



## **Technical closing report on the EMO Hannover 2011**

### **Innovation and integration: well equipped for future challenges**

In the ongoing cyclical boom phase of the world's metalworking industry, the exhibitors at the EMO Hannover 2011 from 19 to 24 September showcased field-proven machinery concepts and innovative new products. Full order books and healthy utilisation of production capacities are making it more attractive for companies to invest promptly in new production technologies.

Vendors of machine tools are continuing to focus on complete machining of workpieces in order to shorten throughput times. The top segment nowadays in terms of metal-cutting with a geometrically determined blade features machining centres operating in 5 axes, equipped with the technology for turning or toothing operations. There is a discernible trend towards integrating further processes from the field of metal-cutting with a geometrically undetermined blade for fine-machining of surfaces. Interfacing with material flow and handling systems, plus downstream metrological tasks are also available, depending on the production requirements involved. So as to offer several manufacturing processes in a single machine, the manufacturers of machine tools are forming alliances in order to provide their individual core competences in a new production environment.

#### **Trend towards integrated production processes**

A machinery solution offered jointly by two exhibitors for machining chucked gear components shows how production processes can be fruitfully combined. In the first part of the machine, the reference surfaces are machined by rotary turning, with options for outer, inner and face turning of soft or already hardened gear components with protruding surface roughnesses ( $R_z = 1 \mu\text{m}$ ) (J.G. Weisser Söhne Werkzeugmaschinenfabrik GmbH & Co. KG, St. Georgen). An integrated component handling system is used to turn the

workpiece and transport the material to the second part of the machine, where straight or helical toothing is given its final grinding (Kapp GmbH, Coburg).

Lasers are gaining steadily in acceptance as a manufacturing instrument. In fields where ultra-hard ceramic materials could hitherto be machined only by grinding, laser systems can now be integrated. One exhibitor of lathes uses the laser for hybrid outer machining of silicone nitride ceramics. The energy of the laser beam focused in front of the blade lowers the flow moisture point of the material concerned, enabling turning operations to be performed with diamond tools. Using lasers opens up further options for metallic materials such as extra hardening, adding hard-aggregate particles or micro-structuring local component sections. If hard-aggregate particles are used, tungsten or titanium carbides are employed, which with their ceramic properties and in particular their extreme hardness improve resistance to wear and tear. Interior machining is currently at the development stage (A. Monforts Werkzeugmaschinen GmbH & Co. KG, Mönchengladbach). In machining centres, laser systems can be used in parallel to classical metal-cutting tools, so as to provide 5-axis-machined component surfaces with micro-structures. Depending on the material being machined and the removal rate involved, users can choose between fibre, diode and pico-second lasers. One vendor, for example, exhibited the incorporation of a grained surface into the dies used in tool and mould construction (Sauer GmbH / Lasertec, Pfronten).

Selective application of thermal energy is also utilised when producing ball screws by means of dry hard whirling. The whirling tool used for this purpose is fitted with cutting inserts made of cubic boron nitride, which provide dry machining of the hardened round steel bar. The premium variant of this machine series is equipped with a solid granite bed, whose rigidity and thermal inertia prevents vibrations and dislocations. Excellent surface qualities are achieved (Reitec GmbH & Co. KG, Hagen).

For large workpieces, where multifarious machining tasks have to be carried out, one manufacturer is offering a manoeuvring-platform milling machine with a very reasonable price-performance ratio. Fast movements are assured by rapid traversing rates of up to 40 m/min. In the case of frequent position and tool changes, this means the non-productive time can be reduced. The key performance data of the main spindle (speed up to 5,000 min<sup>-1</sup>, power up to 30

kW and a maximum torque of 850 Nm) suffice for general metal-cutting operations (Union Werkzeugmaschinen GmbH Chemnitz, Chemnitz).

Specifically for difficult-to-machine materials, such as nickel and titanium alloys for the aerospace sector, one manufacturer is offering a machining centre that provides a cooling lubricant pressure of up to 150 bar. This means that even higher stock removal rates, where a large part of the power inputted is converted into thermal energy, are processed more efficiently. To enable turning operations to be carried out in the machining centre even on cubic workpieces that are not rotationally symmetrical, a round table has been integrated that permits workpiece diameters of up to 1,200 mm (Okuma Corporation, Oguchi, Aichi-Pref., Japan).

Whereas the achievable speeds for round tables had hitherto been limited to  $1,000 \text{ min}^{-1}$ , one exhibitor was showing a bearing system that in directly driven round tables enables limiting speeds of up to  $2,000 \text{ min}^{-1}$  to be achieved. While retaining the requisite rigidity and accuracy, the frictional torque and the temperature obtaining inside the bearing have been reduced. This doubling of the limiting speeds is of particular importance when small workpiece diameters are required to be turned in machining centres at technologically appropriate cutting speeds (Schaeffler Technologies GmbH & Co. KG, Herzogenaurach, Ina Drives & Mechatronics GmbH & Co. oHG, Suhl).

