

# Complex micro components from bar stock

Complete machining of micro components is only possible using machining centres with integrated component handling, clamping and in-process measurement technology. The wide variety of solid carbide micro tools now available plays a vital role in ensuring **PROCESS RELIABILITY**.



**Figure 1. Turning, milling, drilling:**  
With between five and eight CNC axes, turning and milling centres from Willemin-Macodel enable complete machining for micro components

## KONRAD MÜCKE

**P**lates, dials and cases for pocket watches and wristwatches, instruments for minimally invasive surgery, medical orthopaedic and dental implants, appliance housings, carrier plates and bearings used in navigation systems and gyroscopes in aviation all have one thing in common: Their dimensions generally amount to just a few millimetres or even a few tenths of millimetres. These micro components need to be produced in small and medium series to an extremely high degree of accuracy. Tolerances

within micrometres or even nanometres are a standard requirement. To ensure economical working and optimum customer proximity, specialist manufacturers are now producing this type of ultra-precise micro component in many manufacturing locations around the globe. However, the design, engineering and implementation of suitable machining centres, milling and turning centres and stand-alone machines is still the preserve of a handful of specialist manufacturers located predominantly in Europe and specifically in Switzerland. Only these few are able to draw on sufficient expertise and experience gathered over many decades to guarantee the required stringent standard of quality, accuracy and reliability in the machines they produce including the overall production sequence.

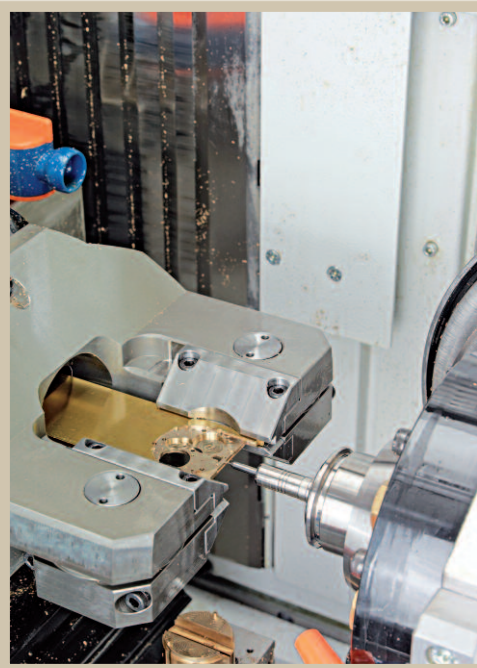
## Complete machining of micro components in a sequence

One such specialist in machining centres for micro production is Willemin-Macodel SA in Delémont. Its location on the edge of the Swiss Jura region is no coincidence: This is the very heart of the Swiss watch and precision mechanics industry. Founded 40 years ago, the company has remained an innovative, sound family firm to this day. At its location in

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**Figure 2. Outstanding economy for small and medium series: The turning and milling centres produce items such as plates for watches with extremely high precision completely from bar stock**

Delémont, over 230 skilled employees working in the development, construction and assembly departments produce

around 400 high-end precision machining centres every year.

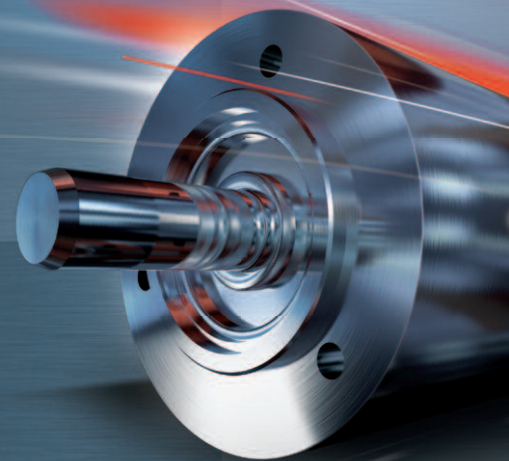
These have workspaces ranging from 200 × 200 × 250 mm to 800 × 500 × 630 mm, and are designed as machining centres with vertical spindle and as turning and milling centres with five (and more) CNC axes. Alongside the turning spindle with spindle passages of between 32 and 60 mm depending on the machine design, the milling and turning centres have a vertically swivelling milling unit with motor spindle (up to 60 000 rpm) and a horizontally displaceable swivel table with three or four stations which accommodates a counter spindle, a tailstock centre and one or two vices (Figure 1).

