

SHAPE IT

OSG Global Tooling Magazine | SUMMER 2019

FORMULA
SAE



Hellermann Tyton

Tomorrow's Engineers

OSG helps prepare the next generation engineering professionals through sponsoring university robotics and automotive projects

Technical Insight

ADO-TRS 'Triple Revolution' 3-Flute Carbide Drill

Customer Report

Ultra-Precision Milling

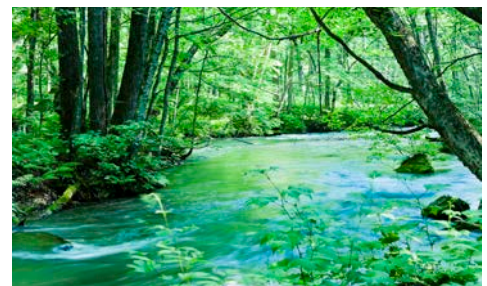
OSG end mills demonstrate high-quality, high-precision milling in fuel cell mold plate production

Meet OSG

Employee Interview in Mexico

OSG 4.0 with High Transparency, Clarity and Focus

A Message from the President



The year 2019 started off with China's nationwide slowdown in economic growth. With significant decline in profits in China's export-oriented manufacturing market, it is unclear how much of an effect it would have on the global economy. At the time of writing this editorial, the political turmoil over Brexit has further deepened economic uncertainties. OSG is highly aware of the potential crisis that lies ahead of the global economy. To ensure OSG and its clients' continued success, we are actively and strategically positioning ourselves to adapt to today's fluctuating business environment as well as rapid technological changes brought about by the automotive sector and the highly interconnected global society.

The OSG Group has the ability to outperform competitors in terms of comprehensive strength. We also have strong confidence in capturing and fulfilling new market demand around the world. In order to capture new emerging markets, prototype products manufactured in small lots are essential, which can create production schedule conflict with existing standard items manufactured in large quantity. To survive in the era of the Internet of things (IoT), OSG must further enhance capability to respond to new market needs (small quantity order) while maintaining existing market needs (large quantity order). The key challenge is to ensure our responsiveness regardless of lot sizes while achieving a balance between delivery time and cost. To further enhance service, OSG has recently launched a new initiative – OSG 4.0.

OSG 4.0 will consist of four key strategic developments that aim to digitally connect every manufacturing process at the company. They include the construction of a new Neo-Shinshiro Factory for smart manufacturing, the development of unmanned operation equipment, automation and monitoring programming, and OSG's product data management system (OPDM).

These efforts will further optimize OSG's manufacturing system to deliver the best possible result for clients in the new era of IoT. Success will not come from organizations that lack transparency. Similar to the environment of the early summer mountain, where one is surrounded by clear river water, refreshing breeze and new greenery, OSG 4.0 will be managed with a high degree of transparency, clarity and focus.

A handwritten signature in black ink, which appears to read 'Norio Ishikawa'. The signature is fluid and cursive, written in a professional style.

Norio Ishikawa
President & CEO of OSG Corporation

CONTENTS

SHAPE IT
SUMMER 2019

Feature

3 Tomorrow's Engineers

Technical Insight

11 ADO-TRS 'Triple Revolution' 3-Flute Carbide Drill

Customer Report

17 Ultra-Precision Milling

21 Quality Meets Efficiency

23 Rethinking the Process

Product Pickup

25 AM-EBT & AM-CRE Carbide End Mills for Additive Manufacturing Applications,
OSG Phoenix Counterbore Cutter

26 AE-VML Long Flute Chipbreaker End Mill, CM-RMS & CM-CRE Ceramic End Mills

OSG News

27 Taiho Tool Mfg. Co. Celebrates 50th Anniversary

28 OSG GmbH Recognized as Top 27 Supplier by Daimler

Meet OSG

29 Employee Interview in Mexico

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Tomorrow's Engineers

OSG helps prepare the next generation engineering professionals through sponsoring university robotics and automotive projects

Marcela Rattin Bombini

OSG Sulamericana

Have you ever wondered who will be taking your place, working and managing the company 30 years down the road? OSG does. For decades, OSG has invested in the younger generation by offering scholarships and training programs to students who are pursuing a career in manufacturing.