## **Styling**

The traditional “green” machines that used to dominate the visual appearance of workshops and production halls were no longer around at the EMO Hannover 2011. They had been replaced by thoughtfully conceived machines styled by industrial designers. Visitors to the fair noticed immediately that machinery styling in line with stringent ergonomics is meanwhile a matter of course. The styling is a significant contributor to cogent sales argumentation and is never an end in itself, but always linked to enhanced ergonomics and efficiency. In addition, the styling is required to underline the machine’s performance capabilities and upgrade the pride in ownership. One example of functional, unfussy and timeless styling is strikingly exemplified by the products of a honing machinery manufacturer, where the machine’s design intensifies the focus on the core functions involved (Gehring Technologies GmbH, Ostfildern). New materials are being used by design engineers not

only for purposes of styling, but also in order to exploit the advantages inherent in the properties of the materials concerned. Carbon-fibre-reinforced plastics, for example, are used not solely in airplane manufacturing. A fine snap gauge made of carbon-reinforced plastic was showcased, which makes it much easier for the operator to measure large shaft diameters, thanks to the dramatic reduction in mass (Kordt GmbH & Co. KG, Eschweiler). Clamping chucks for lathes made of carbon-reinforced plastics enable weight savings of up to 75 per cent to be achieved. Thus thanks to a faster spindle run-up not only is productivity enhanced, but operation is also rendered more energy-efficient (Rota NCL from Messrs. Schunk GmbH & Co. KG, Lauffen/Neckar).

### **Energy-efficiency and sustainability thanks to reduced base load**

Whereas in recent years approaches to saving energy have been predominantly mapped out by the component suppliers of the machine tool manufacturers, the latter have meanwhile taken fully on board the necessity of upgrading their products' energy-efficiency. In parallel to hydraulic units, e.g. in clamping and drive systems, new components on an electro-mechanical basis are now available, with the first machine featuring no hydraulics at all already on the market. In conjunction with regenerative-capability, high-efficiency drives, friction-reduced bearings and adaptive control systems, energy consumption can be meaningfully downsized.

One manufacturer exhibited a machining centre that manages without any hydraulics at all. The CNC control system is used here not only to control the axes, but also to control the components for clamping tool and workpiece. The latter is implemented by means of electro-mechanical components. Besides reducing energy consumption, the replacement of hydraulics is also designed to produce higher availability and a reduction in non-productive time (Grob-Werke GmbH & Co. KG, Mindelheim).

The energy-efficient components installed include a design-enhanced tool revolver for lathes. During machining, the revolver is locked in position entirely by electro-mechanical means. The revolver does not require any energy during the turning or milling operations in order to maintain the clamping configuration and possesses performance data well-nigh identical to its hydraulically operated counterparts. It also excels in terms of these rather impressive performance data: for driven tools, the revolver offers a rating of 11

kW, maximum speeds of up to 12,000 min<sup>-1</sup> and a torque of 33 Nm (Sauter Feinmechanik GmbH, Metzingen).

In addition, one manufacturer of clamping aids was exhibiting a new, compactly dimensioned electric full clamber for lathes. The workpiece clamping system requires energy only when a movement is actually required. The energy consumption thus lies significantly below that of comparable hydraulically operated systems (Röhm GmbH, Sontheim). Another important element in lathes used for machining long, slim workpieces has always been the rests used to support the workpiece involved. At the EMO Hannover, leading manufacturers showcased rests operated entirely in electro-mechanical mode. The field-proven mechanisms of the previously hydraulically operated self-centring rests were altered only insignificantly or not at all. Instead of a hydraulic cylinder, they are now driven by a high-ratio servo-drive. As further advantages over and above energy savings, one manufacturer of rests cites easy control system integration of the rest, self-locking in operation without any energy input, and the relatively low additional costs compared to a hydraulically operated rest (SMW-Autoblok Spannsysteme GmbH, Meckenbeuren; Schunk GmbH & Co. KG Spann- und Greiftechnik, Lauffen/Neckar). As a final summary, it can be said that the above-mentioned machine tool components, by reason of the principle involved, entail a higher capital investment outlay. Some manufacturers, however, adduce cogent sample calculations showing that this can pay for itself quite quickly.

### **Innovations in forming technology and sheet-metal machining as well**

In the field of forming technology, it is already clear that hydraulic drives will in future be at least partially replaced by electro-mechanical servo-drives. For instance, an electro-mechanical press was on show for solid-forming applications. Servo-drive technology enables higher forming speeds and better utilisation of the material's potential to be achieved. Another exhibit was a horizontal forging machine with a pressing force of 500 kN. This press possesses for horizontal forging movements two servo-drives and one vertical knee-lever clamp drive (Schuler AG, Göppingen).

