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The CHALLENGER

Global quality and service system of metal working industry

more than machine tools
EMO 2011

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Welcome user's submission

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 t02@mail.buffalo.com.tw
Only English version is acceptable.

From the Publisher

The head of the International Monetary Fund warned on Wed. November 9 that Europe's debt crisis risked plunging the global economy into a "lost decade" and said it was up to rich nations to shoulder the burden of restoring growth and confidence.
Christine Lagarde told a financial forum in Beijing that European plans to bolster a rescue package for Greece were a "step in the right direction", but that the outlook for the world economy remained dangerous and uncertain.

"There are clearly clouds on the horizon," Lagarde said. "Clouds on the horizon particularly in the advanced economies and particularly so in the European Union and the United States." She also said "Our sense is that if we do not act boldly and if we do not act together, the economy around the world runs the risk of downward spiral of uncertainty, financial instability and potential collapse of global demand. We could run the risk of what some commentators are already calling the lost decade."

In reviewing the development of the route how EU was found, the first big leap toward European Union integration was taken after World War II with the signing of the Treaty of Paris, which created the European Coal and Steel Community (ECSC). They had been trying to create a true single market. From the concept of how its development, "single market" to "single currency", it moved toward to euro-integration.

The scale of country depends on mutual adjustment in three principles operation: economic, society and political. For economic, it can be emphasis scale, this means larger size of the market has more effective integration. In contrary, for society, different nationalities, regions and communities has their own characteristic, so this can define the principle for economic is "seeking the common points" and for society is "reserving differences". Therefore, it needs a political principle to control the balance in pursuit of the ideal state.

The first step for members of EU is to create union (single market), which included removing tariffs on many products, and they do another step is euro-integration. However, referring to the sovereign debts crisis in Europe, they should not only controls monetary policy .For create an even closer union, they should control fiscal policy and depend on EU constitution.

It's not hard to see the conflicts that play out on a local and national level can also play out on the supranational level. How to define the "local" and "nation" well? This is clearly the only issue for today's EU.
" Every day that the euro zone crisis continues, every day it isn't resolved, is a day that has a chilling effect on the rest or world economy," said British Prime Minister David Cameron. " We are ready to do our part to help stabilize the world economy…..
But you can't ask the IMF or other countries to substitute for the action that needs to be taken within the euro zone itself."

It is clear that the members in EU zone are working hard to find a long term solution.
Certainly it is about economic, society and politics, hopefully it can be confirmed in a short period of time. The fact is that the longer time it last, the deeper it hurt the confidence of global market.

Dr. Paul Chang
Nov, 2011

Microcut Newsroom

Newly employed Area sales and support manager for the Nordic countries, Baltic states and Eastern Europe - Göran Widfeldt.

Göran Widfeldt has over 20 years experience in all aspects of the machine tool industry working both within small family businesses to large manufacturing and wholesales companies. This includes skills in:

- Machine tool operation
- Product purchase and modification
- Stock control
- Customer services and supplies
- Industrial relations
- Product design, sales and marketing
- Administration and financial management

Göran has the experience to customer service skills demonstrated trough meeting all areas of customer needs, from establishing product requirements, supply of goods and after-sales service. He has also a proven ability as a product manager to build relationships and establish sound business reputation. During many years of work in the industry extensive working knowledge of production processes and materials has been gathered by Göran and also the ability to keep up to date with products methods and technology. By working as product manager, Göran developed his ability for problem solving and decision making skills as well as to responded to customers demand for products by accessing international markets, establishing cost of customizing product, calculating company profit and managing production and supply.

Göran lives in Sweden. The mission he has is to develop and strengthen Buffalo's relations to distributors and in the long run, a more extensive after sale support and spare parts availability for Buffalo's machines in Europe. This development is getting more and more essential as Buffalo is selling more High Tech machines to the market.
Buffalo welcomes Göran to the staff…..

Strategy to Develop a Business Supporting Center in Europe

BUSINESS CONCEPT

Working name for the business:
MICROCUT European Support Center [MESC]
Mother branch:
Buffalo Machinery Co. Ltd - Machine Tool Manufacturer.
Services:
Sales, service and technical support to MICROCUT agents and/or distributors in English.
Trading:
MICROCUT European Support Center will be established as a “no cost” local (EU) established manufacturers support team and act as a non trading company (all trading between manufacturer and agent/distributor will be direct).
Target group for MICROCUT Support Center:
Microcut's agents and distributors
Mission for MICROCUT Support Center:
Make it possible and interesting for distributors and agents to sell Microcut’s High Tech products
USP – Unique Selling Proposition:
Challenger local presence with knowhow of products

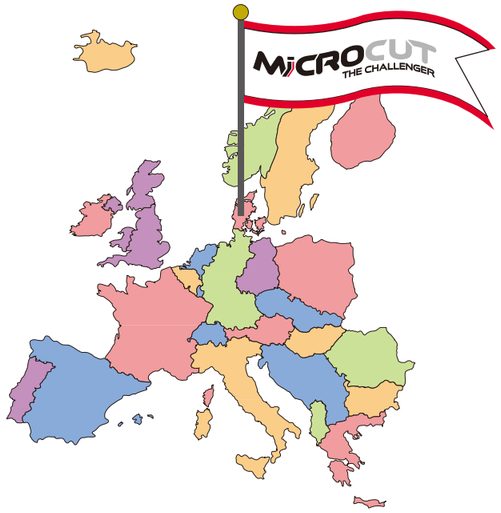
MARKET AND CUSTOMERS

Primary targets are present agents and distributors. Secondary targets are new agents and distributors for those the products or areas are not represented.
What is a typical MICROCUT Support Center customers:
Typical agents/distributors must have an established position in our present and future markets, own sales and service organization and understand our USP. The agents /distributors must be prepared to have our products as first brand.
Where is the market?
MESC shall work within EU.
How will MICROCUT Support Center reach the market and customers?
1) The list of agents/distributors’s fulfillment of criteria:
   a. Well presented on their market
   b. Sales organization
   c. Service organization
   d. Regularly train and update their own organization
   e. High level of English ability
   f. High level of Computer knowledge
2) Evaluate present agents/distributors upon the fulfillment of criteria. Make action plan and act.
3) Create prospect list on non established markets who fulfill the criteria.
4) Approach prospects.
5) Evaluate prospects. Make action plan and act.

How to make an interesting package to the market.
Evaluate different techniques for how the agent/distributor will access information/support with the purpose of excluding misunderstandings due to language as much as possible.
Financing the concept.
Through selling more of our machineries to agents/ distributors. Selling more of our to end-user. Increase sales of especially High Tech Machines.
Our competitor position today:
Main competitors have support centers of some kind.

FUTURE ESTABLISHMENT

After evaluation process, we have the intention to buit a support center covering EU market.



Global Outlook Saint Petersburg

Saint Petersburg, one of the world's most beautiful cities, is Russia's second largest city with a population of 4.7 million. Founded by Peter the Great in 1703, Saint Petersburg was known as "The Venice of the North" in its heyday. In 1914 the name of the city was changed to Petrograd .In honor of communist revolutionary and founder of the Soviet Union the city was renamed Leningrad, and in 1991 back to Saint Petersburg. She is regarded as the most Western city of Russia. A large number of foreign consulates, international corporations, banks and other businesses are located here. She is also home to The Hermitage, the largest art museum in the world.

Climate

St. Petersburg is a city so confident of its good weather. One of the local papers has a long tradition of giving away that day's edition anytime the sun doesn't shine. Surrounded by water and beaches on three sides, the city has drawn generations of winter sun seekers.

The average daily temperature in July is 22 °C (72 °F); maximum about 37 °C (99 °F). A winter minimum of −35.9 °C (−33 °F) .The average annual temperature is +5.4 °C (42 °F). The River Neva within the city limits usually freezes up in November–December and break-up occurs in April. The city has a climate slightly warmer than its suburbs. Weather conditions are quite variable all year round. Average annual precipitation varies across the city, averaging 600 mm per year and reaching maximum in late summer.

Global Outlook Saint Petersburg

Economic

St. Petersburg is a major trade gateway, financial and industrial center of Russia specializing in oil and gas trade, shipbuilding yards, aerospace industry, radio and electronics, software and computers; machine building, heavy machinery and transport, including tanks and other military equipment, mining, instrument manufacture, ferrous and nonferrous metallurgy (production of aluminium alloys), chemicals, pharmaceuticals, medical equipment, publishing and printing, food and catering, wholesale and retail, textile and apparel industries, and many other businesses. Automotive and parts industry is on the rise here during the last decade. For instance, Toyota is building a plant in one of the suburbs; General Motors and Nissan have signed deals with the Russian government too.

The city is also known as a "beer capital" of Russia, due to the supply and quality of local water, contributing over 30% of the domestic production of beer.

In 2006 Saint-Petersburg's city budget was 179, 9 billion Russian rubles, and is planned to double by 2012. The federal subject's gross regional product as of 2005 was 667,905.4 million Russian rubles, ranked 4th in Russia, after Moscow, Tyumen Oblast, and Moscow Oblast, or 145,503.3 rubles per capita, ranked 12th among Russia's federal subjects, contributed mostly by wholesale and retail trade and repair services (24.7%) as well as processing industry (20.9%) and transportation and telecommunications (15.1%).

