



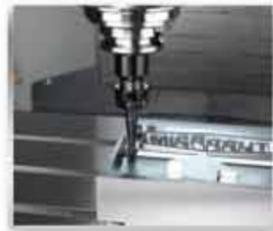
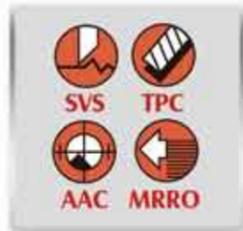
Patent Pending

2011 THE NEW GENERATION

HIGH SPEED & MULTI-AXIS MACHINING SMART CHALLENGER MACHINE



Horizontal Boring & Milling Machine-HBM-series
5 Axes Gantry Type Machine Center-MCG-5X/5XM
Twin Spindles Twin Turrets CNC Lathe- DUAL 500
HSM Machine- V20, V26, V30



Microcut
Quality and Service Built Our Business

Quarterly 2011 VOLUME 3 ISSUE 10

The CHALLENGER

Global quality and service system of metal working industry

MICROCUT in TIMTOS 2011
Asia's Second Largest
Machine Tool Show



CIMT 2011
The 12th China International
Machine Tool Show



Distribution
D'ANDREA-Technology
for High Precision





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Precision Spindle Builder

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HBM-4T HBM-5T CNC Boring & Milling Machine

Spindle quill diameter (W axis) : 130mm for HBM-4T/ HBM-5T/ HBM-5TE

Taper : ISO # 50 for HBM-4T/ HBM-5T/ HBM-5TE

power rated : 22KW (Fanuc) for HBM-4T, 37KW (Fanuc) for HBM-5T/ HBM-5TE

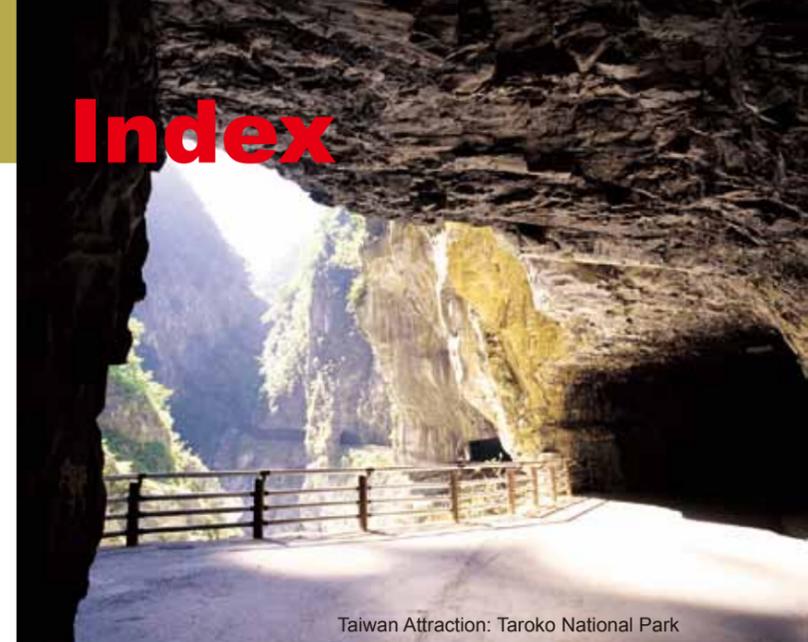
X travel : 2000 (std.) / 3000 (opt.) mm for HBM-4T, 3500 (std.) / 4500 (opt.) / 5500 (opt.) for HBM-5T, 4500 (std.) / 5500 (opt.) / 6500 (opt.) for HBM-5TE

Y travel : 2000mm for HBM-4T, 2600mm for HBM-5T, 4300mm for HBM-5TE

Z travel : 1400mm (std.) / 2000mm (opt.) for HBM-4T, 1400 (std.) / 2000 (opt.) mm for HBM-5T, 1450mm (std.) / 2000mm (opt.) for HBM-5TE

W1 (std.) / W2 (opt.) : 700/800 mm for HBM-4T, 700/800 mm for HBM-5T, 700/1000mm for HBM-5TE

Table dimensions : 1400x1600 mm (std.) / 1600x1800mm (opt.) for HBM-4T, 1800x2200mm for HBM-5T, 4500x3000mm (std.) / 3200x3200mm (opt.) for HBM-5TE



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E-mail: info@mail.buffalo.com.tw
Editor: Christine Chiu
m01@mail.buffalo.com.tw
Editorial board: Christine Chiu
Paul Chang
Sabina Chen

Layout and Typesetting :
Treasure Map Advertising Corp.
E-mail: apchen.ap@msa.hinet.net

Subscription:
Buffalo Machinery Co., Ltd.
56, Lane 318, Der Sheng Road, Ta Ya,
Taichung City, Taiwan
TEL: 886-4-25 60 37 59
FAX: 886-4-25 60 37 69
www.buffalo.com.tw

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of company profile, sharing Challengers' Products experience and pictures of people, products. Please send your story and pictures (images in high-resolution higher than 300 dpi) to your Challenger Factory Outlet or e-mail to m01@mail.buffalo.com.tw
Only English version is acceptable.

From the publisher



was chatting with one of our distributors, talking about the difficulty of machine tools business today, especially what was happening after the global finance crisis since late 2008. Although some certain countries show very promising sales finally, most of our major markets remain very low up to end of 2010. In the mean time, this industry is facing more and more difficulty of its daily jobs. We see that the cost of material and main components have soared strongly, New Taiwan dollars appreciate a lot compared with Euro and U.S Dollars, reducing the competitiveness of Taiwan-made machines and its position. While the local labor costs are rising, and yet, most of the major brands are cutting their prices with huge discount which we never believe how can they have such a high margin to cut. So, at the end of 2010, we found that it was a tough year, working hard to keep all the employee, trying to save every single order and hopefully to maintain the level without lose on balance, and yet, it shows no margin at the end. The friend told me it is the reason why we call ourselves "The Challenger".

Export and Import statistics announced by Customs indicate that the value of machine tool exports during 2010 was U.S.\$2,962 millions, a low level and even decrease of 1.86% compared with 2006! It is still 22% lower export value in comparing 2010 / 2008 for VMC, though the total export of VMC has jumped for 98.4% in comparing with the export amount 2010 / 2009. And the CNC Lathe shows 35.6% lower export value in comparing year 2010 / 2008, though the export value of CNC Lathes jumped 41.7% comparing the export amount 2010 / 2009. The export value to E.U remains lower than previous year, but the market share of export to China including shipment thru H.K has a huge jump to 46%, and then 11.6% from America, 11.3% from E.U. The fact is that Taiwan metal working machines remain as an entry level of products when it has been considered by its main market and the average unit price.

Challenger takes the opportunity to develop a high technology of mechatronics, upgrading the machines to meet the requirement of high speed machining technology. It is called "Smart Machine Technology". Challenger is not waiting the chance to return, but working hard to be ready for the new chances. Challenger has been searching for the great technique to support our client to fight for the better position. With the new techniques, we provide a series of new products which provide much better performance of its accuracy and saving cutting time.

Please make sure that you are aware and ready to give us a chance to support you to be better and stronger while the economy is recovering.
A great success to you all.


Dr. Paul Chang
April, 2011



Microcut Newsroom

CIMT 2011, Beijing, China

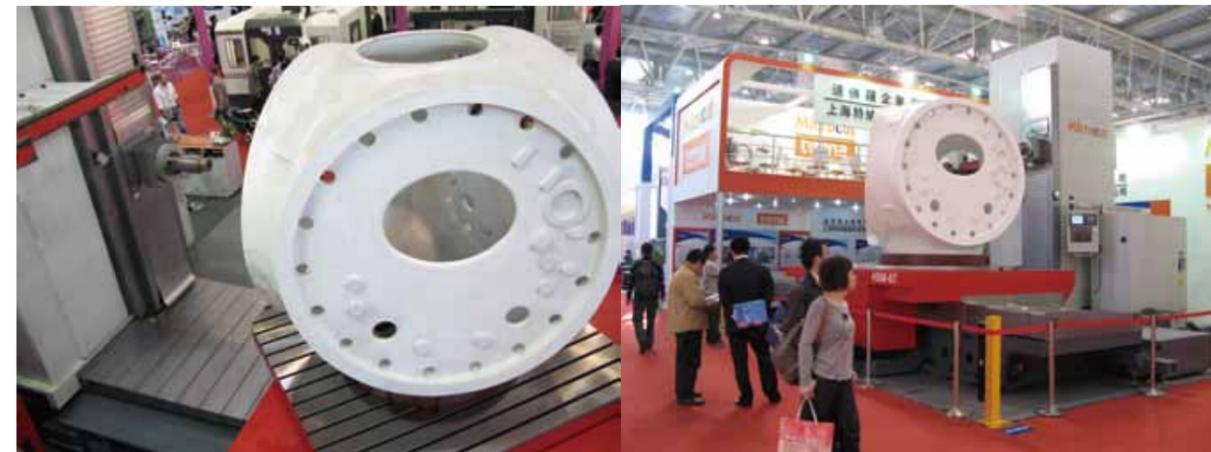
The 12th China International Machine Tool Show (CIMT2011) sponsored by China Machine Tool & Tool Builders' Association will be kicked off on April 11~16, 2011, at the new venue of China International Exhibition Center (CIEC) in Beijing.

It is believed to be one of the four largest machine tool trade shows including EMO, IMTS, JIMTOF and the largest one in China.

All the world's leading machine tool manufacturers will take part in the exhibition.

Microcut will once again present the best quality products in the CIMT2011.