Laser cutting systems for machining sheet-metal are now available with fibre lasers: one vendor exhibited a system able to machine not only steel materials but also non-ferrous materials like copper, brass and titanium. Linear drives

enable positioning speeds of up to 240 m/min. to be achieved. In laser machining of stainless steel sheets in a thickness of 1 mm, cutting speeds of up to 60 m/min are possible. Using fibres means that elaborate and costly optics for beam guidance can be dispensed with, and the space requirement downsized (Amada Machine Tools Co. Ltd., Kanagawa, Japan).

### **Tool innovations increase the quantitative output**

In response to the high price for hard-metal, most tool manufacturers are offering base bodies that can be fitted with different hard-metal-based heads. Tool systems featuring interchangeable heads can constitute an alternative to using solid hard-metal tools, provided no technological disadvantages materialise during the metal-cutting operation. One tool manufacturer showcased an interchangeable-head system whose construction and design offer a high level of precision after a head change-over routine, thanks to radial centring and consistent overhang lengths. The trend towards modularised tool systems can also produce advantages in terms of productivity. By using the right head for the machining function desired, cutting materials can be purposefully changed and the cutting data adjusted. In contrast to solid-hard-metal interchangeable head systems, tool base bodies with a modularised structure can also offer advantages in terms of productivity. A stepped-construction square shoulder milling cutter with a setting angle of 90°, which can be used for cutting depths of up to 4 mm, thanks to the use of smaller hard-metal cutting inserts, provides an option for fitting a higher number of cutting inserts to the circumference. The closer tooth pitch enables overall total feed rates to be increased (Seco Tools AB, Fagersta, Sweden). Restricted initially to hob cutters, one manufacturer is offering an innovative intermetallic cutting materials made from cobalt, molybdenum and iron. The intermetallic phases are separated by a secondary hardening function in the production process. Thanks to the increased ability compared to HSS for maintaining the mechanical strength at higher temperature, cutting speed increases of up to 50 per cent can be achieved and the throughput times of hob cutting reduced (LMT Tool Systems GmbH, Oberkochen).

### **Non-productive, make-ready and standstill times are reduced**

In order to reduce the proportions of non-productive times, a series of dynamic geared-motor units for linear movements were exhibited by a component manufacturer for rack-and-pinion systems. The gear unit's dimensioning

enables it to be responsively matched to the masses being moved. In a typical case, a mass of 300 kg can be accelerated in 0.3 s to 360 m/min. With a weight of 20 t, a speed of 40 m/min is reached after 0.13 s. The pinion is connected directly to the gear unit by means of electron-beam welding, so that the unit is very compactly dimensioned (Wittenstein alpha GmbH, Igersheim). For turning operations involving large components a rest and a clamping chuck were exhibited, for instance, whose centres in their clamped state can be set down to the last micrometer by means of screws. The time-consuming make-ready adjustment of rests in the non-clamped state can thus be eliminated (SMW-Autoblok Spannsysteme GmbH, Meckenbeuren).

For purposefully reducing make-ready times still further, a new clamping jaw replacement system with swivelling jaws was showcased. By turning these jaws and then letting them engage, they can be set to six different working positions. The operation can be completed significantly faster than manual replacement using the previous clamping-jaw change-over systems (MPC Automation Systems AB, Stockholm, Sweden). A system for monitoring the flatness of tool-holders at milling spindles serves to detect chips and soiling in a range of ten micrometers and in the event of a malfunction to communicate this to the control system. The technology for measuring the distance between the contact surface and the spindle and tool-holder is based on using radar electronics and ceramic resonators, and is designed to reduce machinery standstills (Ott-Jakob Spanntechnik GmbH, Lengenwang).

### **Titanium, fibre-reinforced plastics or composite material pose new challenges for the metal-cutting process**

The use of fibre-reinforced plastics in airplane manufacture is causing the proportion of titanium alloys used in the aircraft to rise swiftly. Since in contrast to previous aluminium structures, integral titanium components can be machined only with lower stock removal rates, many companies are intensifying their efforts to achieve increased productivity levels in the titanium sector. A special stand hosted by the Machining Innovations Network and the seminar entitled "New production technologies in the Aerospace Sector" spotlighted current developments. Two cases can be cited to exemplify ongoing efforts. In order to counter the high static process forces involved in titanium machining and general heavy-chip removal, one manufacturer of

shrink-fit chucks showcased an adapted tool clamping system: the shrink-fit chuck features positive-locking cams that engage in grooves machined into the tool shank. This prevents the tool from being pulled out due to a high axial process force encountered (Haimer GmbH, Igenhausen). Generous use of water-based cooling lubricants is the current state of the art for titanium-cutting applications. In this context, one producer of cooling lubricants showed that the tool's useful lifetime can be significantly improved by using media developed specifically for titanium machining (Blaser Swisslube GmbH, Stuttgart).