This allows the machine to use turning, drilling and milling operations to produce any geometry on even the smallest workpieces measuring just micrometres or even nanometres. It goes without saying that the machines are also equipped with optical and sensing measurement systems for measurement and testing tool and workpiece inside the workspace, alongside high-pressure internal coolant supply and tool magazines with slots for between 40 and 90 tools. The machining center also benefits from an extensive periphery. Denis Jeannerat, Director of Technology at Willemin-Macodel explains: »To enable economical and efficient working processes, production companies today expect micro components to be machined and prepared ready for assembly in a single work sequence. This is why our machine concepts are always aimed at achieving the greatest possible degree of complete machining. We equip our machines in a way that they are capable of producing the required micro component completely from bar stock (Figure 2). This encompasses the appropriate handling using grippers and clamping systems within the machining sequence, as well as the removal and correctly aligned and positioned deposition of finished components on workpiece carriers with the aid of linear systems. So what we supply is not just a machine, but a complete production process every time.«

### Ingeniously engineered machine concepts

The wide diversity of workpieces calls for ingenious machine design concepts. The Willemin-Macodel machines are based on a modular platform and come in four different sizes. When it comes to the production of micro components, customers increasingly expect that they will be able to produce smaller batch sizes of different workpieces in quick succession ►

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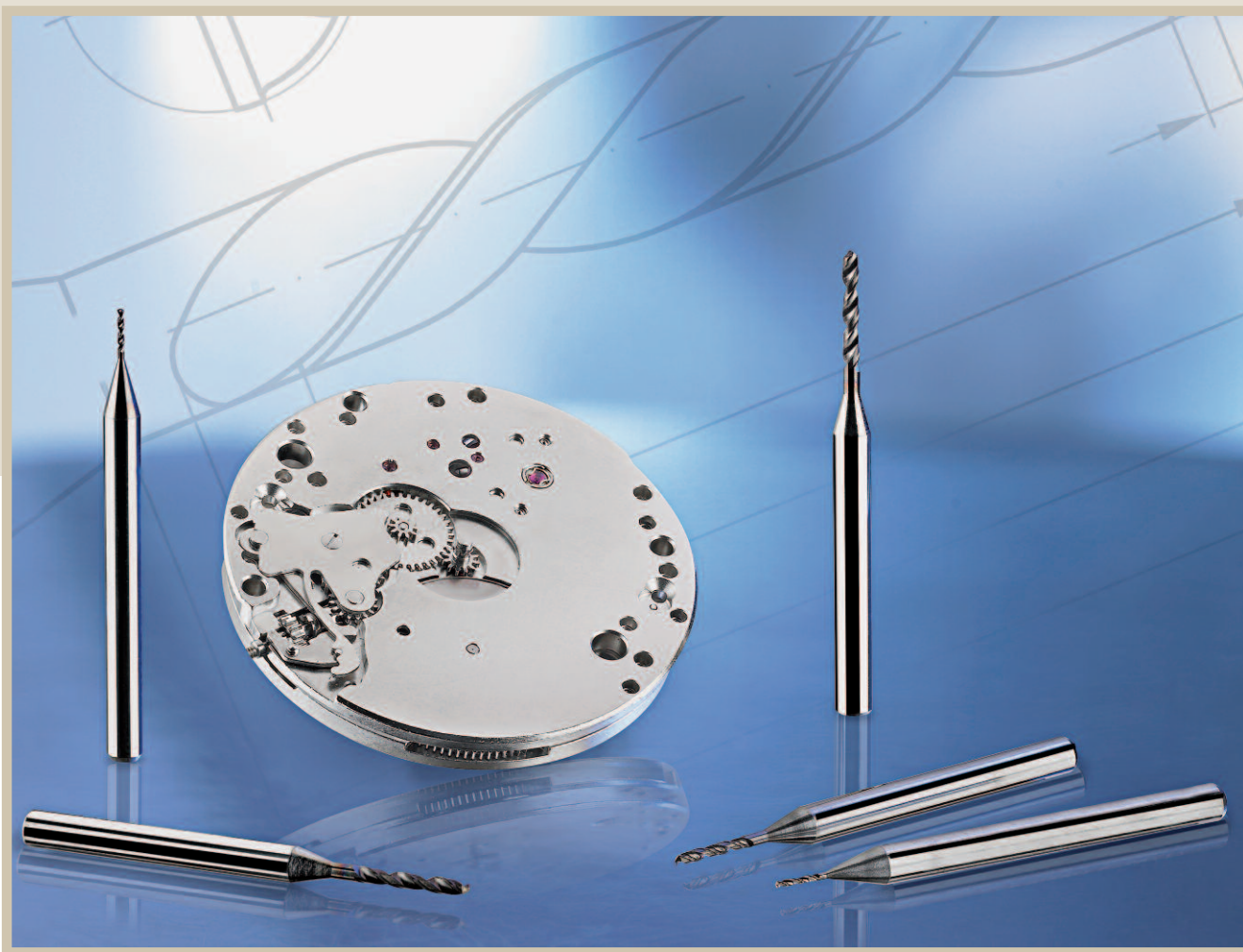
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**Figure 3. Convincing quality:** Two and three fluted micro drills and mills from Sphinx Tools Ltd. guarantee a reliable machining of micro components on high-productivity turning and milling centres