Transportation

Saint Petersburg is a major transport hub: It has one major airport, several centrally located train stations, and several bus terminals. Petersburg has an extensive system of local roads and railway services. The first Russian railway was built in 1837. The city is the final destination of a web of intercity and suburban railways, served by five different railway terminals.

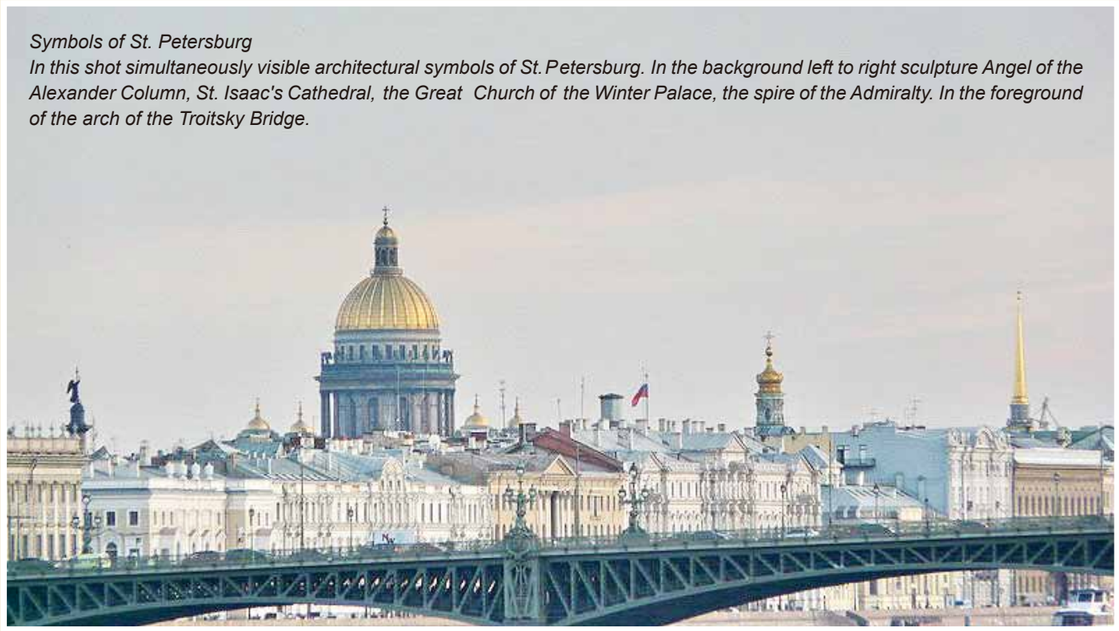
Buses carry up to 3 million passengers daily, serving over 250 urban and a number of suburban bus routes.

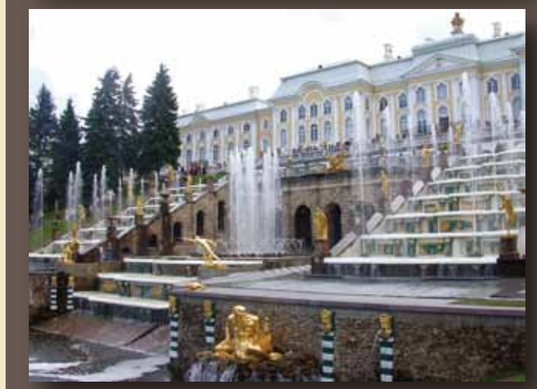
Saint Petersburg's metro is the second largest underground railway system in Russia, second only to Moscow. It is regarded as the cheapest and most effective way to get around the city. Saint Petersburg Metro underground rapid transit system has five lines with 64 stations, connecting all five railway terminals, and carrying 3.4 million passengers daily. Metro stations are decorated in marble and bronze. It's become a major tourist attraction.

Saint Petersburg is also served by Pulkovo International Airport, and by three smaller commercial and cargo airports in the suburbs.

The airport has two main terminals with one domestic and one international. It is widely regarded as one of the larger and more modern airports in the Russian Federation. There is a rapid-bus transit connection between Pulkovo airport and the city center.

Symbols of St. Petersburg
In this shot simultaneously visible architectural symbols of St. Petersburg. In the background left to right sculpture Angel of the Alexander Column, St. Isaac's Cathedral, the Great Church of the Winter Palace, the spire of the Admiralty. In the foreground of the arch of the Troitsky Bridge.





БАЛТИЙСКАЯ ПРОМЫШЛЕННАЯ КОМПАНИЯ
www.bpk-spb.ru

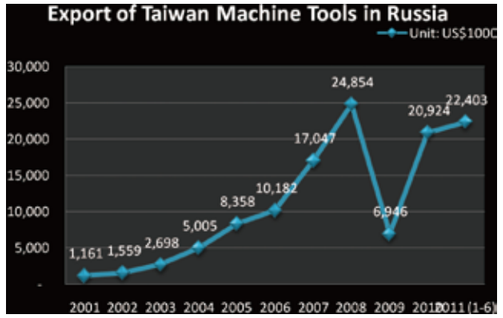
Founded in Saint-Petersburg in 2002, BPK company started as providing repair service of second-hand Russian and foreign made metal cutting machines. Since the company has obtained a good reputation by its good service, the company provided complete repair and modernization of more than 160 sets of equipment during the years of 2002-2006. This built the foundation of the company development to become the major machinery supplier in Russia and CIS countries nowadays. In 2006, BPK started to expend their business by supplying new machines and equipments, step by step; it has become her main business. During the years of 2006-2010, more than 260 sets of equipment had been supplied into customers together with installation work and customers' staff training.

BPK, a privately owned company, has 92 employees (year 2010) including 64 production personnel and 28 office staffs. Today, there are three offices locating in Russia--St. Petersburg, Moscow, and Yekaterinburg. With 2000sq.meter of showroom, BPK Company displays extensive range of metalworking machines, for instance, conventional & CNC lathe, Machining Center, CNC horizontal boring machines, gantry type machines and CNC Vertical lathe. The showroom provides a perfect venue for customers to inspect machines and test the accuracy of cutting work pieces under operating conditions. The other 3000sq.meter warehouse is capable of stocking more than 100 machines. Thanks for the variety and high volume of inventory, BPK always offers quick delivery and constantly focuses on meeting the specific technical and commercial needs for customers.

What makes BPK company successful? Today BPK's business focuses on 4 main aspects offering total sales and service solutions for the metalworking industries. These four main aspects are "turnkey technology, complete range of metal working machines, on-site training, and prompt after sale service and support." In regards to the turnkey technology, BPK Company offers complete engineering services spectrum, such as fixture, tool selection, programs, and cutting test calculating cycle time according to the customers' drawings and sketches. Each machine well suits customer's demand after testing, and customers inspect operation conditions at BPK area. Then BPK supplies whole range of metalworking machines of the leading manufacturers. Customer can get all demand satisfied in one shop.

Besides offering quality products with reasonable price, BPK built customer satisfaction and loyalty by providing training and after sales service support. BPK offers the training mainly on machine operators and software specialists in both BPK side and customer side. The company has professional high qualified teams to provide installation supervision to the customer of any Russian region and CIS countries. The team has excellent experience in mechanism and electric skills from the repair and modernization of machines. Thus, they can always provide the speedy and efficient solution for all kinds of problems with any type of machines. Any service inquires will be answered within 24 hours in such wide territories. Spare parts and accessories are available in stock in order to service customers' need on time.

Russia is a booming market for machine tools in the world. Taking the machine value exported from Taiwan to Russia as an example, it was USD1.1 million in year 2001 and USD20.9 million in year 2010. The value has been grown 21 times in a decade. In late 2008 and early 2009, Russia faced the first recession after 10 years of rising economy, until late 2009, the Russian economy had begun a modest recovery. The economy has not been as seriously affected by the global financial crisis, mainly because of the integration of short-term macroeconomic policies with excess income being stored in the Stabilization Fund of Russia.