We sincerely welcome you to see the latest products and the most up-to-date technologies from Buffalo Machinery including HBM-5T with Fanuc 18i.



HBM-5T Horizontal Boring and Milling Machine

The HBM line is widely productive in power industry, transportation, mining, oil & gas industry, mold and steel construction. Both quill and ram type are available. Big capacity provided by several length 3500 /4500/5500mm in X travel, 2600 or 3200mm in Y travel, 1400 or 2000 mm in Z travel, 700mm in W travel. Machine equipped with latest version of controllers Fanuc, Siemens or Heidenhain controller.

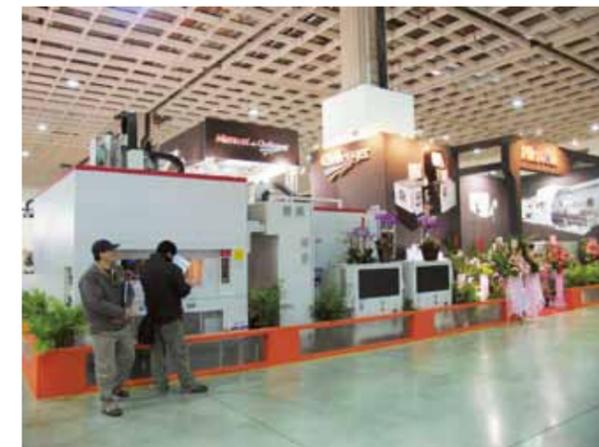
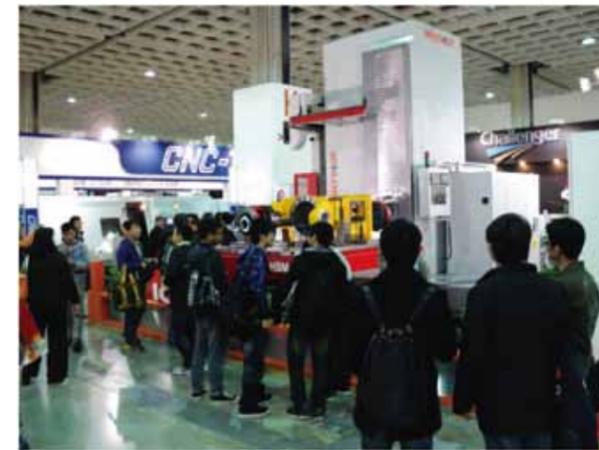
TIMTOS 2011, Taipei Presents Asia's Second Largest Machine Tool Show



The 15th Taipei International Machine Tool Show (TIMTOS 2011) runs from the 1st to 6th of March 2011 at the Taipei World Trade Center and NANGANG Exhibition Hall. Scale at this year's TIMTOS has exceeded 5,000 booths, surpassing the Japan International Machine Tool Fair, thus becoming the second largest machine tool show in Asia. In the meantime, Taiwan is marching towards its "5,000 foreign buyers" target to

achieve its "Double 5K" objective.

While the 2009 TIMTOS had 895 exhibitors and 4,871 booths, this year's show boasts 928 exhibitors who are displaying their state-of-the-art products in 5,152 booths. Also the foreign exhibitors increased from 20 different countries, compared with 15 nations in 2009.



Int'l Visitors from 100+ Countries bring growth and spirit of emerging markets

Buyer representation was strongest from Japan since Taiwanese manufacturers have grown adept at offering products with quality that nearly matches that of Japanese goods. Secondly, Taiwan-made machine tools and components are more competitive in price due to the appreciation of Japanese

Yen. Thirdly, the potential business opportunities provided by the signing of the cross-strait Economic Cooperation Framework Agreement (ECFA) has encouraged many Japanese companies to establish cooperation with Taiwanese manufacturers.

ECFA has come into effect, the era of zero duty has come

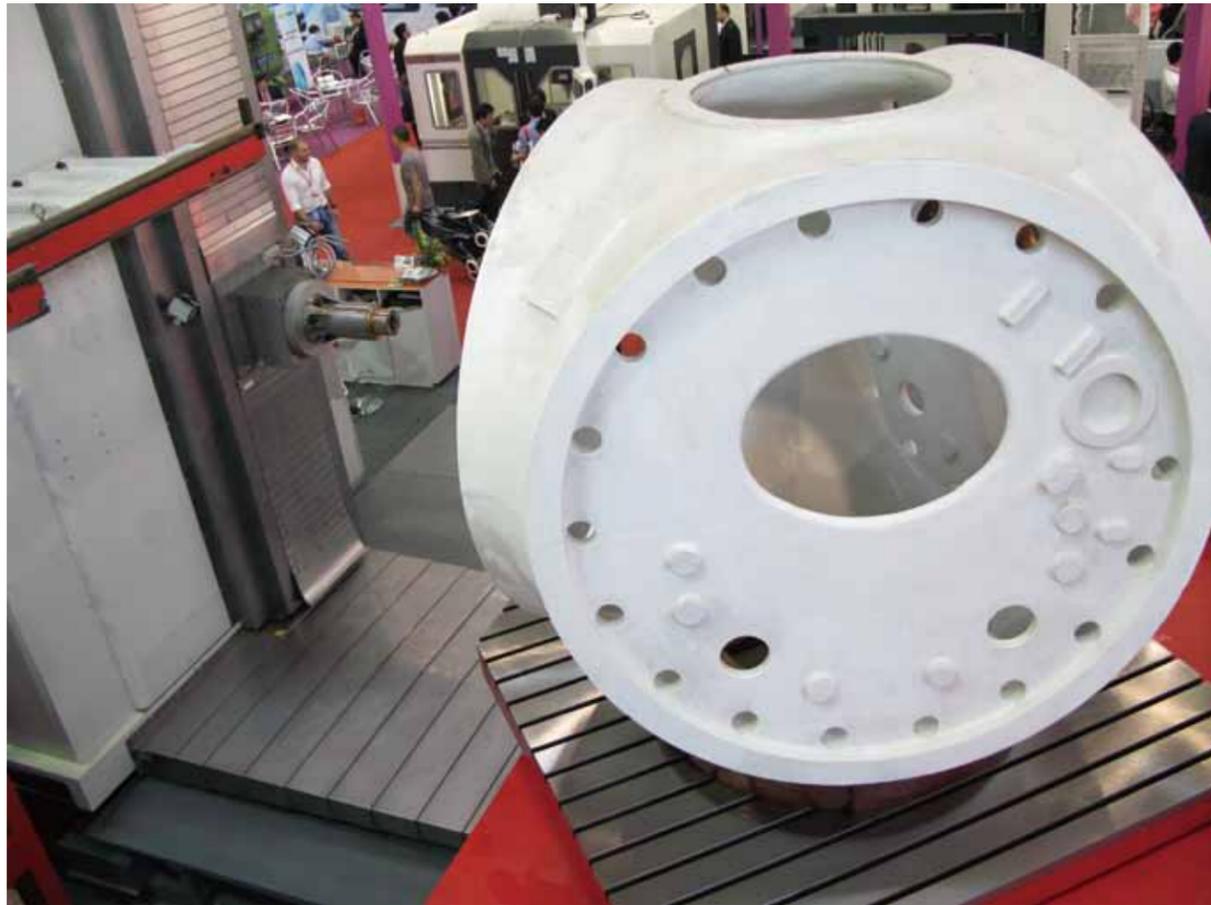
China ranked second in the total number of visiting buyers. TIMTOS 2011 was the first machine tool exhibition held after the release of the Early Harvest List stated in the ECFA, thus drawing a great number of Chinese buyers. Other countries included Malaysia, South Korea, India, Thailand, US, Turkey, Singapore and Russia. For TIMTOS 2011, the organizers had mobilized 56 branches around the world to proactively invite leading buyers and arrange buyer groups from Italy, Russia and India.

The signing of the cross-strait Economic Cooperation Framework Agreement (ECFA) was undoubtedly the most important news for Taiwan's machine tool industry in 2010. A total of seventeen machine tool products, including CNC lathes

and grinders, were included in the Early Harvest List; enjoying reduced or zero tariffs starting on January 1, 2011. Sales volume to China and Hong Kong comprises nearly half of all Taiwan's machine tool exports.

In the meantime, while the automobile manufacturing business is recovering and re-developing in the US and European markets; Taiwan's exploring new burgeoning countries, such as India, Brazil and Russia which pose new targets all companies in Taiwan.

5-axis and turning / milling machine, high speed high accuracy machines, and super large machinery are the focus in this TIMTOS, it shows the necessity and urgency of this important issue.



Taiwan Machine tool export in 2010 grows 70% than 2009

Taiwan exported US\$2.961 billion worth of machine tools in 2010, representing a 70% year-on-year growth, according to statistics compiled by the Taiwan Machine Tool Foundation (TMTF).

Exports of metal-cutting machine tools came to US\$2.331 billion, up a whopping 76.1% from a year earlier, and that of metal-forming machine tools amounted to US\$630.32 million, up 50.4%.

A further breakdown showed that exports for machining centers grew 98.4% year-on-year in 2010, and those of lathes, grinding machines, and milling and boring machines shot up 41.7%, 102.3% and 81.1%, respectively.

Hong Kong and mainland China together was the largest export destination, absorbing US\$1.36 billion worth of Taiwan-made machine tools in 2010, up 109.1% year-on-year and accounting for 46% of the total exports. The U.S. ranked second with US\$162.69 million, up 30.3% and commanding 5.5%. India came third with US\$137.05 million, up 130% and accounting for 4.6%.

