

THE CHALLENGER

— global quality and service system of metal working industry —



Newsroom

- Buffalo Machinery meeting with Taiwan External Trade Development Council

Product

- MICROCUT Twin-Spindle Single Turret Slant-Bed CNC Lathe Launched

R&D Zone

- The Evaluation of Bearing Life Time, Failure Rate and Its Application for Motorized Spindle

Application

- Total Quality Management : Continuous Improvement in Quality Control Circles

Distributor

- Optimum Hungary

Event

- Successfully Staged in AMB 2016

People

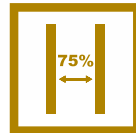
- On the Road to GO

High Pressure
150bar

Speed up to
12000rpm

437 SERIES

- Built-in motor design, saves 25% installation space.
- Tool speed up to 12,000 rpm.
- Suitable for back machining.
- Special cooling design for long-term period cutting.
- Extremely quiet running.



Saving space



High speed



Back machining



Special cooling



Quiet running

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St. Petersburg, photo by Paul Chang

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MICROCUT

Article contribution is welcome!

The Challenger welcome submission from all fields of machine tool industry related. The Challenger is committed to prompt evaluation and publication of submitted articles. Company profiles, production experience, feedback of using MICROCUT's products are the most valuable article to share with "The Challenger" readers. Please send the article and pictures (if any, images resolution in 300 dpi or above) to the local Challenger Factory Outlet or email to info@mail.buffalo.com.tw

Targeting User Satisfaction and Quality Assurance



Either a single machine operation facility or an automation plant, all are expecting the reliable production equipment with lower power consumption and a faster job performance than before. It sounds like as the movie "Mission Impossible", however, as a manufacturer

of metal working machine, the topic has been studied for a long time, and the dream is close to appear via the cooperation between the end user and manufacturer.

After evaluation of different segments requirements which become possible to develop a right product to ensure a faster productivity and lower power consumption at the end. A well design structure and precise simulation will be done which is to perform a best appearance of product. Static modal will be able to confirm which meets the report as CAD simulation. Then a well design of monitoring system for CAM, CNC, Servo, Structure and Processing will also be done. The output will be able to give the

value of mean time before failure, the in time feedback data is to monitor the product works under at normal condition. When error occurs, even minor error, a prior notice will be shared with the service from maker and the management of the organization (user). A proper restoration time can be arranged which is to ensure that there is no time lag in the whole quality management.

A surprise is to carry out a shorter work hours with a much better tolerance appearance. Smart Machining Technology supports to save working hours. At the end, the project makes a happy client, simply because the production lost reduced, a better margin made and a stronger position of competition won. Buffalo Machinery promises a new line of high end, high speed product at reasonable cost will be ready to become your new great partner – AXILE.

Dr. Paul Chang
Nov. 2016

The President of Buffalo Machinery,
A Smart Machining Technology Service

Exhibition Calendar

2016

Month	Period	Title of Exhibition / City, Country	Distribution Company
November	3~4	Microcut Europe open house	Microcut Europe
	15~18	PRODEX/ Basel, Switzerland	NEWEMAG
	16~18	Open House	VOLZ
	23~26	EMAF	MATER
December	Mid. of Dec.	Inauguration of Queretaro dealership	FAMA

2017

Month	Period	Title of Exhibition / City, Country	Distribution Company
March	7~12	TIMTOS/Taipei, Taiwan	Buffalo Machinery

Buffalo Machinery meeting with Taiwan External Trade Development Council

Buffalo Machinery welcomed the TAITRA (Taiwan External Trade Development Council) Market Development team for bilateral discussions on management and sustainable development for machine tool industries.

TAITRA visited the award-winning MCG-5X production line, accompanied by Buffalo's Sales team in discovering how the core value of Buffalo Machinery- Quality and Service build our business is implemented to the products.



Dr. Paul exchanged information regarding Industry 4.0 with TAITRA

Dr. Paul Chang had an exchange regarding Industry 4.0 and Smart factory with the TAITRA. In addition, he gave positive reviews on the efforts of TAITRA in marketing the Taiwanese machine tool industry on worldwide stage. However, Dr. Paul Chang indicated, "If the media could give specific report especially on the achievement and innovation of research and development, it will highly improve the visibility and credibility of Taiwanese machine tool industry, meanwhile, enhance the competitiveness of Taiwanese products on the global market."



Buffalo and TAITRA team

Through solid foundation on theoretical knowledge, experienced and constant development on latest technologies, Buffalo Machinery invented and implemented the patented SMT (Smart Machining Technology) on Microcut high-end product line, including Tooltip Positioning Control, Spindle Vibration Supervision, Straightness Compensation Technology, Axial Accuracy Control, Metal Removal Rate Optimization, and Vision Technology. The 5-axis machining center MCG-5X is successfully upgraded and acquired high recognition from the government and our worldwide partners.



Buffalo shared know-how on corporate management

TAITRA spoke in support of advice from Dr. Paul Chang, agreeing on delivering valuable technical innovation news in the future. Buffalo Machinery was invited to participate in the AMB 2016 press conference cooperated with the German media in regard to the current status and future development on Industry 4.0 for Taiwan machine tool industry.



Sales Manager Angie Tseng made a guided tour for TAITRA at the 5X plant.

GERMANY

Berlin Holocaust Memorial Panorama- photo by Wendelin Jacober on Flickr

Germany, Europe's most industrialized and populous country and officially the Federal Republic of Germany, is a federal parliamentary republic in the heart of Western Europe. Covering a surface area of 357,340 km², Germany has a strategic location on North European Plain along with the entrance to the Baltic Sea.

The Bavarian plateau in the southwest averages 488 m above sea level, reaching the highest point 2,962 m in the Zugspitze Mountains. With an open foreign policy, Germany is, after the United States, the second most popular immigration destination in the world, with around 82 million inhabitants today.

Economy

Export-oriented

The strong export-oriented German economy makes itself the world's fourth largest by nominal GDP at 3,979,664 millions of Int\$ in 2016 estimated by IMF, accounting for more than one-fifth of the European Union's GDP (EUR 16.5 trillion) and the fifth by PPP in the world (see chart 1).

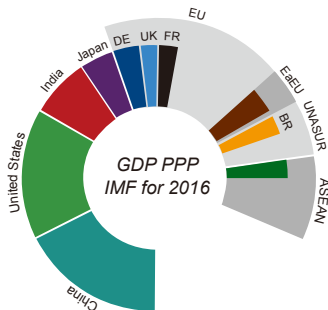


Chart 1: The top ten largest economies by GDP PPP 2016 Source: IMF

Social Market

The social market economy's adaption to digital transformation ("Industrie 4.0"), the earlier labor market reforms, the government subsidies and rigorous foreign trades have contributed to strong economic and employment growth and create a highly skilled labor force. The "Work 4.0" is a framework to be created on the future world of work after digitization and will be presented in a White Paper at the end of 2016.

These advances and the structured social welfare system together bring up innovation, reduce working hours and have explained the stable employment rate even during the recession in 2008-09, keeping the unemployment rate at 4.2 % in August 2016, the lowest among all the other member states of the EU and since the country's reunification. In 2015, the real gross wages and salaries per employee recorded the highest increase for more than two decades, at EUR 3695 per month in July 2016. The low oil price and the weak euro exchange rate

have a positive impact on economic development, bringing a solid growth by a total of 1.7%. The key to maintaining the competitiveness, SMEs in particular, is digitization ("Industrie 4.0").



Fussen, one of the closest town of Bavaria near the famous Neuschwanstein castle - Photo by Moyan Brenn on Flickr

In addition, the Federal Government places a clear emphasis on public-sector investment regarding transport infrastructure, education and the Energy and Climate Fund. More importantly, the Federation is providing more than EUR 6 million to help cope with the issue of refugees and asylum seekers in 2017. The economic policy aims to boost labor force participation, including a further expansion of child-care services to help parents combine work and family life. Not least, the German economy is guided by the United Nations' 2030 Agenda for Sustainable Development as well as the government strategy - "Living well in Germany- what's important to us."

Mittelstand

"Mittelstand," the family-owned small and medium-sized enterprises (99%)(see Figure 1), forms the backbone of German economy. The 3.67 million German SMEs have an annual turnover of up to EUR 500 million, providing 60% of all jobs in Germany, offer training for up to 89% of all trainees – 1.2 million young people.

Figure 1 SMEs and large enterprises in comparison, 2013 percent

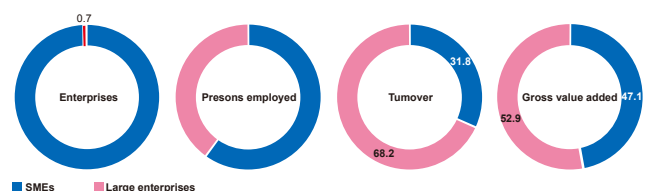


Figure 1: SMEs and large enterprises in comparison, 2013 Source: Statistisches Bundesamt (Federal Statistical Office)



Flag of Germany: black-red-gold tricolor adopted by the Weimar Republic in 1919 - Photo by fdecomite on Flickr

Germany has more world-class companies in a broader range of sectors such as BMW, Siemens, Bosch to name a few which are supported by a more densely packed network of Mittelstand companies.

Micro enterprises with less than 10 employees provide a good third of workplaces (34%). With a strong sense of social responsibility, most SMEs work to secure the long-term existence of the enterprise, they place great value on lasting relationships with the customers and business partners, taking active role by sponsoring education, culture and sport in their regions.

According to the study by KfW in 2015, the vast majority of the German SMEs are small, 87% have an annual turnover of less than EUR 1 million (see chart 2).

Scale distribution in the SME sector by turnover
in percent

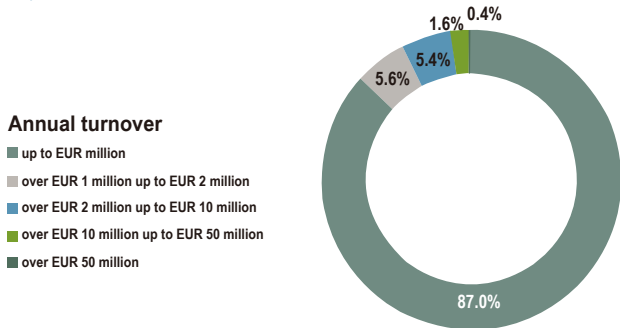


Chart 2: Scale distribution in the SME sector by turnover
Source: KfW Bankengruppe

The wholesale and retail trade and services sectors account for more than 80 % of the turnover and about 90% of gross value added in these sectors.

Only about 7% of the SMEs operate in the manufacturing industry (see chart 3) and SMEs in R&D-intensive manufacturing are most active abroad (65%).

Sectoral distribution SME sector
in percent

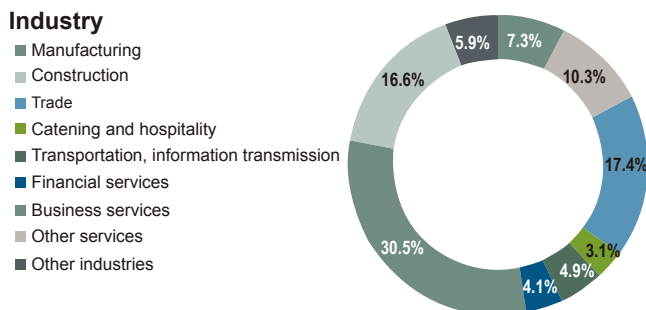


Chart 3: Sectoral distribution in the SME sector
Source: KfW Bankengruppe



Wind turbine on the field in the village of Offen, Germany
- Photo by Jason on Flickr

Free trade is an important factor for the country's prosperity. The Transatlantic Trade and Investment Partnership (TTIP) in 2013 has aimed to gain better market access under negotiation between the European Union and the United States, claiming to reduce the trade barriers that benefits the SMEs. However, these long-running negotiations will not be finished until 2020. In addition, German Vice Chancellor and Economy Minister Sigmar Gabriel revealed in August 2016 that there is a lack of progress in the negotiations and that the free trade talks have obviously failed since Europeans do not want to subject to American demands on compromising its environmental, consumer protection (ex. genetically modified organisms) and public health standards. Another free trade agreement aims at tightening up the relationship including goods, services, investment, government procurement and regulatory cooperation.

