

Basics of Multi-Spindle Turning

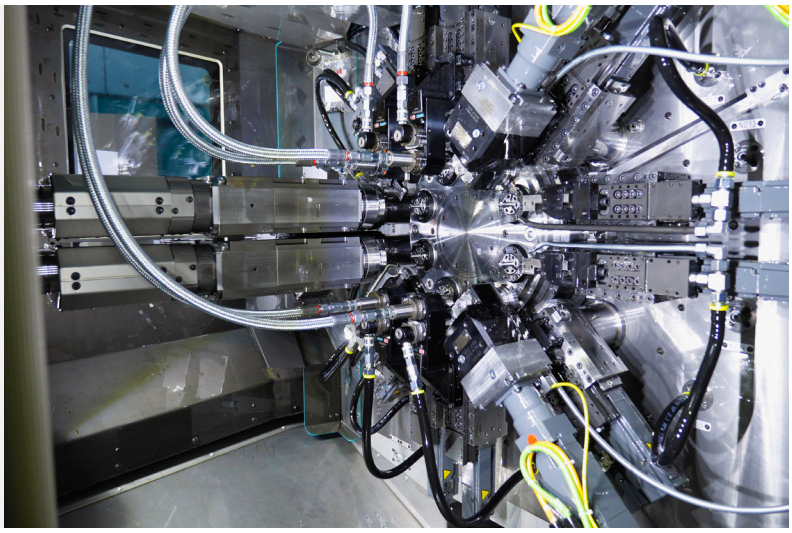
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Engineers designing parts like valve spools, couplings and nozzles have always needed to consider the limitations imposed by lathe operations. This has constrained and complicated design, and sometimes required assembly of multiple pieces. Multi-spindle turning breaks this particular precision machining paradigm.



For centuries a lathe held one workpiece in a single spindle. A single cutting tool acted on it, creating cylindrical and conical shapes. Any feature more complex than an on-axis hole required a second operation, as did finishing the back of the turned part. That is no longer the case. Multi-spindle turning gives engineers unprecedented freedom to design parts with the geometry they need, rather than what the machining processes can achieve.

This eBook introduces the reader to multi-spindle turning. It explains what these machines are capable of and how that affects design flexibility. It covers the benefits of multi-spindle machines for both the machine shop and the customer, and for an even-handed approach to the subject, also addresses their challenges. Individual sections cover:

- **Limitations of traditional turning**
- **Multi-spindle machine basics**
- **Challenges of multi-spindle turning**
- **Benefits of multi-spindle turning in precision machining**
- **Design impacts**

Limitations of Traditional Turning

In turning a workpiece is held in a chuck and rotated. A single point cutting tool is moved in from the side, perpendicular to the axis of rotation, to shear material from the surface. The tool may be moved in one of two directions: parallel to the axis of rotation, which creates a cylindrical shape, or in perpendicular across the end to square-off that face. Another option is to mount a drill in the tailstock and bring it into the workpiece to cut an on-axis hole.



The limitation that should be most obvious is the lack of access to the end of the workpiece held in the chuck. This almost always forces a second turning operation with the workpiece mounted the other way around. (There are a few exceptions where this isn't needed, such as when turning a cylindrical or tapered surface on a casting or forging.)

Releasing and regripping the part to hold it at the machined end – usually done on a second machine - adds time and cost. There is:

- *More part handling and transport*
- *More lead time for the batch to move through the machine shop*
- *Increased geometric errors – principally concentricity – from releasing and regripping*
- *A risk of damaging the machined surface that will be gripped*

Multi-spindle turning addresses the first three of these.

Multi-Spindle Machine Basics

Whereas a traditional lathe has a single spindle with a workpiece-holding chuck mounted on the end, a multi-spindle lathe has multiple spindles and chucks. Each spindle/chuck is addressed by one or more cutting tools mounted on a slideway. This permits simultaneous machining of multiple workpieces. One way to think of a multi-spindle lathe is as multiple lathes merged into a single unit.

Multi-spindle machines usually have six or eight spindles. These are arranged in a circle around a central axis and index in 60° or 45° increments depending on the spindle count. In each position cutting tools can be moved in to turn, face or perform other operations.

Most multi-spindle machines are bar-fed. Some can however be set up for use as chuckers, where a finished part is unloaded and replaced by a new part after each index.



The machine is used by having a different operation performed at each index position. A typical sequence in a six-spindle machine might look like this:

Position 1: rough turn diameter

Position 2: finish turn diameter

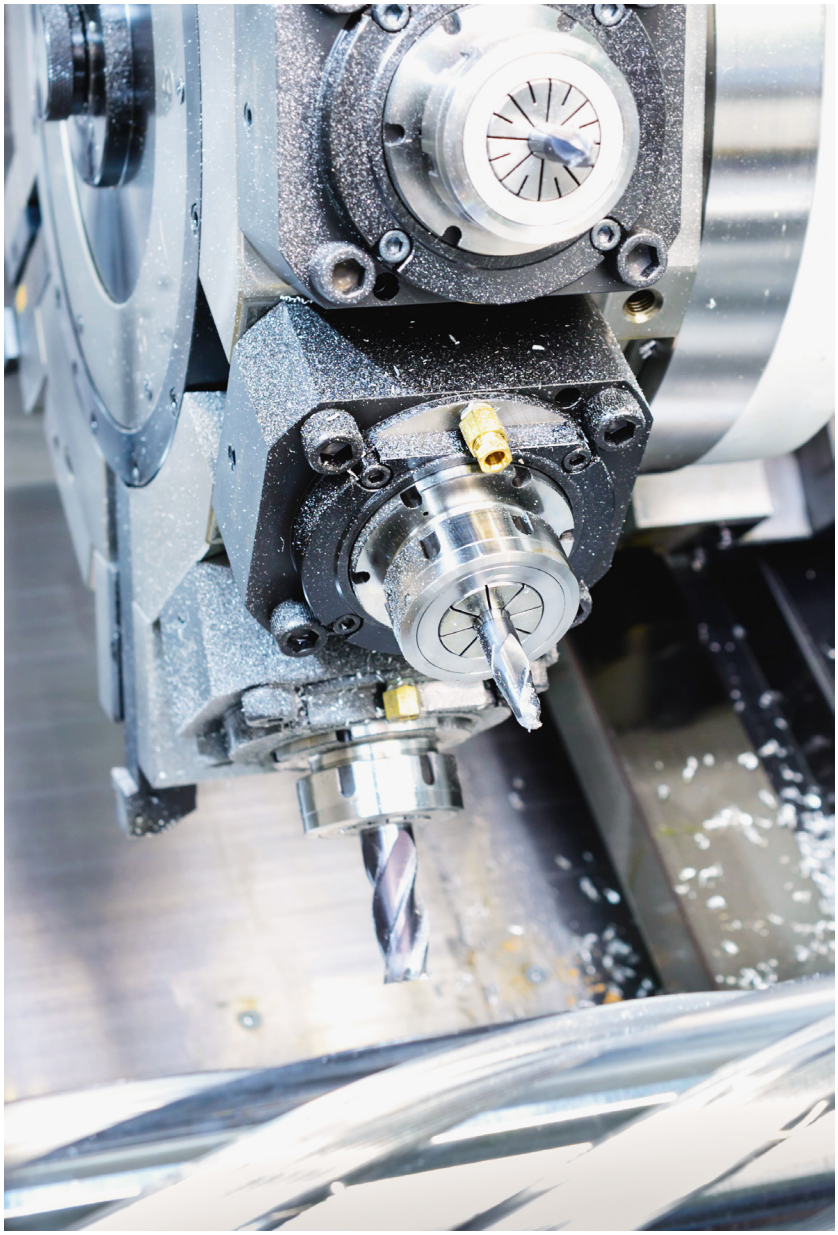
Position 3: cut grooves

Position 4: cut thread

Position 5: face end

Position 6: cut chamfers

Some machines allow doubling-up of stations. This means positions 1 and 2 perform the first operation, 3 and 4 perform the second operation, and so on. It's an approach used for machining parts that need less work.



In early multi-spindle machines the spindles all turned at the same speed. With modern machines this limitation has been removed by giving each spindle its own motor. Motors, indexing, and cutting tool movement all come under the control of a sophisticated CNC system.

To maximize productivity, and address another limitation of single spindle turning, multi-spindle machines have one or two secondary spindles. The turned part is unloaded to one of these where it is gripped on the machined end so back end features can be machined.

Versatility is further enhanced by adding tool turrets and live tooling to the slideways. Applications include milling flats on the side of cylindrical parts, (with the spindle stopped and locked in position,) and drilling axially-perpendicular holes. Depending on their configuration, multi-spindle machines can perform threading, hobbing, contouring and even off-center drilling in the axial direction.

A recent innovation is "polygonal turning". This is where a fixture holding two or three cutting inserts rotates in synchronization with the spindle to cut flat surfaces on a cylindrical workpiece. An application would be to create a hexagonal feature for a wrench to act on.

Challenges of Multi-Spindle Turning

Not every cylindrical part is suitable for or benefits from multi-spindle machining. Part size, complexity and batch size or quantity are the main considerations.

Maximum workpiece diameter is limited by the need to fit multiple chucks into a small space: the multi-spindle machines that Impro uses have an upper limit of 32 mm (1.25”).

When parts only need one or two turning operations there is no reason to run them on these complex machines. (Many single spindle lathes have a sub spindle that grips the part for back end machining.)

Their complexity makes programming these machines more difficult than for single spindle lathes. In addition, when the machines are bar-fed, changing bar diameter extends setup time significantly. The most efficient mode of operation is to produce a medium to large run of identical parts, (thousands rather than hundreds.)

Benefits of Multi-Spindle Turning in Precision Machining

A precision machine shop that adopts multi-spindle turning, (for appropriate part geometries and batch sizes,) sees productivity, quality and throughput improvements.

Productivity is higher because the non-value adding tasks of loading, unloading and moving are eliminated. Instead, the ability to produce a finished part in a single setup on a single machine leads to this being called, “one and done” machining.

Quality is improved because keeping the part on a single machine improves concentricity. In addition, less handling and movement means less opportunity for damage.

Throughput is faster because queuing for successive operations is eliminated. Whereas moving a batch of parts through separate machines might take a week or more, with multi-spindle turning the batch could be finished in hours, or even less.

Design Impacts

Within their size limits, modern multi-axis turning machines free part designers from the constraints of concentric and axial features. They can now add flats, perpendicular through holes, and off-axis holes in whatever sizes and positions part function dictates. In effect, the machine can mill as well as turn, and produces parts that are geometrically finished, needing only cleaning and coating or plating.



For anyone designing small, primarily cylindrical parts like valve bodies or connectors, this allows greater focus on function rather than what the machine shop can do. It can also allow the combination of what were previously separate components – due to machining constraints – into a single piece, with reductions in assembly work, inventory and so on.

Talk to The Precision Machining Experts at Impro

In multi-spindle turning, otherwise separate machining operations are performed in one go on a single machine. This improves precision, lowers costs, and of greatest importance, lets the designer or design team focus on function without getting dragged into manufacturability issues.

Impro offers multi-spindle turning as part of our extensive range of precision machining services. If you'd like to know if your parts are suitable for or could benefit from multi-spindle turning, contact us to arrange a discussion.

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