In Brazil, OSG Sulamericana actively supports college programs by sponsoring and supplying cutting tools to students pursuing degrees in engineering. Since 2014, OSG Sulamericana has become a sponsor of 10 university teams that compete in robot combats and small formula car racing.

Robot Combat

Robot combat is a competition where custom-built robots, commonly referred to as battlebots, use a variety of weapons to destroy or disable the opponent within a designated battle arena. On average, there are six to 10 competitions per year. Each battlebot requires approximately three to six months to build. Using unique strategies, each team strives to win a fight adhering to the competition rules and within the allocated time limit. The combatant robots are usually remote-controlled vehicles. The complexity and cost of the machines vary based on the weight class. In general, the heavier the weight class, the more powerful the machine. The builder and operator must work in unison to craft the perfect battle machine.

Formula Car Development Competition

Out of the 10 teams that OSG sponsors, five teams are concentrated in the automotive sector. These teams are participants of car development competitions, where students are challenged to design and build small electric formula racing cars over a one-year period timeframe. The formula car development competition enables students to experience the entire automobile development process – from conceptualization to construction, encompassing all aspects of research, design, manufacturing, testing, developing, marketing, management and fundraising. Each team strives to produce the best functional prototype vehicle with superior quality in speed, fuel efficiency and safety. The cars are driven by the students themselves and the prototype vehicle is evaluated for its potential as a production item among Brazilian engineering education institutions.



Robot combats and formula car development competitions are not only fun and entertaining, but they can also provide a platform for students to apply what they have learned in the classroom to real-world scenarios. Each competition tests the students' knowledge in mechatronics and innovativeness. Working in teams, students are able to grow in their confidence, leadership, communication and problem-solving skills. These out-of-the-classroom activities serve as an important platform to promote interest in engineering and provide opportunities for students to explore future career paths. To better understand the competitions and the builders' backstories, OSG visited three universities and interviewed a couple of teams that the company sponsors.

THUNDERATZ

ThundeRatz

University: University of São Paulo

Location: São Paulo, SP, Brazil

Number of Team Members: 75

Year of Foundation: 2001

Recent Major Accomplishment: 1st place in the 2018 Robot ReDrum 15kg class finals

Team History

The ThundeRatz team was established in 2001 with the sole purpose of participating in what would become the first ever robot combat competition in Brazil. Only three other teams, also newly established in the same year, participated in the first competition. Since then, ThundeRatz has been participating annually in robot combat competitions and is one of the oldest robot combat teams in Brazil.

Most Frequently Used OSG Tools

Many OSG drills, end mills and taps are used by the ThundeRatz team to build their combatant robots. Round dies are also used at a lower frequency.

Comments by Matheus Ivanaga, Head of ThundeRatz

ThundeRatz is extremely grateful for the partnership with OSG. It is very difficult for a team made up of only college students to obtain funds and function on its own. In the eyes of the ThundeRatz Team, companies who provide sponsorships are not only supporting the teams, but are also supporting the advancement of science and technology in the country. Moreover, the cutting tools provided by OSG allow ThundeRatz to manufacture parts with great precision, resistance to impact, and excellent surface finish. With OSG's support, ThundeRatz will strive to continue to evolve as a team and to become great professionals with a broad knowledge in the field of robotics.



1. Julia Morone, mechanical engineering major from ThundeRatz uses an OSG hand tap to thread a robot part.

2. Kleberson Alves, mechanical engineering major and machining leader of ThundeRatz uses an OSG drill to process a part of the combatant robot.



3. The ThundeRatz project development room at the University of São Paulo.

4. One of the many combatant robots built by ThundeRatz.

5. Trophies earned by the ThundeRatz team over the years.

6. Matheus Ivanaga, mechanical engineering major from ThundeRatz uses an OSG end mill to machine the combatant robot's weapon.

