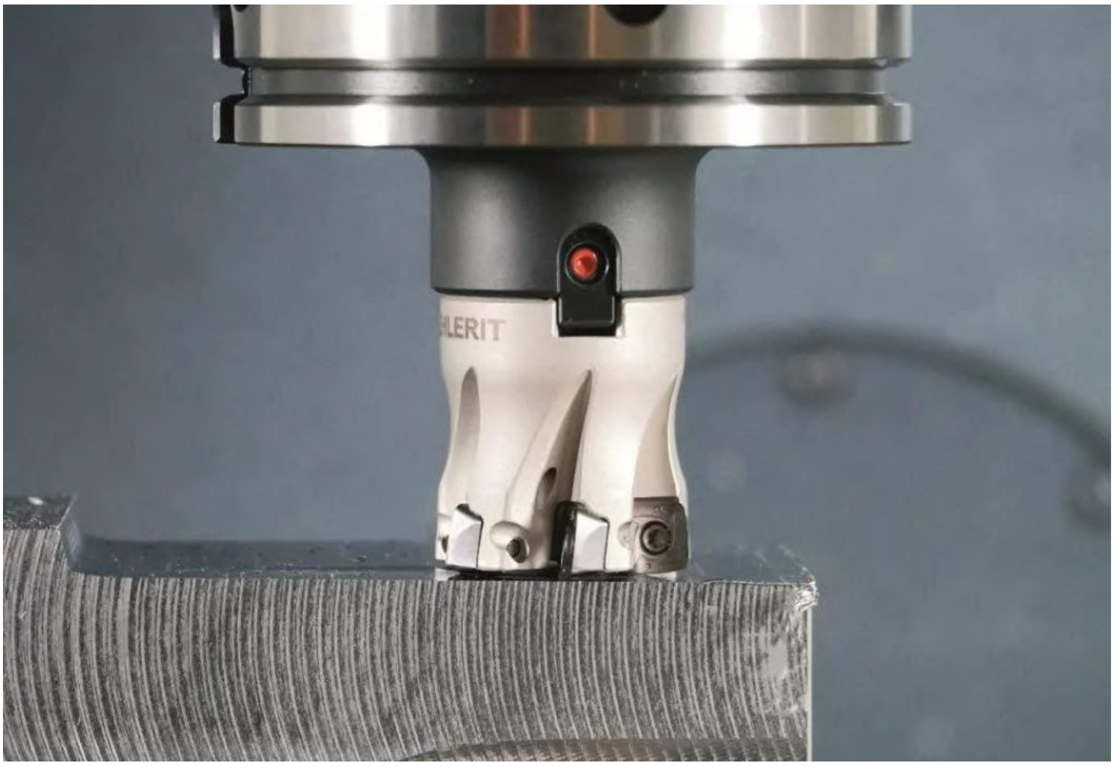
Various CNC intelligent tool setting processes and their trends

Overview: tool setting (tool determination origin) is the main operation and important skill in CNC machining. Under certain conditions, the accuracy of tool setting can determine the machining accuracy of parts, and the efficiency of tool setting also directly affects the efficiency of CNC machining. It is not enough to know only the tool setting methods, but also the various tool setting methods of the CNC system and the calling methods of these methods in the machining program. At the same time, we should know the advantages and disadvantages of various tool setting methods, use conditions, etc.



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1. Knife setting principle

The purpose of tool setting establishes the workpiece coordinate system. Intuitively speaking, the tool setting establishes the position of the workpiece in the machine tool workbench, which is actually to find the coordinates of the tool setting point in the machine tool coordinate system.

For CNC lathes, the tool setting point must be selected first before machining. The tool setting point refers to the starting point of the tool relative to the workpiece when machining the workpiece with the CNC machine tool. The tool setting point can be set on the workpiece (such as the design datum or positioning datum on the workpiece) or the fixture or machine tool. If it is set at a point on the fixture or machine tool, the point must maintain a certain dimensional relationship with the positioning datum of the workpiece.

During tool setting, the tool point should coincide with the tool setting point. The so-called tool point refers to the positioning reference point of the tool. For turning tools, the tool point is the tip. The purpose of tool setting is to determine the absolute coordinate value of the tool setting point (or workpiece origin) in the machine coordinate system and measure the tool position deviation value of the tool. The accuracy of tool point alignment directly affects the machining accuracy.