It is important to note that although as United States' largest European trading partner, Germany should protect their most important trading partners, their European neighbors, for the significance of the single European market concept. The business in the EU accounts for 60 % of the imports and 71% of the exports. Moreover, the trade in goods with Asia is larger than that with North America, China being the major trading partner of German SMEs, accounting for 14% of exports and 7% of imports.

Approximately 44% of German companies contribute directly to the success of the German economy on the international markets with above an annual turnover of EUR 2 million. With the ambition to promote competitiveness in commerce and industry and provide security to the nation, gaining energy independency is the priority for Germany. The energy transition offers great opportunities for the development of new technologies particularly for SMEs.

Energiewende (Renewable Energy)

As the first major industrialized nation to commit to the renewable energy transition called Energiewende, Germany plans to phase out nuclear power by 2022 and is leading the country towards a future with a secure, economic and environmentally compatible energy supply. It has shut down the 8 nuclear reactors permanently after the Fukushima accident in 2011.

Until 2015, 30% of the gross electricity generated from renewable which has become the main energy source in Germany. Lignite is the second electricity source (24%), following hardcoal (18.2%) then nuclear (14.1%) (see chart 4). Wind power is now (13.3%) the main renewable energy among the others.

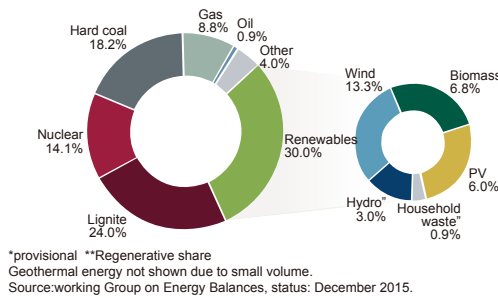


Chart 4: Gross electricity generation in Germany in 2015 in TWh*
Source: Working Group on Energy Balances, status: Dec. 2015

On average, Germany's energy efficiency increased by an annual 1.6% between 2008 and 2014. However, the issue on the transport of electricity has to be tackled and grid expansions have to be carried out to deal with the poor transmission networks. The Bundesnetzagentur (electricity grid expansion) takes on the responsibility in finding the right balance on the construction of best cable routes around Germany.

In May 2016, Germany first time got almost all of its power from clean power and is on the track to phase out nuclear (17%) and fossil fuels (53%). As the leading producer of wind turbines in the world and the leader in new installations (47%), Germany has the most wind power capacity (32%) installed in Europe in 2015.

Manufacturing

Germany Manufacturing PMI

Germany's manufacturing industry has focused on cost containment and competitiveness rather than new market entry due to the slowing economic growth of China – its biggest export partner.

According to KPMG International's report on German manufacturing industry, 45% will invest into robotics to achieve their growth agenda and 40% indicates that the top supply chain priority is to understand cost-to-serve.

Due to the high wages of employees and efficiency gains, German manufacturers have been implementing floor automation to drive growth, but "Industrie 4.0" is implemented on a slow progress since most prefer to wait for market forces before they fully commit to digitization. The "Industrie 4.0-Successful Strategies for SMEs in NRW" is held on 28 September 2016 in Düsseldorf's Rheinterrasse by ProduktionNRW which stressed the importance to work together to pool expertise, strength and share the knowledge.

Export country	Growth rate 2016
EU	+1.7 %
UK	-0.8 %
USA	-0.9 %
OPEC countries	-16.3 %
Turkey	+5.6 %
Southeast Asia	+2.1 %

Chart 5: Exports growth rate in first half of 2016 compared to the previous year. Source: VDMA Aug. 2016

In September 2016, German manufacturing PMI index remained strong and was confirmed at 54.3% (see chart 5), and the export orders component is at the second highest level for 31 months (since early-2014) and it is the 22nd straight month of expansion. New business is enjoying solid growth as well as the job creation.

"Manufacturing PMI in Germany averaged 50.94 from 2008 until 2016, reaching an all time high of 63.70 in February 2011, and a record low of 32 in January of 2009", reported Markit Economics.

Mechanical Engineering Industry

The GDP by expenditure of machinery and equipment in Germany has reduced to 2.2 % in 2016, half of that in 2014.



bPart IoT device for the Industrie 4.0
- Photo by TECO on Flickr

According to a report disclosed by VDMA, Mechanical and plant engineering and plant engineering companies in Germany exported machines worth EUR 76.7 billion in the first half of 2016, down by a nominal 1.1% when compared with that of 2015 (EUR 77.6 billion). German mechanical engineering's largest sales region EU accounts for nearly 45 % export. With the influence of Brexit, export to the UK declined by 0.8% in the first half of 2016. The EU covers nearly half of the exported

machines (47.3%), rose by 1.7%, proving itself to be a stabilizing force.

"Exports to the USA fell slightly by 0.9%, but with the strong increase by 11.2% in 2015, it remains to be the largest foreign market for German mechanical engineering companies with 10.7% of the market share."

Exports to China declined significantly by 11.5% whereas Russian market had a relatively low decrease of 5.2% compared to last year. Exports to OPEC (Organization of the Petroleum) countries depend on the oil price, sinking by 16.3% on average. Moreover, Saudi Arabia and Brazil dropped even twice more. However, exports to Turkey enjoyed a strong increase of 5.6%, even exports to Southeast Asia rise by 2.1% (see chart 5).

Despite all the political and economic disarrays, the future of German manufacturing is looking bright with the Federal Government's strategy towards a more stable democracy built on Germany's strong social consensus of working together towards a digitalized country.

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Optimum Hungary

Last 20th and 21st of October took place the already traditional Openhouse of the Hungarian dealer Optimum. With over 300 sqm, and 20 machines shown, this event gathered more than 130 end users from all over the Magyar country. Buffalo was present in the event with machining centers and lathes and the official launch in Hungary of its 5X products, represented by the Microcut MCU-5X; the 600 mm diameter trunnion table vertical machining centre for a wide range of applications.



Openhouse of the Hungarian dealer Optimum

Optimum Hungary, a success story

Optimum is a rather young company founded 13 years ago by its shareholder and Managing Director Mr. Gábor Werderitsch. The company deals with the German-based Optimum products but also represents some higher-tech CNC machines brands in the Hungarian market. Buffalo and Optimum reached an agreement last September that Optimum to be the sole distributor of Buffalo's Microcut products and the new high-speed branded products.

Since its birth, Optimum had a sustained turnover growth based on its sales model. Mr. Werderitsch, experienced in selling cutting tools and other machine tools consumables as well as other sheet metal machines, helped in building up the model. The company has an aggressive e-marketing activity

that spreads the products information throughout their data base in notime. The smaller and daily business machines are then diverted to a countrywide sub-dealers network, while the higher technology and price leads are managed by their own sales team (5 people), with more personal and dedicated efforts. When the sale is closed, customers are then supported by an excellent and well-trained service and application team that can handle commissioning, training and service of the complex machines in the best way possible.

The company sales and service teams are highly motivated, as Mr. Werderitsch uses a very close communication managing style in which every member makes suggestions and comments to the company strategy. The benefit for the managing is a high-quality and real-time information on the market trends which helps making good decisions. The trans-

parency and proximity enhance employee's self-confidence and motivation, which boosts customers' confidence in Optimum, closing the virtuous cycle in the sales success.



Their approach to 5X technology



Presentaion during openhouse

The models proved to be especially effective with Buffalo's 5X machines. The first MCU-5X machine is already installed in a high-tech tyre mould manufacturer called TAUFORM. The same company already bought a second 5X machine (V20/5) and is willing to invest further in 2017 to renovate its impressive 5X machine section. In the first 2 months of activity, other 2 MCU-5X are sold and some other leads are being followed for this and the new High-Speed G8 premium 5X model with 800 mm diameter table.

The MCU-5X in TAUFORM is producing the based resin models of the tyre sections (40 degree section). The machine proved to be an excellent choice as the tyre models need excellent surface finishing in 5X continuous movement and a perfect closing areas between the 9x40 deg sections. TAUFORM is basically supplying high-tech moulds to Hankook (Korea) and Continental (Germany), both to their Hungarian and their subsidiary plants all over the world.



The Hungarian machine tool market - Microcut's MCU-5X

Hungary has a traditional industry that has been boosted by foreign investment since Hungary's entry in the EU. Today, automotive and industry base components are the main driving force for machine tool consumption. The machined parts tend to be rather small and with some complexity. This explains the rapid growth demand in 5X machining centers that Optimum wants to take advantage of with Buffalo's products. During the last few years, the investment in machine tools has been rocketed by the EU dotations. With the expectation that those will finish in 2018. many are afraid of a machine tool consumption contraction, but Mr. Werderitsch thinks it will open new opportunities for Buffalo high-tech products that are offering "same performance with less cost" compared to our European competitors.

Mr. Gábor Werderitsch expects to reach over 10% of the market share of 5X machining centres sold in the Hungarian market, which would mean close to 10 machines per year by 2018. Buffalo will support them to reach this ambitious number in the shortest time possible. Moreover, Buffalo will also benefit from the hard work of Optimum as this will create references in the heart of Europe which is easily reached by other Eastern European end-users.



Visitors gathered to check out Renishaw application used for MCU-5X

Procedures for SAUTER VDI tool disc adjustment

Important notices before adjustment:

- Move the turret to the reference point then check if the turret is in the first tool position and is hydraulically clamped.
- Prepare a torque wrench (N.m) and a dial Indicator (with a graduation of 0.001mm).
- The test mandrel is used in the following demonstrations. If the test mandrel is not available, the turning holder (for outside diameter) can be used.

Step 1

Check if the turret is in first tool position and is clamped. Install the test mandrel or the turning holder and put the dial indicator on it and return to zero. Start moving the X axis then read the parallelism from the dial indicator.

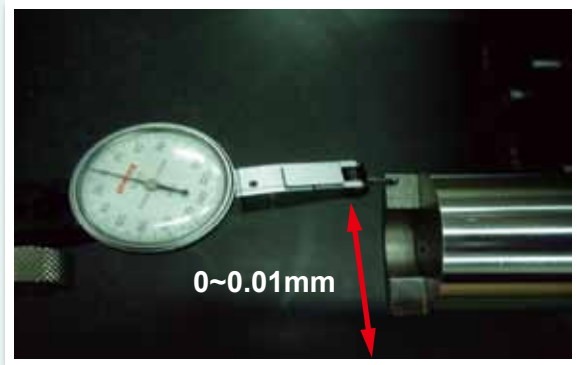


Step 2

Check the inclination of the parallelism. Please do not move the dial indicator. Use the torque wrench to unclamp 1-2 teeth of the tool-disk setscrew. Apply and tighten a screw at the side of the disc as the beating point then beat it with rubber hammer



Measure the parallelism of X axis on disc and adjust the precision to <math><0.01\text{mm}</math>.



Step 3

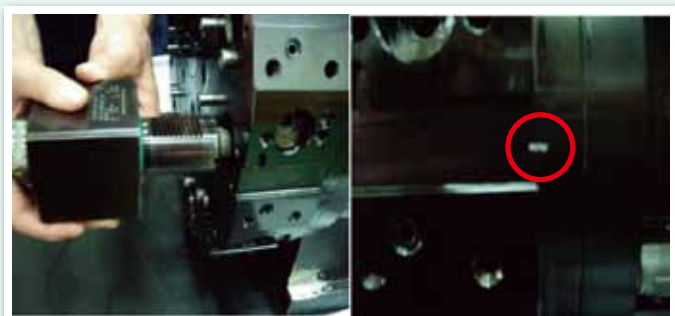
When the precision is <math><0.01\text{mm}</math>, securely tighten the setscrew in diagonal position of the disc. Measure the parallelism of the disc again.