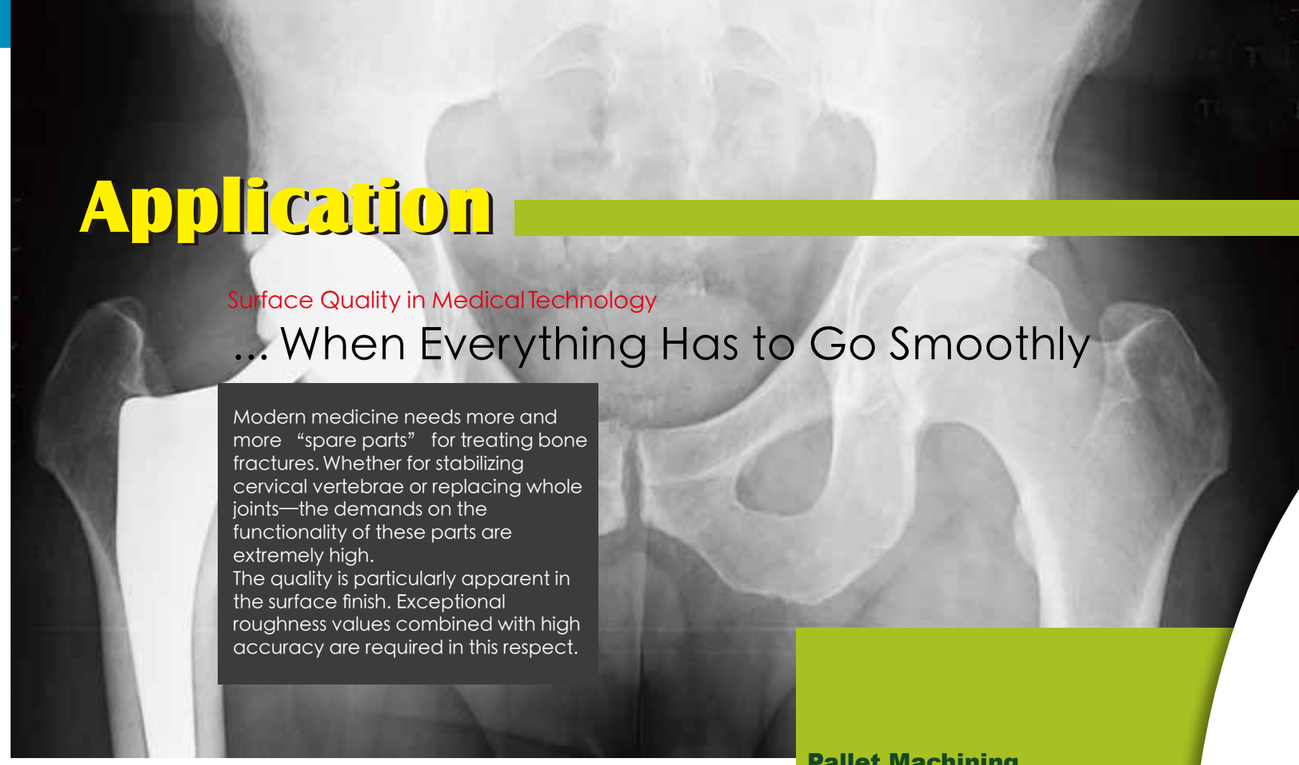


Distribution

To develop the market, starting from year 2007, BPK has been participating in 10 main local trade shows all over Russia studying customer's requirements and offering the best solution of equipment supply. Attending the biggest trade shows in Russia, such as Moscow Metalloobrabotka show, and displaying the best machines each year give BPK opportunity not only to attract key customers with the best quality, technology and innovation product but also to get more new orders for future years.

BPK company and Buffalo Machinery have started a business relationship since 2008. With a close cooperation to Buffalo Machinery, BPK double their success. With wide range of Buffalo machines, BPK adds product lines and catches more customers of different industrial fields: CNC machines exactly match the demands of general machinery, Boring machines suit power engineering and military sector, 5-Axis machines are mainly for die & mold and aerospace industries, High-Speed machines are for mold manufacturers and for medicine industries. Since year 2010, both parties agreed to arrange 3-quarter advanced production plan which brings more sales in this high demand market by prompt delivery. Moreover, Buffalo's development on the mechatronica on high speed machining technology brings advantage for distributors. Both parties are introducing HSM and multi-axis machines into those strongly developed industries in Russia and CIS countries.

Application



Surface Quality in Medical Technology

... When Everything Has to Go Smoothly

Modern medicine needs more and more "spare parts" for treating bone fractures. Whether for stabilizing cervical vertebrae or replacing whole joints—the demands on the functionality of these parts are extremely high.
The quality is particularly apparent in the surface finish. Exceptional roughness values combined with high accuracy are required in this respect.

Mastering the dynamics

The workshop is buzzing with activity: the milling cutter is moving so fast that you can barely see it. Medical components are being machined on small to mediumsized machine tools. Dynamics are high: the tool is whizzing around the work envelope at about 50 to 60 m/min. The paths of traverse are correspondingly short. The danger: the machine may start vibrating, which could have a negative effect on the accuracy.

HEIDENHAIN controls play an important role in mastering these high dynamics. With its high-precision motion control, the iTNC 530 can deal with high speeds and follow the contour outlines with outstanding accuracy. Even at high feed rates, the control ensures ultra-accurate tool traverse over the workpiece surface.

Avoiding collisions

Fast motion and little available space in crease the risk of collisions. In these circumstances, machine operators have little chance to stop the machine in time. A crash will inevitably lead to scrap-but crashes are avoidable. With the dynamic collision monitoring (DCM) function the HEIDENHAIN control monitors all movements and issues a warning in time about an impending collision between the tool and fixtures or permanent machine components.

This "real-time protection" is also in effect during setup or while the program is interrupted, for example if the machine operator traverses the axes manually.

Controlling motion

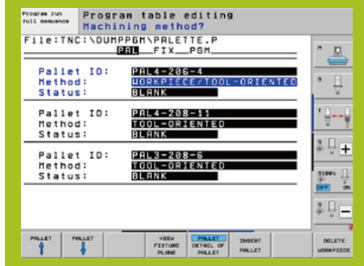
The process chain for creating intricate shapes involves potential sources of error from the interfaces between the systems. Complicated joint shapes are programmed on CAD systems, transferred to CAM systems that add the machining strategies and the parameters for spindle speed, feed rate, etc., and then translated to motion control in the iTNC 530. The control automatically smoothes the block transitions to achieve a high surface definition. The iTNC 530 also offers users possibilities to easily set the jerk and acceleration parameters for the feed axes, i.e. to directly influence the ratio of machining velocity to tolerance. As a result, users can adjust the contour deviation to suit their specific requirements.

HEIDENHAIN controls are therefore the best "medicine" against production inter ruptions and extensive reworking-also in medical technology.

Pallet Machining for Series Production

With HEIDENHAIN controls you can easily organize the series production of your medical devices: the clear and straight-forward pallet management feature helps you to do this. Using the pallet table, you can define the machining strategy for your workpieces in such a way that the NC program is optimally executed according to the tool changes. This has the key advantage that you can also apply the machining method to other applications, i.e. to other NC programs. By enabling the appropriate datum shifts and datum tables,the pallet table saves you valuable time when machining identical workpieces on multiple fixtures.

In real-world production, jobs are often interrupted to fit in more urgent workpieces. This requires flexibility. In such a case, the pallet editor stores the pallet file with a code. You can then use this code to reenter the program at the point of interruption.



Migration to the iTNC

Precision Starting from the First Workpiece

First-class instruments are essential for surgical operations. Their surfaces and contours must be produced with exceptional quality. After all, nothing that could cause an infection should remain behind after an operation...

Smooth migration

Managing Director Robert Ott found the appropriate solution in the iTNC 530 from directly on the shop floor was quickly implemented with the new machine and its iTNC 530 control. A short time later, the machining of complex contours with just a few setups was already a standard process.

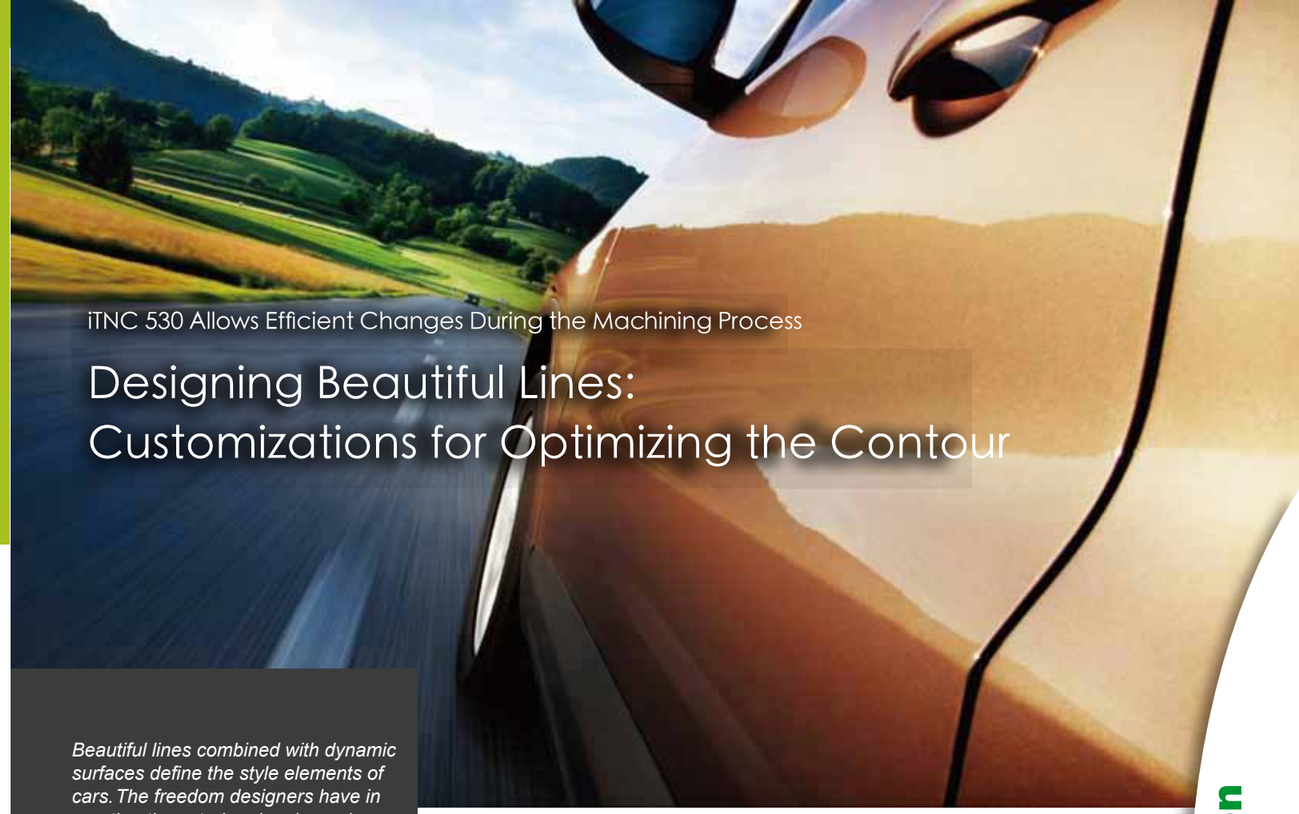
KinematicsOpt helps maintain a consistently high level of precision when machining the workpieces. The software option is integrated directly in the iTNC 530. It eliminates deviations of rotary axes due to thermal influences, and compensates their drift. A laser system for automatic tool measurement also plays an important role in ensuring the dimensional accuracy of the finished workpieces.