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In the actual processing of workpieces, the use of one tool generally cannot meet the processing requirements of workpieces, and usually, more than one tool is used for processing. When conducting quality CNC turning services, the geometric position of the tooltip will be different after the tool change under the condition that the tool change position remains unchanged, which requires that different tools can ensure the normal operation of the program when starting machining at different starting positions.

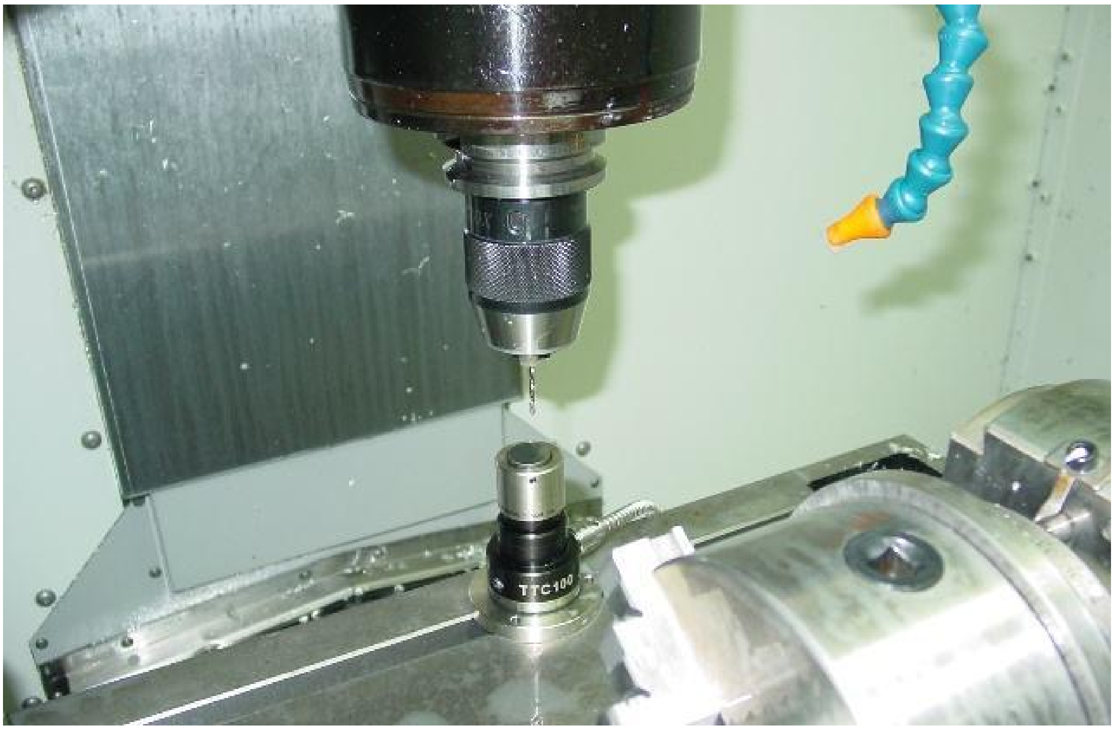
To solve this problem, the CNC system of the machine tool is equipped with the function of tool geometric position compensation. By using the function of tool geometric position compensation, as long as the position deviation of each tool relative to a pre-selected reference tool is measured in advance, it is input into the specified group number in the tool parameter correction column of the CNC system, and the tool position deviation can be automatically compensated in the tool path by using t command in the machining program. The measurement of tool position deviation also needs to be realized through tool setting operation.

2. Knife setting method

In CNC machining, the basic methods of tool setting include trial cutting, tool setting instruments, and automatic tool setting. This paper takes the CNC milling machine as an example to introduce several common tool setting methods.

2.1 Trial cutting and knife alignment

This method is simple and convenient, but it will leave cutting marks on the surface of the workpiece, and the accuracy of the toolset is low. Taking the tool setting point (which coincides with the origin of the workpiece coordinate system) at the center of the workpiece surface as an example, the bilateral tool setting method is adopted.