7. OSG is one of the official sponsors of ThundeRatz.



TROIA

University: Federal University of Lavras

Location: Lavras, MG, Brazil

Number of Team Members: 32

Year of Foundation: 2012

Recent Major Accomplishment:

2018 National Champion of the Robot Hockey Category (3-time champion of the category)



1 The workshop of TROIA at the Federal University of Lavras in Lavras, MG, Brazil.

Team History

TROIA – an acronym for Technology, Robotics, Optimization and Artificial Intelligence, came from the fusion of two nuclei studies from the Federal University of Lavras. In 2011, 10 students from the Control and Automation Engineering course at UFLA met with the objective of building a combat robot to participate in national competitions promoted by the company Robocore. Since then, TROIA has participated in more than 20 competitors and has earned more than 25 trophies, including two from world-wide competitions. Despite its short history, TROIA has set itself as a benchmark in the robot combat competition, currently occupying the eighth place in the national ranking with more than 400 competing teams.

Most Frequently Used OSG Tools

OSG end mills, drills and taps are used by TROIA. HSS end mills and HSS end mill with TiN coating are most frequently used.

Comments by Anna Caroliny, Marketing Leader of TROIA

None of TROIA's development would have been possible without the support of sponsors, society and the commitment of team members. OSG has a direct influence on the personal development of team members, who leave the college more prepared for the job market. The cutting tools supplied by OSG offer faster machining with an excellent surface finish. TROIA has a lot of pride, admiration and honor being supported by OSG.



2. Thales Roger from TROIA uses an OSG drill to process a part of the robot structure.



3. Anna Caroliny, marketing leader of TROIA uses an OSG end mill to machine a part of the robot structure.



4

4. One of the many combatant robots built by TROIA.



5

5. Anna Caroliny, marketing leader of TROIA uses an OSG hand tap to thread a hole in the structure of the combatant robot.



Omegabotz

University: The Sorocaba Engineering School

Location: Sorocaba, SP, Brazil

Number of Team Members: 26

Year of Foundation: 2005

Recent Major Accomplishment: 2nd place in the 2018 Winter Challenge Hockey Pro (6.8 kg) category and 2nd place in the 2018 Winter Challenge ArtBot-Kinetic category

Team History

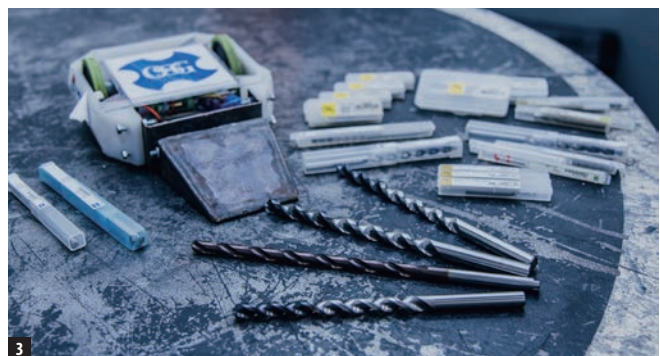
Omegabotz began its activities in 2005 with students of the electrical engineering course. Members were inspired by the Winter Challenge event that had emerged the same year, and began to develop on their own a 55 kg combat robot named Steppe. Omegabotz is among the best robotics teams in Brazil with a specialty in the category of hockey robots.

Most Frequently Used OSG Tools

The most commonly used tools are end mills, which are used in 85 percent of Omegabotz's projects. The end mills are mostly used for the development of shields, bases, walls – basically the entire structural part of the robot. Drills are also well used, but at a much lower usage rate when compared to milling cutters.

Comments by Gregory Nomura, Head of Omegabotz

The support and trust provided by our sponsors are fundamental for helping us excel in university project, extension projects and professional training. These activities are not only beneficial to our personal development, but also to the development of new technologies in our society. OSG's products have always demonstrated long tool life. To this day, none of the tools have lost their sharpness yet. It really shows how committed OSG is to quality and customer satisfaction. At Omegabotz, we will strive to mirror OSG in terms of commitment, management and quality.



