# Clobal quality and convice system of metal working industry

Global quality and service system of metal working industry

#### R&D Zone

Thermal Growth Measurement and Compensation for Integrated Spindle

#### Newsroom

New Organizational Structure of Buffalo Machinery

**Event** Events Preview - 2nd Half of 2012

Artist Report Master Huang, Yin-Pu





# Microcut's Upcoming New Heavy Duty CNC Lathe - 117HT

Looking for a powerful CNC lathe with all standard features integrated into an economic compact package? Here is the ONE – 117 HT, whose extraordinary performance will bring you the best return on investment!

#### Highlights

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- · Large window with safety window.
- · Ergonomic panel.
- · Easy loading/unloading.
- · Large spindle power.
- · Geared head.
- · Wide selection of bar capacity.
- · Large 12 station turret with fast indexing.
- Programmable tailstock and rapid positioning.









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# **From the Publisher**



Further to my discussion in last issue, the finance crisis in EURO zone is hurting the global economy deeper than the evaluation earlier this year. Many of the solutions have been proposed from IMF and ECB, such as a reasonable amount of funds to be built to support those countries in need. But there are so many debates which are hard to become an agreement from EU members, as well as the uncertain reason due to the upcoming election which is giving the politic leaders hardly to take any action or decision. As we are aware, the longer the problem lasting, the worse it could prevent the global economy from become stable again. It is certainly a big challenge to all the private enterprises.

CNBC is reporting that big airline like Air France – KLM failed to win cabin crew support for a key restructuring plan, due to net losses widened to EUR 895 million from EUR 195 million. "These results demonstrate how crucial the success of the transform 2015 plan is the turnaround of the group," Chairman and Chief Executive Jean-Cyril Spinetta said in his statement. Air France – KLM has been considered as one of the most successful airlines, it could be affected due to so many uncertain factors of economy which have been lasting for such a long time. Things surprised mainly as it happened in financial healthy countries as well. There must be many more other business also facing the similar problem due to the area finance crisis. And it is going to cost much more and take long to resolve the problem, as well as to make it stronger again.

Many facts are showing an endless trouble is going on:

The euro zone has had to rescue the countries with financial difficulties such as Greece, Ireland and Portugal since the euro debt crisis erupted in early 2010. Evolving to the present, the crisis seems getting harder to fight and out of control, Spain and Italy, the fourth and third biggest economy of euro zone, are both in the critical economic condition and seeking for the radical solutions.

The bailout of Spain and Italy combined would probably be more than double the Greece, Ireland and Portugal combined, the EU has already agreed to lend up to 100 billion euro to rescue Spanish banks. However, all the reports show that is far behind sufficient. The EU Leaders now urgently to find the adequate solutions to protect the euro zone. Fiscal and Structural reforms, rate cut and new liquidity program all have been discussed.

The ECB would resume buying sovereign bonds, while the German monetary authority is against restoration of inactive bond-buying program which has been believed setting the wrong motivation. More options are needed to resolve the euro zone problems, further rates cut, monetary policies reforms, and even the Germans disagreement of buying sovereign bonds could really rescue the euro zone from the crisis? or the EU Leaders, financial specialists, policy makers could figure out substantial solutions to settle the crucial period, it remains to be seen.

Taiwanese has an old tradition of its family and finance saving concept, it was easy to find many generations live in a big house, each one save a certain level of salary for the family, seniors look after young generations, and the family finance has been controlled by the seniors, too. The family is growing bigger and stronger, but never the loan or credit from outside is needed, should this be considered as one of the best and reliable finance system for the enterprise or family?

Dr. Paul Chang Aug. 2012

Reference:

Euro Zone Crisis / Monetary Policy Role in EU Debt Crisis Limited / What Europe's Central Bank May Do to Save the Euro? CNBC Jul 30, 2012



### **New Organizational Structure of Buffalo Machinery**

For better performance and development, Buffalo renewed its organizational structure in the first half year of 2012. Due to the fast expansion of the company, some of the departments and positions need to be clarified and redefined. It is believed that, after the reorganization, the communication and cooperation between departments can be enhanced, company resources can be utilized and allocated more evenly and the staff performance efficiency can be improved greatly. Therefore this restructuring is certainly good news for all clients that better products quality and superior services are expectable in the near future.

Buffalo Machinery is now consisted of six major departments: Product Department, Business Department, R&D Department, Customer Relation Department, Finance Control Department and Administration Department. All of the departments are led by experienced vice general managers who are fully capable of leading and managing the team with professional knowledge and skills on his/her own profession background and domain.

**R&D Department** 



**Product Department** 



Led by Scott Tsai, who has joined Buffalo Machinery for more than 11 years since February 2001. Scott is responsible for the development and innovation of all machinery and technical resolutions including the improvement of new products, design and evaluation of advanced technology and integration of product engineering and R&D system. As the core department of Buffalo Machinery, R&D department has three strong function divisions: mechanical, automatic control and the newest mechtronic technology. With the complete structure and function, R&D certainly speeds product innovation, optimizes machinery design and provides Buffalo Machinery with the driving force to improve and strive for excellence.

Product Department is led by Andy Lin, who has recently received a special honor award of serving at Buffalo Machinery for more than 20 years. When first joined Buffalo Machinery in 1991, Andy was specialized in guality control. For improving professional knowledge and pursuing better career pathway, he studied at NCUE and awarded the Master of Electrical Engineering in 2000. With two decades of experience on manufacturing process examination and machine production. Andy accumulates rich experience and fundamentals including quality and reliability management, production planning and control, industrial engineering and operational efficiency etc. With the prosperous background, Andy manages the production division, quality control division, production planning management division and purchase control division of the Product Department efficiently. Among which purchase control division is highly focused, due to the raising importance of timing and cost control in manufacture industry at current economic situation.

### MICROCUT Newsroom

#### **Finance Control Department**



#### Customer Relation Department

Joan Huang joined Buffalo Machinery in July 2003. As the vice general manager of Finance Control Department, she is mainly in charge of enhance company's financial stability and profits. With the professional finance background possessed by Joan and her team, the department provides finance and accounting services including treasury, tax, asset management, strategic investment and financial and accounting management and so on. Furthermore, apart from financial knowledge, Joan strengthens her basic mechanical knowledge regularly in order to provide better working performance. For the moment, Joan also acts for the vice general manager of administration department, in which Human Resource Management (HRM) is aggressively constructed as its major goal in the short term.