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（1）x. Y-direction knife setting。

① Install the workpiece on the workbench through the fixture. When clamping, the tool setting position should be reserved on the four sides of the workpiece.

② Start the medium speed rotation of the spindle, quickly move the workbench and spindle, make the tool quickly move to a position close to the left side of the workpiece with a certain safe distance, and then reduce the speed to move close to the left side of the workpiece.

③ When approaching the workpiece, use the fine-tuning operation (generally 0.01mm) to approach, let the tool slowly approach the left side of the workpiece, so that the tool just touches the left surface of the workpiece (observe, listen to the cutting sound, look at the cutting marks, look at the chips, as long as there is one situation, it means that the tool contacts the workpiece), and then retreat 0.01mm. Write down the coordinate value displayed in the machine coordinate system at this time, such as -240.500.

④ Retreat the tool along the positive Z direction to the above surface of the workpiece, approach the right side of the workpiece in the same way, and record the coordinate value displayed in the machine coordinate system at this time, such as -340.500.

⑤ According to this, the coordinate value of the workpiece coordinate system origin in the machine coordinate system is {-240.500+ (-340.500)} / 2=-290.500.

⑥ Similarly, the coordinate value of the origin of the workpiece coordinate system in the machine coordinate system can be measured.

2.2 Z-direction knife alignment

① Move the tool quickly over the workpiece.

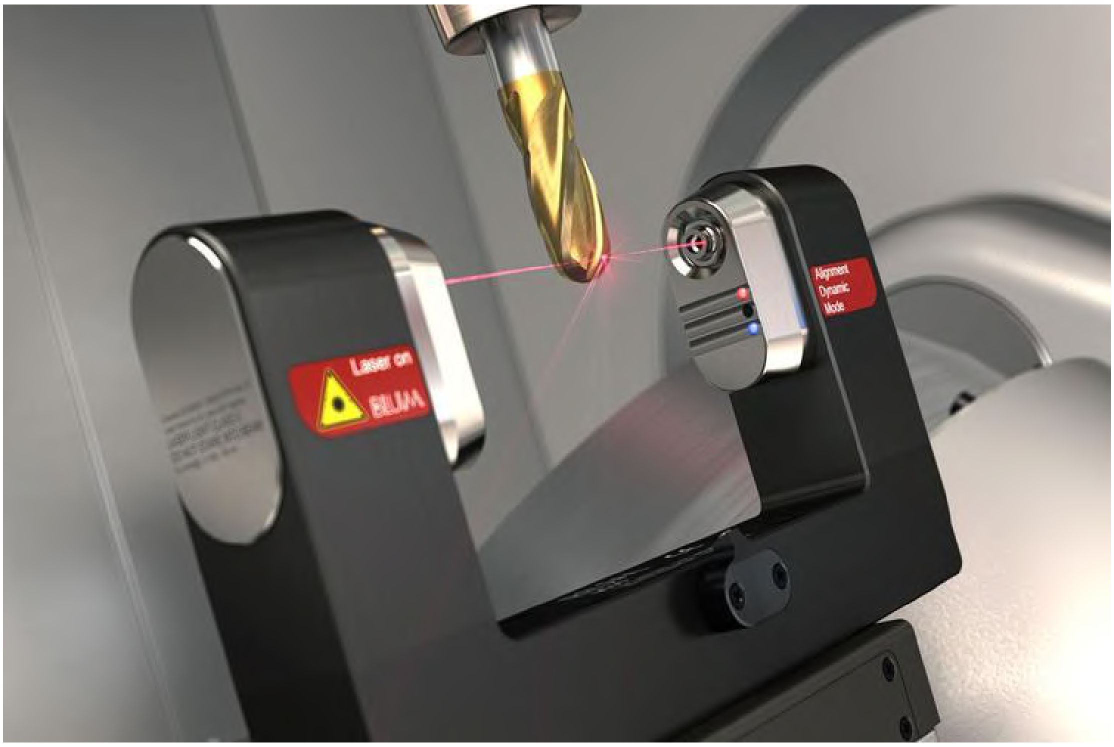
② Start the medium speed rotation of the spindle, quickly move the workbench and spindle, and quickly move the tool to a position close to the upper surface of the workpiece with a certain safe distance, and then reduce the speed to move the end face of the tool close to the upper surface of the workpiece.