<i>Tightening torque for screw:</i>	436.216	M8	41N.m
	436.220	M10	83N.m
	436.225	M12	145N.m



Step 4

Ensure the precision is <math><0.01\text{mm}</math> and tool disc setscrew is secured, install the power tool holder and test if the indexing works smoothly. Check if the mark at the side of disc is exactly straight in the same position. The VDI tool disc adjustment is completed if there is no diverse.



Check if the indexing works smoothly

Check if the mark at the side of disc is exactly straight to the same position.

The Challenger would like to acknowledge SAUTER ASIA CO., LTD. for the contribution of material.

MICROCUT Twin-Spindle Single-Turret Slant

LD series

LD-52 / LD-65

MICROCUT LD series is equipped with twin-spindle single-turret coupled with a Y-axis of 100mm, featuring high-speed spindles, high-rigidity linear guideway to provide fast machining speed and excellent cutting ability to meet the high efficiency demand.

This CNC turning lathe allows multi-axis turning and milling in one machining operation, which not only enhances productivity, but also improves quality and efficiency.



Machining capacity

- Swing over bed $\varnothing 650\text{mm}$
- Max. turning diameter $\varnothing 380\text{mm}$
- Bar capacity: $\varnothing 52\text{mm}$ (LD-52)/ $\varnothing 65\text{mm}$ (LD-65)
- Tooling system: VDI40/ BMT55
- Swing over cross slide $\varnothing 380\text{mm}$
- Max. turning length 520mm



Highlights

- Twin spindle single turret
- Reduce idle time
- Apply all processes on one machine
- Support power turret and hydraulic turret
- Reduce frequency of loading & unloading
- Linear way ensures faster movement-Rapid feed 24 m/min
- 8" and 10" Hydraulic chuck

-Bed CNC Lathe Launched

High-speed cartridge type spindle

Fast spindle speed with powerful 11kW spindle drive.

Main spindle/Auxiliary spindle:

LD-52 : 5000rpm / 5000rpm

LD-65 : 4000rpm / 5000rpm

30 degree one-piece slant bed design

Allows better chip evacuation, better rigidity, and better part accuracies due to better thermal dissipation

Larger X-axis travel

Provides a larger part capacity with a compact machine

Turning & milling in one-setup

The combination of Y axis and C axis with braking system brings higher efficiency and enhances the productivity of high complex parts.

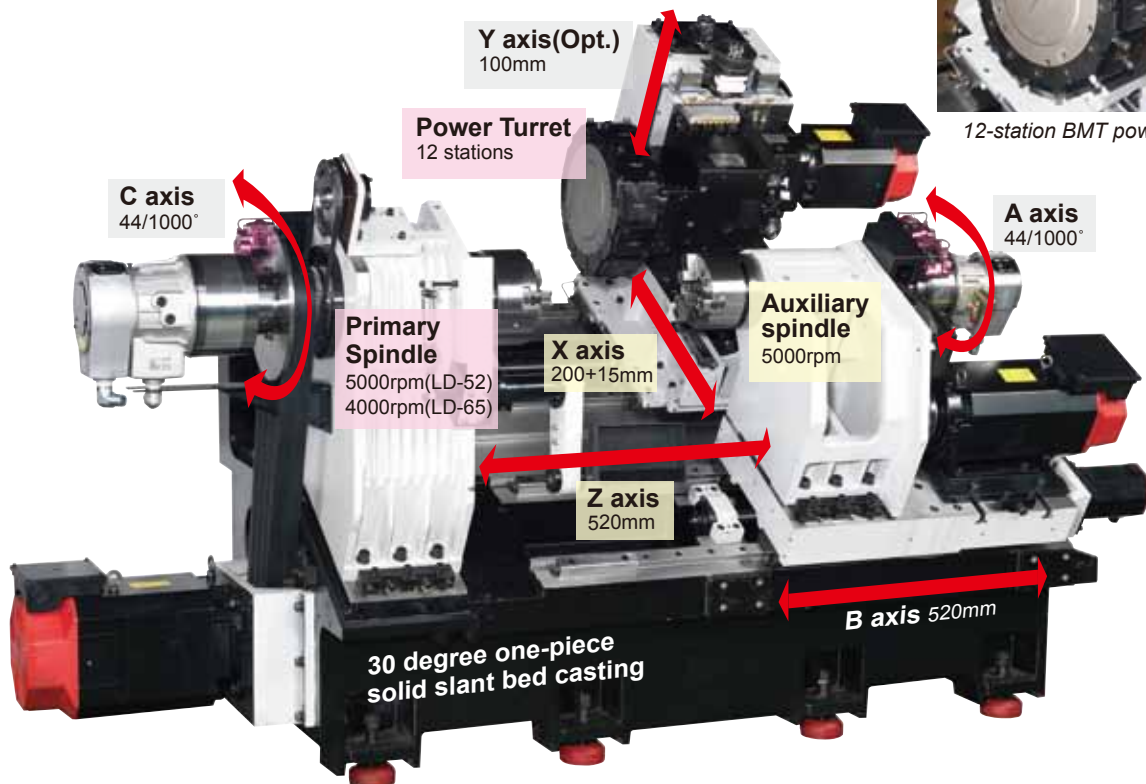
Wide guideway distance design

Assure the rigidity to withstand heavy-duty cutting loads.

The guideway distance:

X axis: 240mm

Z axis: 360mm



12-station BMT power turret

The Evaluation of Bearing Life Time, Failure Rate

Dr. Yi-Lin He, Dr. Jerry Tang, and Hsun-Fu Ciang

Abstract

For the metal-cutting application, the motorized spindle plays a decisive role, because of the high-speed cutting and high precision characters. The service time of a motorized spindle is significantly influenced by the life time of the high precision bearing. In this paper, the calculation of the failure rate and the life time of bearings and the bearing system in a spindle is considered. The relationship and evaluation of methodology between the life time of bearing system and failure physical mechanism are presented. To demonstrate the aforementioned methodology, a case study is discussed. A commonly used bearing configuration and a cutting process are demonstrated. The methodology could not only enable designers to evaluate the bearing life of spindles but also provide as a basis for the improvement on the design of bearing arrangements of spindles.

I. Introduction

In the metal-cutting application, the motorized-spindle fulfills two purposes. First, it allows the tool (for milling machine and boring machine) and/or workpiece (turning machine) to rotate precisely. Second, it transfers enough power to remove the metal from the cutting region. The support bearing is the key component in supporting the rotating mechanical component and maintaining the stiffness of the shaft to satisfy the requirement of cutting. If the performance of the bearing system is not good, the surface finishing of the workpiece is affected [1].

The potential failure modes for bearings have been discussed [2], [3] and standardized [4]. The modes are classified into fatigue, wear, corrosion, plastic deformation, fracture and electrical erosion. The potential causes for failure include loss of lubrication, incorrect mount of bearing, misalignment, over preload and excessive load. Since the external loading, e.g. cutting force on tool, directly acts on the bearing, the bearing failure is significantly associated with these stresses. Hence, it is essential to consider the proper force acting on the spindle. In this paper, a systematic approach is discussed on the applicability of a given bearing configuration. The calculation of failure rate and life time on each bearing and a bearing configuration are defined. Both the natural intrinsic characteristic of bearing configuration and the external force are discussed.

II. Bearing Failure Rate

A. Bearing arrangement

Strictly speaking, it is difficult to acquire a design of bearing arrangements perfectly adapted to the known environmental conditions and the expected life. Therefore, similar speculations and experiences could help shape the primary design of bearing arrangements. Steps to be considered for the design include the bearing type, bearing parameters and the bearing lubricant methods. Regarding the bearing type, it depends on the basic applications such as angular contact ball bearings and roller bearings. Bearing preload methods include the commonly used position preload, spring preload and constant pressure preload. Bearing basis parameter includes materials of angular contact ball bearings, the roller body and bearing cages as well as the interference of rings and shaft, etc. The spindle speed, the life and the applied loading on a rotating shaft system is dependent on the design of basic parameters.

The conditions to be considered in the design of bearing arrangements

- 1) Bearing arrangements
- 2) Preload force of spring
- 3) Work temperature of bearings and environmental temperature
- 4) Cooling conditions
- 5) Loading condition

B. Life time, failure rate, intrinsic characteristic and safe operation area of bearings

Once the bearing arrangement is determined, the influence of the bearing load, acting on the bearing system and each bearing, can be analyzed, and the performance of a given system can be evaluated. Next, the metrics of bearing dynamic loads such as contact pressure of inner/outer ring, P , the spin-roll ratio γ , and the operating contact angle α can be calculated. The failure rate of each bearing and that of the overall bearing system are calculated. Finally, the safety operation area of this bearing design can be determined by the limited parameters of bearing dynamic loads.

- 1) Life time and failure rate of a single bearing

Several methods of quantification are used to calculate the life of a single bearing. The most commonly used method is shown in (1), it is found simply in technical manual from bearing manufacturers. The physic mechanism that causes failure is the degree of force. It is turned into the contact pressure between the surface of rolling body and inner/outer ring in a bearing. The safety factor, C/P parameter, is defined; the rated axial load C represents an endurance force on

e and Its Application for Motorized Spindle

bearing and it can be found in the bearing manual provided by the manufacturer. According to the metal fatigue theory, the higher the safety factor, the longer the bearing life will be. In general, C/P parameter can be used for the basic evaluation. However, it depends on the operation environment and lubrication factors.

In the modern industrial application, the working and environmental factors will be considered to identify that specific work conditions will affect the bearing life. Thus, (1) is modified to (2). In 2007, International Standard Organization released the ISO 281:2007, (3) is adopted more frequently [5]. The subscript letter “n” in (2) and (3) represents the failure possibility. For example, n=10, i.e. L10, represents the reliability of bearings is 90%, while, n=1(L1), means that the reliability of bearings is 99%.

$$L_{10} = a \left(\frac{C}{P} \right)^b \frac{B}{N} \quad (1)$$

Where

L_{10} : the life time as the failure possibility is equals 10 %, in hour

a: life adjustment factor

b: based on bearings type. b=3, for ball bearings; b=10/3 for roller bearings

C: the radial-rated bearing load rating

P: applied dynamic equivalent radial load on the bearings

B: a factor that depends on the method and unit used in the equation

N: the rotating speed of the bearings

$$L_{n,a} = a_1 a_2 a_3 L_{10} \quad (2)$$

a₁: The adjustment factor for requisite reliability depends on the failure probability, for instance, a₁=1 for L₁₀, that is 90 % reliability. a₁=0.64 for L₅, means 95 % reliability and 5 % un-reliability.

a₂: The factor for manufacturing methods, such as forming method, material process and heat treatment.

a₃: The factor for operating condition, including lubrication, contamination, misalignment.

$$L_{n,a} = a_1 a_{iso} L_{10} \quad (3)$$

a_{iso}: The correction factor for the influence of lubrication, contamination, fatigue limit load. The a_{iso} is a function of the aforementioned parameters.