Positive review

When asked about their new experiences, the machine operators Robin Suter and Lukas Dietiker praised the strengths of the iTNC :

- The iTNC has a convenient editor with simple functions for copying, moving and structuring program blocks and program sections.
- The HEIDENHAIN cycles are indispensable. They permit rapid program creation for five-axis machining.
- Even complicated tasks, such as machining on an inclined plane, are made easy by the PLANE function.
- The iTNC's manual is easily understandable, and the functions being searched for are found quickly.

Surgical instruments meeting high demands on surface quality and contours are produced iTNC 530 .



iTNC 530 Allows Efficient Changes During the Machining Process

Designing Beautiful Lines: Customizations for Optimizing the Contour

Beautiful lines combined with dynamic surfaces define the style elements of cars. The freedom designers have in creating the exterior also depends on what is technically feasible in making the molded parts. Tool making plays a key role and needs to prove its efficiency anew with every new car model.

Making the large form tools is very time-consuming. The automated roughing and finishing process can take far above 100 hours. As the majority of large tools are one-of-a-kind, highest levels of accuracy and surface definition are a must. After all they have a direct impact on the quality of the finished vehicle components of an entire series. The production costs are correspondingly high.

Machining these tools requires excellent expertise and experience from the machine operators. The intricate contours could not be manufactured with this high accuracy without frequent manual interventions in the automated machining process. To keep costs as low as possible, the interruptions to the machining process must be brief and deliver reliable results.

Risks of manual intervention

Perfection in milling the outline is the key to ensuring ultra-accurate contours. The machining process is largely automated, but often requires specific follow-up work, e.g. milling edges and arcs in individual sections of the contour with a tool that has a smaller radius. This, in turn, frequently means trudging off to the CAD office, which leads to a time-consuming interruption of the machining process. The CAD office writes and tests a program for the contour section concerned. Then the program is transferred to the control and executed there. These are many steps for attending to a single detail.

To optimize the quality or the machining speed, specific parameters like feed rates need to be changed globally. In this case the running machining process has to be interrupted as well. Another common cause for delays is that the control cannot simply resume the machining program, but has to consider all the previously executed program sections from the very beginning.

Every manual intervention in the automated machining process involves a risk. The large machining programs make the display in the control's editor appear complicated and cluttered. This wastes valuable time. Some global settings require changing machine tool parameters in widely distributed places. The more steps you need for these adjustments and the more complex the changes are, the more error-prone they are. And errors are something these very expensive workpieces can tolerate the least.

Correcting axis movements—safe and easy with the HEIDENHAIN wireless handwheel

Easy contour rework

In contour milling, it often happens that a specific part of the contour has to be reworked with another tool. Typically, the corres ponding program segment from the CAD/CAM system has to be adjusted and then a new, short program is created.

An easier way without the detour to a CAD/CAM system is to use the DXF converter that is integrated in the iTNC 530 from HEIDENHAIN. In a graphics view, users can interactively select tool paths that have been created in a CAD/CAM system. The selected parts of the contour can be quickly stored as a separate machining program in the control. This function saves users some of the time-consuming visits to the CAD office and allows them to carry out minor changes themselves. Also useful in this case are the functions for the safe approach and departure of the contour, which can be easily included in the newly created machining program via simple dialogs.

Conclusion: For example, if you need to rework parts of contours with a smaller tool, or even if you just want to rework some parts of a 3-D shape, the graphic, interactive selection in the DXF converter is very convenient and saves you a great deal of time.

Fast and safe adjustment of global settings

If a tool has to be taken from the running production process because it needs to be reworked—the toolmakers have to be quick. They won't always be able to use the same machine for which the NC program of the tool was written. The Global Settings option makes it possible to quickly adapt the NC program to the axis configuration of an available machine.

To change global settings, the current machining process has to be stopped. With an iTNC 530 from HEIDENHAIN, a safe stop is possible at any time and the operator can easily make the changes: without modifying the machining program, the operator can define coordinate transforma tions and settings that are effective for the current program. A clearly structured form further simplifies the process. This helps to avoid errors and ensure that inter ruptions are as short as possible.

The start of the machining program does not cause any delays, either. The iTNC 530 begins immediately and, if necessary, moves to a new position using the positioning logic that the operator previously defined.

Conclusion: Changes to the global settings are uncomplicated and safe. Inter ruptions are kept short.

Reliable handwheel superimpositioning

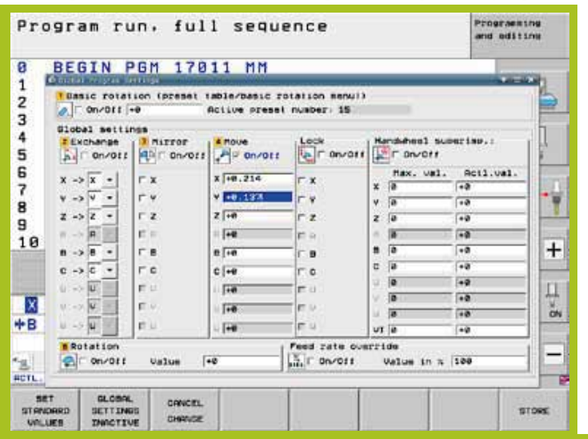
When machining undercuts in the large tools, the operator has to intervene directly in the automated machining process. With the handwheel--preferably with the wireless HR 550 FS from HEIDENHAIN--you can precisely correct tool movement in a defined axis by superimposed positioning. Before doing so, you define in the global settings for which axes and to what extent you want to allow the superimposition. Handwheel superimposition is also safe and easy to use in a tilted system, for example if you want to directly influence the movement of a virtual axis.

Conclusion: The functions for handwheel superimpositioning are conveniently defined in the global program settings. The HEIDENHAIN wireless handwheel allows performing superimposed movements precisely and without restricting cables--even in the virtual axis.

Strategies for safe and quick changes

HEIDENHAIN controls are designed around the needs and requirements in the field. The iTNC 530 has many functions to make the complex adjustments during the machining process as easy as possible for the machinist. Whether it's the global settings, handwheel superimpositioning or the graphic selection of contour parts--the goal is always to deliver reliable results in minimum time. This reduces costs.

A clear, straightforward entry form facilitates global settings for the programs.



Global Settings function overview

The functions are designed to meet the typical needs and requirements of toolmaking:

- Exchanging axes
- Additional, additive datum shift
- Superimposed mirroring
- Axis locking
- Handwheel superimposition, with axis-specific memory of paths covered per handwheel, also in virtual axis direction
- Superimposed basic rotation
- Superimposed rotation
- Globally valid feed-rate factor

Study on Ram-Type Spindle Compensation of Tolerance

Jerry Tang[1], Ching-Wei Wu[2] and Paul Chang[3]
National Chang-Hua University of Education, Department of Electrical Engineering, Taichung County, Changhua 428, Taiwan

Abstract—Ram-quill combination spindles have been widely applied in horizontal boring milling machines. One of the greatest benefits of using these spindles is that the machine can be used for a variety of applications.

Experiments have shown that the ram housing bends when it extends beyond half of its maximum travel. The straightness of the ram housing is no longer within the tolerance, and the spindle cannot provide the needed extension adjustments when it is at its maximum run-out point.

This paper proposes an electro-hydraulic monitoring and compensation system that is able to adjust the pressure to the mechanism in real-time. The experiments demonstrate that the required straightness of the horizontal surface can be satisfied, and a ball bar test at the weakest point shows an improvement in the roundness tolerance of 50.2%. This tolerance makes the machine able to perform high precision machining.

Keyword: Ram Housing, Straightness, BallBar

I. INTRODUCTION

Based on the differences in the mechanical structure and the application requirement, spindles of horizontal boring machines can be classified as ram-type, quill-type or ram-quill combination-type. Fig. 1 shows a ram-type spindle. A ram-type spindle can extend to enlarge its working area. Ram-type spindles enhance the capability of large milling machines [1]. When the ram extends, the spindle maintains the rigidity for boring and facing [2]. The disadvantage of this arrangement is that spindle quill movement is limited by gravity [3]. Therefore, the ram-type horizontal boring machine is suitable for facing large areas, but not for deep boring. It can perform deeper cuts than a traditional horizontal boring machine [3].