Other major export outlets, in descending order, were Thailand, Turkey, Brazil, Malaysia, South Korea, Indonesia, Germany, Vietnam, the Netherlands, Japan, Italy, and Singapore. Export values to Turkey, Thailand and Brazil had risen year-on-

year by 214.2%, 67.1% and 81%, respectively.

The 2010 sales distribution of Microcut is slightly different to the country export of Taiwan. The Brazil is the largest market, accounting for 27% total market share. The China ranked second, up to 15% market share. Then follow U.S, Germany, Russia and South America with market share of 13%, 10%, 6% and 5%, respectively.

According to 2010 sales distribution of Microcut, it shows the vibrant contribution from emerging economics such as Brazil, China and Russia. As the 2011 CECIMO (European Committee for Cooperation of the Machine Tool Industries) conference will take place in June in Portugal, the delegates will take BRIC challenges and opportunities as important issues to be discussed.

In recent years, vast quantities of Taiwan-made machine tools have been exported worldwide. This phenomenon has also spurred the export of tool components. Several advanced countries, such as America, Japan and Germany favor Taiwan-made components because of their competitive prices. Furthermore, fast growing economies such as China, India, Brazil and Thailand are also investing in Taiwan-made components to boost their own competitiveness.

As a result, Taiwan has become a principal global base for machine tools and components; next only to Japan and Germany. Between January and November of 2010, the total export value of Taiwan-made machine tools reached nearly 3

billion USD, marking a 70% growth compared to the same period of 2009. The significant growth of export value indicates that Taiwan is well back on the road to recovery.

Fanuc 31iB, 31iB5 will be introduced in the 5 axes Microcut machines

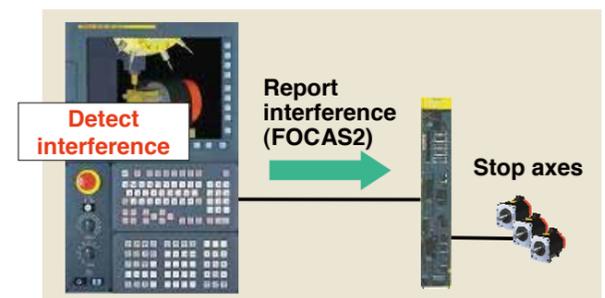
Series 31 i B suits for high grade lathe and machining center and Series 31i B5 with additional feature of simultaneous 5-axis machining function will be introduced on the Microcut 5-axis machining center in 2011. Max controlled axes for 31 iB is 26, feed axes is 20, spindle axes is 6. Max controlled paths is 4 and max controlled axes per path is 12. Max simultaneously controlled axis is 4 and 5 for 31 i B5. Max part program storage capacity is 8MB. Max PMC path is 5.

- The latest features for FANUC Series 31iB5 include the following:
- Latest Features for 5-axis machining
 - The CNC achieves tilted working plane machining and smooth high-speed simultaneous 5-axis machines.
 - High speed High accuracy machining
 - Enhancement of synchronization between spindles and servo

- axes. High-precision operation in nanometers and acknowledged HRV control.
- High speed and large capacity Multi-path PMC
 - Large scale sequence control is processed at ultra high speed and max 5 independent ladders can run concurrently.
- Enhancement of productivity
 - Cycle time is shortened by reducing non-cutting time.
- Excellent Operability and easy maintainability
 - Operability is enhanced with USB memory and so on. Enhanced fault diagnosis and predictive maintenance function reduce down time.
- Reduce wiring
 - Enhanced hardware built on latest technology realizes further reduction of wiring and lower wiring cost.

- This function is enabled in both automatic operation by NC programming and manual operation by handle.
- An interface (FOCAS2) between animated simulation and the CNC is provided.

(Note) FANUC does not provide any 3-dimensional animated simulation feature. For animated simulation vendors supporting this function, contact FANUC.



Easy to set 5-axis machining condition

5-axis machining condition meeting the various purposes of machining can be easily selected on a setting screen.

- 1) The machining condition can be specified by NC program.
- 2) The machining condition can be easily set on CNC screen.



CNC Screen

1) The condition can be specified with CAM



CAM

2) The condition can be specified on CNC screen
 - Easy selection by Soft-key or Cursor
 - The names of conditions can be customized

(Notice) This function is available only with Series 30i-B/31i-B5.

Global Outlook Poland



LOCATION

Poland is located in Central Europe, the geometrical centre which is near Warsaw-the capital of Poland. Poland's total surface area is 312,679 sq km (120,726 sq mi) This makes it the 9th largest country in Europe, after Russia, Ukraine, France, Spain, Sweden, Germany, Finland and Norway, and the 69rd largest in the world.

With the Population of 38.2 million people Poland is ranked as 34th in the world, and 8th in Europe. Neighboring countries are: Russia (Kaliningrad District), Lithuania, Byelorussia, Ukraine, Slovakia, Czech Republic, Germany.

In the northwest is the Baltic Sea and in the south lies the Polish mountain region, including the Sudetes, and the Carpathian Mountains, with its highest part-the Tatra Mountains.

CLIMATE

Poland has a moderate climate with both maritime and continental elements. The weather tends to be capricious and the seasons may look quite different in consecutive years. This is particularly true for winters, which are either wet, of the oceanic type, or - less often - sunny, of the continental type. Generally, in north and west Poland the climate is predominantly maritime, with gentle, humid winters and cool, rainy summers, while the eastern part of the country has distinctly continental climate with harsh winters and hotter, drier summers.

Polish strong winter



Financial center of Warsaw



THE EUROPEAN UNION

On May 1st 2004 Poland became a member state of the European Union (EU) and thanks to its location occupies a specific place within it. Poland's eastern border became the EU's eastern border. In the wider geographical and geopolitical sense Poland occupies a central position. It is, furthermore, likely that after accession, Poland will perform the role of a transit state in Europe.

Beside the European Union, Poland is also a member of the NATO, the United Nations, the World Trade Organization, and the Organization for Economic Co-operation and Development (OECD).

ECONOMY AND INDUSTRY

Poland's economy is considered to be one of the healthiest of the post-Communist countries and is currently one of the fastest growing within the EU. Since the fall of the communist government, Poland has steadfastly pursued a policy of liberalising the economy and today stands out as a successful example of the transition from a centrally planned economy to a primarily market-based economy. Poland is the only member of the European Union to have avoided a decline in GDP during the late 2000s recession. In 2009 Poland had the highest GDP growth in the EU. As of November 2009, the Polish economy has not entered the global recession of the late 2000s nor has it even contracted.

Poland is recognized as having an economy with significant development potential, overtaking the Netherlands in mid-2010 to become Europe's sixth largest economy. Foreign Direct Investment in Poland has remained strong ever since the country's re-democratisation following the Round Table Agreement in 1989. Despite this, problems do exist, and further progress in achieving success depends largely on continuing development and modernisation of the economy.

Commodities produced in Poland include: electronics, cars (including the luxurious Leopard car), buses, helicopters, transport equipment, locomotives, planes, ships, military engineering (including tanks), medicines, food, clothes, glass, pottery, chemical products and others.

SCIENCE

Poland is becoming an interesting location for research and development investments. Multinational companies such as: ABB, Delphi, GlaxoSmithKline, Google, Hewlett-Packard, IBM, Intel, LG Electronics, Microsoft, Motorola, Siemens and Samsung have set up research and development centers in Poland. Over 40 research and development centers and 4,500 researchers make Poland the biggest research and development hub in Central and Eastern Europe.

Figures about Poland

- Population: 38,192,000 (June 2010)
- Area: 312,679 square kilometer
- Population density: 120 per square kilometer
- GDP (PPP) 2009 estimate:
 - Total \$727.086 billion
 - Per capita \$18,705
- GDP (nominal) 2010 estimate:
 - Total \$479.026 billion
 - Per capita \$12,575

Kraków Wawel, the seat of Polish kings



Krakow Market Square



Distribution



Technology for High Precision



To permit to do turning operations on all machining centres with the new line of heads TA-CENTER for machining centres arranged with a U-DRIVE motor drive unit connected to the CNC. The heads, located in the tool magazine, are loaded by the tool change on the machine spindle and automatically connected to the U-DRIVE. TA-CENTER heads permit to do all kind of turning operations, cylindrical and conical borings and threading, facing, radius and spherical operations.

TA-CENTER
100 - 125 - 160 - 200

EASY CONNECTION
REDUCED DIMENSIONS AND WEIGHTS
EASY TO INSTALL
HIGH PERFORMANCES
CONTAINED COSTS

D'ANDREA is an Italian company, world leader in the manufacturing of high precision machine tool accessories. Known worldwide for the quality of its products, D'ANDREA has been developing increasingly effective technologies since 1951, keeping pace with the modern demands of the mechanical industry. The entire D'ANDREA range comes from their headquarters in Lainate, just outside Milan: TA-CENTER, TA-TRONIC, U-TRONIC, U-COMAX and AUTORADIAL facing and boring heads.

The high precision modular toolholder and boring system MODULHARD'ANDREA and the high precision monobloc toolholders system for high speed applications TOPRUN. Also manufactured at this facility is the popular 'MONOd', MONOforce, GRINTA and MCD' range of holders. From here, thanks to a modern and efficient logistics system and a capillary, skilled distribution network, D'ANDREA products arrive in workshops throughout Italy and the world.

D'ANDREA vast range of heads and toolholders, available in different versions and sizes, is enhanced by attentive before- and aftersales service, always focused on meeting the specific technical and commercial needs of the customer. The entire D'ANDREA production, guaranteed by engineering, manufacturing and sales procedures in compliance with ISO 9001 standards, is accompanied by a training and information system that involves the user in every new feature. Facing, boring, milling, tapping and drilling: D'ANDREA responds to any application requirement with high precision technology.

