



5-Axis Machining Alternatives

There are currently three alternatives to achieving full 5-axis machining capabilities:

Dedicated 5-axis Machining Center

Tilting - Rotary / Trunnion Table

Spindle Head Attachment

Dedicated 5-axis Machining Center

There are currently more than twenty (20) original equipment manufacturers of 5-axis machining centers sold in the U.S. These manufacturers include all of the biggest names in manufacturing technology including: Cincinnati, DMG, Feeler, Fidia, Haas, Hurco, Johnford, Makino, Mazak, Mighty, Mitsubishi, Mori, Okuma, Parpas, SNK, Toshiba, Visionwide and Zimmerman.

Until recently, the majority of these machines are large, powerful, accurate and expensive with prices averaging well above \$500,000. The chief draw-back of these large 5-axis machines is their range of motion which is generally limited to +/- 30°. Work pieces that require a steeper angle of cut must be manually repositioned and restarted. Also, these machines are significantly less rigid than a 3-axis machine of the same size and class.

A relative newcomer to this market are the 'trunnion style' 5-axis machining center which allows the machine bed to tilt and rotate thereby providing access to all 5 sides of a part exactly as a performed by tilting-rotary tables (see below). Unfortunately, this design severely limits both the size and weight of the parts that can be machined, reducing the accessible machine envelope by up to 60%.

Tilt - Rotary and Trunnion Tables

Several manufacturers now produce a tilting-rotary table that can be mounted to the bed of a (3-axis) CNC machine. Simple rotary tables have been available for many years and are used extensively by small and large machine shops around the world to index parts for various machining operations.

A 'tilting' rotary table can rotate and tilt a part at various angles to provide machine access to five sides of the part, simulating true five axis machining.

The relatively small work surface of a tilting-rotary table places significant limits on the type of the work piece that can be mounted to it including limits of length, width, height and weight. Additionally, tilting-rotary tables are themselves very large and use much of the host machine's working envelope. Even the largest tilt-rotary tables can reduce the working envelope of the host machine by 75% or more. Many Tilt-Rotary tables are not suitable to hold parts during heavy cutting operations.

Spindle Head Attachments

The primary advantage of a spindle head attachment is that it can access all points of the machining center's work envelope. The head places no limit on the size of the work piece that can be machined.

At least two European companies manufacture and sell a programmable spindle head for attachment to large 3-axis milling machines. When properly installed, these heads are fairly dependable, accurate and expensive. Because of their size and weight they cannot be mounted onto any of the small to mid-sized machining centers and are reserved for only the largest gantry type milling machines. Installation is permanent and requires custom fabrication and fitting. The price range for these head attachments is \$100,000 to \$250,000 plus the cost of custom fabrication and installation.

Tri-Tech Model 5414 spindle head attachment is fully programmable and can be used to convert nearly any 3-axis CNC machine to a true, simultaneous 5-axis machining center. The M5414 has a wide range of motion including tilt capability of +/- 90° and continuous 360° rotary motion. Because the M5414 is a spindle attachment, it can access all points of the machining center's work envelope. The M5414 is portable and can be mounted, in less than thirty (30) minutes, with no modification to the host machine. At 175 pounds, the M5414 is a heavy duty attachment yet compact enough to attach to many smaller to mid-size machines.

While the "low priced" 5-axis machining centers are fairly rigid, they cannot match the rigidity of their 3-axis counterparts for significant metal removal. The M5414 allows the user to perform all significant metal removal using the heavy duty 3-axis machining center *then* mount the M5414 attachment to complete 5-axis profiling, holes, pockets, etc. using up to 3/4" cutting tools.