### **Choice of process control as the key to competitive advantages**

One approach for doing without cooling lubricants when machining difficult materials, while at the same time increasing productivity, can involve choosing an innovative mode of process control. Cryogenic machining, e.g. by low-temperature cooling with liquid nitrogen or with carbon-dioxide-based snow crystals, can crucially increase the stock removal rates involved. In order to upgrade efficiency when machining tempered steels, cast materials made from vermicular graphite or difficult-to-machine materials based on titanium and nickel, one machine tool manufacturer showed how the machining process can be cooled. For this purpose, liquid nitrogen at a temperature of  $-200^{\circ}\text{C}$  is passed through the cutting insert of the tool system to the actual working position. For rotating tools, the spindle system has been appropriately adapted to suit the supercooled temperatures (MAG IAS GmbH, Göppingen). At  $-78^{\circ}\text{C}$ , the carbon-dioxide-based snow-jet cooling system provides an alternative to liquid nitrogen. One advantage here is the less elaborate feed system, since liquid carbon dioxide exhibits room temperature and only cools down at the nozzle discharge. This provides an option for simple retrofittability on existing machine tools as well, enabling difficult materials to be machined (Global Retool Group GmbH, Lebach).

### **Use of software in the production process steadily increasing**

The devices used for presetting tools can not only determine the position of the cutting edge, they can determine the envelope contour of tools as well. One vendor of presetting devices showed how the 3D data generated can be stored in different formats and utilised for collision monitoring, e.g. in CAM packages. Work is proceeding on digitising non-rotationally-symmetrical tools, like turning tools. For purposeful digitisation of tools, a system was also



showcased that no longer detects merely the envelope contour but the entire shape of the tool. The integration of strip light microscopy enables the complex structures of rotationally symmetrical tools to be determined for feedback. High-precision strip light projection also enables cutting-edge rounding to be detected (E. Zoller GmbH & Co. KG Einstell- und Messgeräte, Pleidelsheim).

One producer of CAD-CAM software packages focuses purposefully on optimising non-value-creating worksteps in order to shorten the throughput time. Mid-tier companies, in particular, who frequently have to process small batch sizes of high variance and with corresponding repetition cycles, benefit from shorter make-ready, run-in and standstill times. The CAD-CAM system not only ensures optimised, collision-free NC programs, which are particularly important in 5-axis machining, it also features an integrated tools and clamping aid management function, which synergises organisational details on status, scheduling and locations (Coscom Computer GmbH, Ebersberg).

The machine tool's control system can be used as a platform for visualising the energy flows involved: at the control panel from one manufacturer, the operator can use an easily memorable key combination to evaluate directly the energy consumption of the entire machine, during standstills, for example. This enables consumers to be easily identified and switched off. There is also an option for analysing the energy consumption for producing a particular workpiece, and to derive from this improved machining strategies (Siemens AG Industry Sector Drive Technology Division, Erlangen).

### **Process monitoring**

This year, too, the long-standing pressure on costs in the utilisation of production lines is being reflected in enhanced capabilities for operating machine tools automatically thanks to process monitoring systems. The focus here is on aspects involving intuitive operator control and improved usability of the systems by the production staff concerned. At the same time, simple adaptability of process monitoring systems to users' specific needs is playing a very important role this year (Marposs S.p.A, Bentivoglio, Italy). There is a generally observable trend, in both the software and the hardware used, towards modularising the monitoring systems involved, a vital and fundamental precondition for creating adaptability to customers' wishes.

### **Growth through internationalisation**

Currently on everyone's lips are the BRIC countries of Brazil, Russia, India and China, all of whom were represented at the EMO Hannover 2011. Brief reports on the two BRIC nations of India and China will be provided below. India's machine tool industry is focusing on providing machines for its fast-growing domestic market, with exports playing a relatively insignificant role. In particular, machines are needed for automated production of components used in small cars and bicycles. China's machine tool industry continues to essentially meet the demand in the low- and mid-tech segments, and cannot at present show any technically innovative products or highlights. Future developments here, however, remain potentially exciting: one major Chinese machinery manufacturer says that in future joint ventures are in the pipeline with prestigious Western machinery manufacturers for progressing technological expertise. Western Europe's manufacturers of tools and components can regard this as an opportunity to no longer supply only European companies that are operating in the BRIC nations, enabling them to access local sales markets in these countries as well, not least with low- and mid-tech products.

### **Summary**

The exhibitors at the EMO Hannover 2011 showcased top-performing high-end products offering maximised productivity, availability and cost-efficiency. Topical issues like resource-economy and the machining of new design materials were widely discussed at the relevant side-events. The verdict is indubitably that the machine tool manufacturers and their component suppliers are well equipped to meet and master the challenges ahead.

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