The department of customer relation is newly established especially because Buffalo Machinery values the customers and believes in quality and service built business. Three divisions are contained in this department: after sales service, after sales administration and application support. Counting on the multiple and wide variety working experience in addition to proactive attitude for problem solving, Gus Chang is acting vice general manager of this department for the moment.

#### **Business Department**

Led by the general manager Dr. Paul Chang temporarily, as the vice general manager of the department is still in the selection. The business department is consisted of sales division and marketing division. With the long history of sales experience, the team of sales division are all familiar with professional knowledge about products. Because of the professional knowledge possessed, the division can always offer information promptly and provide excellent service for all distributors and customers. As to the marketing division, it is a new division established for handling company promotion affairs such as market analysis and forecast, promotional material production and event organization and so forth.



# Gloobal Outlook American Automotive Industry

#### Overview

American automotive industry began in a hundred years ago. By virtue of its large domestic market and the use of mass-production, it rapidly developed into the largest industry in the world and became one of the world's most important economic sectors. The automakers in the U.S. is not only producing the most important transportation mode in America, but also closely intertwined with national and global economics and policy.

The automakers in the U.S. had been playing the role as a leading producer of vehicles in the global market for a long time. Before the Great Depression in 1929, the world had 32,028,500 cars in use, and the American automotive industry produced over 90% of them. Afterward the automakers in the U.S. led the world in total automobile production until Japan narrowly passed the U.S. in 2006 and held this rank till 2009. The biggest vehicle producer was replaced by China in 2009 with production of 13.8 million units. In 2011, China maintained its leading place by producing nearly twice the number of second place America and third place Japan. (See Figure 1.)

#### History

- 1890s First American automobiles developed. Variety of engine technologies developed including internal combustion engines, battery-powered electric engines and steam engines.
- 1900s Electric cars and steam cars were popular and lasted for about a decade.
- 1910s Gasoline powered cars replaced the market after the invention of electric start and lower production costs in 1911.
  - Ford Motor Company improved mass-production with the conveyor belt-based assembly line in 1913.
- 1920s Assembly largely reduced costs; the price of a model dropped to USD290 from USD850.
- 1930s Many automakers demised because of the Great Depression, hence brought up the Big Three <sup>[1]</sup>: Ford, Chrysler and General Motors (GM).

- 1940s America entered World War II, all factories ceased by February 1942.
- 1950s Rising and flourishing of the Big Three. - Foreign automakers tried to enter the market.
- 1960s Imports increased their share of the market (e.g. German Volkswagen and Japan Toyota).
- 1970s Small fuel-efficient cars from foreign automakers took a sharply higher share due to the oil crisis in 1973.
  - Second oil crisis (or energy crisis) occurred in 1979; economy slid into turmoil; automakers suffered large operating losses.
- 1980s American government imposed Automobile VER (Voluntary restraint agreement) to limit the annual export number of Japan cars, to protect American auto industry from threats of cheaper fuel-efficient Japanese cars.
  - Japanese car companies started establishing assembly plants or "transplants" in the United States and exporting bigger and more expensive cars for gaining more profits on each of them.
  - Oil prices fell sharply by the mid of 1980s, leading to the revitalization of the industry.
- 1990s Invasion of Kuwait <sup>[2]</sup> by Iraq caused a temporary jump in oil prices.
  - Light truck sales including SUV(Sport utility vehicles), Pickup trucks and Minivans rose sharply. Low oil prices gave incentives for consumers to buy these gas-guzzling vehicles. The American automakers sold millions of light trucks during this period.
  - Automakers purchased or invested in foreign automakers, for example, GM and Ford established joint ventures with Chinese auto companies.
  - Foreign automakers such as BMW and Honda opened factories, engine plants and assembly plants in the United States. Some of them expanded several times since their original construction.





- 2000s The 9/11 terrorist attacks happened in 2001 and affected the sales and profits significantly.
  - Stock market declined and affected the U.S. automakers.
  - Oil prices rose in 2005, consumers turned to smaller, cheaper and more fuel-efficient imports from Japan and Europe. The sales of American cars fell sharply.
  - With high oil prices and a declining US economy caused by the subprime mortgage crisis <sup>[3]</sup>, the Big Three were in weak financial condition and resulted in the automotive industry crisis of 2008 2010.
  - Chrysler and GM entered Chapter 11 bankruptcy
     <sup>[4]</sup> and received financial bailout from the government.
  - China supplanted the U.S. as the world's largest auto market in 2009 after its vehicle sales jumped 46 percent, ending more than a century of American dominance of automotive industry.

#### The Motor City

With the development of American automotive industry, Detroit - known as the historical heart of the American auto industry and nicknamed "the Motor City", was utterly transformed by the rise of the industry, becoming a global symbol of modernity and of the power of American capitalism and the labor.

Located in the heart of the Great Lakes region, Detroit was ideally situated to be a center of the industry. Geographically, the region is extended like a belt, in which Detroit's central location gave its auto producers easy access to the capital and markets; moreover, all of the raw materials needed for automotive production were easily accessible to the city by the Great Lakes waterways. In addition to geographic reasons, Detroit was close to the nation's major centers of coal, iron and copper mining. Because of all this advantages, many automakers, including Ford Motor Company, established their first production factory in Detroit, and more importantly, attracted over a million new migrates to the city. When Ford first established in Detroit 1903, it was only a second-tier industry city; by the mid-twentieth century, one in every six working Americans was employed directly or indirectly by the automotive industry which was centralized in Detroit.

However, Detroit fell with the automobile industry after the automotive industry crisis in 2008. Because of the impact of crisis, factories related to auto industry or its components were forced to be shut down. Bad economy drove many people out of the city that its population - once the fourth in the U.S. - dropped from 10th in 2000 to 18th.

#### Automotive Industry Crisis of 2008 -2010

The automotive industry crisis was a part of a global financial depression. Car sales declined in the United States, affecting both US based and foreign car manufacturers. The annual capacity of the industry is 17 million cars that it dropped to 10 million cars in 2008.