The sharing of business objects is part of the company strategy and it is made by the team top management with the very important contribution of all the employees. Since many years D'Andrea has been also involved in many humanitarian projects in Italy and abroad.

D'ANDREA has two Microcut machines in the workshop: HBM-4, MCG-5X1set here in D'Andrea headquarter for demo and another one in our second facility for production.

"We produce the stationary body and the rotating body of our UT3-360S, UT5-500S, UT5-630S with very good results. And in the near future we will try to produce also the UT8-800" said Amedeo D'Andrea, sales manager of D'Andrea.



Product

Maximum value for 5 faces or 5 axes parts

Cutting complex contours, meeting tight tolerances and reducing setups are just a few of the most celebrated benefits of five-axis machine tools. Over time, these complex machine frames have become smaller, more affordable and increasingly popular.

This can be accomplished by incorporating a two-continuous rotary table into a three-axis machine. To increase working capacity and interference free, V20/5 is not only enabled simultaneous five-axis cutting at less cost than a new five-axis machine tool, but also improved flexibility.

Production from every important industrial sector, such as the automotive sector and aerospace, as well as the medical, hydraulics, pneumatics and energy industries, are turning to 5-axis or 5 faces machining as a means to speed manufacturing ability and increase repeatable accuracy. The ability to machine complex shapes, undercuts and difficult angles in a single setup reduces tooling cost and labor time, saving cost per part.

The innovation of Microcut / Challenger high tech products has set the trend of developing full range of 5 axes machining center. A newly-developed trunnion VMC model V20/5, is under production. A diameter 320mm 100 kgs loading table is provided. Both sides opening door design is for handy operation.

V20/5 - Space and Time Savers

V20/5 saves time in the cut is to machine all the parts with only one time of workpiece setup. It simplifies the use of jigs and reduces machining process. The quickest tool change time is 4 seconds. The superior design allows a minimum space requirement with absolute stability, highest accuracy and a powerful milling performance for smaller and lighter machining.

Five-Axis Cycle Time Reductions

The machine's five-axis oscillating head can reach lower to the table, extra machining is combined in a single step. Eliminating extra machining has improved flow and throughput by 40 to 50 percent. The operator can run more parts in a single shift, freeing some much-needed capacity and reducing overtime.

One-Piece Flow

Integrating rotary tables with the VMCs has enabled the shop to complete the implant machining process in fewer steps. The V20/5s' five-axis capability reduced the number of milling operations. Efficient use of the table allowed the company to run both operations simultaneously, completing one set of parts per machine cycle. V20/5 can be one of the powerful Turn-key project equipment as it's reliable and productive.

The rotary table features a trunnion and clamping torque of 686/1380 Nm. With a face-plate diameter of 320 mm and a maximum workload of 100 kg, the device is driven by worm gear and with high precision encoders. The compact C type VMC with high speed torque spindle. Excellent for 5-axis simultaneous machining or 5 face machining. The roller type linear guideway on 3 axes with 48 M/min traverse speed and 6 m/s² acceleration enhances rigidity and high speed movement.



R&D ZONE

Techniques for spindle thermo growth Dr. Ching-Feng Chang

Abstract—Based on eddy current, a dual displacement measurement device applied in this study, a precise and stable output support a reliable compensation unit. It can greatly increase the accuracy and match the laser inspection report.

However, the non-flat surface of motion and fluctuating measurement distance create a certain percentage of error when the single displacement meter is applied. The addition of a differential amplifier will greatly enhance the linear output voltage fed back to the CPU and provide a high sensitive level of compensation. This new application of dual displacement meter can reduce the measurement tolerance from 6 μm down to 1 μm . This level of accuracy greatly increases the quality of the machine tool and its overall cutting performance.

I INTRODUCTION

High speed machining (HSM) technology is used in a broad range of applications to machine aluminum alloys, ferrous metals and nonmetallic materials [1-3]. Based on its application, a motorized high speed, high power/torque spindle is the single key technology that drives HSM. However, as the speed and power of these spindles increase, spindle thermal growth becomes a critical factor to be considered.

The spindle dynamic model is constructed using finite elements based on Timoshenko beam theory. The thermal growth of the spindle, housing and bearings are calculated based on predicted temperature distributions and are used to update the bearing preloads depending on the operating conditions. The thermal growth compensation of the spindle is again used to update the thermal model [4-6].

Although a good spindle design with proper bearing preload has been considered acceptable with a small amount of thermal growth, the bearings loading will increase rapidly by the centrifugal force with the increase of working time and spindle speed [7-9]. The higher speed of spindle revolution, the higher centrifugal force will be. Fig. 1 illustrates a typical spindle structure. A pair of angular contact ball bearings is used to support the lower portion of the spindle. It is also a

proven design and good solution for higher revolution speeds as the angular contact ball bearings are capable of absorbing both axial and radial thrust typical of a normal machining [7-8]. In Fig. 2, as the load on the bearings increases during a normal cutting from many different directions, the resultant decrease in the gap of bearings will cause rapid temperature rising which is nonlinear [9]. Though the spindle was manufactured with the proper preload on the bearings and operated within acceptable parameters, the added loading of the cutting application still causes the spindle thermal growth and unacceptable part finish.

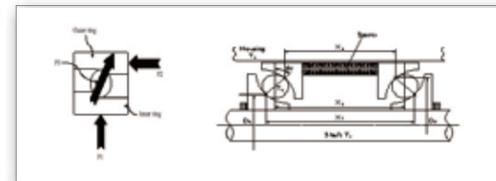


Fig. 2. Left: Bearing pressures from different directions
Right: preload mechanism

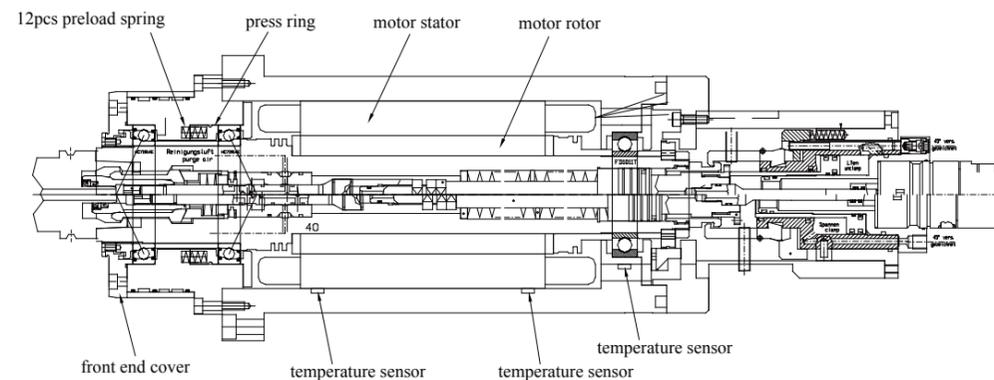


Fig. 1. Motorized spindle structure

PT100 platinum thermo couplers [10] have been traditionally used in this application as they provide reasonably reliable feedback, which is a linear device is usually used in measuring wide range of the temperature raise, such as 0-1000 $^{\circ}\text{C}$. It is usually adopted in sensing seriously varying temperature. Therefore, for the application in spindle with smoothly varying temperature, the accuracy will be acceptable but not optimal as it is indirect measurement. The thermo meter is typically placed as close to the front spindle bearings as possible, but still remains less accurate to measure the actual temperature increase.

Based on the theory of Foucault Current, this study applies the displacement meter in front of the spindle to measure the value of spindle extension. The PLC which directly compensates the thermal growth of all axes not only feeds back quickly but also is more accurate than traditional PT100 thermal coupler. The result proves to increase the machining accuracy, meeting the requirement of high speed machining technology and undoubtedly increasing the value of the machining tools.

II THERMAL DISPLACEMENT MODELING OF SPINDLE

This section investigates the effect of spindle thermal growth on tolerance and the design of bearing load control. We attempt to further identify the characteristics of thermal growth and the restriction of traditional PT100 thermal coupler, which is not optimal for reflecting the irregularity of heat. Besides, this section identifies the characteristic of Foucault Current and its application on the spindle growth measurement.

2.1 Bearings loading control

Fig. 3 shows a motorized high speed spindle using spring force to preload the spindle bearings. Most high speed spindles are designed for high rotational speed in order to RPM (rotations per minute), and high simultaneous axes feeds for light cutting tool load applications.[7-8] A piezoelectric actuator has been placed at the rear of the spindle to maintain proper bearing loading shown in Fig. 4, but the front spindle bearings continue to be of the traditional design and configuration which ultimately still produces considerable heat with the increase of spindle RPM and running time.

Preload device

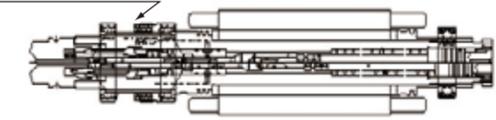


Fig. 3. Motorized spindle with spring preload structure

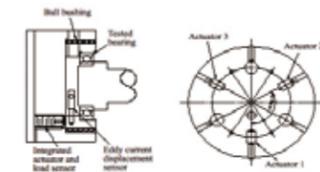


Fig. 4. Spindle bearings with actuator

2.2 Thermal Characteristic statement

Fig. 5 outlines the thermal growth of a motorized high speed spindle running at different RPM for a constant time period. All speed curves are nonlinear and the differences between all curves are not parallel. Each thermal raise curves are not identical and nonlinear. See A & B in Fig. 5. A constant compensation parameter will not improve its performance. [11-12]

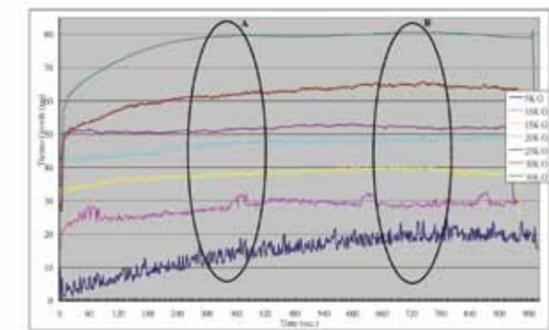


Fig. 5. Temperature rise vs. spindle speed

2.3 Single displacement meter

Based on the law of Foucault current (Eddy Current) and Faraday law, a displacement meter is developed, see Fig. 6. It provides a much precise result of spindle thermal growth. The meter measures spindle expansion directly, the voltage is a perfect linear output.