Fig. 1 Ram-Type Spindle of a Horizontal Boring Machine

Fig. 2 shows the quill-type spindle. The quill can extend for deep hole boring. Quill-type spindles are not as rigid as ram-type spindles, especially when the quill is extended to its maximum length. Because the diameter of the quill is much smaller and lacks the proper support found on ram-type machines, the working capacity is limited by the ratio between diameter of spindle and the extension distance [1] [4]. Vibration of the quill is a difficult issue to solve, especially when the machine is performing deep hole boring or large diameter facing [5-7]. The weakness of the quill spindle impacts the tolerance and quality of the work-piece. Therefore, quill spindles are mostly used for boring and threading.

Fig. 2 Quill-Type Spindle of a Horizontal Boring Machine

Combining the structures of both types of spindles as described above, a new ram-quill combination type is created, as shown in Fig. 3. The quill spindle is built into the ram housing, which provides a much larger working capacity and other features.

Under machining conditions, the ram is extended until it is close to the work-pieces in order to stabilise the quill and achieve better tolerance. Thus, the ram-quill spindle is used for deep inner boring and threading. The machine has a large working capacity and meets the requirements of various complex machining tasks. However, the impacts of gravity and the structure of the ram still cause tolerance problems. They limit the bearable axial thrust force.

To increase the tolerance, stability and rigidity while the ram-quill spindle stretches out, a tolerance compensation mechanism can be fitted onto the machine to reduce the deformation and ensure that the ram is within tolerance.

Fig. 3 Ram-Quill-type Horizontal Boring Machine

A.C. Okafor [8] used a temperature sensor to react to temperature changes and utilises mathematical models to estimate the deformation of the ram, and then a fixed compensation value is set. The function compensates based on the estimated value of the deformation. A tolerance difference could occur due to variations in tool weights, pressure of the coolant through the spindle and the weakness of the ram after working a long time, all of which may give a larger tolerance error than the estimated value. Mahbubur Rahman [9] pre-measured the change in the mechanical tolerance and compensates for the error while machining to improve the machining accuracy. However, this method can never ensure that the compensation value is accurate, and it cannot modify the compensation value while machining. Chana Raksiri [10] estimated the geometrical error with a back-propagation neural network before adding both the error analysis and the cutting force into the model. This approach does not compensate for errors outside the model nor does it compensate in real-time. Alberto Caballero-Ruiz [11] used genetic algorithms to analyse micro-machining tools and build a mathematical model of the error for reducing the tolerance error. However, these algorithms can only apply to no-load cutting. They cannot effectively compensate for the changing ram tolerance under working conditions. Weidong Zhu [12] employed the B-Spline method to measure three-dimensional (3D) volumetric error as a basis for error estimation. Zhu analyses and adjusts the servo parameters to compensate for the tolerance of machine.

These papers provide different mechanical tolerance compensation solutions; however, the capability to correct the errors accurately in tolerance monitoring and time compensation, which is the most important target, has not been considered.

The demand for ram-quill boring spindles is high in the metal working machine industry. However, how the tolerances and rigidity can be maintained while the ram-quill housing and spindle are extended for multiple machining functions is an extremely important issue.

II. MECHANICAL STRUCTURE

The spindle structure design of horizontal boring machines is based on the large axial and radial torsion requirements. Large axial thrust forces are required for large diameter boring and facing, which are common machining tasks in the wind power and aerospace industries. The highest axial thrust considered in this study is 60,000 N. This thrust is suitable for machining alloy steel and nodular cast iron.

The dimensions of the ram are 540 mm x 540 mm, and it is made of grey cast iron. The material is ISO R185-30 certified; the tensile strength is excellent and meets the required high axial force. Fig. 4 shows the ram structure and its supporting block.

The ram is supported by 3 sets of 45 mm roller linear guides. This construction saves a large amount of lubrication oil because the guides are lubricated with grease instead of oil. Therefore, the use of roller linear guides will not cause environmental problems, and it will extend the lifespan of the cutting tool because no lubrication oil will be mixed into the cutting liquid. The adhesion strength of grease also matches the design requirements of the axial and radial torsions of the spindle.

The ram is supported by 3 sets of 45 mm roller linear guides. This construction saves a large amount of lubrication oil because the guides are lubricated with grease instead of oil. Therefore, the use of roller linear guides will not cause environmental problems, and it will extend the lifespan of the cutting tool because no lubrication oil will be mixed into the cutting liquid. The adhesion strength of grease also matches the design requirements of the axial and radial torsions of the spindle.

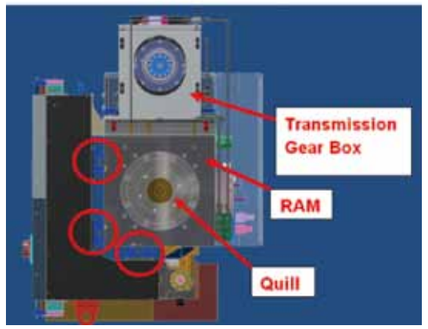


Fig. 4 Supporting Design for Ram

According to the geometrical test, when the ram was extended 800 mm, the largest tolerance was 0.015321 mm. The extension length will cause spindle run-out beyond the standards, as shown in Fig. 5, and the eccentricity of the quill increases. The increased eccentricity has a huge impact on machining precision. Therefore, real-time tolerance compensation is necessary while the ram is moving [13].

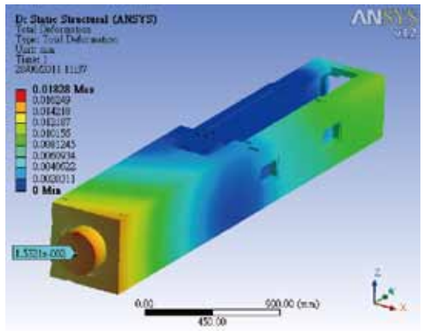


Fig. 5 Ram Deformation

Fig. 6 shows the overhang value and the desired compensation for the ram-quill-type spindle. AutoCAD ANSYS software is used to perform a simulated rigidity analysis. The pull force required to make the ram meet the tolerance is shown in Table 1.

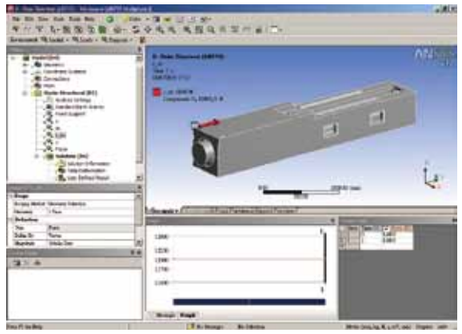


Fig. 6 Ram-Quill-type spindle compensation analysis

Table 1 The overhang value of the Ram and the desired tension

Ram-Quill Position	Natural Error	Pull Force Requited
0mm	0μm	0N
100mm	-0.86μm	2000N
200mm	-1.36μm	2500N
300mm	-1.64μm	3500N
400mm	-2.62μm	4500N
500mm	-3.8μm	5500N
600mm	-5.66μm	7000N
700mm	-7.86μm	8500N
800mm	-11.44μm	10000N
900mm	-17.4μm	12000N
1000mm	-25.6μm	14000N

III. COMPENSATION DESIGN

The tolerance of the spindle run-out cannot meet the geometrical requirement. This paper proposes a hydraulic compensation mechanism for ram-quill-type housing deformation. A hydraulic checking sensor is used to measure the variance in endurable tension in real-time while the ram is moving in and out.

The output of the checking sensor passes through an amplifier and is then read by the CPU. Based off of this reading, the CPU decides to increase or decrease the pressure of the hydraulic unit to make sure that the ram housing remains within its tolerance, even if a high axial thrust force is applied.

Fig. 7 shows the control structure and the adjustment procedure for the axial controls of the ram housing. C is the hydraulic cylinder. E is the pull rod, which is made of grade S45C mild steel and has a cross-sectional area of 836 mm2. The rod has a tensile strength of 569 MPa and a yield strength of 343 MPa and can endure approximately 286,748 N of tension, which exceeds the design requirement of 14,000 N. F is the hydraulic checking sensor.

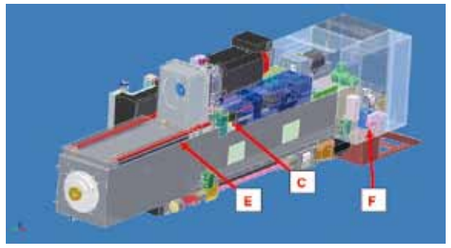


Fig. 7 Hydraulic compensation mechanism for Ram-type housing

The checking sensor gives pressure feedback in real-time. When the machine is under normal working conditions, as the ram position changes, the pressure feedback value continuously changes. The analogue pressure signal is sent to the microprocessor, which calculates and places a proper pull force on the hydraulic cylinder. This adjustment brings the ram within the acceptable tolerance [14].

Fig. 8 shows the hydraulic compensation control diagram. C' is the pressure boost and decompression device. G is the hydraulic decompression switch. F' is the pressure feedback unit.

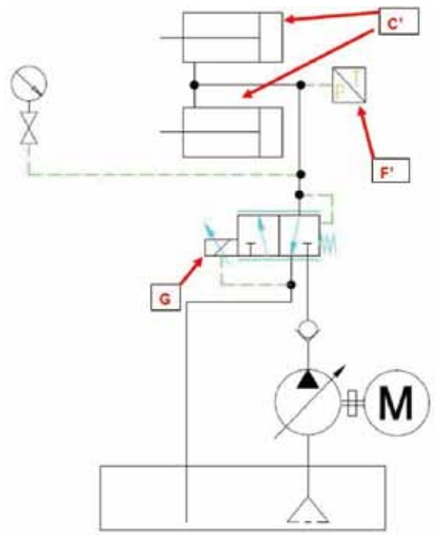


Fig. 8 Compensation diagram of the hydraulic circuit

The diameter of the hydraulic cylinder is 50 mm, and the stroke is 40 mm. The diameter of the pressure boost and decompression device spindle is 30 mm. For easy maintenance, the unit is placed on the top of right and front sides of the ram.