It was mainly caused by the energy crisis from 2003 to 2008. With increasing oil prices, consumers stopped purchasing light trucks and SUVs which contributed half of the profits of the Big Three. In addition to the effects of high labor costs <sup>[5]</sup> and the subprime mortgage crisis, the American automotive industry experienced the financial crisis. Because of this, the CEOs of the Big Three requested government aid in November 2008.

In response to the crisis, President Bush gave USD17.4 billion to GM and Chrysler from the Troubled Asset Relief Program (TARP)<sup>[6]</sup> in December 2008 as temporary relief for their cash flow problems. Several months later, President Obama formed the Automotive Task Force [7] to decide how to rebuild the automotive industry. In the end, Chrysler received a total of USD12.5 billion in TARP funds and entered Chapter 11 bankruptcy in April 2009. GM entered Chapter 11 bankruptcy one month later with a bailout of USD49.5 billion received. In addition to the bailout of USD62 billion from TARP, they received an additional USD17.8 billion from Canadian government (USD10.8 billion to GM and USD2.9 billion to Chrysler) as incentives to maintain production facilities in Canada. At the same time, GM and Chrysler closed numerous production plants and eliminated hundreds of dealerships and thousands of jobs.

Ford did not request any government assistance, but also downsized the company by selling out and phasing out some of its divisions after the crisis. Furthermore, Ford borrowed USD5.9 billion to help their vehicles meet higher mileage requirements under the Advanced Technology Vehicles Manufacturing Loan Program.



# Resurgence of the American Automotive Industry

Just two years after the financial crisis, the American auto industry is showing signs of a full recovery. Manufacturing has led the recovery by adding over 250,000 jobs since December 2009; it's the strongest period of job growth since the late 1990s. Although with 2 million under the figure prior to the crisis, the industry is in a positive come back with 13.5 million units production last year.

GM and Chrysler are emerged from bankruptcy. General Motors is expanding production, while Chrysler repaid its outstanding loans to the U.S. Treasury in May 2011, which is a full six years ahead of schedule. Furthermore, GM, Ford and Chrysler have all returned to profitability and competitiveness. For the first time since 2004, the iconic Big Three are profitable; expanding production and jobs which can translate into more American jobs; and gaining market share against their competitors. "While we are still early in the recovery we are somewhat optimistic about both the future rate of growth as well as the overall health of the industry," said John Humphrey, senior vice president and general manager for J.D. Power and Associates' Global Automotive Division. Regarding the sales part, American auto sales are on pace for the best showing since 2007 and a third straight year of at least 10 per cent gains, according to news of Bloomberg on 10 May 2012. Because of the financial crisis, sales in the U.S. fell to 10.4 million in 2009 - the lowest since the end of the 1982 recession. The sales improved to 11.6 million in 2010 and 12.8 million in 2011. While the American automobile industry continues to face substantial challenges, its future prospects are stronger than it has been in over a decade, which is undoubtedly good news for everybody.





#### **Trends of the Industry**

With gasoline at record prices, demand for alternative fuels or gas-electric hybrid vehicles is booming and fuel-efficient vehicles CUVs – car-based crossover vehicles are popular as well. Also, the industry is continuous developing new technologies on reducing fuel consumption and carbon emission, in order to put cleaner automobiles on the road and provide a better environment. Minimum quantity lubrication (MQL), for instance, is implemented by Ford's Van Dyke transmission plant. The technology of MQL lowers the large volume of coolant used in conventional operations, and therefore offers economical and environmental benefits.

Except technology development, the economic structure of automotive industry is gradually changed. According to the prediction from Detroit branch of Boston Consulting Group, by 2014, one-third of world demand of automobile will be in the four BRIC markets (Brazil, Russia, India and China). Iran and Indonesia are also considered as potentially powerful automotive markets. Actually these emerging auto markets already buy more cars than established markets that, according to a J.D. Power study, 51 percent of the global light-vehicle are sold in these area in 2010 and the number is expected to accelerate.

[1] Big Three: also known as the Detroit Three, when used in relation to the automotive industry, generally refers to Ford, General Motors and Chrysler. These three companies had been being the largest automakers in the United States and Canada and were the largest in the world for a period.

[2] Invasion of Kuwait: also known as the Iraq-Kuwait War or Gulf War. It was a war waged by an UN-authorized coalition force from 34 nations led by the United States, against Iraq in response to Iraq's invasion and annexation of Kuwait.

[3] Subprime mortgage crisis: from 2000 to 2005, many home loans were taken out and given at a subprime rate while a housing bubble occurring on America. This led to extensive foreclosures on home loans and in consequences many people had to leave their homes because they couldn't afford the payments. The crisis was one of the first indicators of the late-2000s financial crisis, which put the U.S. economy into the worst recession since the Great Depression.

[4] Chapter 11 bankruptcy: is a chapter of the United States' Bankruptcy Code. It is usually the choice for large businesses seeking to restructure their debt. When a business is unable to pay its debt, it can file with a federal bankruptcy court for protection under Chapter 11, by which the debtor remains in possession of its assets and in control of its business operations under the supervision of the court in most instances.

[5] High labor costs: there are arguments about the high labor wages for production workers at the Big Three. Since the majority of their operations are unionized (UAW, United Auto Workers), the labor costs are higher than other multinational automakers, and therefore make the industry uncompetitive with foreign automakers. According to the Cato Institute, GM's average labor costs (including both wages and benefits) were USD73 per hour, and Toyota's at USD48 per hour, with similar productivity.

[6] Troubled Asset Relief Program (TARP): referred to as mortgage bailout bill, is a government program created for the establishment and management of a Treasury fund, in order to curb the ongoing financial crisis of 2007-2008 and restore liquidity and stability to the financial system of the United States. The TARP was signed into law by U.S. President George W. Bush on October 3, 2008 which gives the U.S. Treasury purchasing power of USD 700 billion.

[7] Automotive Task Force: a special team consists of a collection of Wall Street investors, responsible for the restructure of GM and Chrysler under terms of the federal loan agreement, pressing for sharp reductions in the wages and benefits of autoworkers and drastic downsizing of the auto industry.