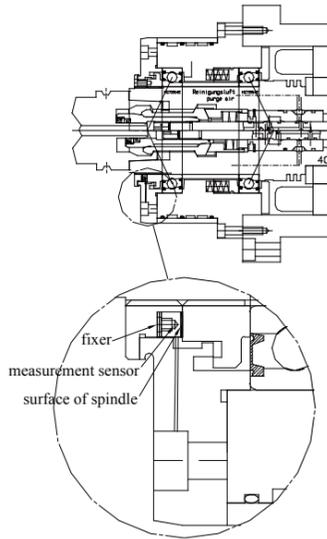


Fig. 6. Spindle with single displacement meter.

2.4 Mechanical design

This new model consists of dual pieces of displacement meters placed in front of the spindle. Single meter is used as a reference and the other one is used to measure 3-5mm away, depending on the space and its rigidity of the spindle end cover. Both meters should be fitted very closely, facing to the spindle end upright, and all geometrical distance between two meters should be as close as possible. The differential amplifier is then applied. Fig. 7 shows the meters placed on the bottom cover of spindle.

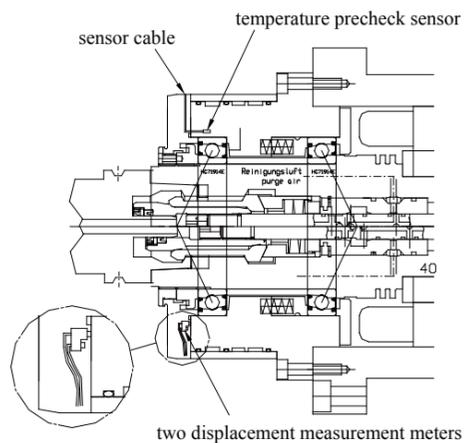


Fig. 7. Spindle with dual displacement meter.

2.5 Logic concept & Amplifier

To get a perfect performance of cutting result, the compensation logic has been set to allow the spindle axis compensation of every 1 μm when the output voltage changes per +/-0.02v. The flow chart is shown in Fig. 8.

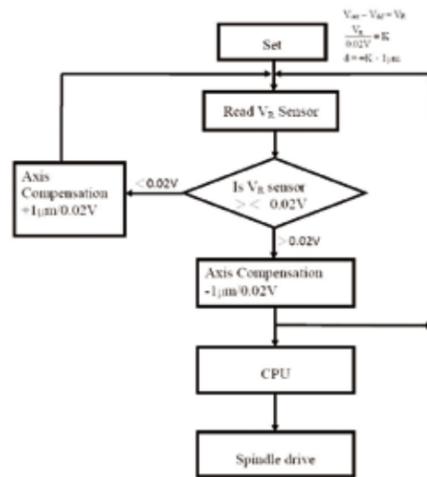


Fig. 8. Flow chart of dual displacement meter

2.6 Control system

The control system is used to measure the output voltage, it can be designed to be a reference level which links to the designed scale of the CPU control system. A M-Code reference has been designed to measure output voltage in sequence. It includes definition of sequence times, analog signal for CPU and reset measurement process. The system will control when the spindle growth is within tolerance or output voltage is larger than constant value K. Then, the voltage is converted to be compensation value.

III EXPERIMENT AND PERFORMANCE

3.1 Amplifier Experiment

To assure the quick and accurate measurement of voltage gain and phase, a high frequency response checking equipment (Model TF-2000) made by Voltech Instrument is used in this study. For the accuracy and reliability of the amplifier designs in this study, the voltage gain and phase testing will be testified in this section.

1) Experimental results and discussion of the dual displacement meter

The testing procedures of the dual displacement meter are

similar to the single displacement meter, except that there are two input voltages in the dual displacement meter amplifier. The two input terminals are connected to one signal source for experimental testing. From the simulation results in section 2.9, one can see that the frequency response of the dual displacement meter is nearly the same as the single displacement meter. Therefore, the experimental results of the dual displacement meter should be similar. Fig. 9 and Fig. 10 show the measured gain and phase bode plots of the dual displacement meter. It is seen that the measured 3 dB frequency is about 10 kHz which meets the design requirement. The experimental results are nearly identical with the simulation results with PSpice.

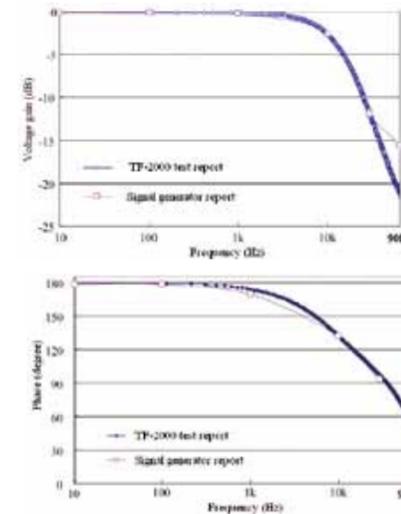


Fig. 10. Bode plot of Dual displacement meter phase

3.2 Laser check

The test is performed on a high speed vertical machining center, which is equipped with a 24000rpm high speed spindle. A laser checking unit is placed on the surface of the working table, as shown in Fig. 11.



Fig. 11. Laser check unit.

A comparison of the spindle equipped with only one displacement meter with the proposed new model is shown in Fig. 12. An additional laser report is also provided to prove the test results. This figure shows that there exists some discrepancy between the measure 1 (single displacement meter), and the laser curve. The measure 2 (dual displacement meter) with this new model nearly matches the laser curve.

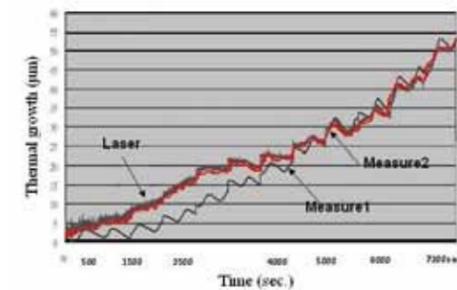


Fig. 12. Comparison curve of lasers and two models.

3.3 Cutting report

Fig. 13 shows a the main checking dimensions of working piece, the material is plastic mould tool steel, code DIN M-461 (GMP21M), and it is the most popular high grade mould steel, the hardness of raw material is HRC 38-42 degree. [17] A three dimensions simultaneously program with highest spindle speed is applied. The tools used as shown in table 1, representing different working time of roughing, 2nd rough cut, pre-finish cut and fine cut. Each sample had been done on the same machining tooling and program. The cutting performance presents a significant improvement of tolerance and its working time when the dual displacement meters are applied. Table II shown cutting report of all models. Take checking point "A" as an example, tolerance in between the spindle equipped with PT-100 thermo coupler and dual displacement meter shows a 6 times improvement. And it is better performance when comparing with a single meter, too.

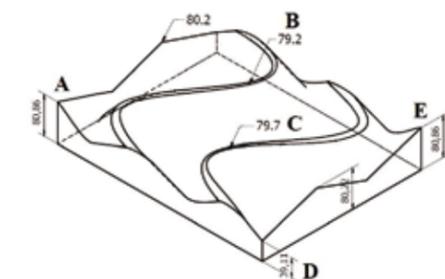
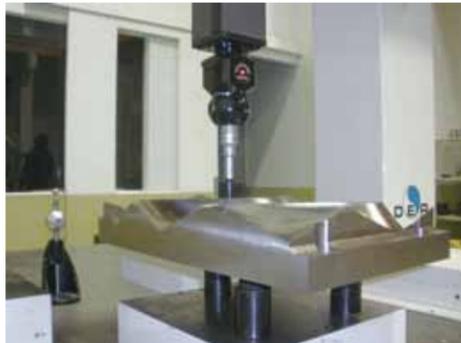


Fig. 13. Working piece and its main checking points.

R&D ZONE

A DEA brand high precision three dimensional coordinate system is applied to check all samples, as shown in fig.14.



Equip. made by DEA spa, Torino, Italy
Model SCIROCCO-201009

Fig. 14. Three dimensional coordinate system

IV CONCLUSION

The proposed new model discovers that the measurement error is 3 times better than the single displacement meter design. The work piece cutting time is much shorter than the spindle equipped with PT-100 and a much better geometrical report is shown. It's a great quality improvement of the accuracy performance for machine cutting. This will greatly help to improve machining quality level and meet the requirement of HSM technology. Moreover, machine daily warm-up time is no longer needed, it saves a lot of energy waste and increase significantly the productivity of machine.