This study sets the maximum tension applied by the hydraulic pressure at 14,000 N. The pressure can be calculated by Eq. 1. The maximum hydraulic pressure is 113.68 kg/cm^2.

$$P = \frac{4F}{9.8(D^2-d^2)\pi} \quad (1)$$

F is the desired tension in kg/cm^2.

P is the maximum hydraulic pressure in N.

S is the area of pressure of the hydraulic cylinder in cm^2.

The area of pressure of the hydraulic cylinder can be given by Eq. 2.

$$S = \frac{(D^2-d^2)\pi}{4} \quad (2)$$

D is the diameter of the hydraulic cylinder in cm.

d is the diameter of the pull rod in cm.

The desired compensating tension is directly proportional to the maximum hydraulic pressure [15]. The pressure control valve that adjusts the hydraulic pressure is controlled electromagnetically.

Fig. 9 shows the pressure control valve, G is controlled by a spring balancing device. The spring balancing device is operated by an electromagnetic. A magnetic force is generated by the electromagnet unit while the valve is operating. The switching function is controlled by the electromagnetic unit, which is based on the value of the magnetic force. It can compensate to maintain the straightness of the rectilinear motion of the ram.

Fig. 10 shows the characteristic curves of the pressure control valve. It has pronounced magnetic hysteresis. The maximum magnetic hysteresis is 4%. Its effect on the desired maximum tension of the ram is a maximum error of 560 N. Therefore, the maximum error value of the tension is set to be 500 N to reach the requirement of the hydraulic pressure control valve.

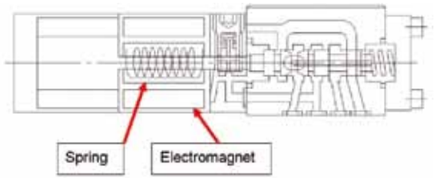


Fig. 9 Control Diagram of the Hydraulic Pressure Switch

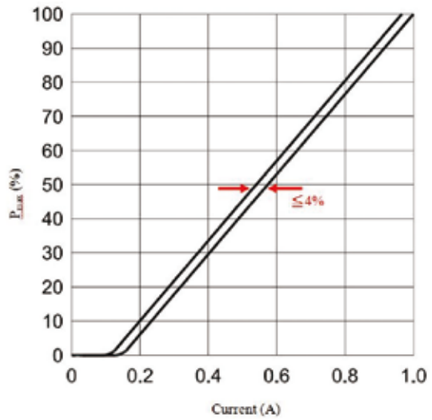


Fig. 10 The proportional Pressure Relief Valve characteristic curve

The ram's working position is monitored by an analogue signal that is given to the microprocessor. The compensation device then adjusts the tension to control the tolerance of the ram.

The tension values and the position reference are given by the CPU, which is pre-set by the value from the AutoCAD ANSYS system analysis.

The tension design unit is based on the tension feedback device and ensures that the correct tension is maintained. When the tension is lower or higher than the set pressure value, the hydraulic pressure is controlled and compensated for by a programmable logic controller (PLC). The research stipulated the range of the allowable tolerance to be between +500 N and -500 N. This range is based on the characteristic of the pressure control valve. The AutoCAD ANSYS analysis shows that when the tension difference is 1,000 N, the maximum error is 0.68 μm, as shown in Table 2.

Table 2 Ram-Quill-type spindle tension strength

RAM Position	Error of the most suitable tension (μm)	Error of the most suitable tension -500N(μm)	Error of the most suitable tension +500N(μm)	Error of the most suitable tension +/-500N(μm)
100mm	-0.01	-0.05	0.02	-0.07
200mm	-0.02	-0.07	0.02	-0.09
300mm	0.00	-0.07	0.07	-0.14
400mm	0.02	-0.07	0.11	-0.18
500mm	0.00	-0.13	0.12	-0.25
600mm	0.06	-0.10	0.22	-0.32
700mm	0.07	-0.12	0.27	-0.15
800mm	0.00	-0.23	0.24	-0.47
900mm	0.04	-0.26	0.32	-0.58
1000mm	-0.06	-0.39	0.29	-0.68

As long as the deformation compensation tension of a ram-quill-type spindle horizontal boring machine is at or below the allowable tolerance range of +500 N to -500 N, the system will reduce the deformation by adjusting the compensation tension by up to 500 N, until the tension matches the set range. These adjustments avoid hysteresis impacts on the compensating effort.

Fig. 11 is a flow chart of the actions of the deformation compensation of a horizontal boring machine with a ram-quill-type spindle.

K1 is the set tension. K2 is the pressure value from the hydraulic examining switch. K is the difference between the set tension and the pressure value fed back from the hydraulic examining switch.

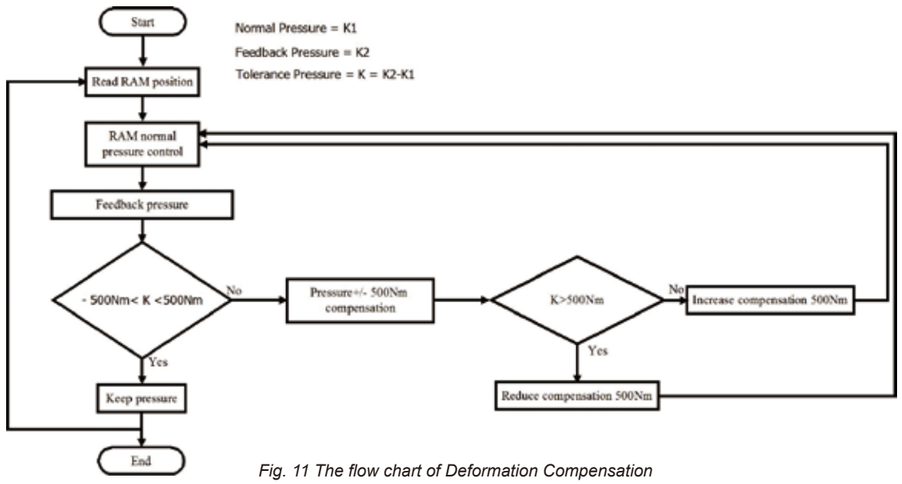


Fig. 11 The flow chart of Deformation Compensation

The output analogue voltage signal is representative of the electric current signal from the PLC. Based on the characteristics of the pressure control valve curve, when the value of current is lower than 0.15 A, the output is non-linear.

The range of the output voltage of the PLC is designed to be between approximately 1.5 to 9.5 volts; therefore, the current is ranges from around 0.15 to 0.95 amp. The converter diagram is shown in Fig. 12.

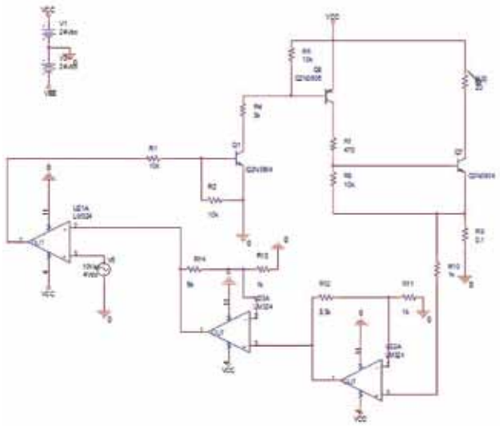


Fig. 12 Converter diagram

IV. EXPERIMENT

To verify the performance of the ram-quill-type housing with the compensation function, the straight-line motion is measured.

Furthermore, a 150 mm radius ball-bar is used to check the tolerance when the ram has been extended 850 mm. The accuracy meets the requirements [16] even when the ram extends to the maximum working position of 1000 mm.

Fig. 13 shows the measurements of the straightness of the ram movement. Table 3 shows the bending value under the above condition of the ram-quill with and without compensation. The data from this test are shown in Fig. 14. Curve H shows the motion when the compensation is OFF, and curve J shows the motion when the compensation is ON. The largest difference between the two curves is 27.6 μm.

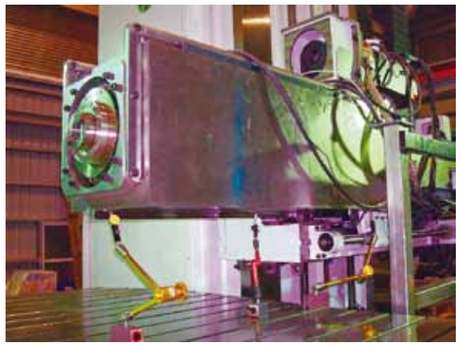


Fig. 13 The measurements of the straight-line motions of the ram

Table 3 The straightness test of the Ram-Quill

Ram-Quill Position	Without Compensation(μm)	With Compensation(μm)
0mm	0.0	0
100mm	-0.7	0.34
200mm	-1.2	0.49
300mm	-1.7	0.59
400mm	-2.8	0.84
500mm	-3.9	0.96
600mm	-6.0	1.59
700mm	-8.9	1.98
800mm	-12.4	1.3
900mm	-18.3	1.7
1000mm	-27.3	0.3

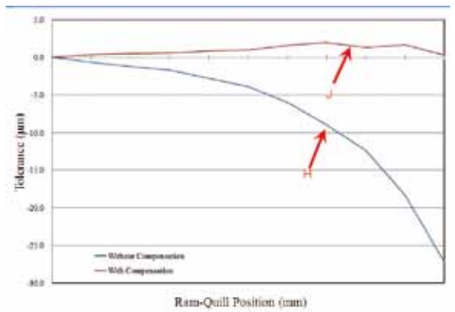


Fig. 14 Curves showing the straightness of both Ram-Quills

Fig. 15 shows the ball-bar test with a radius of 150 mm for taking contour measurements. The measured results are shown in Fig. 16. The error in roundness is 20.7 μm when the compensation unit is off. With the compensation system, the error in roundness is 10.3 μm, as shown is Fig. 17, an improvement of 10.4 μm, or 50.2%. This result demonstrates that the ram-type spindle deformation compensation system can effectively improve the tolerance.