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FINEL CHEEKS BEILD

PSHOUOT

## Chun Zu Machinery Industry

Chun Zu Machinery Industry Co., Ltd., a subsidiary of Chun Yu Group, was established in 1973 and is famous for its product brand - Lion. The main products of Chun Zu include cold forming machines, thread rolling machines, slotting machines and forming dies for bolts, nuts and special parts. The market area of Chun Zu is expanded that no matter domestic (Taiwan) and international (China, Japan, Korea, East-South Asia, Indian, Middle-East, America, Europe...etc) are contained. Moreover, Chun Zu Machinery Industry has a years-lasting tradition in the fastener industry that, through the years, it has developed more than 102 models independently and sold more than 12,600 sets of various cold former, thread roller and other fastener making machinery all over the world. Characterized with high productivity efficiency, longer durability, easy adjustment and maintenance and outstanding cost effectiveness, products from Chun Zu are well suitable to fasteners production applied to automotive, rail way, aviation, construction and electronic industries. Furthermore, Chun Zu Machinery Industry earned good reputation from its domestic and international customers and in the fastener industry by their professional machines and molds.

Apart from the company in Taiwan, Chun Zu Machinery Industry has a shareholding company called SHCZ (Shanghai Chun Zu Machinery Industry Co., Ltd.) in China. Based on and benefited from the rich experience in fastener manufacturer of its parent company in Taiwan, SHCZ can manufacture all types and models of cold formers and thread roller with high quality. Since its establishment in June of 1999, SHCZ has manufactured and delivered about 3,000 sets of cold formers and thread rollers to more than 300 customers in China and abroad.

In recent years, Chun Zu Machinery Industry successfully expanded its product range and upgraded its machines, from traditional cold forming machines and molds for bolts and nuts production, to multi-functional cold forming machines which can product varied metal components with complex shapes. These new machines are equipped with quick mold change system, forging power detect function and numerical control system and also qualified with EU's newest safety requirements. To reach the goal of upgrading machines, machine selection is extraordinary important, and Buffalo Machinery is honored to be one of the suppliers for providing suitable and up-to-date machines to Chun Zu Machinery Industry. The model purchased from Buffalo is HBM-5T, one of Buffalo's newest CNC horizontal milling and boring center. Through processes of HBM-5T, Chun Zu makes the main structures of bolt formers, cold forming machines, thread rolling machines and slotting machines...etc. HBM-5T is made of Meehanite Cast Iron - a type of cast iron featured with outstanding rigidity and stability. It therefore enhances the heavy cutting ability, vibration absorbability and stability for producing workpieces. In addition, HBM-5T can automatically analyze and display loading data, eliminating processing errors caused by human judgment; because of this, HBM-5T can achieve the strict tolerance of size and quality for workpieces. For example, HBM-5T can achieve an accuracy of 10µm while the maximum tolerance for the workpiece is 30µm. In addition, benefited from HBM-5T's superior automation, labor cost is declined significantly and productivity efficiency is improved twice that a workpiece needs only half a day to finish while it took a day before. Once HBM-5T is programmed and set up, its process is fully automated, which means it can repeat the process flow with high accuracy and consistency and require minimal numbers of operators. Furthermore, Chun Zu is going to add a second shift to operate HBM-5T in order to raise productivity, relying on its 24 hours continuously working ability. In the other hand, SHCZ has already adopted shift work and is planning to purchase a new HBM-5T in the near future.

As an old saying goes, "To do a good job, one must first sharpen one's tools". Buffalo is glad that Chun Zu made HBM-5T as their first choice. It is honored to be the partner of a company who makes its persistent effort to contribute to the development of their equipment and the fastener industry.



# **R&D** Zone

# R&DZONE

#### Thermal Growth Measurement and Compensation for Integrated Spindles - Part I Authors Chang Paul · Tang Chia-Hui

Abstract The errors which affect the processing tolerance of a machine tool are due to the built in volumetric errors in the machine tool structure, and also the thermal displacement of the machine tools during its cutting. In this paper, a dual-displacement meters system is developed which is to improve the error of thermal displacement compensation. The new model has a better tolerance control than the single-displacement compensation meter method; also, it has a great potential of saving machine's warm-up time, as well as enhancing productivity.

A dual-displacement meters is designed to detect the variation of spindle thermal growth, and a differential amplifier is applied which is to ensure a precise output signal of spindle thermal growth. The unstable signal which is effect by the flatness tolerance of spindle surface is then omitted. Finally, the spindle thermal growth compensations are successfully reduced. It meets the requirement of high-speed machining and high precision machining application.

#### 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]. (Aluminum alloys are metallic and non ferrous.) Based on its application, an integrated high speed, high power/torque spindle is the key core component of HSM. However, with the increase of speed and power of spindle, spindle thermal growth becomes a critical issue to be considered.

The spindle dynamic model is constructed by 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].



Fig.1 Motorized spindle structure

Although a good spindle design with proper bearing preload is widely accepted, the long working hour and high spindle speed will cause thermal growth and increase bearings loading rapidly by the centrifugal force [7-9]. The higher speed of spindle, the higher centrifugal force will be. Fig. 1 illustrates a motorized spindle structure. A pair of angular contact ball bearings is used to support the lower portion of the spindle. It is also an ideal design and solution for higher speed revolution as the angular contact ball bearings can absorb both axial and radial thrust under machining [7-8]. In Fig. 2, asthe load on the bearings increases during cutting from different directions, the resultant decrease in the gap of bearings will cause nonlinear temperature rise sharply [9]. Though the spindle bearings are properly preloaded and operate within acceptable parameters, the increased loading of the cutting application still leads to spindle thermal growth and poor surface finish.

PT100 platinum thermo coupler [10] has been traditionally applied as it provides reasonably reliable feedback, this linear device is usually used in measuring wide range of the temperature rise, seriously varying temperature such as 0-1000. Therefore, for spindle with smoothly varying temperature, PT100 is acceptable but not optimal as it is indirect measurement. While the thermo meter is placed very closely to the front spindle bearings, its measurement inaccuracy still remains.

Based on the theory of Foucault Current, this study applies the displacement meter placed in front of the spindle to measure the value of spindle expansion. The PLC can compensate the thermal growth of all axes and can feed back quickly with higher accuracy than PT100 thermal coupler. The result shown increases the machining accuracy, meets the requirement of HSM technology and undoubtedly adds value of the machine tools.