Table I. Tools Table

| Program | Tool diameter (mm) | Tool No. of edges in the tools | Working time PT-100 (min.) | Working time Single meter (min.) | Working time Dual meter (min.) | Spindle speed (rpm) |
|--------------------------|--------------------|--------------------------------|----------------------------|----------------------------------|--------------------------------|---------------------|
| Roughing | 12 | 3 | 98'15" | 98'15" | 98'13" | 2000 |
| 2 nd Roughing | 10 | 2 | 113'0" | 113'0" | 112'0" | 4000 |
| Pre-finish | 10 | 2 | 64'14" | 56'25" | 50'50" | 5500 |
| Finishing | 10 | 2 | 655'15" | 610'30" | 560'10" | 6000 |

Remark: All tools are Sandvik brand tools. Tool no.: R300-32T16-12M / R300-20A25C-10L / R216.44-10030-AK22N / R216.44-10030-AK22N

Table II. Geometrical Test Report

| | Check points & requirement | Spindle without compensation (Tolerance) | Spindle with PT-100 (Tolerance) | Spindle with Single Displacement meter (Tolerance) | Spindle with Dual Displacement meter (Tolerance) |
|---|----------------------------|--|---------------------------------|--|--|
| A | 80.86 | 80.24(-0.62) | 80.80(-0.06) | 80.85(-0.01) | 80.85(-0.01) |
| B | 79.20 | 78.60(-0.60) | 79.14(-0.06) | 79.20(-0) | 79.20(-0) |
| C | 79.70 | 79.05(-0.65) | 79.65(-0.05) | 79.69(-0.01) | 79.70(-0) |
| D | 39.11 | 38.50(-0.65) | 39.06(-0.05) | 39.11(-0) | 39.11(-0) |
| E | 80.86 | 80.20(-0.66) | 80.80(-0.06) | 80.84(-0.02) | 80.86(-0) |

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Application

FANUC Series 30i-B/31i-B5 The advanced control technologies for 5-axis machining

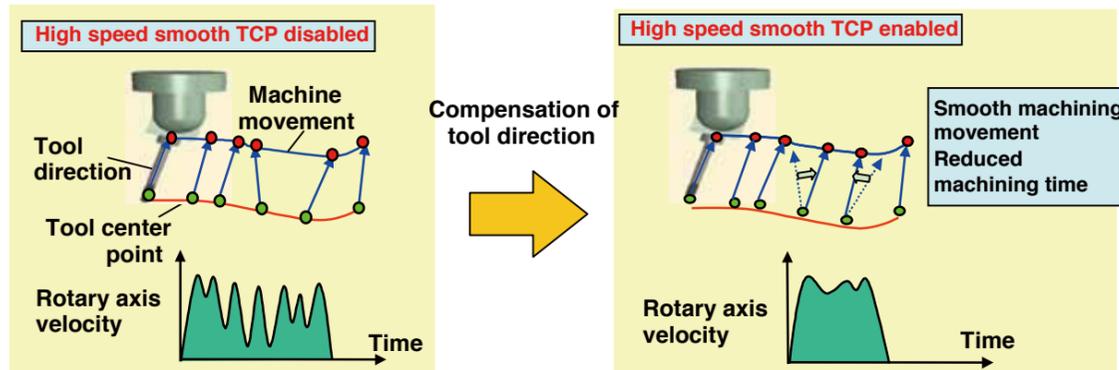
AI Nano CNC: Series 30i/31i/32i-Model B

Shorter cycles, enhanced performance, and easier maintainability are achieved by FANUC's Series 30i platform of CNCs that control up to 24 axes simultaneously with maximum paths at 10. Combining speed, precision, and user-friendliness to better satisfy multiple user needs, the 30i, 31i, and 32i achieve new levels of accuracy, reliability and efficiency in all machine tool operations. These advanced CNCs are the optimum system for the latest high-end machines requiring multi-axis, multi-path, complex and ultra nano high-speed machining.

High-speed smooth TCP

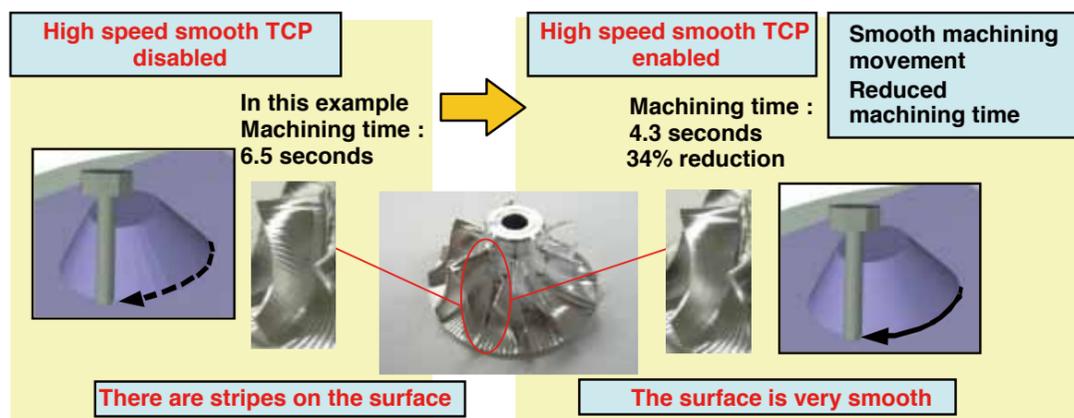
High-speed and smooth machining using tool center point

When a machining program with TCP (Tool Center Point control) has unevenness in tool direction command in comparison with TCP movement command, the tool direction varies, and a machined surface is degraded (strips appear) and a machining time increases. High-speed Smooth TCP makes the machining movement smooth by compensating tool direction so as to decrease the unevenness, and improves the quality of the machining surface and reduces the machining time.



High-speed and smooth machining using tool center point

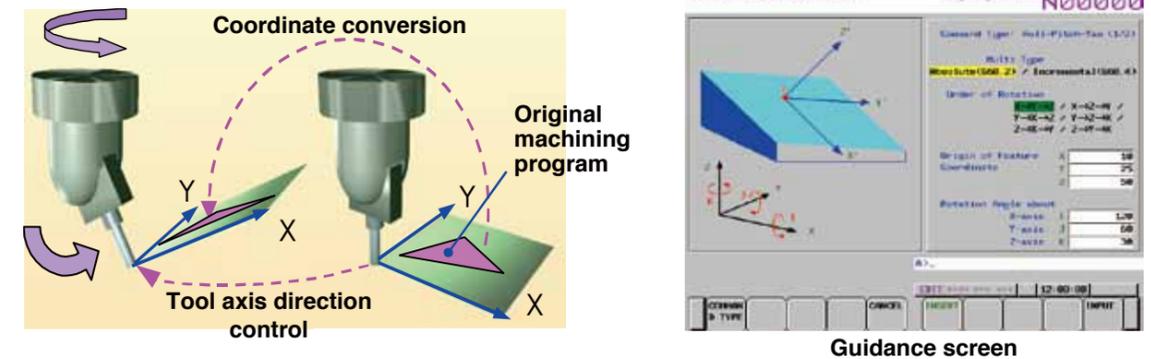
High-speed smooth TCP improves the quality of the surface greatly by moving tool posture and tool center point smoothly.



Tilted working plane indexing

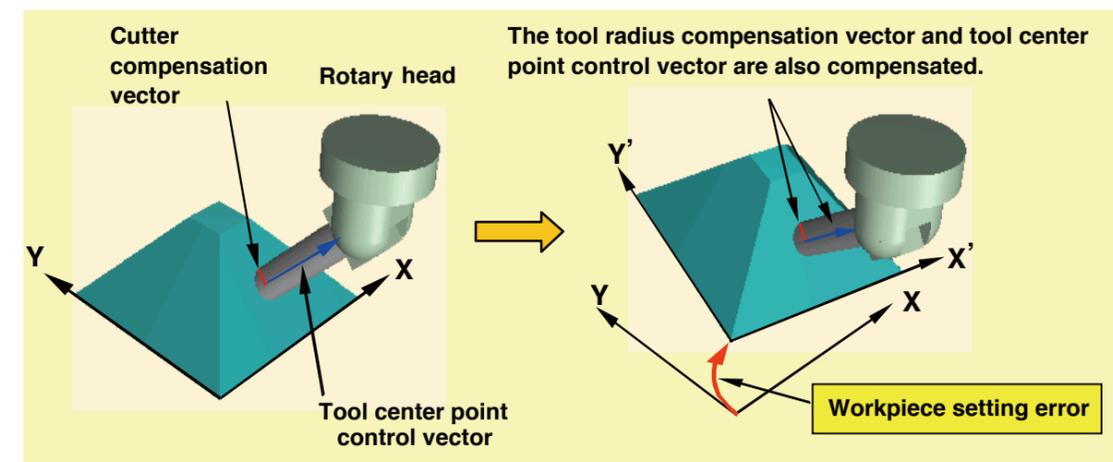
For machining a hole, pocket, or another figure on a tilted plane on a workpiece, specifying the working plane with plane (X, Y) makes programming very easy. The tilted working plane command enables this specification and also positions the tool automatically so that the tool becomes perpendicular to the tilted working plane without specifying the tool direction.

There are 6 kinds of tilted working plane command types (Eulerian angle, two vectors, roll-pitch-yaw, projection angles, three points, tool axis direction), and they can be visually selected with the guidance screen. The necessary data for each command types can be directly inputted with the screen. So, the tilted working plane can be specified easier.



Workpiece setting error compensation

A workpiece placed on the table may be slightly displaced from its correct position. In this case, workpiece setting error compensation can be used to automatically compensate the position error so that the original machining program can be used as is. This function can be used with the 5-axis machining functions, scaling, coordinate system rotation, canned cycle for drilling, and so on.