Fig. 15 Ballbar test

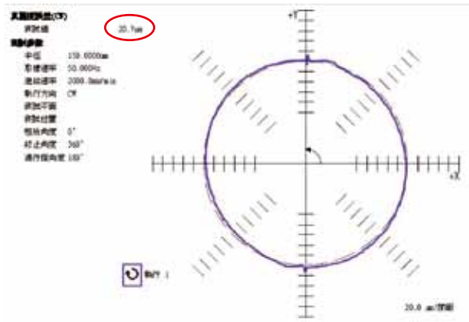


Fig. 16 The diagram of the contouring system without the compensation system

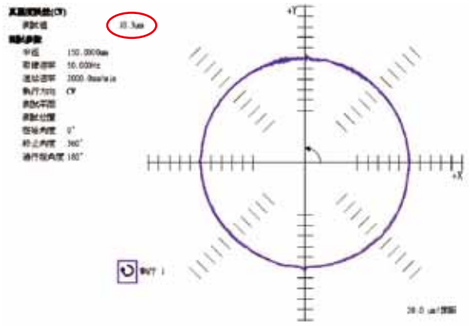


Fig. 17 The diagram of the contouring system without the compensation system

V. CONCLUSION

Without any support from the ram housing, the sagging of the ram-quill-type spindle is an unavoidable physical phenomenon. This paper proposes a hydraulic compensation mechanism that is based on the data from an AutoCAD ANSYS simulation. This mechanism is applied to pre-check the tolerance under applied axial thrust forces. The proposed compensation mechanism reduced the roundness.

The compensation mechanism improves the tolerance of the ram housing due to sagging. The mechanical error correction is as high as 50.2%. It ensures the linearity of the ram's spindle and improves the accuracy of the machine.

With the compensation mechanism, the ram-quill-type horizontal boring machine will be of great benefit to machining industries, such as wind power, automotive and aerospace.

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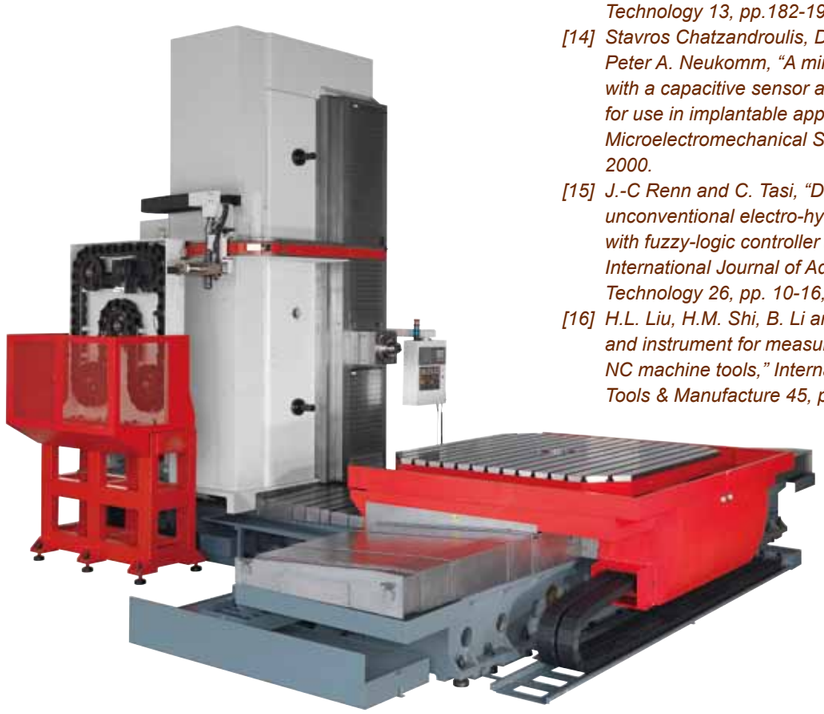


FAQ Trouble Shooting

Dear Dean,
We have the model HBM-5T installed for ten months, machine is on job everyday and work fine. However, the ATC doesn't act smoothly recently, could you provide us the tool alignment instruction.

Dear Nick,
Normally the tool alignment is required when machine is installed. Unless a crash happened after the commissioning or parts broken, it should not be necessary to do the tool alignment. It is required to check from the foundation of tool changer and make it clear if the problem caused by foundation has been moved. Adjustment of foundation is then required. If the foundation remains good condition, then the checking and adjustment of tool alignment is second step.
Following is the procedure of tool alignment.

1. Move Z-axis and pay attention to the connecting point of ATC arm rack. Be careful to prevent crash on two sections of racks. Fig. 1 shows that the rack is out of alignment.

Fig. 1 Rack alignment

2. Adjusting ATC arm rack height and space by adjusting ATC stand foundation bolts, as shown in Fig. 2 ad Fig. 3

Fig. 2 ATC stand

Fig. 3 ATC standard

3. Fig. 4 shows how to check the parallel tolerance of two section of ATC arm racks, which should be within 0.03mm~0.07mm.

Fig. 4 ATC arm rack

4. Prepare 3-section gauge as shown in Fig. 5.

Fig. 5 3-section gauge

5. Put arbor into spindle and clamp it.
6. Take off the key of tool guidance as shown in Fig. 6.

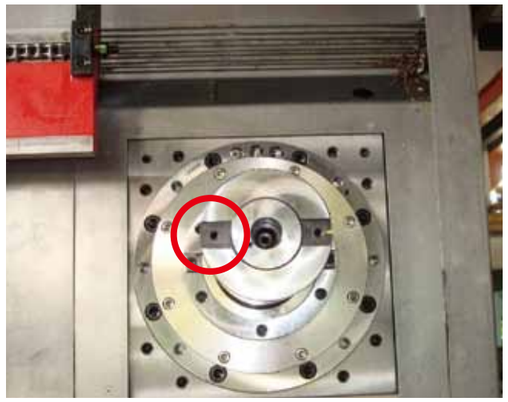


Fig. 6 tool guideance

FAQ Trouble Shooting

7. Put the middle part of 3-section gauge into tool change arm jaw, and move ARM to the front of spindle by using MPG Service mould, as shown in Fig. 7.
   Warning: Be careful of no interferece between W-axis and ARM.

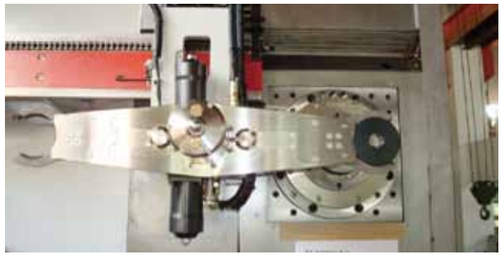


Fig. 7

8. Use finger to check the center hole of spindle and guage. Adjustment can be done by moving Y-axis by MPG Service mould. See Fig. 8.

Fig. 8

9. Arm left/right position is adjusted by buffer circuled, shown in Fig. 9.

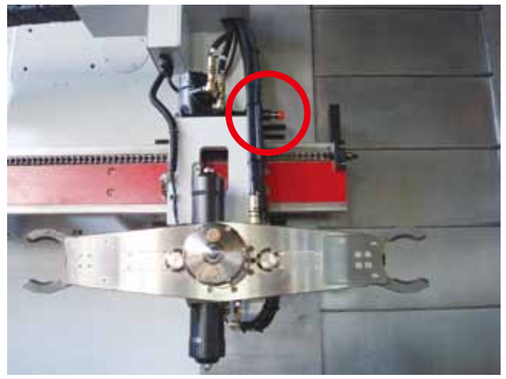


Fig. 9

10. Record Y-axis mechanical coordination after Y-axis position is done.
11. Put back the spindle orientation key and put the tool holder on spindle.
12. Execute M19 (spindle orientation) and release spindle orientation.
13. Move Y-axis to tool alignment position (mechanical coordination of step 10).
14. Using MPG service mould to move arm to be front of spindle and pay attention to spindle orientation key angle.
15. Fig. 10 shows how to move W axis to match Vee position of ARM jaw to tool holder.

Fig. 10

16. After the Vee position matches, move ARM to tool change position. This is to ensure toolholder alignment is correct. Shown as Fig 11

Fig. 11

17. Set Z-axis, Y-axis and W-axis tool change positions.

Please follow the procedure and please feel free to contact with the local service or service@mail.buffalo.com.tw. if there is any questions raised.