③ When approaching the workpiece, use the fine adjustment operation (generally 0.01mm) to approach, so that the end face of the tool slowly approaches the surface of the workpiece (note that when the tool, especially the end milling cutter, is best to lower the tool at the edge of the workpiece, and the area of the end face of the tool contacting the surface of the workpiece is less than the semicircle, try not to lower the center hole of the end milling cutter on the surface of the workpiece), so that the end face of the tool just touches the upper surface of the workpiece, then raise the axis again, and record the Z value in the machine coordinate system at this time, -140.400, then the coordinate value of the workpiece coordinate system origin w in the machine coordinate system is -140.400.

（3） Input the measured x, y, and Z values into the storage address g5* of the workpiece coordinate system of the machine tool (generally, g54 ~ G59 codes are used to store tool setting parameters).

（4）Enter the panel input mode (MDI), enter "g5*", press the start key (in automatic mode), and run g5* to make it effective.

（5）Check whether the toolset is correct.



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2.3 Tool alignment with a feeler gauge, standard mandrel, and block gauge

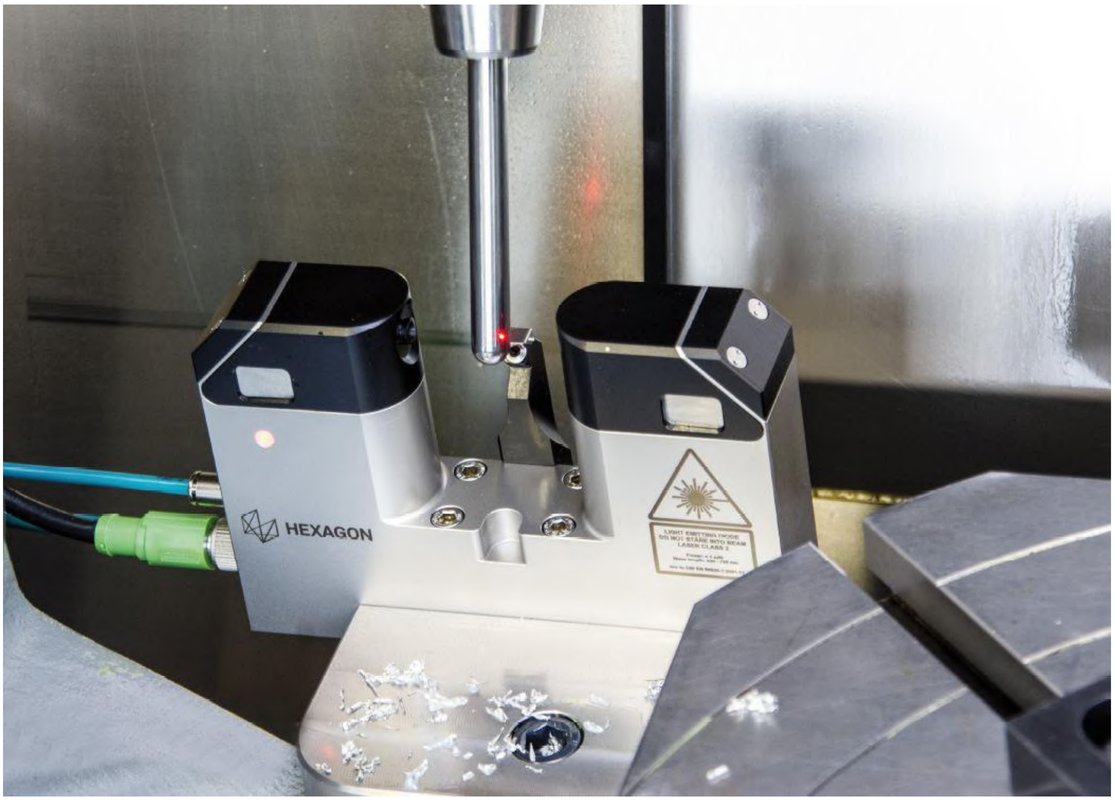
This method is similar to the trial cutting tool alignment method, except that the spindle does not rotate during tool alignment, and a feeler gauge (or standard mandrel, block gauge) is added between the tool and the workpiece, subject to the fact that the feeler gauge just cannot move freely. Note that the thickness of the feeler gauge should be subtracted when calculating coordinates. Because the spindle does not need to rotate for cutting, this method will not leave traces on the surface of the workpiece, but the tool setting accuracy is not high enough.