1. Omegabotz's Hockey Robot built with OSG cutting tools.

2. Gregory Nomura, captain of Omegabotz, uses an OSG drill to make holes in the structure of the Hockey Robot.

3. Omegabotz's 1.36 kg Beetleweight combat robot is pictured with a group of tooling that OSG supplies to the team.

4. Omegabotz's workshop at the Sorocaba Engineering School in Sorocaba, SP, Brazil.



B'Energy

University: The Sorocaba Engineering School

Location: Sorocaba, SP, Brazil

Number of Team Members: 24

Year of Foundation: 2014

Recent Major Accomplishment: 2nd place in the 14th Formula SAE Brazil 2017 Competition

Team History

B'Energy was established in 2012, the same year that the electric category of Formula SAE was released in Brazil. The team has participated in every single SAE Brazil formula competitions since then.

Most Frequently Used OSG Tools

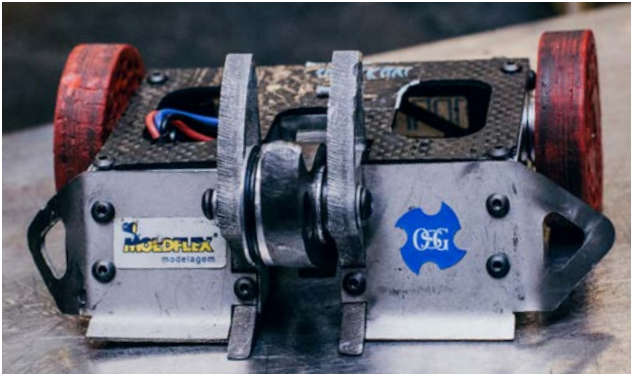
End mills are used to build the suspension points for B'Energy's B18 vehicle. Taps are used to open threads on the suspension parts and on battery components, which are designed and manufactured by the team.

Comments by Lucas Andrade, Head of B'Energy

The partnership with OSG allows B'Energy to manufacture vehicles with great precision and quality. The competitions we participate in are highly valuable to our future professional development.



1. The workshop of B'Energy at the Sorocaba Engineering School in Sorocaba, SP, Brazil.
2. Lucas Maximiliano from B'Energy uses an OSG hand tap to thread a hole for the construction of the team's vehicle.
3. An OSG end mill is being used to machine a component for B'Energy's vehicle.



OSG has grown substantially over the years, so has its sponsorship and scholarship programs. OSG will continue to encourage and support tomorrow's engineers, who will design the next generation of robotics systems to further advance science and technology.



ADO-TRS 'Triple Revolution' 3-Flute Carbide Drill

Ultra-machining efficiency and stability
in steel applications

Takahiro Yamamoto
OSG Corporation Applications Engineer
(Drill Development Division)

Three-flute drills are commonly employed in manufacturing. However, they are mostly used in the processing of materials with short cutting chips and low cutting resistance, such as cast iron, ductile cast iron and aluminum alloy. Three-flute drills are sometimes advertised to be suitable for steel materials such as carbon steel, alloy steel and mild steel. However, with a smaller chip room geometry than 2-flute drills, the cutting thrust resistance in 3-flute drills is also greater.

Due to constraints in workpiece configuration, equipment and setup, conventional 3-flute drills often are unable to maximize both speed and precision as advertised. Moreover, in steel processing, the strength of the work material and viscosity are high, making chip separation and stable processing a challenge. With high thrust force and poor chip evacuation, sudden machining troubles such as tool breakage and chipping are common headaches of 3-flute drills.

To help manufacturers maximize productivity, OSG has recently introduced a new revolutionary drilling innovation – the ADO-TRS – nicknamed as the 'Triple Revolution' drill, for ultra-machining efficiency and stability in steel materials.

The ADO-TRS 'Triple Revolution' is OSG's latest drilling innovation for ultra-machining efficiency in a wide range of materials. Its unique R gash geometry enables high thrust resistance and exceptional chip control, which are common challenges of 3-flute drills.



Features of ADO-TRS 'Triple Revolution' Drill

There are three major features that enable the ADO-TRS to stably process steel applications. The most notable key feature is the newly engineered R gash geometry (pat. P) as illustrated in figure 1.

The optimized R shape geometry is designed to control chip flow direction to facilitate trouble-free chip-evacuation. With this new feature, the ADO-TRS is able to significantly improve chip separation even in steel materials by breaking them into small pieces and consistent shape. In addition, this new geometry can reduce cutting resistance (thrust resistance), by as much as 30 percent versus conventional tooling, enabling it to outperform even 2-flute drills in high-feed processing with minimal cutting resistance.