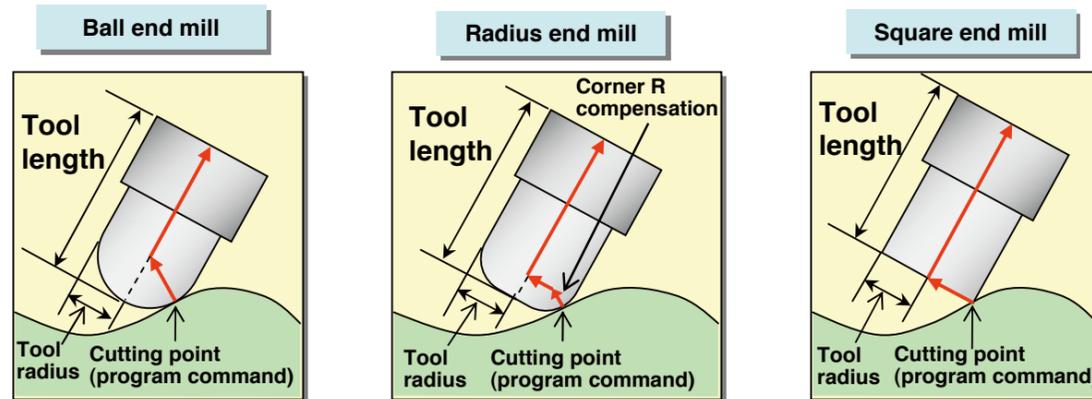


Application

FANUC Series 30i-B/31i-B5 The advanced control technologies for 5-axis machining

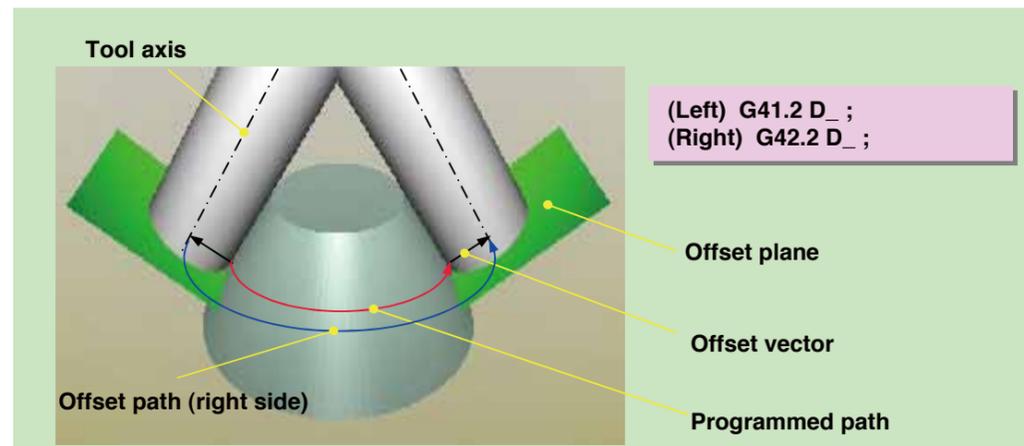
Cutting point command

In Tool center point control for 5-axis machining, the cutting path can be programmed. The same program can be used even if the kind of the tool, the tool radius, and the tool length are changed, so the programming efficiency improves greatly.



3 dimensional cutter compensation

Tool radius compensation is done on the vertical plane of tool axis toward the left/right side of commanded direction with Tool radius compensation for 5-axis machining.



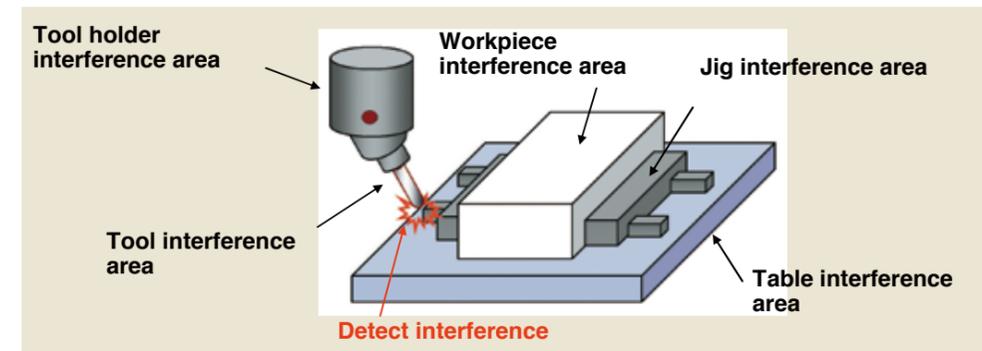
3D Interference Check

With compound machine tools and 5-axis machines, complicated machining can be performed without making a workpiece setup change, so high machining efficiency can be achieved; however, programming for such machine tools is difficult, and interference between machine components such as a spindle and a table may occur during automatic operation and manual operation. A 3-dimensional interference check function is therefore provided to check for such interference in advance to enhance safety operation.

Built-in 3D Interference Check

This function checks for any interference between machine components such as the tool, tool holder, workpiece, jig, and table in 3-dimensional space in a real-time manner to detect interference in the machine in advance.

- This function is built into the CNC and does not require additional hardware or software.
- Interference areas are defined using rectangular prisms, circular cylinders, and planes.
- An interference area can be defined and modified using a dedicated screen or an NC program command.
- This function is enabled in both automatic operation by NC programming and manual operation by handle.
- This function is applicable also to 5-axis machines that turn the tool or table.
- This function supports up to four paths and is applicable also to multi-path compound lathes.



3D Interference Check with Personal computer function

When a 3-dimensional animated simulation feature used in CAM and so forth is included in the personal computer function of the Series 30i-A/31i-A/31i-A5 or Series 30i-B/31i-B/31i-B5, interference checks can be made in a realistic manner.

- 3-dimensional animated simulation shows machine motion realistically.
- Interference between machine components such as the tool and workpiece can be detected through animated simulation.
- The CNC notifies the animated simulation feature of a forecasted position ahead of machine operation, so interference may be detected through animated simulation before actual interference occurs.

Key Component



Accessories for high quality machining requirement



LCM is an Italian Company founded in 1986 initiated by two brothers: Nicola and Roberto La Vista. During the first years, the activity has been focused on the manufacturing of mechanical components, electrical motors, special machines and, among them, customized machining centers. In this period, the company has developed a deep knowledge about this kind of machines and the machining needs. This means a strong sensitivity on how the machine and its accessories should operate to properly satisfy high quality machining requirements, accuracy and low tolerances.

To introduce components closer to the real needs, pushed the Company, in the 1993, to start in the designing and manufacturing of some among the most important machining centre accessories like rotary tables and tilting heads.

- The design focused the care on some sensitive topics:
- Accurate selection of materials to grant the best compromise on both: rigidity and weight.
 - Mechanical driving system with preloaded worm screw-wheel solution. In this way, screw and wheel will have contact

surfaces in all the conditions, particularly when the system must reverse the direction: no backlash.

- Torque motors for high speed performances.
- Very effective, compact and safe brake system.
- Full protection of the internal components from contamination with high reliability.

This attention has carried LCM to be leader in the domestic market and one of the most qualified suppliers worldwide and allows covering the most important machine tool manufacturing area.

During the last years, a strategy has been developed to focus on 3 market levels:

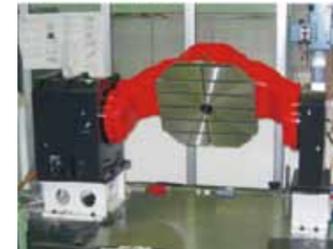
- 1st equipment (OEM market) with a particular care on the customized solutions mainly in the 4th and 5th axis, with suitable overall dimensions and technical performances.
- Post-market (dealers, retrofiters, end-users) with a dedicated product line (that includes models like TDE, BSC, BAS and MTX) highly appreciated, in addition to the a.m. features, for the very compact dimensions leaving more room for the machining operations.

- Special applications, like medical (dental and prosthesis), EDM (full waterproof 5th axis table with high loading capacity) aerospace and energy (different operations for turbine blades) and so on.

The territory (North-West of Italy) where LCM is located is a mix of human and natural excellences where automotive, aerospace, electronics have reached worldwide top technological level as well as some natural scenarios and natural products like wine or truffles.