2) Calculation of failure rate for bearing configuration

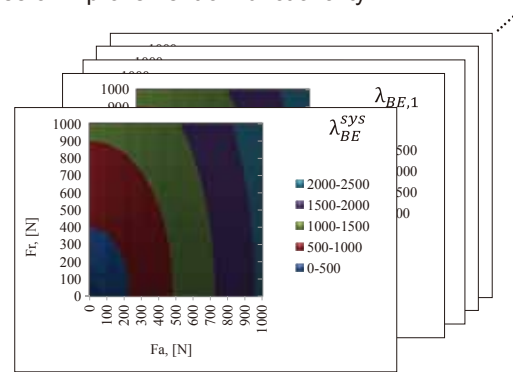
Suppose there is a bearing system, the bearing configuration is composed of numbers of bearings. In this bearing configuration, the functionality of bearings is irreplaceable. Therefore, it is regarded as a series-connected model and the total failure rate λ_{BE}^{SYS} calculated as follow:

$$\lambda_{BE}^{SYS} = \sum_{i=1}^n \lambda_{BE,i}^{SYS} = \sum_{i=1}^n \frac{1}{L_{a,i}^{SYS}} \quad (4)$$

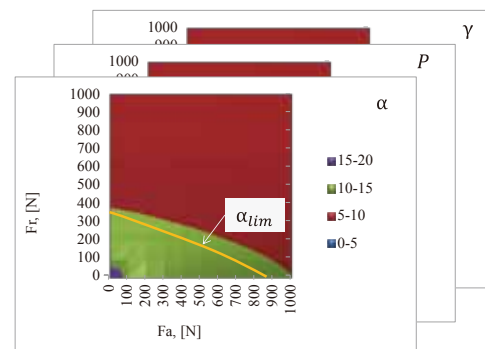
where

$$L_a^{SYS} = \lambda_{BE}^{SYS}$$

The cutting force should be divided into two components, the axial force Fa and the radial force Fr. Because there are two independent variables and one dependent variable, the distribution diagram of bearing intrinsic property includes three axes to present this information. An example for the intrinsic characteristic of bearing is shown in Fig. 1. There are several distribution diagrams, including the distribution diagram of failure rate, the contact stress and the spin-roll ratio. The other diagram can be illustrated as well, depends on whether the parameter is significant or not. The data in the distribution diagram are applicable only to the specific design and the operating conditions. Once the design of bearing preloading and/or the operating speed of spindle is changed, these data parameters are no longer applicable. According to the bearing safety parameters, each distribution diagram can be separated into several parts to identify the appropriate working area, such as safe, sub-safe, risk, and high-risk work zones. This data is provided as a resource for users or for the purpose of improvement on functionality.



(1) The distribution diagram of failure rate (λ_{BE}^{SYS} and $\lambda_{BE,i}$)



(2) The distribution diagram of contact angle, contact press, and spin-roll ratio Fig 1: The diagram for bearing intrinsic characteristics chart- for a given specific speed condition

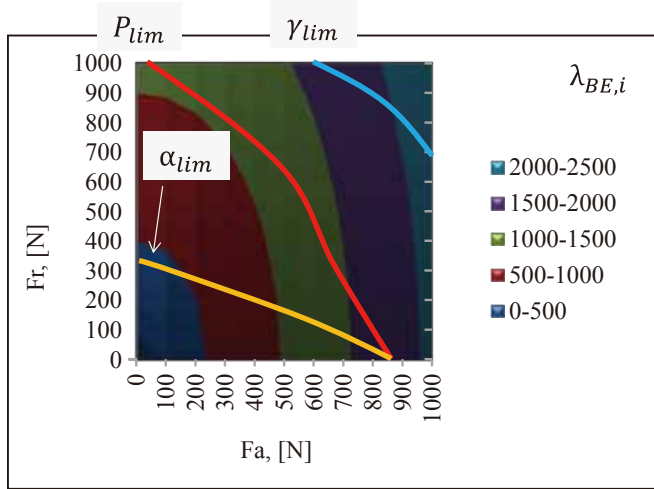


Fig. 2. The diagram of the working area for a single bearing

III. The calculation of the cutting failure rate on bearing system for a given cutting processing

A. Given a simplified Cutting Processing

In order to reduce processing time and reach higher rigidity in metal-cutting processing, several cutting properties are introduced, such as heavy cutting, high-speed milling, high speed metal removal rate and high precision. In the rotating system, these properties are represented with the requirement of cutting force and power, spindle speed and work period.

Meanwhile, the changing scope of cutting power and spindle speed could be relatively high, especially on the application of high-speed motorized spindles. However, these dynamic cutting properties are not appropriate for analysis because of the complexity. In order to simplify the analyzing steps, the complicated cutting conditions should be simplified into several important and representative metrics, such as basic spindle speed, power and time.

B. The cutting failure rate analysis of each bearing and the bearing system

In this step, the cutting failure rate for a given cutting process is obtained by (5). In this paper, it is called as cutting failure rate λ_{BE}^{cut} . The processing is equivalently simplified from all cutting conditions. The cutting life time L_a^{cut} is presented in (6).

$$\lambda_{BE}^{cut} = \sum_{j=1}^n U_j^{process} \lambda_{BE,j}^{process} \quad (5)$$

- $\lambda_{BE,j}^{process}$ The failure rate of the j-th cutting process
- $U_{BE,j}^{process}$ The duty cycle of the j-th cutting process
- j The j-th cutting process

$$L_a^{sys} = \frac{1}{\lambda_{BE}^{cut}}$$

IV. Case Study

A. The Bearing System and its Arrangement

To explain the relation between aforementioned lifetime, failure rate and metrics of bearing dynamic loading, a case study is discussed. The bearing configuration of this case is illustrated in Fig. 3. In this case study, there are four bearings in the bearing system design, including the shaft. The bearing arrangements are assembled with the face-to-face method. The first two bearings and the other two are the same size and the model. The spring preload is selected. The axial force F_a and the radial force F_r are applied to the front of the shaft which represents the cutting force is applied here. The force ranges from 0 to 3000 N. Owing to the limited space, only the analyzed data of the bearing surface stress parameter is shown below. The maximum contact pressure of bearing P_{max} is 2000 N/mm^2 .

B. The Analyzed Result of the Intrinsic Characteristic of bearing configuration

In the case study, the bearing failure rate and bearing life time are shown in Fig. 4 and Fig. 5, respectively. Due to the exponential relationship in the distribution model of Probability Density Function for bearing, the failure rate and the life time are reciprocal. When the failure rate increases, the bearing life decreases. The higher the cutting force applied to the shaft of the system, the lower bearing life expectancy. In addition, when bearings are not influenced by the exterior force, i.e. $F_a=F_r=0$, the life time of four bearings are different..

However, it is insufficient to judge if the bearing system can meet the requirement of users with the analyzed result of only failure rate/life time. Apart from the application requirement (failure rate and life time), it is necessary to consider the metrics of bearing dynamic load and the loading condition. As aforementioned, the limitation of the loading condition for bearings should be deliberated, such as the contact pressure P and contact angle α . The working boundary should be drawn in the distribution diagram, and exam the safe operation area of such system. Take the case study as an example, as shown in Fig. 6(a) and (c), the bearing No. 1 and bearing No. 3 have high risk, because the high contact pressure on the ring surface. This will cause metal fatigue damage. As the

boundary line, the limitation of external force acting on bearing No.1 and No.3, is mapped in Fig. 5(e), the new distribution diagram is obtained for examination, as shown in Fig. 5(f). It is clear that the safe operation boundary is surrounded by four lines, which are the vertical axis, the horizontal axis and the

curve of safe operation boundary for two bearings. Although the safe operation area is given by the aforementioned curves, it is preferable to operate this system under the maximum contact pressure P_{max} such as the blue-dotted curve indicated in Fig. (5) e.

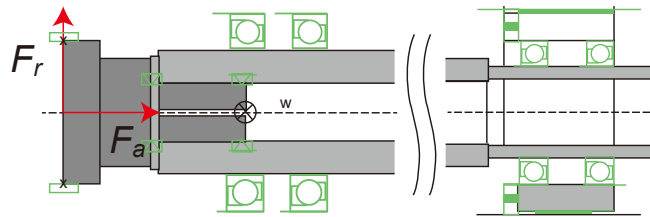


Fig. 3: The bearing arrangements of the motorized spindle for the case study (not in scale)

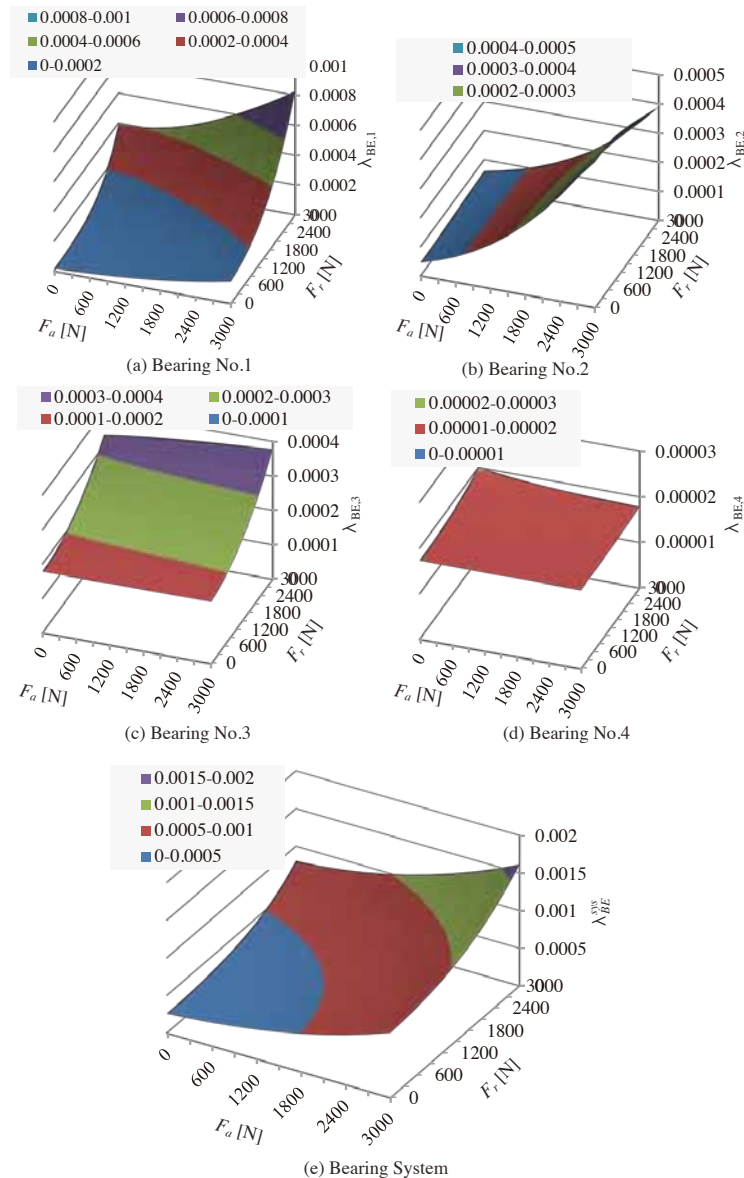


Fig. 4. The distribution diagram of the failure rate for each bearing and the given bearing system