The second key feature of the ADO-TRS is its wide chip pocket configuration. In 3-flute drills, chips are difficult to be discharged from the center of the drill. The ADO-TRS employs a wide chip room flute geometry to improve chip ejection. Combined with the R gash specification, chips are curled for greater separation capability, which leads to smooth and stable chip evacuation.

Last but not least, the ADO-TRS is coated with OSG's original EgiAs coating for high durability. The EgiAs coating is consist of overlapping nano-periodical layers and wear-resistance layers, engineered to suppress the propagation of cracks that are likely to occur during drilling. The wear-resistance layer is composed of multiple hard layers; while the nano-periodical is a combination of hard and soft layers. With a mixture of hard and soft layers, internal stress can be relieved, allowing the EgiAs coating to achieve both high wear resistance and extreme toughness to ensure stable and consistent tool life under aggressive cutting conditions.

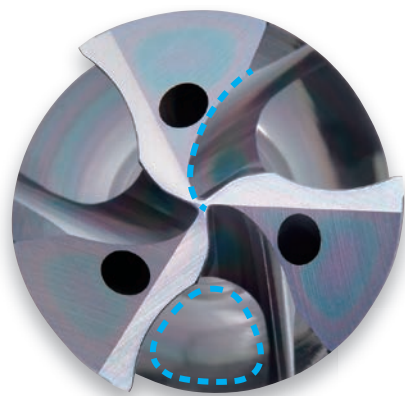


Figure 1. ADO-TRS' unique R gash geometry enables low cutting resistance and creates short and compact chips stably.

Cutting Data

1. Excellent Chip Formation and Evacuation in Steel Applications

Two of ADO-TRS' most notable benefits are its superior chip management and low resistance drilling capability in steel materials.

SCM440 (raw) is one of the more viscous materials among steels. When processing this material with MQL, chips generated by conventional 3-flute drills and 2-flute drills are elongated as depicted in figure 2. As depicted in figure 3, the conventional 3-flute drill is unable to break chips into small pieces. As a result, remnants of elongated chips remain in the flute of the drill. The ADO-TRS, on the other hand, is able to demonstrate excellent chip form consistently as shown in figure 2.

Figure 2. Chip shape comparison in SCM440.

Tool	ADO-TRS-5D
Size	φ 16
Work Material	SCM440 (82~90 HB)
Cutting Speed	80 m/min (1,592 min ⁻¹)
Feed	1,019 mm/min (0.64 mm/rev)
Depth of Hole	50 mm (Through)
Coolant	MQL (2~3 cc/h)
Machine	Horizontal Machining Center (HSK-A 63)



Figure 3. Condition of the conventional 3-flute drill after processing SCM440.



Figure 4. Chip shape comparison in SS400

Tool	ADO-TRS-5D
Size	φ 16
Work Material	SS400
Cutting Speed	80 m/min (1,592 min ⁻¹)
Feed	1,019 mm/min (0.64 mm/rev)
Depth of Hole	50 mm (Through)
Coolant	Water-Soluble
Machine	Horizontal Machining Center (HSK-A 63)



Figure 5. Tool life comparison in SS400

Tool	ADO-TRS-5D
Size	φ8.5
Work Material	SS400
Cutting Speed	100 m/min(3,745 min ⁻¹)
Feed	1,273 mm/min (0.34 mm/rev)
Depth of Hole	43 mm (Blind)
Coolant	Water-Soluble
Machine	Horizontal Machining Center (HKS-A 63)



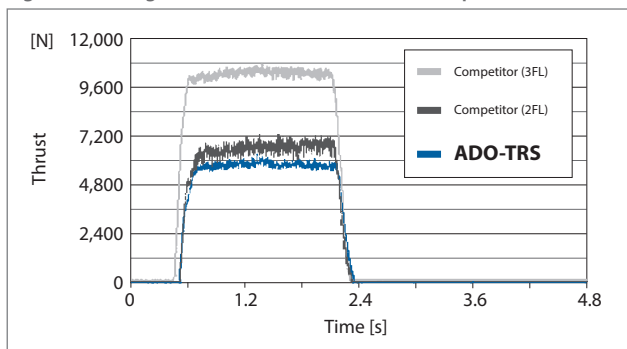
Moreover, in the processing of SS400 using water-soluble coolant, sudden tool damage and chipping caused by tangled chips are prone to occur. The stability in chip formation and evacuation is a key factor for achieving stable processing in mild steel SS400, which

is particularly prone to chip problems. As illustrated in figure 4 and figure 5, the ADO-TRS demonstrates overwhelming chip separation capability and long tool life even in the processing of SS400 in comparison to the conventional 3-flute drill and 2-flute drill.