3. Tool alignment with edge finder, eccentric bar, shaft setter, and other tools

The operation procedure is similar to the method of trial cutting and tool alignment, except that the tool is replaced by an edge finder or eccentric rod. This is the most commonly used method. High efficiency, can ensure the accuracy of the toolset. When using the edge finder, care must be taken to make the steel ball part slightly in contact with the workpiece. At the same time, the workpiece to be processed must be a good conductor, and the positioning datum plane has a good surface roughness. The z-axis setter is generally used for transferring (indirect) tool alignment.

2.4 Transfer (indirect) knife method

Processing a workpiece often requires more than one knife. The length of the second knife is different from the length of the first knife, so it needs to be reset. But sometimes the zero point is processed, and the zero point cannot be retrieved directly, or it is not allowed to damage the machined surface. There are also some knives or occasions that are not good for direct tool alignment. At this time, the indirect change method can be used.



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(1) First knife

① For the first knife, the trial cutting method and the feeler gauge method are still used first. Write down the machine coordinate Z1 of the workpiece origin at this time. After the first knife is processed, stop rotating the spindle.

② Place the tool setter on the flat surface of the machine tool workbench (such as the surface of the vise).

③ In the handwheel mode, use the hand to move the workbench to the appropriate position, move the spindle downward, press the bottom end of the knife against the top of the tool setter, and the dial pointer rotates, preferably within one circle, record the indication of the shaft setter at this time and clear the relative coordinate axis.

④ Raise the spindle and remove the first knife.

（2）Second knife

① Put on the second knife.

② In the handwheel mode, move the spindle downward, press the bottom end of the knife against the top of the tool setter, the dial pointer rotates, and the pointer points to the same number position as the first knife.

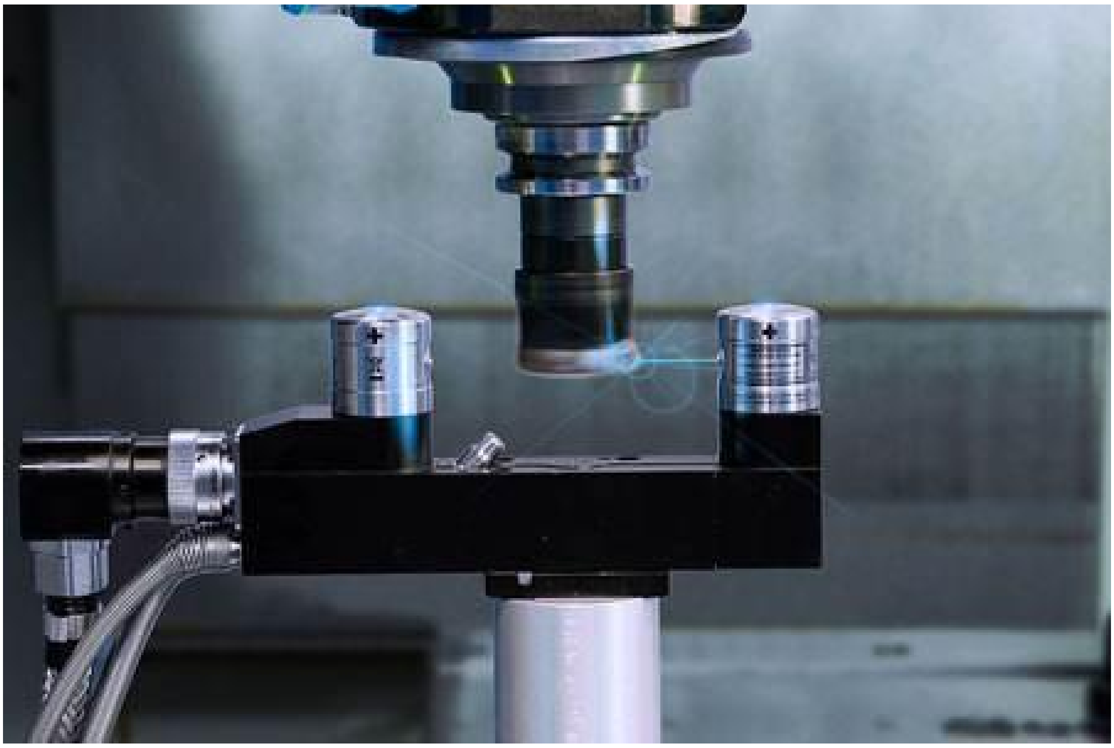
③ Record the value Z0 (with sign) corresponding to the relative coordinates of the axis at this time.