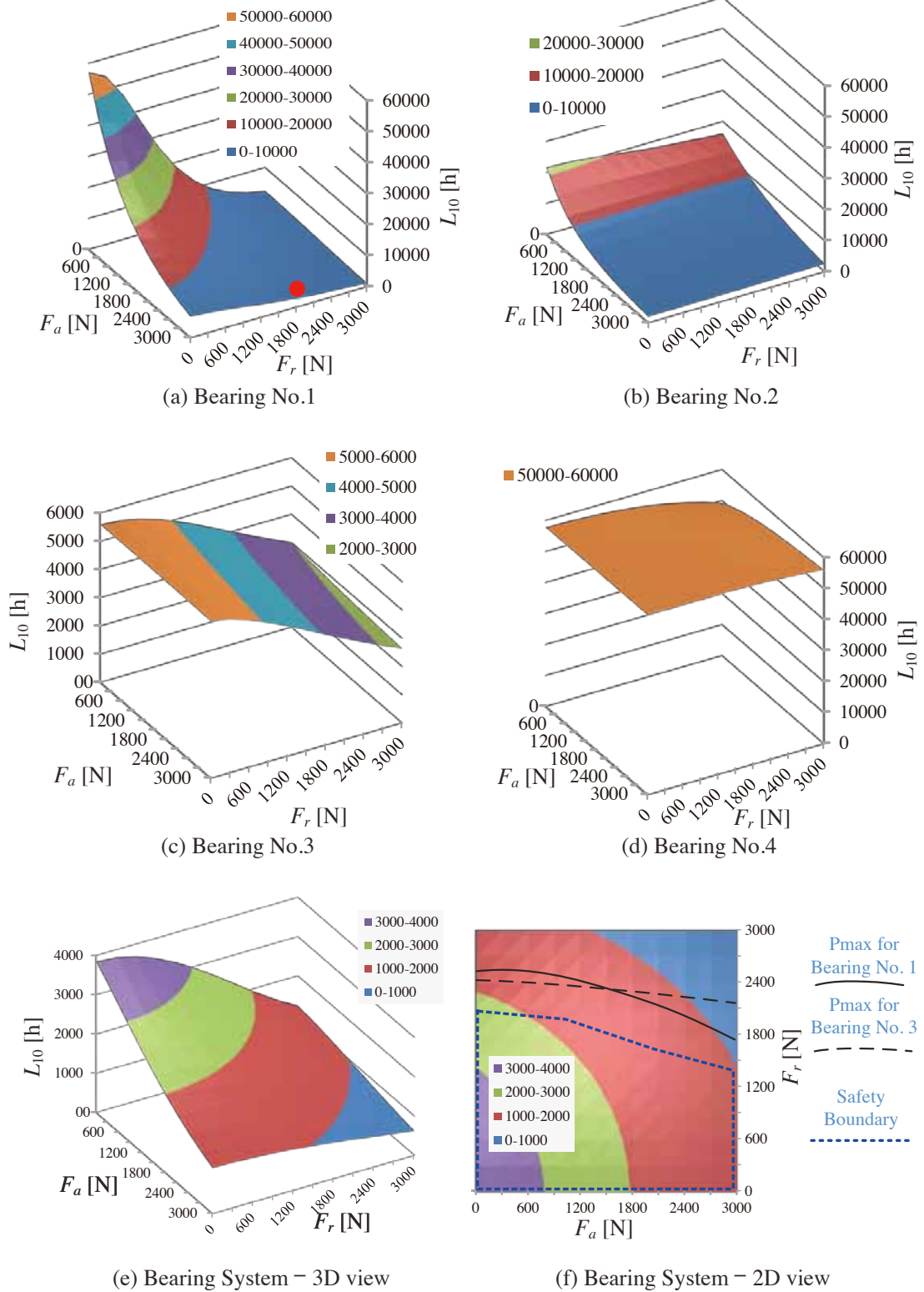


Fig. 5. The distribution diagram of life time for each bearing and the given bearing system

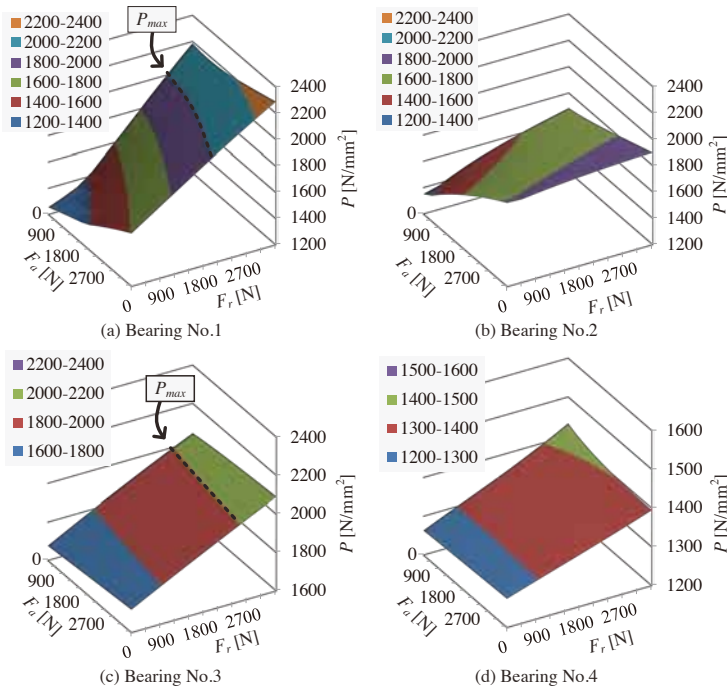


Fig. 6. The distribution diagram of a bearing surface pressure

C. The Bearing Failure Rate of Bearing System for a Given Cutting Process

The cutting process is considered, and the parameters of cutting processes for bearings are shown in Table I. As shown in Table I, the case study included four cutting process under the highest spindle speed. The process No.1 indicates that the bearing system of the spindle is forced without external cutting force. And, the operation of the machine tool is assumed only in axial motion, the cutting tools are not in contact with the workpiece. Technically, the process No. 1 takes less time which is only 10%; the process No. 2 is considered as the fine finishing for a smoother surface. Therefore, the feed rate and force on bearing is lower, whereas the process time is longer.

According to the loading force on shaft in Table I, and the intrinsic characteristics of bearing, presented in section III, the failure rate and the life for the given bearing configuration are looked up and shown in Table II. As the bearing system working in a specific cutting process, the cutting failure rate λ_{BE}^{cut} and cutting life time L_a^{cut} are $3.91e-4$ and $2620h$, calculated by (5) and (6), respectively. Because the cutting failure rate is obtained from the multiplication of $\lambda_{BE,J}^{process}$ and $U_i^{process}$ and the $U_i^{process}$ is between 0 and 1. Hence, the cutting failure rate will be between that of the highest and the lowest in the original failure rate. Therefore, the cutting life time has the same characteristic.

Table I: The parameters for a given cutting process

Cutting Process	Fa [N]	Fr [N]	[%] Percentage for the processing time
No.1	0	0	10
No.2	300	300	60
No.3	300	1200	10
No.4	2400	1200	20

Table II: The failure rate and life time of the bearing system for a given cutting process

Cutting process	Life time for a cutting process L_{10}^{sys} [h]	failure rate for cutting process $\lambda_{BE,J}^{process}$	Duty cycle $U_i^{process}$
No.1	3851	$2.60e-4$	0.1
No.2	3498	$2.86e-4$	0.6
No.3	2970	$3.37e-4$	0.1
No.4	1334	$7.49e-4$	0.2

V. Conclusion

In order to calculate the bearing life and evaluate reliability of the main spindle system effectively which is the key bearing sub-system of the main spindle, it is necessary to evaluate the exterior force which influences the bearing life. Considering the force imposed and that of the bearing system can analyze the system life and the bearing dynamic load to obtain the intrinsic characteristic of bearing, the paper indicates that not only the main spindle life is important but the bearing dynamic load conditions (surface pressure and contact angle, etc.) should be considered in order to understand the failure mechanism and avoid the current system design which does not meet the force requirement.

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Total Quality Management : Continuous Improve

Dr. Ching-Kun Chen

I. Introduction

Historically, quality control, in its modern terms, was born in the U.S. [1], and Japan, in its high economic growth period, imported and developed that concept as Total Quality Control (TQC) [2], which later evolved into Total Quality Management (TQM). Contrary to many misunderstandings, TQM is not a tool merely for big companies or the manufacturing sector; it is a way of managerial thinking for any type of corporation. TQM includes a number of management practices, philosophies and methods to improve the way an organization does business, makes its products, and interacts with its employees and customers.

The Quality Control Circle (QCC) method, a Japanese-made institutional development tool by which employees continuously strive for improvement in their work, usually functions as an integral part of TQM. Generally, the QCC method can serve to enhance people's problem-solving skills in organizations, and company-wide quality management through TQM is the most effective way to sustain QCC activities in an organization.

The concept of quality circles or quality control circles has originated in Japan. In 1962, Dr. K. Ishikawa presented this

II. Concept of Quality Control Circles

idea in the inaugural issue of Japanese Union of Scientists and Engineers journal. In the last 36 years, this concept has been introduced in as many as 130 countries.

QCC is a small team functioned with people usually from the same work area that voluntarily meet on a regular basis to identify, investigate, analyze and solve their work-related problem. The quality control tools (QC tools) applied to QCCs are Pareto Diagrams, Cause-and-Effect Diagrams, Stratification, Check Sheets, Histograms, Scatter Diagrams, Graphs and Control Charts. Also, logical thinking and experience are a must for solving problems [3]. QCC adopts a democratic process and introduces a participative management culture in the organization. In the QCC philosophy, the circle members share their ideas and expertise on the management. All people in the circle put their minds together to solve work-related problems. The circle presents the solutions to management and implements them after approval. Reviewing and following up after implementations are also the responsibilities of the circles. Figure 1 shows the 7 stages of QCC activities in PDCA Cycle. Table 1 shows the QC tools are used to assist members to think creatively, collect, summarize, and analyze data (quantitative and qualitative) in the QCC activities.

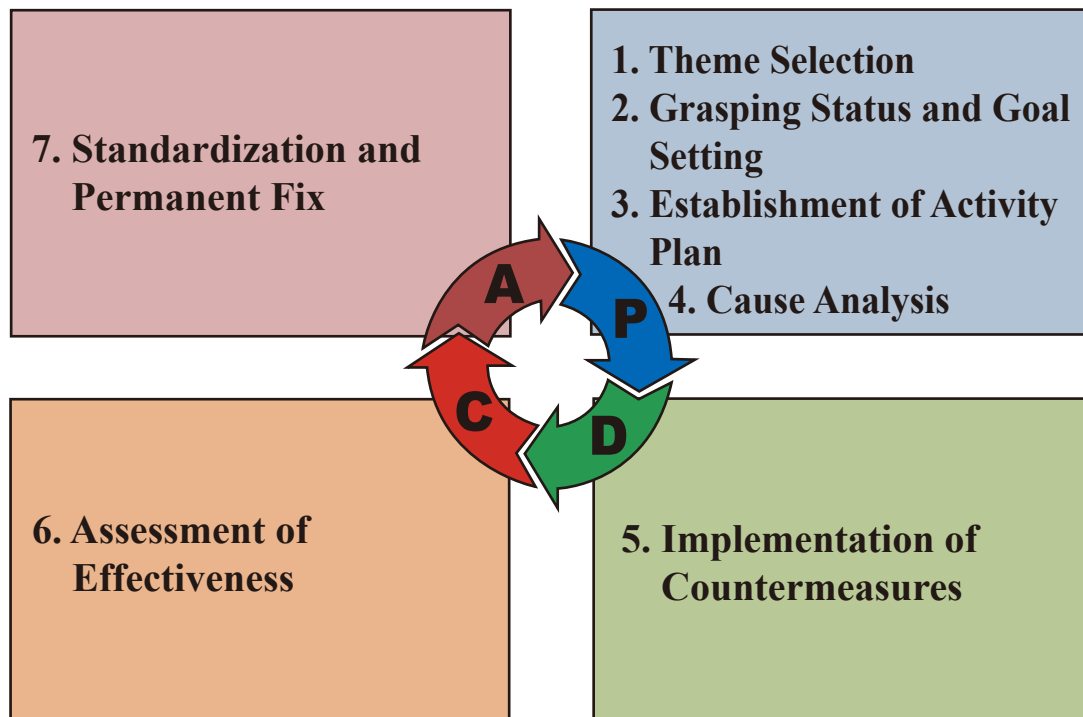


Figure 1. 7 stages of QCC activities in PDCA Cycle

ment in Quality Control Circles

Table 1. The QC tools applied for the QCCs

Stage	Method	QC tools							
		Stratification	Pareto Chart	Cause and Effect Diagram	Graphs	Check Sheets	Histograms	Scatter Diagrams	Control Charts
Theme Selection		✓	✓						
Grasping Status and Goal Setting	Current status	✓			✓				
	Set goal	✓			✓				
Establishment of Activity Plan									
Cause Analysis	Study relationship between factors and result	✓		✓					
	Study past and present situation				✓	✓	✓		✓
Implementation of Countermeasures				✓	✓				
Assessment of Effectiveness			✓				✓		✓
Standardization and Permanent Fix						✓			✓

Stage 1: Theme Selection

At the first stage, members select a theme from among the problems in the workplace—a theme concerning problems for which they think solutions would be most beneficial. This is to provide clear vision on the objectives for the activity. Members ask themselves, “What kinds of problems do we have and how do we improve?”