economically and just in time using a machine which enables flexible and economical retooling. It is also important for production processes that have once been implemented to offer both dependability and process reliability. This becomes all the more important as the machines are installed all around the world to produce micro components for watches and precision mechanics, medical and dental technology and for devices used in telecommunication and aviation applications in close proximity to the processing manufacturer.

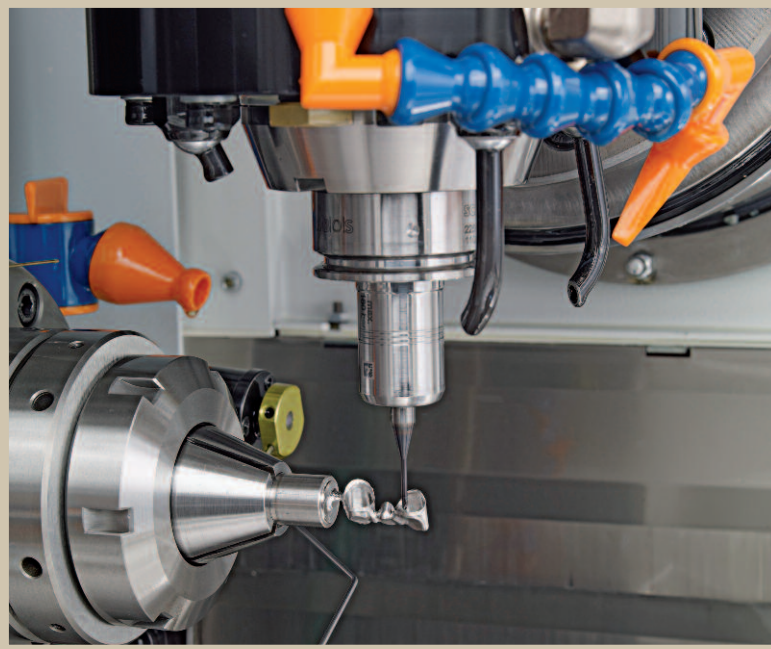
To reliably comply with the high standards of precision, process reliability, flexibility and availability demanded for the production processes implemented, the Swiss company is particularly reliant on a supply of high-end drills and mills. Regarding micro tools in particular – which refer to a diameter range of a few hundredths of millimetres through tenths of millimetres to a few millimetres – Jeannerat believes that only a handful of really competent manufacturers exist. One of these, he confirms, is the company Sphinx Tools Ltd. in Derendingen, whose solid carbide micro tools have proven particularly successful (**Figure 3**). »Micro tools from Sphinx made of uncoated and coated solid carbide comply with the most stringent demands in terms

of reliability and accuracy. This applies both to the micro drills and micro mills from the standard range as well as to special tools individually designed and implemented in line with our requirements for specific production processes«, adds Jeannerat (**Figure 4**).