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

# R&DZONE

#### **II. Thermal Displacement Modeling of Spindle**

This section investigates the effect of spindle thermal growth on tolerance and the design of bearing load. The characteristics of thermal growth and the restriction of PT100 thermal coupler will be further investigated. 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 and high simultaneous axes feeds for light cutting applications [7-8]. A piezoelectric actuator has been placed behind the spindle to maintain proper bearing loading. Shown in Fig. 4, the front spindle bearings is considered to be a traditional design which still induces greater heat with the increase of spindle speed and running hour.



Fig.3 Motorized spindle with spring preload structure



Fig.4 Spindle bearings with actuator

#### 2.2 Characteristic of Thermal Growth

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



Fig.5 Temperature rise vs. spindle speed

#### 2.3 Foucault Current

Foucault current (also known as eddy current) is a phenomenon discovered by a French physicist named Leon Foucault [13-15]. It defines that a moving conductor changes in the magnetic field generated by a stationary object, the relative motion will cause a circulating flow of electrons or current. Faradays Law outlines the equation as below:

(D)

 $V_L = L \frac{d_L}{d_F}$ 

where V<sub>L</sub> is the induced voltage in volt.

- L is the value of inductance in henries.
- $d_i/d_t$  is the rate of the current change in Amp. per sec.

It is very important to know the characteristic of the current penetration depth and current density. Fig. 6 presents the penetration, which shows a narrow range of data to be measured.



Fig.6 penetration for foucault current(14)

(2)

S.

this penetration depth is given by: where

f is the test frequency, which is 50 or 60 Hz.

 $\mu$  is the magnetic pereability of the spindle in H m.  $\sigma$  is the electrical conductivity of the spindle in S m.

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Fig.7 Spindle with single displacement



Fig.8 Flowchart of single displacement meter

In this research, the material used for these spindles is Chromium Molybdenum Steel (grade 4140), with a magnetic permeability of 750H/m and the electrical conductivity is set 9.8 S/m. Thus, the penetration depth of the spindles can be calculated by using eq.(2), and the value is 0-3 mm.

#### 2.4 Single Displacement Measurement Meter

Based on the law of Foucault Current (Eddy Current) and Faraday Law, a displacement meter is developed, shown as Fig. 7. It provides a much precise result of spindle thermal growth. The meter can measure spindle expansion directly and the voltage is a perfect linear output. [13-16]

#### 2.5 Single Displacement Meter Compensation

The controlling flowchart of single displacement meter for thermal growth of spindle is shown in Fig. 8. When the expansion of spindle is  $1\mu$ m, the output voltage is defined as 20mV. The boundary condition is Vn=Vo-Vr, where Vr is the reference value of voltage, Vo is the incremental voltage from thermal growth of spindle. [17-25]

The compensation value of thermal growth is d, where d=Vn /20 mV, its unit is 1  $\mu$ m. If the difference between output voltage and reference voltage is less than 20 mV, the compensation for thermal growth will not be implemented by the controller. In contrast, the negative compensation for axes by d  $\mu$ m will be activated when the difference between output voltage and reference voltage is larger or equal to 20 mV.

The simplified diagram is shown as Fig. 9.



Fig.9 Operational amplifire of single displacement meter

The input voltage Vi is detected by the distance variance of displacement measurement meter. The relationship between input current i of amplified circuit and impedance z can be expressed as:

t s+jukit.	m	
24 II. 1+100 Cr	141	
In Eq. (3)-(4) z is the parallel impedance of c1 and R2.		
# 7 <u>1</u>	15	

 $\Gamma_0 = -i \cdot z \equiv -\frac{\Gamma_1}{R_1} \cdot z \equiv -\frac{\Gamma_1}{R_1} \cdot \frac{R_2}{1 + \log C_1}$ (0)

Input voltage and output voltage can be expressed as equation (6).

2.6 Simulation of Single Displacement Meter

Fig. 10 shows the amplifier diagram of single displacement measurement meter. The amplifier is a single pole low pass filtering device. In Fig. 10, V1 is the testing power supply, RL is the load resistor. Resistor R1 and R2 is used for changing voltage gain of low frequency. Band width can be adjusted by capacitor C1 and resistor R2. The simulation is based on the following data: R1=10K, R2=10K, C1=1.6nF and RL=10K.



Fig. 10 Amplifire diagram of single displacement meter

# R&DZONE

Fig. 11 shows the Bode plot of frequency v.s output voltage, it indicates that the voltage is a stable output between 10HZ~1 kHz, reflecting that the amplification ratio will not change within this range. Thus, we can find the band width is 10 kHz, which meets the requirement of the application.



Fig.11 Bode plot of single displacement meter voltage gain.

Fig. 12 is the Bode plot of frequency v.s phases, and illustrates the phase differential of input and output voltage is 180 degrees when the frequency is under 300 Hz. From the view of mechanic physical structure, the band width is quite large for normal mechanical structure. As a result, the band width of the amplifier fits the measurement demand of spindle thermal growth compensation.



Fig.12 Bode plot of single displacement meter phase

Fig. 13 shows a comparison of spindle growth v.s. laser measurement value. It's clear that spindle growth matches the laser value after 4200 sec. running of spindle. It meets the requirement of high speed spindle. But point c and point d still show a difference of 7.5 $\mu$ m & 3 $\mu$ m due to measuring error.



Fig.13 Spindle growth v.s. laser value

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# Application

## **Fast and Automated Health Check on**

#### AxiSET<sup>™</sup> Check-Up

Developed by Renishaw, AxiSET<sup>™</sup> Check-Up is a new cost-effective solution for checking the alignment and positioning performance of rotary axes. In just a few minutes, users of five-axis machining centers and multi-tasking mill-turn machines can identify and report machine alignments and geometry that used to need lots of process setting times.

There has been strong growth in the market for multi-axis machines, thus a simple and reliable process for analyzing the performance of their rotary axes is important to identify problems caused by incorrect machine set-up, collisions or wear. The key of precision machining is the ability to locate the rotation centers of the rotary axes related to the machine's linear axes. Without accurate data about these "pivot points", a machine's controller will be unable to reliably control the relative positions of the tool and the component as the rotary axes are moving, and therefore leading to inconsistent machining results.