Stage 2: Grasping Status and Goal Setting

After a theme is selected, members try to understand the current situation of the problem. They list all of the possible problems related to the process, use data to validate that the “problems” are indeed problems, select the priority problem, and again use data to define the extent of this problem. The main objective of these steps is to gather information and grasp the status of the problem so that members can establish a detailed set of goals. A Pareto diagram is a bar chart with the items arranged in descending order so that you can clearly identify the highest contributing factors to a problem and tackle first, the form of Pareto diagram as shown in Fig. 2.

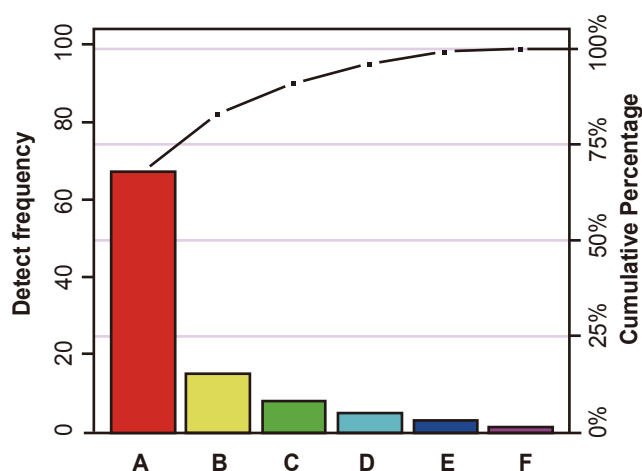


Figure 2. The form of Pareto diagram

Stage 3: Establishment of Activity Plan

Based on the data acquired in the second stage, the members establish an activity plan, according to the 5W1H concept. In this concept, five W questions and one H question are addressed. The members decide the issues to be tackled (what), the rationale for tackling them (why), the detailed time scheduling of the program (when), and the place and resource allocation (where, and who and how).

Stage 4: Cause Analysis

The main objective of this stage is to confirm which measures can be taken for what kinds of problems. After a theme is selected, the causes and effects of problems are to be identified. This is the most important stage of the process, as it identifies the root causes of the problems and shows what needs to be changed. In problem-solving processes, it is very important that results are examined in line with causes, thus identifying the cause–effect relationship. Members consider all possible causes of the problem and see if there is any correla-

tion among them. Then they use data to verify the causes, narrow these down to root causes, and finally select the most critical root cause. They then consider all possible solutions to eliminate the most critical root cause, select the best solution, and establish a detailed plan on how to implement it. The Cause-and-Effect Diagram (also called a fishbone diagram) is a very effective tool for analyzing the causes of a problem, the construct of cause-and-effect diagram as shown in Fig. 3.

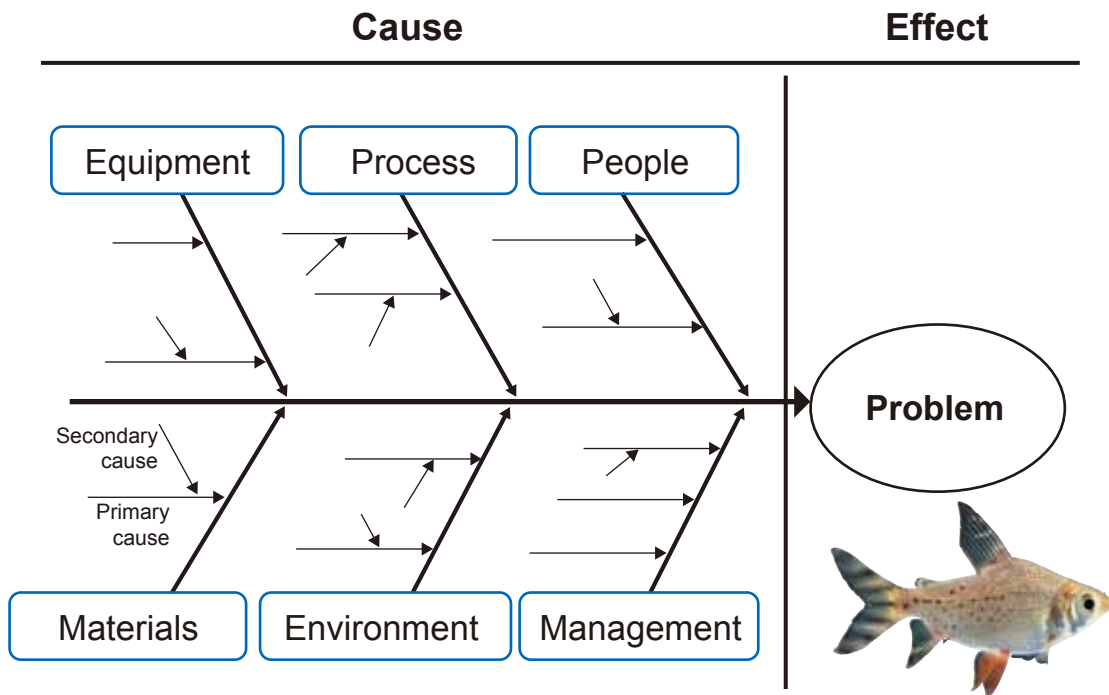


Figure 3. The construct of cause and effect diagram

Stage 5: Implementation of Countermeasures

After causes are identified, countermeasures are examined, evaluated, and selected. This stage aims both to correct the root causes and to establish the most effective measures to prevent the reoccurrence of the problems. All the people concerned on the issue are gathered to discuss it, considering factors such as effectiveness, cost, condition of restrictions, and impacts on the other factors. Members then implement countermeasures in daily operations, according to the plan, and monitor the results.

Stage 6: Assessment of Effectiveness

Then an assessment is carried out to see whether the impediments have been overcome or to what extent the initial objectives have been met. It is carried out together with evaluation for further improvement of the work. The Circle identifies the tangible and intangible results, verifies them using data, and compares them with the initial goal. Tangible results are results targeted through changes in processes, whereas intangible results are those in areas such as improvement in employee learning skills and education. If the results do not meet the goal, then the Circle needs to return to previous stages and reexamine the processes.

Stage 7: Standardization and Permanent Fix

Finally after effective methods are identified, they are standardized and made a permanent part of daily operations. Based on the standardization, members train the people concerned. Also, new training manuals are created and disseminated among the people concerned, and evaluation is carried out from time to time, aiming at ensuring that the process is maintained appropriately.

- To improve quality and productivity.
- To reduce the cost of products or services by waste reduction, safety, effective utilization of resources, avoiding unnecessary errors and defects.
- To identify and solve work-related problems and interfere with production as a team.
- To tap the creative intelligence of people working in the org. and make full use of human resources.
- To improve communication within the organization.
- To improve employees loyalty and commitment to the organization and its goals.
- To build a happy, bright, meaningful work environment.
- To satisfy the human needs of recognition, achievement and self-development

III. Objectives of the QCC Activities and its Benefits

Establishment of the QCC activities is highly beneficial, not only because of its problem-solving properties but also because of what the members learn as they proceed through the steps. In fact, the QCC activities bring both internal and external benefit to those involved in the processes. As for the internal benefit, through QCC activities, members systematically learn analytical skills as well as knowledge on statistical tools used in the process. The steps of the QC activities can serve as a roadmap for those who are not familiar with problem-solving processes. What Circle members learn through these activities can be applied to future processes. Externally, the QCC activities have great impact horizontally, as it disseminates individual experiences among all those interested in the QCC concept. Therefore the main objectives of QCC are:

IV. Conclusion

The pursuit of quality management never stops in Buffalo Machinery. It faces more and more tasks in controlling and improving quality in the increasingly high-end machine market. Requirements of the new version ISO 9000:2015 are representative of that truth. It's certain that TQM and QCC can contribute tremendously to any institution that has become conscious about quality management. Generally, a quality control circle program requires the same framework as an ISO 9000 quality standard with regard to the management structure and training. In the TQM framework, the management announced the company's mission and vision to its employees, and each one of them plays a significant role in implementing quality management activities. The QCC activities play an essential role in a company's management system, the development of which will lead to an activation of quality management throughout the company. Hence, QCCs should be part and parcel of company's TQM initiative.

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Successfully Staged in AMB 2016



A corner of Buffalo's stand at AMB 2016

The AMB 2016 was successfully rounded off on September 17th in the center of Europe's leading high-tech region Stuttgart. As a leading industry trade fair held each even year, this year AMB gathered 1,469 exhibitors of 33 countries and accumulated nearly 90,000 visitors to participate in the Stuttgart Exhibition Center, which has 105,200 m² of the fair area. According to official statistics, the international visitors from 83 countries increased in 2016, accounting 16 percent of the whole visitors. With this result, the AMB 2016 asserted its leading position among international metalworking trade shows.

with ideas exchange, Buffalo fully communicated with existing customers and successfully attracted numerous potential customers with particular interest of Buffalo's high-end solution.

During the exhibition period, Dr. Paul Chang, General Manager of Buffalo Machinery, was invited to give an interview with German media to illustrate how the functional self-learning and advanced Smart Machining Technology are combined with Buffalo's high-end machines as well as the achievement of machine reliability and what multiple benefits these machines can create. The unique features and performance of Buffalo's high-end machine tools are introduced comprehensively.



Dr. Chang from Buffalo and Mr. Michael Helle from POS were interviewed by German media.



Visitors gathered inside Buffalo's stand for an intense discussion.

Co-exhibition with POS, this year AMB was also a great success for Buffalo, as well with several remarkable results achieved. In the 170m² compelling and attractive exhibition stand, Buffalo presented the patented innovation and associated high-tech products, including two 5-axis vertical machining centers MCG-5X and MCU-5X, and the high-speed machining center V series. During the 5 days, Buffalo was pleased to attract hundreds of customers and interested visitors attending the stand to learn about Buffalo's patented Smart Machining Technology, the machine reliability and high-end machine tools. Through intense discussions

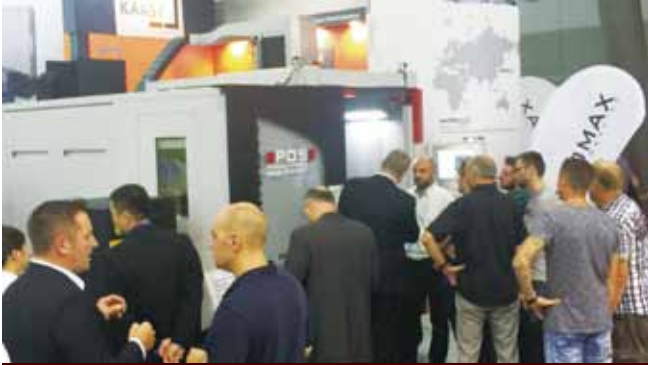
Buffalo Showcases

▪ 5-axis series features:

The MICROCCUT MCG-5X and MCU-5X are the 5-axis machining centers providing simultaneous machining in five axes with superior precision to achieve a superior surface finishing quality. Rigidity and reliability endured, this series is ideal for complex contouring for broad-based industries.

▪ HSM series features:

The MICROCCUT V series is a high-speed vertical machining center that features excellent cutting speed with high precision and fine surface quality achieved. With Rapid feed rate of 42m/min and high-speed processing with advanced controller, this series creates high productivity.



