head as it connects to the spindle.

- The same cautions apply to this type of head relative to weight and mass.
- These heads are heavy and may not be able to be automatically changed into the spindle.
- The additional weight of the head may contribute to thermal issues as their gear train and motor add weight to the spindle.

TURN-CUT ADVANTAGES

1. Use a single tool for multiple diameters
2. Process intensive machining in one setup
3. Fewer tools required; less setup required
4. Provides desired machining finish in seal surfaces
5. Can handle unbalanced workpieces
6. Turn-Cut maintains the machine's standard functions
7. Works with readily available tooling components
8. Turn-Cut does not add weight, length, or heat to the spindle in order to operate
9. Does not require special fixturing
10. Does not require special programming
11. Turn-Cut can be retrofitted in some cases
12. Turn-Cut function can also be used for threading

Special Purpose Machines

Some CNC machine tool builders offer machines specifically designed for stationary part boring.

- One example uses a boring spindle equipped for machining center work such as milling, drilling, and tapping. Additionally, a quill is incorporated to control a differential system for contour-head movements during turning operations.

A second spindle is sometimes used above the main spindle headstock which provides U axis-controlled turning capacity.

The machine construction is based on fabricated weldments as opposed to cast iron. Cast iron construction provides higher resistance to cutting forces and offers better vibration dampening qualities.

- Another example uses a spindle that is controlled radially by two rotating disks. The smaller of the two disks has a centerline offset to the larger one. The tool is attached to the smaller of the two disks which can rotate independently to create controlled diameter changes. This design limits the spindle speed to 600 RPM. This limits the capability of the machine for general purpose machining.

Index Chucks

Index chucks have been used for smaller valves that can fit in a CNC lathe. Index chucks started as manual devices where the operator had to index the part by hand. Modern index chucks are now M-code/hydraulically actuated. In some cases, the part can be indexed while the spindle is rotating. Index chucks are the ideal solution for smaller parts that can fit in a 10" cube.

- Index chucks add significant cost, are heavy and complex, and make changeovers challenging when the lathe needs to be converted over to standard chucking.
- Index chucks, by design, move the part further from the spindle nose where greater strength and accuracy exists, which leads to potential accuracy and surface finish issues.

TURN-CUT CONSIDERATIONS

Typically, the Spindle Speed (RPM) is determined by the workpiece material that is specified and the tooling material that is available. When using Turn-Cut, the acceleration required to generate the spindle speed must also be considered.

ACCELERATION IS INFLUENCED BY:

- Specified Spindle Speed
- Diameter of Turn-Cut Rotation (X/Y) axes

ACCELERATION INFLUENCES:

- Roundness of the feature being machined by Turn-Cut
- Diameter of Turn-Cut Rotation (X/Y) axes

CALCULATION OF ACCELERATION /CUTTING SPEED:

Fundamental Relations

n = RPM (Synchronized C-Axis and Cutting tool)

RPM / C-Axis Limitations are:
 MA-400 --- 225 RPM
 MA-500 --- 300 RPM
 MA-600 --- 250 RPM
 MA-800 --- 200 RPM

D = Workpiece Diameter (bore or hub)

r = Tool radius (mm) (usually defined as "f" or "f1" in lathe tooling catalogs)

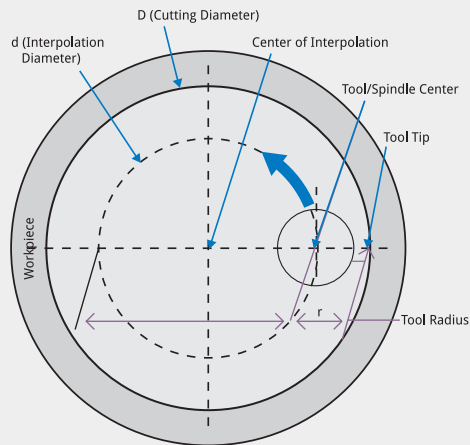
d = Interpolation diameter [(D/2)-r]

a = Acceleration of X/Y servo drives (m/s/s)

f = Feedrate at Interpolation Diameter (mm/min)

V = Surface Speed at Cutting Diameter (m/min)

G = Acceleration of X/Y servo drives (G-force)



Note:
 "r (Tool Radius)" is also used as the value of the 2nd Tool Offset. The direction negative (-) or positive (+) for "r (Tool Radius)" and the 2nd Tool Offset is determined by the relationship of the Spindle CL to the tool tip when the tool tip is at the starting point of the cutting circle (3 o'clock). In the example to the right, both "r (Tool Radius)" and the 2nd Tool offset are negative.

Turn Cut is activated using G codes within a standard formatted program.

EXAMPLE OF TURN-CUT PROGRAM

```

• (TURNCUT TOOL)
• G15 H25 (*)
• G56 H2 (TOOL LENGTH OFFSET)
• G0 X0 Y0
• Z10
• G149 E180 (TURN-CUT FUNCTION - ON_E-VALUE IS FOR ORIENTATION OF TOOL TO CUTTING CENTER)
• G95 F.2 M8
• G18 (X-Z PLANE SELECTION)
• G0 X0 Y0 M120
• Z5 M51
• G189 X1 H3 (2ND TOOL OFFSET_CUTTING RADIUS OF TOOL)
• G165 X19.1 Z1 S250 (CONTINUOUS CW CIRCULAR MOTION STARTS)
• N50 G1 X19.1 F.05
• (*****)
• (ROUGH PASSES DELETED FOR CLARITY)
• (*****)
• N130 G1 Z3.0 F2
• (****FINISH PASS****)
• G1 X27
• Z1
• Z0 F.05
• N155 G1 X26.904
• N160 G2 X23.364 Z-1.503 R1.794
• N165 X19.63 Z-9.979 R40.448
• N170 X19.5 Z-10.459 R1.794
• N175 G1 Z-25.1
• N180 X18
• N185 G1 Z2.0 F2
• M09
• N255 G164 (STOP CIRCULAR MOTION)
• G188 G148 (CANCEL 2ND TOOL OFFSET - TURN-CUT_OFF)
    
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TURN-CUT DEMONSTRATIONS

Okuma's philosophy of mechatronics — the blending of machine with control — allows the Turn-Cut functionality to attain peak cutting performance while maintaining the longevity of the machine. The Turn-Cut option allows simultaneous turning and cutting, thereby reducing the need for special fixturing and tooling and eliminating the need for secondary machine operations.

Okuma provides demonstrations of Turn-Cut at the following locations:

Okuma America Corporation

11900 Westhall Drive
Charlotte, NC 28278
P 704.588.7000 | **F** 704.588.6503

Partners In THINC

12428 Sam Neely Road
Charlotte, NC 28278
P 704.587.6789 | **F** 704.587.7669

The Okuma Technical Center

4727 S. Pinemont, Suite 200
Houston, TX 77041
P 704.504.6104 | **F** 704.504.6105

The Okuma Technical Center at Morris Midwest

68 Congress Circle W
Roselle, IL 60172
P 630.351.1901 | **F** 630.351.1912

Additionally, there are over 45 distributor locations in North and South America where a Turn-Cut demonstration can be arranged.

FOR ADDITIONAL INFORMATION CONTACT BOB BALDIZZI, PRINCIPAL ENGINEER AT OKUMA AMERICA.

BOB HAS OVER 30 YEARS OF EXPERIENCE AND SPECIALIZES IN TROUBLESHOOTING MANUFACTURING PROBLEMS

EMAIL: BBALDIZZI@OKUMA.COM **PHONE:** 704.340.6983