2. Low Resistance Drilling

Next, figure 6 illustrates a comparison of cutting resistance when processing under the cutting condition depicted in figure 2.

Figure 6. Cutting resistance (thrust resistance) comparison in SCM440.

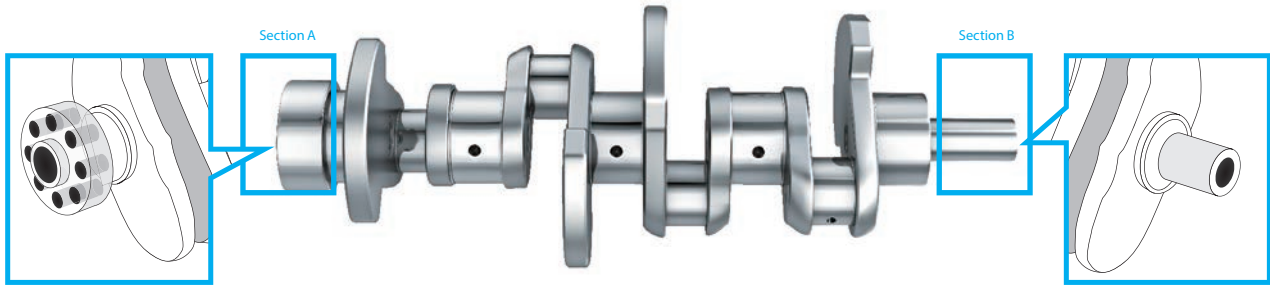


As shown in figure 6, the ADO-TRS is able to reduce thrust resistance by approximately 35 percent versus conventional 3-flute drills, and generated even less overall thrust resistance when compared to a standard 2-flute carbide drill, which has one less flute and larger chip rooms. Under identical cutting condition, the ADO-TRS is able to achieve the lowest thrust resistance.

Due to high cutting resistance inherent in conventional 3-flute drills and the various constraints present in processing environment, such as the machine, workpiece geometry, work fixture, etc., conventional 3-flute drills are often unable to maximize high-feed performance and precision. The ADO-TRS, on the other hand, excels in wide range of cutting conditions, truly reflecting its versatile capability.

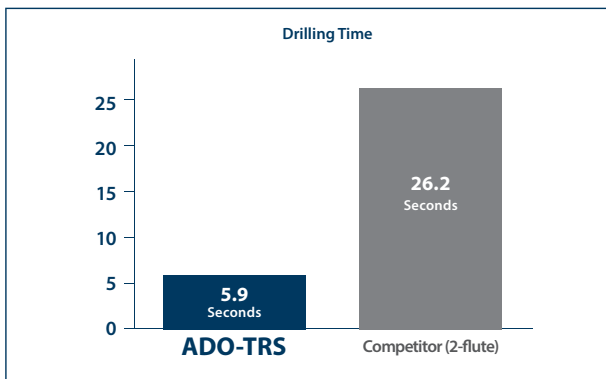
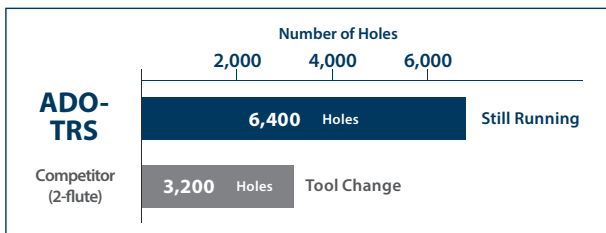
Next, we will evaluate the performance of the above features combined with OSG’s original EgiAs coating in the following case study, where the ADO-TRS is able to demonstrate long tool life and stable processing in a crankshaft made of alloy steel. In terms of shape, although the work holding force (clamp) at the time of processing is not high, the effect of the low cutting resistance of the ADO-TRS is able to surpass the carbide 2-flute drill with greater feed-rate. As shown in figure 7, the ADO-TRS is able to achieve higher efficiency and significantly reduce processing time versus the competitor 2-flute drill.