Visitors gathered to check out MCU-5X

All Buffalo's high-end models are designed with the inclusive and patented Smart Machining Technology to provide a better monitoring and compensation solution for vibration and thermal issues while operation to achieve higher precision and better metal removal rate. Moreover, hundreds of hours reliability test before machine shipment is the essential for all the high-end products.



Visitors at Buffalo's exhibition stand



The superior Taiwan machine tool manufacturers were invited to discuss the application of advanced technology of machine tools



Mr. Juan Martin, Buffalo's marketing manager of Europe, gave a keynote speech on the topic "Targeting Industry 4.0"

What's more, at the second day of AMB, Buffalo was honored to be invited to deliver keynote address in a press conference titled "Taiwan Machine Tools Advancing Smart Manufacturing" held by Taiwan's Ministry of Economic Affairs Bureau of International Trade. Four of Taiwan's excellent machine tool manufacturers including Buffalo were invited to discuss the application of advanced technology in machine tools and their strategies towards smart machining.

The press conference focuses on the broad topic of machine tools for smart manufacturing, inviting four superior Taiwan machine tool manufacturers to report their related technological strategies and innovative products. Mr. Juan Martin, Buffalo's marketing manager of Europe, gave a keynote speech on the topic "Targeting Industry 4.0", elaborating the technology and application aspects of the new generation 5-axis machine tools to apply to Industry 4.0 environment.

The MICROCUT heavy duty high speed simultaneous machining center MCG-5X was awarded the 24th Taiwan Excellence Gold Award this April, the award confirms Buffalo's dedication of quality and stability on both machine design and manufacturing, and the efforts put in innovation. The pursue of theoretical science and technology and dedication on innovation, plus the far-sighted blueprint, Buffalo now is ready for the forth industrial revolution and is confident to ensure a prosperous future for the high-end machine tool market.

Reference:

Messe Stuttgart. (2016). No.26 AMB 2016: Positive mood in the mechanical engineering industry [Press release]. Retrieved from <http://www.messe-stuttgart.de/en/amb/journalists/press-material/detailseite/text>



X-life cylindrical roller bearing with plastic cage

New Materials and Improved Processes

For maximum spindle performance

X-life cylindrical roller bearings with plastic cage – Higher speeds, increased load ratings, reduced running noise and more design options

With its new X-life generation, Schaeffler has achieved an up to 19% further increase in the basic dynamic load ratings of its proven series N10 and NN30 high-precision cylindrical roller bearings in the bore diameter range between 30 mm and 120 mm. The bearings are equipped with a window-type cage made of PPA (polyphthalamide) high-performance plastic. Tests have shown that they offer significantly improved speed capability compared to bearings with brass cage, and this applies to double row bearings in particular. Bearings with the new polyamide cage feature up to 12 K lower operating temperatures. At the same time, they achieved up to 25% higher speeds in the limiting speed test due to this reduced heat generation. Another advantage of the lower running temperatures with polyamide cages in comparison to brass cages is longer grease operating life. The use of the light-weight plastic cage with better damping properties also has a positive effect on the running noise – the bearings run more quietly. With their increased limiting speeds, the new X-life cylindrical roller bearings enable significantly performance-enhanced designs to be implemented. This is especially true in combination with high-speed axial bearings of series BAX. Speed parameters of almost one million mm/min are possible with minimal quantity oil lubrication.

Bearings from Vacrodur – top performance for the future

One way to increase the load carrying capacity of bearings whilst keeping the speed capability constant is the use of superior bearing ring materials. Schaeffler rolling bearings with rings of Cronidur have represented the top of the range for many years now in terms of superior load carrying capacity and grease operating life. In comparison, the new Vacrodur high-performance steel provides even higher static and dynamic load carrying capacity in conjunction with excellent wear behavior. Vacrodur is a powder metallurgically produced high-performance steel. Its fine, homogenous microstructure provides an excellent combination of hardness and strength. It has demonstrated exceptional wear behavior even under conditions of lubricant starvation and contamination, since the material is harder than most dirt particles. The great surface hardness also ensures lower sensitivity to brinelling. Bearings made from Vacrodur can support higher



Milling spindle in action

loads without plastic deformation in the raceway. The basic dynamic load rating compared to a bearing with the same interior design made from 100Cr6 increases by 65%. Schaeffler offers spindle bearings from Vacrodur as a special solution for very heavily stressed bearing supports. Further fields of application for this high-performance steel include bearing supports that are subject to risks arising from mixed friction and contamination as well as high static loads.

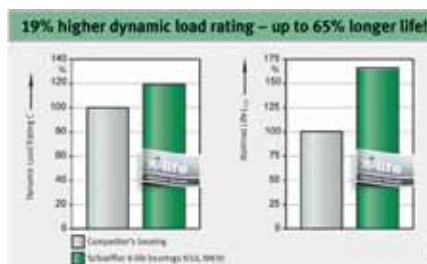
Spindle bearings with P4 accuracy



New FAG spindle bearing with running accuracy P4

Schaeffler now offers a range of spindle bearings with P4 running accuracy which can be used in simple milling spindles with belt drive and high-speed electric motors, for example. The open-design single bearings are equipped with a plastic cage guided by the rolling elements and large steel balls in the diameter range B70. With contact angles of

15 and 25 degrees respectively and standard preload in the UL class, apart from their accuracy the bearings correspond to the well-known P4S high-precision spindle bearings of series B70 from a mechanical point of view. The available bore diameters range from 25 to 100 mm. In addition, FAG P4 spindle bearings already come with a data matrix code. In conjunction with the new PrecisionDesk app (see page 12), this allows the authenticity of the bearing to be verified and will offer additional functions in the future, including the retrieval of performance capacity and mounting information.



Increased basic rating life thanks to X-life technology



X-life cylindrical roller bearing on top of new telescope box

The Challenger would like to acknowledge Schaeffler for the contribution of material.

On the Road to “Go”- from Lukang to the World



Following the last chapter in discovering local treasures in the historical town of Lukang, this time The Challenger has embarked on another journey to unveil the mystery and the virtue of the profound human intelligence- the game of Go, also known as Weichi, Ranka and Shudan.

Considered one of the four essential arts (guqin, go, calligraphy, painting) of the cultured aristocratic Chinese scholar caste in antiquity and the oldest board game of the world, Go is said to be invented 5,500 years ago by the Chinese emperor “Yao” for the purpose of educating his son through guidelines on discipline, concentration and balance. By coincidence, Mr. Yu Zu-He stepped into the world of “go” also for the same reason. What’s more, he aims to pass this culture to the next generation— sustainability, the ultimate goal that every corporate is pursuing.

Mr. Yu Zu-He, originally a local calligrapher, started exploring “Go” by guiding his son onto the career path.

The Coming of AlphaGo

Sitting in Da Jia Zhai, a private Go institute in the cultural town of Lukang, the Challenger started the interview with the founder Mr. Yu Zu-He together with the world champion Taiwanese amateur Go player, Zhan Yi-Dian, a guest Go professional who was giving his last lesson in the summer extensive course here.

The conversation is first centered around the well-known topic — AlphaGo, the computer program developed by Google DeepMind that beat the 9-dan rank professional Korean Go player, Lee Sedol, marking a significant event in artificial intelligence on 15 March, 2016

“The coming of AlphaGo certainly has a positive impact on Go, because it grabbed the global attention, attracting a lot more people to play this old traditional Chinese board game,” says Mr. Zhan. Mr. Yu Zu-He is the bridge to the world who started teaching Go 3 years ago after acknowledging his son’s potential in the game of Go. The role as a calligrapher originally provided him with more free time to accompany his son to different matches and make acquaintance with professional Go players around Taiwan. Later, Mr. Yu’s calligraphy studio became a private Go institute, educating more than 30 students today aged from 4 to 13.



“大家齋”- Da Jia Zhai, name of the Go institute in calligraphy writing, signifying that the studio is a place gathered with great masters; with another meaning that it is a well-known school. A pun in both Chinese and Taiwanese language

“The like-minded gather together. This is why Mr. Zhan is here with us” says Mr. Yu. They met in one of the matches earlier and Mr. Zhan who is still a university student proposed to teach at Da Jia Zhai during the summer holidays.

“When I was young, . . . I wanted to be the world's best Go player.”

– Bill Gates

Only the Here & Now

Mr. Yu gives positive review on the coming of AlphaGo for the same reason that it raises the global awareness of Go:

“It is great how this computer program attracted people’s attention to Go. Nowadays, people are so obsessed with technology. Therefore, here in my institute, I have 4 computers installed with software programs for students to train skills with the artificial intelligence or play with international players from all over the world. Distance learning has become more and more popular. Students get to train themselves at anytime anywhere.



Students play online with international players after actual match with their classmates.

However, for the long-term development, the actual competition will still be indispensable. To be honest, direct learning has the irreplaceable benefits because one of the most important prerequisites about learning is concentration and only by 'being there together and work simultaneously' can we help students. With distance, there is a lot missing."

Google DeepMind researcher David Silver says: "Humans have weaknesses: they get tired, they make mistakes and they are not able to make the precise, tree-based computations that a computer can perform. And perhaps most importantly, humans are limited to the number of Go games they can play and process in a lifetime, while AlphaGo can play millions of games every single day. It's at least conceivable that, as a result, AlphaGo —given enough processing, training and search power—could reach a level that's beyond any human."

Everybody is unique. The concept of perfection and to win every game is too ideal that it is impossible to do. Even machines have flaws. We should be reminded that we can only get benefits if we use technology wisely. It is vital to remember that the main purpose of education is not to train humans to work as quickly and efficiently as machines but to train them to think independently and make a better world.

Simplest Yet the Most Complicated Board Game in the World

Mr. Yutold the Challenger that the most enchanting and hardest part of Go is the unpredictable and changing characters.

Go has 250 possible moves, and by exponential extension, the number of possible moves by some estimates is greater than the number of atoms in the visible universe.

Category	Computational complexity
Chess	10^{123}
Chinese chess	10^{150}
Japanese Shoji	10^{226}
Go	10^{360}

Go tops the strategic board games with a computational complexity of 10^{360} !

Taking an inside look of the history behind AlphaGo, the lead programmer of AlphaGo from Taiwan, Aja Huang, who is also a 6-dan Go player mentioned the foundation of theoretical knowledge in Taiwanese education paves the way to his success. However, we should train students more on the organizational skills to build their confidence.

Go, therefore, is the best way for this training. Starting from zero with a plan but since every step from the opponent can change the whole game, constant adjustment is essential. During the game, we are doing the most rigorous brain sport that requires full concentration. Time of each game varies greatly. It could last for 15 mins, 3 hours, or even days. In the past, the aristocrats could adjourn a game and play a single game for months. Go is a long battle both in mind and body and to a higher level - the spirit.



Concentration is the key to success.



The strength of AlphaGo stems from the use of neural networks also known as deep learning. This artificial imagination tree search puts all pieces together. One neural network designated as the “policy network,” another “value network.” It can analyze 30 million games played by human go players, via constantly simulating Go games against itself. It strengthens its skills and evaluates the positions on the board and determines next steps, training itself to a higher level of competitiveness.

“While the Baroque rules of Chess could only have been created by humans, the rules of Go are so elegant, organic, and rigorously logical that if intelligent life forms exist elsewhere in the universe they almost certainly play Go.”- Edward Lasker, the world chess champion

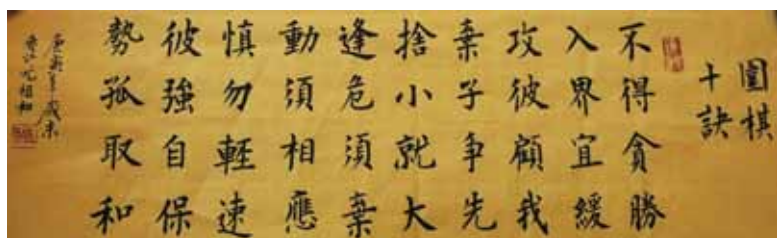
The Art of the Game

From calligraphy to Go, Mr. Yu depicted to us the similarities and differences between these two ancient Chinese aristocratic arts: “From the visual perspective, both are in black and white. They share the same philosophy in the idea of changing but at the same time holding onto the core value in the creation of harmony. To master these two very special arts, it is vital to be perseverant and be provided with a good learning environment.”