Dear Dean,
My company has a LT65, the clicking noise happens occasionally while spindle rotates. We are concerned the spindle will be damaged soon. Should we disassemble the spindle to check the problem?

Dear John,
Please do not disassemble the spindle. The abnormal sound could be caused by following reasons. We suggest checking these possible reasons firstly.

a. The transmission belts are too tight and pull the pulley causing a gap between pulley and the spindle nut shown as A on Fig.1.
b. Spindle pulley nut comes loose.
c. Spindle bearings are damaged.

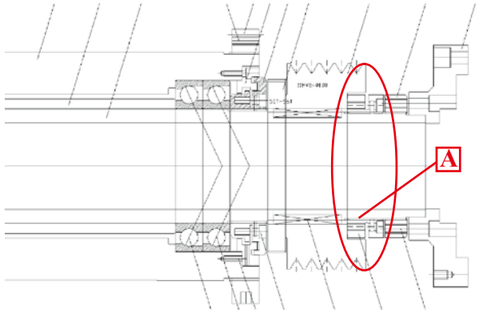


Fig. 1

In order to clarify the problem, please refer to the following procedure:

1. Disassemble the hydraulic chuck and cylinder, run the spindle. This testing can exclude the hydraulic chuck and cylinder, test possible fault from the spindle with motor and pulley only.
2. Rotating the spindle up to the 90% of the Maximum speed.
3. Turn power off and wait until spindle stops completely then rotate the spindle manually, if the noise happens that means the noise comes from the spindle. If there is no noise that means the noise may come from the spindle motor.
4. If the noise comes from the spindle motor, please contact us or contact with local controller office for the replacement of the spindle motor.
5. If the noise comes from the spindle, the abnormal noise could be caused by loosen belt or loosen pulley nut. Please follow the following procedure to solve the problem.

The checking procedure for noise from spindle pulley nut:

5.1 Please adjust the belt tension with the tension gauge perpendicular to the belt span, apply a force to the belt in the center of span. Deflect the belt 5mm from its normal position, and ensure the deflection force to be within 11.78~17.37N. Then rotating spindle.

5.2 If the noise still remained, please loose the spindle pulley nut showed as B on Fig. 2 and tight it again. This pulley nut is only for fastening the pulley, no function of bearing preload, so just tight it with copper stick and hammer. After the pulley nut is tighten, run the spindle again and noise should be erased.

Fig. 2

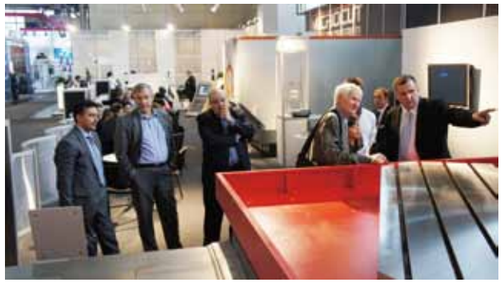
If the spindle pulley nut is well fastened, the other reason is spindle bearings are damaged, if so, please contact us for further replacement of spindle. Do not break down the spindle to replace the bearings as the warranty of spindle will be voided once the spindle is broken down.

EVENT

About EMO

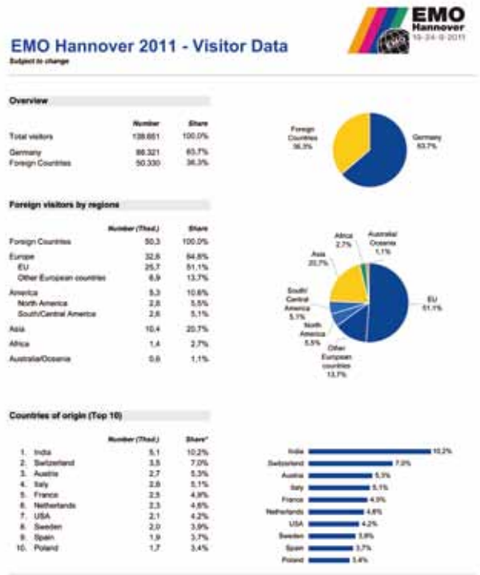
EMO, one of the leading exhibitions for metal working machines is taken settle in stage once again in Hannover during Sep 18th-25th 2011. The motto of EMO 2011 is “more than machine tools” which has 2037 companies from 41 countries showcasing their products and services. The six-day event in Hannover featured the latest machineries, solutions and services for every conceivable aspect of metalworking.

Highly qualified experts and decision makers from all over the world visited the show, and average staying periods is over 3 days. This show successfully attracted 140,000 visitors from more than 100 countries, nearly 40 percent of the attendees coming from aboard. The strong international appeal is the key factor in its success. Since its globalization, machinery manufacturers, solution and service suppliers over the world meet at the EMO, because it takes technical dialog and personal business connection to achieve globalization. The exhibitors showcased top-performing high-end products which offer maximized productivity, availability and cost-efficiency. There is no other way to establish trust and competitive advantages in an international market.



Taiwanese machine tool makers in EMO

In number of participants, Taiwan ranks third, only behind Germany and Italy and the No. 1 among the non-European Union nations. 155 Taiwan machine tool makers occupied a net floor space of 10119sqm joined in the EMO Hannover 2011, most came from the industrial cluster in Taichung. The features of the cluster are equipment, talents and technology of machine tools accessible within a 60-kilometer distance. It is one of the major factors that the products can be competitive in comparing to the other world's producers of machine tools.



EMO Hannover 2011 - Visitor Data

Subject to change

Overview

	Number	Share
Total visitors	138.651	100.0%
Germany	88.321	63.7%
Foreign Countries	50.330	36.3%

Foreign visitors by regions

	Number (Thsd.)	Share
Foreign Countries	50,3	100.0%
Europe	32,6	64.8%
EU	25,7	51.1%
Other European countries	6,9	13.7%
America	5,3	10.6%
North America	2,8	5.5%
South/Central America	2,6	5.1%
Asia	10,4	20.7%
Africa	1,4	2.7%
Australia/Oceania	0,6	1.1%

Countries of origin (Top 10)

	Number (Thsd.)	Share*
1. India	5,1	10.2%
2. Switzerland	3,5	7.0%
3. Austria	2,7	5.3%
4. Italy	2,6	5.1%
5. France	2,5	4.9%
6. Netherlands	2,3	4.6%
7. USA	2,1	4.2%
8. Sweden	2,0	3.9%
9. Spain	1,9	3.7%
10. Poland	1,7	3.4%

Microcut-the Challenger in EMO 2011

Buffalo Machinery normally participate the international exhibitions, such as TIMTOS, EMO and BIMU, this is the way how Buffalo Machinery support the distribution in building its market potential and displaying the top grade products. EMO fair is always considering as one of the most important exhibition in exploring its updated technology. And the highly international audience at EMO is a perfect match for the international profile of Buffalo Machinery. Particularly, it is the most important territories while considering of 50% of the turnover is made from European market. On top of that, distributors can attract more potential by expressing its new features.

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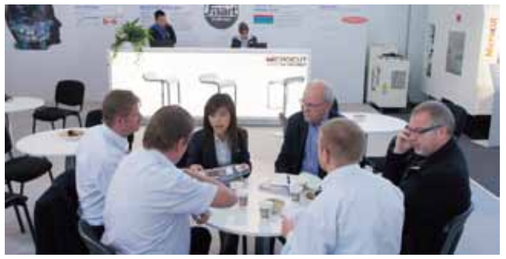
During EMO 2011, Buffalo Machinery displayed many high-tech machines in 312sqm exhibition space. Around 50 current distributors visited the booth and there are more than 30 new contacts met, which is beyond it targeting expectation. The result of the fair performed more and more potential distributors interested in high-tech machine.

Microcut/Challenger is focusing on advanced high-tech and high-speed machining technology, providing the updated skill of SMART Machine Technologies as distinct from most of the Taiwan local makers dedicating in cheap mainland market, Buffalo Machinery has been dedicating in high speed machining technology (HSM) research and development in the past 4-5 years. It has been successfully introduced V-Series and MCG-Series into European market, and a good feedback is obtained. While looking at the topics shown in this EMO, it is a great to confirm that Microcut- the Challenger is on the right direction of development.

With the correct forward direction of product development and service offering, Buffalo Machinery has extended



its commitment to develop new products based on the needs from customers and stay competitive in the global marketplace.

Again, thanks for the visit of our distributors worldwide. Buffalo put our efficiency and innovative power to the best. It is a great opportunity to present all updated products to international audiences and keep working closely with all distributors.

(Reference: http://www.asiatoday.com/pressrelease/taiwanese-machine-tool-firms-50-2011-emo-hannover)

Exhibitions

2011	Period	Title of Exhibition / Country	Distribution company
February	2/28-3/3	METAV 2012, Dusseldorf Germany	VOLZ Maschinenhandels GmbH & Co. KG
March	6-8	Expo Manufactura Cintermex, Monterrey, N.L. Mexico	FAMA - Fabrica de Máquinas y Accesorios
	8-11	3T'12 - Izmir Turkey	Celik Makina
	29-31	MEC SPE (PARMA), Italy	Tecnor Macchine
		Cluj Napoca Romania	NCT
April	16-20	CCMT 2012 – NanJing, China	Shanghai Terna Mechanical & Electrical Technology Co., Ltd.
	26-29	Konmak 2012 – Konya, Tureky	Celik Makina