Renishaw's AxiSET<sup>™</sup> Check-Up provides accurate and repeatable test results using automated probing routines to gather performance data from a reference artefact, and includes simple, yet powerful analysis. All tests utilize existing spindle-mounted Renishaw touch probes, with probing routines generated using machine-specific macro software supplied with AxiSET<sup>™</sup> Check-Up.

Set-up is fast and simple. To perform the test, a user firstly locates a supplied calibration sphere within the machine tool's working envelope using a magnetic mount. Using the supplied custom macro software, a touch probe is then programmed to automatically take reference measurements around the sphere. Users are in full control and can define their own test angles to ensure that machines are tested at critical orientations. Measurement results from the AxiSET<sup>™</sup> Check-Up test are output to a PC where a supplied Microsoft® Excel® spreadsheet presents easily understanding analysis of the data and compares machine performance with defined tolerances. If necessary a user can then alert a machine supplier to carry out further detailed checks and possible errors correction.

AX SET Check 4

CHUR MM

# Application

# **Multi-axis Machines**



Analysis of a machine's capabilities is presented in various formats including a graphical representation of performance that highlights tracking and centering errors, a function that compares two sets of data for the same machine, a simple "pass" or "fail" test against the user's pre-defined tolerances, and a history screen that allows comparisons of the performance of rotary axes over time. All spreadsheet analysis can be incorporated in a simple report generated using Microsoft® Word®.









Key Componet

facturer in the world, who defines his value in working closely together with the machine tool manufacturer during the design phase to develop and manufacture complete modules of the machine tool such as the headstocks with spindle swiveling function. Moreover, its complex workpiece and spindle position systems are laid-out for "plugand-play", which means easy to connect by simple and reliable interfaces to the machine tool environment. Kessler also produces high quality direct drive technology, work-piece and spindle position systems providing turn-key solutions for its customers. The company was founded in 1923 as a manufacturer of motors for machine tools. Located in Bad Buchau, Germany, Franz Kessler has more than 700 employees in this location and a network of service stations in key countries such as China, USA and India.

#### Turning Tilting Tables with Direct Drive – the "must-have" for High Accurate and High Productivity 5-axis Machining

Kessler's latest development is a series of standard turning tilting tables with a high degree of standardization, available with table diameters 400, 500, 630, 800, 1000 and 1250 mm. All axes are directly driven by torque motors and allow simultaneous 5-axis machining with all the advantages of a direct drive such as:

Hihg dynamic acceleration of the axis »high productivity
No wear and tear of the drive »high accuracy and availability
No backlash »high machining accuracy

Various table versions such as T-slots, pallet changing fixtures or tapped holes are available. High speed turning axis (C-axis) can be delivered on request as many machine tool builders are offering their end users the possibility using the machines as a turn-milling machine in order to increase the functionality of the machine tool.

The new standard line offers a standard modular system where the customer can chose the requested table size and options such as:

Rotary union

**Turning Tilting Table &** 

- Pneumatic clamping
- Safety clamping
- · Encoder with a higher position accuracy
- · High speed rotary table
- · Adaption of laser for tool measurement

To adapt the turning table to the specific dimension of the machine tool, the variation is made in the arms holding the rotary table. The rotary table itself and the bearing blocks for the A-axis remain the same. By this the customer is participating in the fact that the main components are standard. The Three-Pieces type bridge reduces production costs due to the fact that smaller single parts are used to build up the bridge which can be machined easier.



New KESSLER Turning Tilting Table - new design with Three-Pieces Bridge

#### Spindle Positioning Systems – 2-axis Heads

Kesser is offering a line-up of 4 standardized spindle positioning systems (2-axis heads) with direct drive technology. The swivelling heads can be used either in vertical or horizontal orientation and equipped with various motorized spindles of speed-up to 30,000 rpm and power up to 105 kw. The 2-axis heads have many advantages:

- Fork is made out of one part in case of a crash almost impossible to generate a geometrical impact.
- High tilting acceleration » productivity.
- Service friendly, if clamp or motor of A-axis is defective it can be changed without touching bearings no loss in geometrical accuracy repair can be done at site.
- One supplier of spindle and head.
- · Low weight.







# Key Componet TBman RAM

#### Headstock with RAM

Buffalo is cooperating with TBman to develop a large RAM-type borer equipped with W1 and W2 axes. The spindle head provided by TBman can offer essential technological solutions to achieve very high level of performances and precision without critical sophistication of the design. This will correspond to high machining performances requiring minimal maintenance and service requirements.

#### Features

Specification:

Quill diameter	140mm	
Ram dimension	380*420mm	
Pam travel	800mm (std.);	
	1000mm (opt.)	
W axis travel	700mm (std.);	
	800mm (opt.)	
Spindle speed	3000rpm	
Spindle motor	37Kw	



- Automatic compensation of RAM deflection by active rods.
- Ready for hydrostatic guide system.
- Prepared for the implementation of any accessory on the RAM nose, including electro-spindles.
- A special clamping system for the accessory mixture of hydro-mechanical is provided to ensure high holding force, proper accuracy and max safety.
- High precision spindle bearings are provided to offer high spindle speed together with high rigidity and minimal termal effects.
- Nitradted boring spindle guided on special lapped bronze bushings.
- 2 ranges of gearbox designed to offer the most convenient utilization of the power and torque of spindle motor.
- Thermostatic cooling system for gearbox and spindle bearings.
- Encoder for spindle orientation.
- Linear guide-way with scale for the boring spindle with integrated direct transducer of its position and tolerance.
- High flexibility in the configuration to respond to specific application.

#### **Advantages**

This RAM type boring spindle is allowed to achieve considerable **spindle extensions** without major loss of power or chip removal performances. On the front face of the RAM, it is possible to mount accessories such as milling heads, facing heads and special extensions, in order to expand machine flexibility. Moreover, the CNC controlled RAM axial feed allows for accurate operations when utilizing the accessories. Two alternative solutions are available for the **RAM bearing guide**. One is the linear roller guide system, which offers simple and effective solution. High rigidity of the RAM is guaranteed by the use of 4 linear guides, each one provided with 3 re-circulating roller blocks. The other one is hydrostatic bearing guide system, which represents the most advanced technology solution by virtue of its high rigidity, low friction coefficient and efficient vibration dampening.