### Process-reliable micro drills and mills

The exotic materials currently in increasingly widespread use present a particular challenge. These include such materials as high-strength titanium alloys, tough, corrosion-proof steel alloys, but also cobalt-chrome alloys for medical and dental technology. To machine these materials productively and with the greatest possible process reliability, Sphinx has implemented micro tools using ultra-fine grained carbide qualities with ingeniously engineered geometries for points, cutting edges, chamfers and chip flutes.

For instance when it comes to drilling on uneven surfaces, the ›Tricut‹ series drills with their three cutting edges are able to centre the workpiece without the need for special pilot drills. As a result, they enable rapid drilling of even deep holes with high surface quality in a single work sequence. The ›Phoenix TC2‹ micro high-performance drills are



**Figure 4. Ideally equipped for difficult machining operations: Micro drills and mills made of coated and uncoated solid carbide with special tip, cutting edge and chamfer geometries are capable of machining even hard and tough materials with the utmost hard and tough productivity and economy**

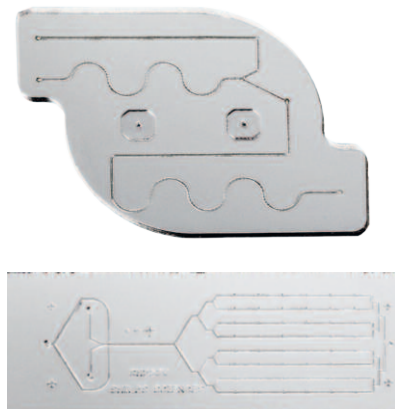
designed specifically for holes of up to  $30 \times D$ . The head is coated in a hard, temperature-resistant layer of AlCrTiN. With diameters of between 1.00 and 8.00 mm in graduations of 0.1 mm, they feature inner coolant channels and an extremely smooth surface. For boreholes of up to  $12 \times D$ , uncoated or

micro drills for boreholes of up to  $6 \times D$  measuring between 0.03 and 3.00 mm in graduations of 0.01 mm are available off the shelf. All of them have a negative tolerance of  $4 \mu\text{m}$ . Depending on the tolerance situation of the borehole to be produced, the selected drill can be bigger or smaller by

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**Figure 5. Plenty of bite: Micro mills with two or three cutting edges are ideally suited for machining components used in dental implants**

one or two hundredths of a millimetre. The single-toothed engraving cutters of the ›70xxx‹ series with a point angle of between 30 and 90 degrees and an end face of between 0.02 and 0.15 mm in width or a small end radius of between 0.04 and 0.1 mm are designed for engraving minuscule trapezoidal or rounded grooves, particularly in the watchmaking industry.

For case machining, particularly helical plunging and clearing pockets, the uncoated and coated micro mills with two and three teeth and useful lengths of up to  $8 \times D$  are the most suitable option. They have a 30 or 35 degree twist angle and cut over the centre, meaning that they can also be used for plunging. They are available in diameters from 0.1 to 3 mm and in graduations of 0.1 mm. Alongside this comprehensive range of standard micro tools, Sphinx also produces solid carbide micro drills and mills with non-standard geometries. These include in particular two- and three-fluted step drills capable of combining several machining operations such as opening up boreholes, second step drilling and chamfering in a single work process. This saves the need for tool changes and so improves machining centre productivity (Figure 5).

### **Partnership for innovative and reliable micro machining**

As Jeannerat confirms, it is first and foremost the geographical proximity to the tool manufacturer in Derendingen and Porrentruy, coupled with the extensive expertise of the tool specialist that ensure

the optimum supply of equipment for the Willemin-Macodel machining centres. He continues: »Working in cooperation with the technicians at Sphinx, we are able to optimize machining processes individually for different workpieces and materials. The experts at Sphinx have been consistently supportive with their recommendations on the choice of the most suitable micro tools. This partnership ensures that we are able to implement the required machining solutions efficiently and within the shortest possible time.«

The Technical Director's attention is particularly focused on process reliability, which »we can depend on with micro tools from Sphinx. And we know we can rely totally on the warranted quality characteristics. For us, these are vital criteria when it comes to selecting our suppliers. Because once production processes have been defined and optimized, they have to work with absolute reliability in production locations around the world. Only in this way can we compete effectively in the international arena«, he adds. ■

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