CNC Tilting rotary tables

Designed and made for 5 axis machines
Mechanical transmission - Hydraulic clamping



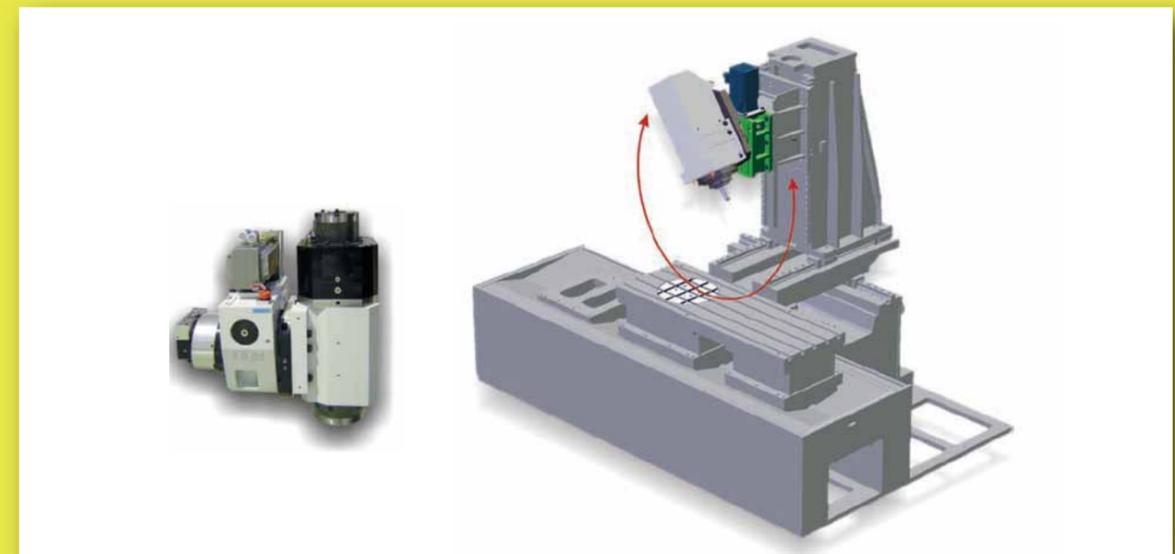
| Models | BRC-TM 400 | | BRC-TT 600 | |
|---------------------------|------------|---------|------------|---------|
| Table diameter(mm) | 400 | | 600 | |
| Table T-slot width(mm) | 14 | | 14 | |
| Tilt range | -110°÷110° | | -120°÷120° | |
| Axis | Rotary | Tilting | Rotary | Tilting |
| Clamp system | Hydraulic | | Hydraulic | |
| Indexing accuracy(sec.) | ± 5 | ± 25 | ± 5 | ±25 |
| Allowable work weight(kg) | 400 | | 600 | |

The MD series head represents the best solution for manufacturers of 5 axis machines who require the 4th axis behind the spindle. The MD-M units allow the spindle axis to be tilted with continuous motion from +100° to -100°. They have mechanical transmission system, hydraulic clamping and high resolution encoder mounted in axis.

To meet customer demands, 5 versions are available in various configurations.

Selection of the head is determined by some basic requirements:

1. Choice of size according to the required spindle dimensions and capacity.
2. To provide greater flexibility, MD units can be prepared for square spindles not manufactured by LCM, or, with a housing designed for cartridge spindles.
3. According to the machine construction and space limitations, different motor locations and a choice of flexible cable system or rotary union is possible.



Big hit of Microcut /Challenger in TIMTOS 2011

Sarah Chen



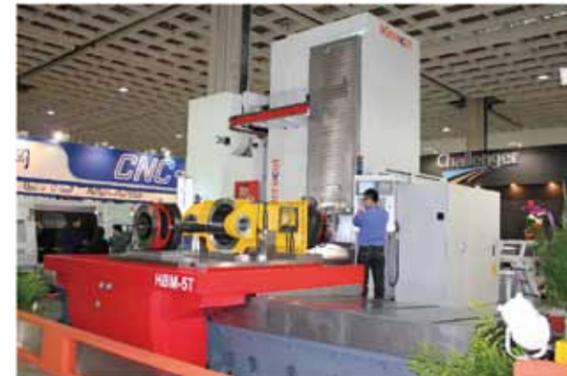
The biannual TIMTOS brought down its curtain on Mar. 6, 2011. Microcut/Challenger was shown to offer its high quality, high precision, excellent products to all local and foreign customer as usual.

Microcut / Challenger got 270 SQM space this time and multiple updated technologies are well introduced by this chance. The scale of 2011 TIMTOS exhibition is the second large machine tool show in Asia. We can see its importance as one of main international fair in Machine Tools Business.

In Microcut / Challenger booth, it was always full of visitors attracted by Microcut machines. Microcut/Challenger is focusing on more high-tech, high-speed machining & SMART Machine Technologies in product development. The high tech machines displayed are popular in this show.



HBM-5T with FANUC 18iMB is a mature product and catch all user's eye. With the automatic facing head, customer can do I.D.&O.D turning continuously; this application satisfied the gap for most of horizontal borer users. To offer quicker delivery, the production capacity largely increased after the operation of new 8th plant since last year.



V-26 with HEIDENHAIN iTNC 530- The high speed machining center with the latest SMART technologies(TPC, SVS, AAC, MRRO) launched the era of Microcut smart machine. A series of 5 axes vertical machining center, V20/5, MCG-5XM and MCG-5X made their official debut and showcased full range of 5 axes machining center.

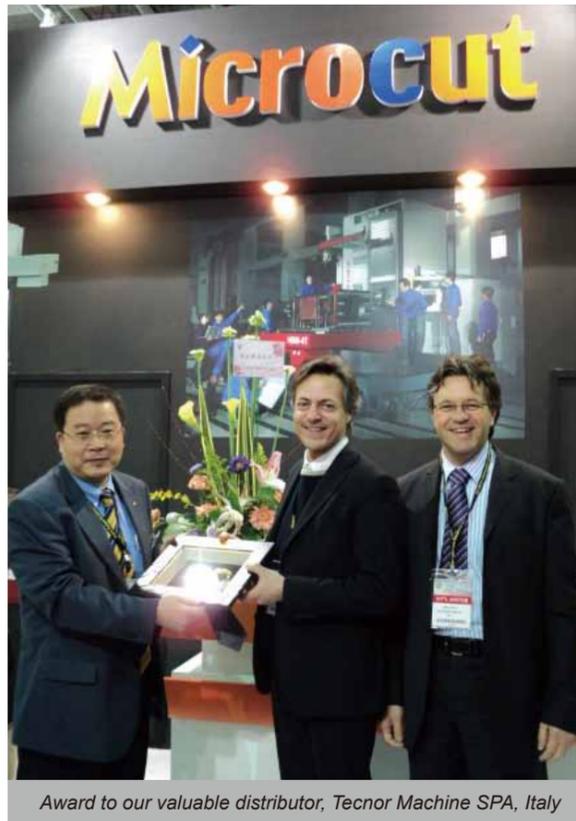


MCG-5X 630 with HEIDENHAIN iTNC 530 & MCG-5XM HEIDENHAIN iTNC 530 offer best solution for aerospace, medical, die & mold, automobile industry. The SMART technology developed in the Microcut HSM and 5-axis machine adds high value for our products. Besides 5-axis machine, another compact and competitive models are also presented:



LT-65 with FANUC 0iTD and Cs axes is an automatic 3 axes lathe with high resolution ring encoder design.
MICROPANTHER 446 with FAGOR 8055i / A & MM-430/Z-460 FAGOR 8055i/A: The right products for small workshop & education market keep serving customer's demand. **Dual 500 with SIEMENS 840 D SL** is displayed at Siemens' booth. Combined with Siemens CNC cutting technology, this multi-axis machine presented high productivity for small-size & complex parts in multi-axes application.

EVENT



Award to our valuable distributor, Tecnor Machine SPA, Italy

During TIMTOS 2011, 54 distributors & 126 end-users are coming to this event. This is a wonderful result, especially some valuable potential customers are also interested in Microcut / Challenger and more & more potential customers are interested in high-tech machine, ex. MCG-5XM, V20/5... which inspires us so much. Not only HBM model is getting more and more inquiry from different areas, but also the 5 axes machining center is quite successful. From the feedback of market, we can see the cold winter is leaving and the warm spring is coming, the job shop is getting more & more job. And with the correct forward direction of product development & service offering, together with all our distributors' support, Microcut/ Challenger will definitely grow & become stronger in coming years!



Exhibitions

| 2011 | Period | Title of Exhibition / Country | Distribution company |
|-----------|------------|---|---|
| April | 12-14 | Metalloobrabotka. / Russia | Baltiyskaya Promishlennaya Kompaniya, Zao |
| | 12-16 | CIMT / China | TERNA |
| | 12-15 | FORMA TOOL / Slovenia | CADNEX |
| May | 18-20 | POWER-KAZINDUSTRY-2011 / Russia | Baltiyskaya Promishlennaya Kompaniya, Zao |
| | 23-27 | Metalloobrabotka 2011 / Russia | Baltiyskaya Promishlennaya Kompaniya, Zao |
| | 23-28 | FEIMAFE / Brazil | MEGGATON |
| | 24-27 | AUSTECH / Australia | James Machinery Pty.,Ltd. |
| | | LEGERE OPEN HOUSE / Canada | Legere industrial |
| June | 7-11 | Open House / Belgium | Mondaile |
| | 14-17 | MAQUITEC-2011 / Spain | Dimasolda |
| | 21-24 | MACH-TOOL 2011 / Poland | IGO Sp. z o.o |
| September | | Machinery. Machines. Tools / Russia | Baltiyskaya Promishlennaya Kompaniya, Zao |
| | | Open house Puebla / Mexico | FAMA-Fabrica de Máquinas y Accesorios |
| | 19-24 | EMO 2011 / Germany | Buffalo Machinery |
| | 9/28-10/1 | Russian Industrialist 2011 / Russia | Baltiyskaya Promishlennaya Kompaniya, Zao |
| October | 5-7 | TOOLEX 2011 / Poland | IGO Sp. z o.o |
| | 11-13 | Metalloobrabotka, Welding. Machinery. Ecology-2011 / Russia | Baltiyskaya Promishlennaya Kompaniya, Zao |
| | 11-14 | PromSalon-2011 / Russia | Baltiyskaya Promishlennaya Kompaniya, Zao |
| | 17-20 | Canadian Manufacturing Technology Show / Canada | Modern Tool |
| | 18-21 | Stankoexpo-2011 / Russia | Baltiyskaya Promishlennaya Kompaniya, Zao |
| | 19-21 | EUROTOOL-2011 / Poland | IGO Sp. z o.o |
| November | | Open House / France | DIDELON MACHINES OUTILS |
| | | Open House / Germany | VOLZ Maschinenhandels GmbH & Co. KG |
| | 11/30-12/3 | MTI 2011 / Indonesia | FMU |



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