Compensation System for RAM Deflection. The RAM and the spindle will deflect for their own weight proportionally to the RAM (Z) and the quill (W) extension. The RAM and guill deflection will cause inconsistent positioning accuracy on the XY plane with different RAM and quill extensions, reducing the quality of the work produced and forcing the operator to complex and difficult empiric activities to compensate for the deflection itself. To prevent this inconvenience and to allow for constant positioning accuracy on the XY plane with different RAM and quill extensions, the RAM is provided with a deflection compensation system. It consists of two active rods placed inside the RAM on its upper part. Each rod is operated by a hydraulic piston which is controlled by a proportional valve. This system works automatically and keeps the spindle CL within a specific band under any extension of Z and W axis. (Please refer to system A on sketch 1C and to sketches 1A and 1B.)

Compensation of Head Inclination. The variety of accessories to be utilized on a HBM is guite wide and their weight can go up to 500 Kg. or more. Due to the weight of the accessories that will be applied on the front face of the RAM, the head will possibly change its level with a consequent loss of precision and reference to the operations performed without the accessory. To prevent this inconvenience and to allow for constant positioning accuracy on the XY plane with different RAM extensions when an accessory will be loaded, the head is provided with a compensation system for its inclination: it consists of a hydraulic piston posed on the front rope/chain of the head counterweight. The piston is controlled by a proportional valve. This system works automatically and it will allow to keep the spindle CL within a specific band with any accessory. (Please refer to system B on sketch 1C.)

**Spindle Speed up to 4,000 rpm.** This feature is typical of high tech machines with modern design, oriented toward the use of high speed cutting technology . Modern cutting tools are able to remove large volume of chips utilizing high spindle speed and high feed rates, keeping very low the stress on the machine structure and on the workpiece and its fixture. A positive result of this cutting technology will be the small size of the chips produced, with much easier and safer chip removal and workpiece/workzone cleaning.



# Key Componet

Considerable High Spindle Torque. Despite the high spindle speed, a maximum torque of 1,800nm will be available on the spindle. This is possible for the utilization of a 2 steps gearbox in the transmission to the spindle.

Spindle Bearing Lubrication. For the main spindle bearing, the lubrication is by air/oil. This lubrication system is the most advanced one to minimize friction, preventing the generation of heat and ensuring long life to the bearings. In addition, a chamber is provided around the bearing housing with flow of temperature controlled cooling liquid. The cooling liquid will also circulate in the transmission gearbox.

Control of Head Temperature. One of the most difficult jobs when utilizing a HBM for accurate machining operation is to control and compensate for the spindle extension due to thermal effects. We are minimizing the thermal effects and causes of temperature change in the head via two methods. One is using particular type of lubrication for the spindle bearings to allow for the production of the minimal amount of heat. The other is removing the heat generated by the spindle bearings and the gearbox to prevent that it will diffuse in the head.

Hydraulic Clamping for Y Axis. The head is provided with a hydraulic clamping system to lock the head itself on the front guide of the column. The clamping is operated by floating bronze pistons. The availability of the hydraulic clamping will avoid any form of stress on the Y feed system especially when performing heavy milling operations with constant/fix Y position or when performing operations with cutting force changing continuously its direction (heavy drilling or facing/boring operations). A very rigid condition will be guaranteed with improved tool performance and longer tool life.

Easy Maintenance. The high technology solutions offered for the improved quality and work efficiency are linked to simple solutions which do not involve any complex maintenance operation.



# New machines and solution are brought to customers worldwide through

#### IMTS



Events Preview - 2nd Half of 2012

several exhibitions during September to November 2012.

IMTS, the International Manufacturing Technology Show, is well known as the biggest and longest running manufacturing technology trade show in the United States and also recognized as one of the world's leading state for introducing and selling manufacturing equipment and technology will be grandly hold at McCormick Place in Chicago from September 10th to 15th, 2012.

During the six days, over 1,100 exhibitors from the metalworking industry all over the world will display their products and productivity solutions here. In which visitors from every level and industry can compare new equipment side by side, experience the developments and new features, and even gather information of emerging technologies and trends under one roof at one time.

For better and quicker searching, exhibits are organized in pavilions that are geared toward specific industries, technologies and solutions. It is easy to find your particular needs, no matter it is finishing machine, tooling system or gear generation, etc. Aside from pavilion, you can also search an exhibitor by its name, its product category, or the building it is located.

IMTS is now entering its 83th anniversary since first held in Cleveland, Ohio in 1927. According to report, this big event drew more than 8.200 visitors and 1.700 exhibitors from the U.S. and some 40 other nations in 2010. Furthermore, more than 15,000 new machine tools, controls, software, components and systems were displayed in the show. Visitors of this show are various, people involved in manufacturing such as executives of a business, manufacturing equipment purchasers, engineers, plant superintendents, operators, etc. are expected to participate in the exhibition. During the show, Buffalo's partner Milltronics INC will have a big booth in North Hall. Machines displayed are various models for wide applications including big hole CNC Lathe equipped with 127 millimeter through hole diameter and 18 inch chuck size. Apart from the booth, there is a "must visit" in this show called ETC - Emerging Technology Center. ETC has been sponsored by IMTS since 2004 that new developments from both academia and industry are showcased here. In 2010, for instance, ETC focused on Cloud computing and the MTConnect communication standard. Visitors can also find productivity seminars, trade associations, and government agencies at ETC according to their interests.

Look back to IMTS 2010, it signaled a strong comeback in manufacturing. It is worth believing that IMTS will bring more exciting news to the industry in 2012. Attend the tremendous event this year to see new technology demonstrated, get ideas, find answers to your manufacturing problems and then choose the best for your needs!





**TMTS** 



Taiwan International Machine Tool Show (TMTS) was first held in November 2010 in Taichung, Taiwan, with 300 exhibitors and 22,950 square meters exhibit space. During the five days show (November 3-7), more than 50,000 visitors were attended that, although only occupied a small amount about 2%, overseas visitors were varied from 41 countries. As a successful result, the show reached the number of follow-up orders of NTD 2 billion in 2010. This year, TMTS is going to hold in Greater Taichung International Expo Center at Taichung, Taiwan from 7th to 11th November; about 350 companies from 10 regions and more than 55,000 visitors are expected to participate in this exhibition. In this show, Microcut and the new local distributor Terdali company will display HBM-4T - a t-type horizontal milling and boring machine, equipped with 130 mm quill diameter and 8 tons table load. This exhibition is particularly important for Taiwan Machine Tool manufacturers since Taichung is the home town of machine manufacturing. It brings visitors advantage to visit not only the exhibition but also machine building companies.