④ Raise the spindle and remove the tool setter.

⑤ Add Z0 (with sign) to the Z1 coordinate data in g5* of the original first knife to obtain a new coordinate.

⑥ This new coordinate is the actual coordinate of the machine tool of the workpiece origin corresponding to the second tool to be found. Input it into the g5* working coordinate of the second tool, to set the zero point of the second tool. The setting method of other knives is the same as that of the second knife.

Note: if several knives use the same g5*, steps ⑤ and ⑥ change to store Z0 in the length parameter of the second knife, and call the knife length to correct g43h02 when processing with the second knife.



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2.5 Top knife alignment

（1）Tool setting in X 、 Y directions.

① install the workpiece on the machine tool workbench through the fixture and replace it with the center.

② Quickly move the workbench and spindle, make the top move close to the top of the workpiece, find the center point of the workpiece drawing line, and reduce the speed to move so that the top approaches it.

③ Use the fine-tuning operation to make the top slowly approach the center point of the workpiece drawing line until the top tip point is aligned with the center point of the workpiece drawing line, and write down the X and Y coordinate values in the machine coordinate system at this time.

（2）Remove the center, install the milling cutter, and use other tool setting methods such as the trial cutting method and the feeler gauge method to obtain the z-axis coordinate value.

2.6 Tool setting method of a dial indicator (or dial indicator)

（1）Tool setting in X 、 Y directions.

Install the mounting rod of the dial indicator on the tool handle, or suck the magnetic seat of the dial indicator on the spindle sleeve, and move the workbench so that the center line of the spindle (i.e. the center of the tool) moves approximately to the center of the workpiece, adjust the length and angle of the telescopic rod on the magnetic seat, so that the contact of the dial indicator contacts the circumferential surface of the workpiece, (the pointer rotates about 0.1mm) slowly rotate the spindle by hand, so that the contact of the dial indicator rotates along the circumferential surface of the workpiece, Observe the convenient movement of the dial indicator pointer, and slowly move the axis and axis of the workbench. After repeated times, the pointer of the dial indicator is basically in the same position when the spindle is rotated (when the gauge head rotates for one week, the runout of the pointer is within the allowable tool setting error, such as 0.02mm). At this time, it can be considered that the center of the spindle is the origin of the axis and axis.

（2）Remove the dial indicator, install the milling cutter, and use other tool setting methods such as the trial cutting method and the feeler gauge method to obtain the z-axis coordinate value.

2.7 Special tool setting device tool setting method

The traditional tool setting method has some disadvantages, such as poor safety (such as feeler gauge tool setting, hard-hitting, and hard tooltip is easy to be damaged), more machine time occupation (such as repeated cutting for several times for trial cutting), large random error caused by human beings, and so on. It has not been able to adapt to the rhythm of NC machining and is not conducive to the function of NC machine tools.

Using the special tool setter to set the tool has the advantages of high accuracy, high efficiency, and good safety. It simplifies the cumbersome tool setting work guaranteed by the experience and ensures the play of the high-efficiency and high-precision characteristics of the NC machine tool. It has become an indispensable special tool to solve the toolset on the NC machine.

Well, today's dry goods will be over here. What about? Have you learned these seven knife-setting methods?

Nowadays, precision manufacturing and complex parts processing, which have great requirements for cutting tools, are no longer the proper terms of a few cutting-edge industries such as national defense, military industry, aerospace, and so on; With the continuous development of processing technology and manufacturing means, discrete precision machining has become the development trend of many fields of the manufacturing industry. Communication, mold, automobile, medical, and other industries all carry out a new round of product upgrading based on precision machining.