Figure 7. Case study of machining time and tool life improvement in the processing of an automotive crankshaft.



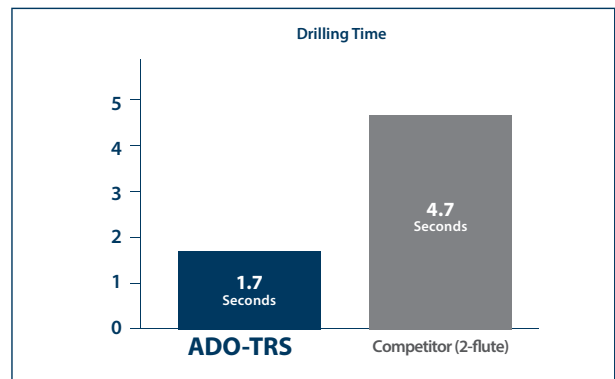
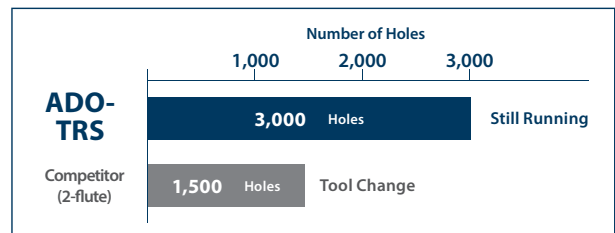
Section A

Tool	ADO-TRS (special)	Competitor (2-flute)
Size	$\phi 8.8$	
Work Material	Alloy Steel	
Cutting Speed	80 m/min (2,895 min ⁻¹)	
Feed	1,563 mm/min (0.54 mm/rev)	347 mm/min (0.12 mm/rev)
Coolant	MQL	
Machine	Horizontal Machining Center	



Section B

Tool	ADO-TRS (special)	Competitor (2-flute)
Size	$\phi 12.5$	
Work Material	Alloy Steel	
Cutting Speed	80 m/min (2,038 min ⁻¹)	
Feed	1,101 mm/min (0.54 mm/rev)	408 mm/min (0.2 mm/rev)
Coolant	MQL	
Machine	Horizontal Machining Center	





ADO 40xD

ADO 50xD

The ADO-TRS' unique R gash geometry feature has also been applied to OSG's ADO 40xD and 50xD carbide drills with through coolant for highly efficient deep-hole drilling. The R gash geometry enables super low cutting resistance and exceptional chip control, optimized for superior performance in ultra-deep-hole applications.

As depicted in this case study, the ADO-TRS is able to demonstrate exceptional stability, high-productivity, long tool life in steel materials, which conventional tools are challenged by instability. Furthermore, with capabilities to resolve common challenges of 3-flute drills such as high thrust force and poor chip evacuation in steel applications, the ADO-TRS is setting a new standard for 3-flute drills with reliable performance never witnessed before in the cutting tool sector.

The ADO-TRS' unique R gash geometry feature has also been applied to OSG's ADO 40xD and 50xD carbide drills with through coolant for highly efficient deep-hole drilling. The R gash geometry enables super low cutting resistance and exceptional chip control, optimized for superior performance in ultra-deep-hole applications. This geometry has proven success not only in 3-flute drills, but also in 2-flute drills. OSG will look to apply its superior tooling geometry to other products to further enhance productivity, tool life, stability and precision.

For manufacturers who are especially struggling with chip evacuation problems in steel applications, look to the ADO-TRS to experience ultra-machining efficiency and stability.

The ADO-TRS is available from diameter 3 mm up to 20 mm, in processing depth of 3xD and 5xD, and is suitable for applications in carbon steels, alloy steels, mild steels, cast iron and hardened steels.