#### TATEF



TATEF, as one of the 5 largest exhibitions in the world, is recognized by manufacturers and distributors worldwide and attracts over 400 companies, 1,000 brands and 70,000 buyers from all over the world in 2010. TATEF 2012 will be held between **2nd to 7th October** at Istanbul Expo Center at **Istanbul, Turkey**. In this grand event, three of Microcut's model will be displayed by distributor CELIK MAKINA: HBM-4, RH-20 and LT-52. HBM-4 is a CNC horizontal milling and boring center and will be equipped with 0.001 degree table index. RH-20 is CNC box way machining center. LT-52 is CNC slant bed lathe equipped with 52 mm through hole diameter and 5000 rpm spindle speed.

**BI-MU** 



As the most important Italian fair of the sector, BI-MU presents large and qualified range of technological solutions for metal forming and metal cutting machines, robots, automation and auxiliary technologies. The biennial event gathered 1,223 exhibitors in 2010, among which 44% were foreign companies. In the 90,000 square meter surface, over 3,000 machines were displayed and the value of 300 million Euros was created. In 2012, the 28th BI-MU will be held in **Milan** at Fieramilan (Rho) from **2**<sup>nd</sup> **to 6**<sup>th</sup> **October**, organized by EFIM-ENTE FIERE ITALIANE MACHINE. During the period, BI-MU will present the most advanced proposals concerning components and structural machining and specialized reviews of the most recent technological solutions for welding, surface finishing, assembling and press-forging, etc.

Official websites of the exhibitions: IMTS http://www.imts.com/index.html TMIS http://www.tmts.tw/en/index.php?lang=en TATEF http://www.ite-turkey.com/ver3/fairs/tatef\_en/ BI-MU http://www.bimu-sfortec.com/bimu/eng/index.cfm?id=99



### Master Huang, Yin-Pu

#### Profile

1956, Taiwan, Changhua

- Chief of the board of Taiwan public art research and development association.
- Chairman of the association of honorary probation officers for Prosecutor's Office in Taichung District Court.
- · Chief of the board of Chun Hua non-profit organization administration academy.
- Program committee member of public art of Taichung City.

#### **The Creation of a Bronze Sculpture**

Sculpture is jokingly called as the heavy industry of the art world, especially for large size artworks, it is relatively hard and dangerous in the creation process comparing to other creation methods. Among the materials used to make a sculpture, bronze is the material that Master Huang uses to make his metal sculptures most of the time. The technique to build bronze sculptures is an ancient skill which has been lasting for nearly 5,000 years and is still popular today. To many people, a bronze sculpture is an elegant and powerful piece of art, because it shows not only the sense of beauty of an artist but also his/her ability to bend and shape metal into artwork.

The creation of a bronze sculpture is very complicated and time-consuming; an artist needs to build a full-sized model before making its mold. Master Huang usually uses wood and hemp ropes to frame a rough skeleton at the first step, and then covers the skeleton with clay. For large sculptures such as Buddha statues, water-based clay is usually a proper choice while oil-based plasticine is recommended for small sculptures. Once the rough appearance is shaped, Master Huang begins to sculpt it carefully and absorbedly. This is the most important part of the creation that needs exquisitely carved. The figure and style of the sculpture, the look on a statue's face and the spiritual expression and so on are all created by Mater Huang in this stage.



Build a skeleton with wood and hemp rope.



Cover the skeleton with clay and then shape it carefully.

After the model of clay is completed, it is ready to be casted. The most common practice used to cast is known as the "lost-wax" process. Apart from it, there are other processes such as centrifugal casting and sand casting. Master Huang will choose a suitable casting process to make the mold. During this stage, mold needs to be examined in details and refined again and again, in order to make a perfect mold. Next, the mold will be handed over to another process of pouring liquid bronze. It is a difficult and dangerous procedure that leads to astonishing results. Before the artwork is completed, the final stage is to do the surface treatment, including polish and coloring.



Final look of the model and the finished bronze sculpture.

#### **Four Buddhist Heavenly Kings**

Master Huang has built a set of large-sized Buddhist kings for Hanshan Temple in Tainan; it is a big case which took nearly a year to complete the four statues. According to Master Huang, the type of these four kings belongs to the Ming Dynasty, each statue is 4 meter high and the tables of them are 2.37 square meter. Because of the utilization of modern materials, these four sculptures are extremely large and strong visually, but each of the finished statues is only 200 kilograms. At the beginning, about 1,500 kilograms of clay is needed to make such a huge model. With the help of Master's assistants, the time for shaping one model is nearly one month. Since it is a series of Buddhist kings, the height and figure of the four kings must be in consistency, therefore the first statue has to be placed next to the second one as a reference when the second one is building, and so forth. After all the four Buddhist kings are finished, polishing and coloring are needed. It still needs a lot of time in this stage that, with the effort of two or three people, it takes one month to polish a statue. As to coloring, multi-layers of primer paint are used to color the statues, in order to preserve them for a long time. While talking to the skills of making large-sized sculpture, "it is important to view it from a long distance regularly, so that the dignity and power can be displayed in the finished sculpture," said Master Huang.



Four Buddhist Heavenly Kings





Collection of Master Huang

# **Exhibition Calendar**

2012 Q4	Period	Title of Exhibition / Country	Distribution Company
October 2-6 2-7		BIMU Show / Milano, Italy	Tecnor Machine SPA
		MAKTEK EURASIA 2012 / Turkey	Celik Makina Ticaret A.S.
2013	Period	Title of Exhibition / Country	Distribution Company
March	5-10	TIMTOS 2013 / Taiwan	Buffalo Machinery
April	TBA	MEC SPE / Parma, Italy	Tecnor Machine SPA
Мау	21-23	Balttechnika 2013 / Lithuania	Formosa CNC



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