“Calligraphy is pure art, whether it is good is quite subjective. There is no such thing as good and bad because it is more of an expression of one’s characteristics. In contrast, Go is strictly guided with very simple rules and has a win-lose situation. Clear logic thinking and calm attitude are indispensable, thus, starting at the age of 4 to 6 is required if one wants to master Go. Looking back on the life of Go elites, we could easily find out that playing Go is their family tradition. They all started learning at a relatively early age under good family influence.”

In Song dynasty, Go players take playing Go as an act of philosophy that reflects their life. Black and white stones signify sun and moon, yin and yang, day and night. The round shape of stones signifies the universe, whereas, the four corners of the board represent the land. Whatever happens in the game, the high and low, the ups and downs are like a mirror of our life, reflecting the spirit of Taoism.

“You’re striving for harmony, and if you try to take too much, you’ll come to grief.”– Michael Redmond, the only Western Go player to reach 9-dan, the highest level of profession play



10 Tips of Go in Mr. Yu Zu-he’s calligraphy writing

1. Be steady in winning, do not be greedy.
2. Be discreet in entering new territory.
3. Attack but protect yourself at the same time.
4. Give up for new developments.
5. Go with a big-picture thought.
6. Yield to avoid dangers.
7. Never haste.
8. Keep up the pace of your opponent and adjust steps.
9. Step back to stay alive.
10. Look for peace in the opponent’s territory

The greatest Go player in the 20th century, Go Seigen, pointed out that reaching the highest state of Go, it is more of a game of mind, it is about playing a good game, forgetting winning, and enjoying traveling in the rhythm of black and white and reaching a harmonious state of mind. A documentary film about him called, “The Master of Go,” was released in 2006.



Go board model with 19×19 lines forming 361 crossing points dated from 595 AD. - Photo by Zcm11

Since it takes such a big amount of time to master Go, we have once again wondered what positive influences Go has to offer.

Go as an abstract strategy game, it can exercise, train and strengthen one's mind. People enjoy winning, but in this game, players gradually acquire the ability to accept failure, face problems and go on the next game. They learn to live with their choices while constantly correct mistakes with every possible chance in life. The ability to stay calm in facing all situations cultivates one's problem-solving skills.

Moreover, Mr. Yu said that team work is of vital importance. Students, teachers and parents must work together to make things happen. A good plan plus constant adjustments and good implementation is the formula. The Challenger marvels at the power of learning Go. It unites three parties, sending the message: "Together we're stronger."

"Carpe diem."

Mr. Yu told the Challenger that taking every opportunity provided, and simply doing with a good incentive with a clear goal sometimes is the way to success, perhaps not the shortest but the most challenging and glorious.

"Trust the instinct and stick to your goal", he says.



Mr. Yu with his son and wife presented his calligraphy fan as present to the Taiwanese Go professional player, Lin, Hai-feng, during the visit in Japan, June, 2016. - Photo by Wu Chien-lin

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The Challenger would like to thank Taiwanese Weichi Education & Development Association for the contribution of materials.



Match on the train between Japanese Go professional players and members of Taiwanese Weichi Education & Development Association - Photo by Wu Chien-lin

Vision

Mr. Yu's son who has been a 6-dan rank amateur player has recently completed junior high school and decided to enter a professional Go institute in China instead of going to high school. Mr. Yu envisions a Go institute to be established in Lukang in the future. In merely 3 years' devotion, he has encountered almost all the important Go players in Taiwan and connected his students with matches weekly.

Mr. Yu pointed out the importance of reading can expand the vision and broaden the horizon. He has invested lots in books regarding calligraphy and Go. To this date, he reads every day and discuss with people alike. He then tells us, "Keep going even when you are alone. You will attract the like-minded."

Go as the ultimate mind sport has no equal in the strategic gaming world. Once a player excels at finding balance in the game, he/she undoubtedly knows how to find balance in life. The learning path may seem steep in the beginning, but it gets better as you go along.



Student can play with opponent from all different levels thanks to the Go handicaps rule

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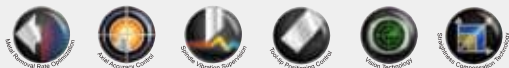
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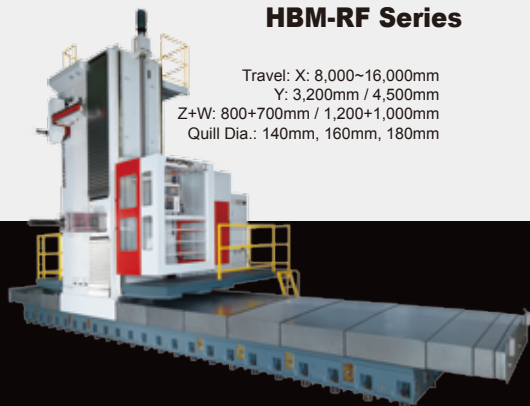
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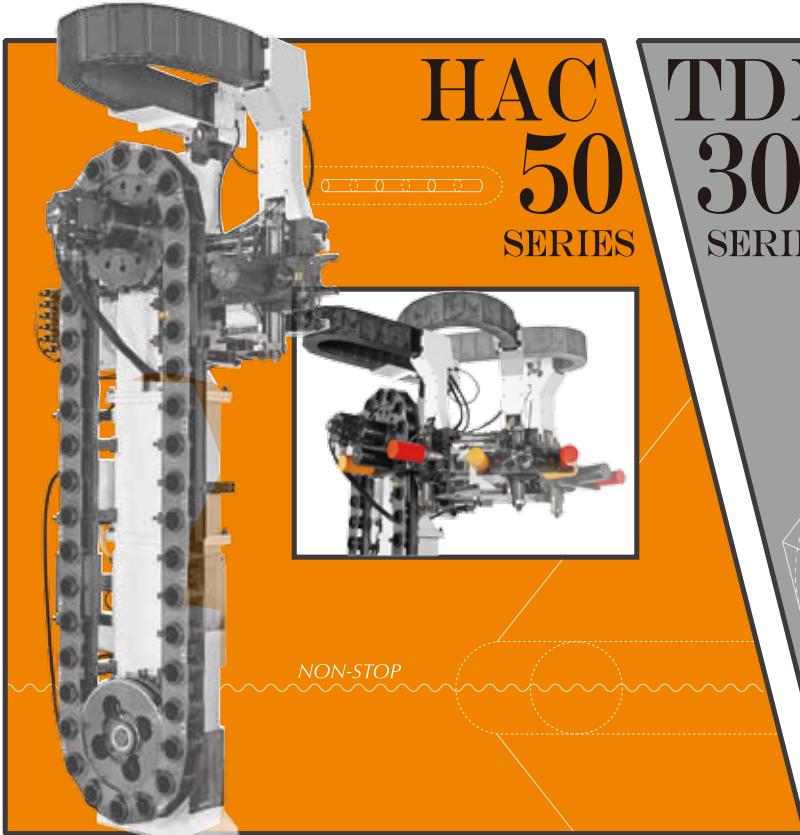
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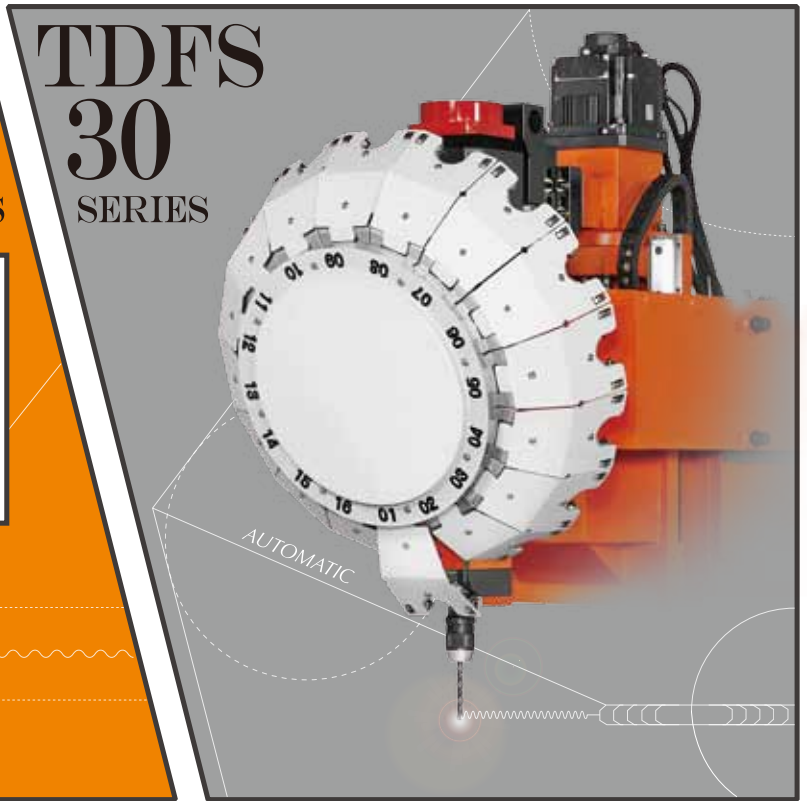
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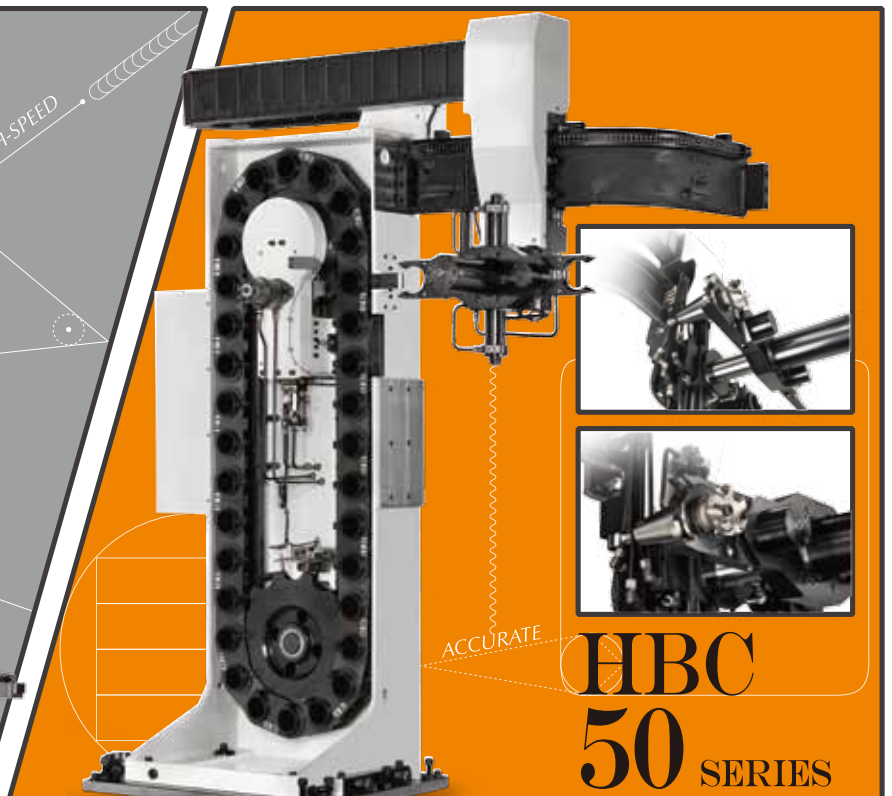
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