¹ Established in 1946 as one of the largest and oldest tool factories in Scandinavia, Hjerno Tool Factory specializes in the production of injection molding tools with the highest attention to quality and detail. Photo courtesy of Hjerno Tool Factory.

Ultra-Precision Milling

OSG end mills demonstrate high-quality, high-precision milling in fuel cell mold plate production

Peter Cramer Jensen
OSG Scandinavia

In recent years, fuel cell powered systems have emerged as an efficient and reliable alternate technology for electricity generation, and are finding applications in various industries globally. The surge in adoption is driven by growing environmental concerns, as well as increasing government initiatives for hydrogen fuel cell infrastructure.

Hjerno Tool Factory in Odense, Denmark recently received an order that involves the machining of mold plates made of 59 HRC tool steel used in fuel cells. Established in 1946 as one of the largest and oldest tool factories in Scandinavia, Hjerno Tool Factory specializes in the production of injection molding tools with the highest attention to quality and detail. Utilizing some of the latest machineries and equipment, Hjerno

Tool Factory is able to provide innovative tool design solutions for intricate parts with tolerances as low as two microns. With more than 50 tool specialists stationed at its 4,000-square-meter modern manufacturing facility, Hjerno Tool Factory is able to produce on average one new injection molding tool per day.

A majority of Hjerno Tool Factory's orders are complicated, involve difficult-to-machine materials, require strict tolerances and short cycle time for maximum cost efficiency. Hjerno Tool Factory's recent fuel cell project for an international client was one of such orders.

About Fuel Cells

A fuel cell is an electrochemical cell that is powered by forcing hydrogen gas through a catalyst-coated membrane where it bonds with oxygen from the air. This electrochemical reaction creates water vapor and a stream of electrons that can power the same electric motors found in a battery-electric vehicle. Although expensive when compared with gas generators and lithium-ion batteries, fuel cells are capable of producing electricity continuously as long as hydrogen and oxygen are supplied. Moreover, the only emissions from fuel cells are water and heat, thus many see fuel cell technology as a new sustainable and low-carbon based energy source.

Machining the Fuel Cell Mold Plates

The fuel cell consists of a number of components required for it to function. The proton exchange membrane (PEM) plates are especially critical to the fuel cell as it serves as an energy generator where the chemical reaction of converting hydrogen and oxygen into electricity and heat takes place. The thin steel flow plates are composed of complex channel patterns for the hydrogen and oxygen gas to flow through.

Several months of non-stop precision machining was required of Hjerno Tool Factory to machine eight molds for these fuel cell power stack separator plate

membranes with extreme tolerance requirement in 59 HRC tool steel. The project included uninterrupted 0.4 mm ball milling over several months, eight days of non-stop finishing milling and tolerances within three microns.

All of these factors combined made it a one-of-a-kind project, said Peter Jørgensen, Managing Director of OSG Scandinavia, who supplied the cutting tools to Hjerno.

"In OSG Scandinavia's 40 years of existence, it is the first time we've been involved in a project as remarkable as this one," said Jørgensen. "The requirements from the machine, tool fixture and the tool itself were all on the verge of impossibility."

To tackle the challenge, Hjerno Tool Factory relied on a V33i milling machine from the Japanese machine tool builder Makino; the shrink fit tool holders came from MST, while OSG supplied two different sets of cutting tools – the WXS-LN-EBD ball nose carbide end mill and the CBN-SXB ball end mill.



Utilizing some of the latest machineries and equipment, Hjerno Tool Factory is able to provide innovative tool design solutions for intricate parts with tolerances as low as two microns. Photo courtesy of Hjerno Tool Factory.

The WXS-LN-EBD is a 2-flute, long-neck ball nose carbide end mill designed for high-precision milling of hardened steels up to 65 HRC. Equipped with OSG's original WXS coating for superior heat and wear resistant, this rib processing end mill series is able to achieve optimal performance with high precision and efficiency under aggressive machining conditions.

The CBN-SXB is a small-diameter 2-flute super ball end mill designed for high-precision finishing. Its spiral gash end cut geometry provides a strong and sharp edge with cutting performance equivalent to carbide tools. The CBN-SXB is especially effective in profile milling and workpieces with large inclines. It is most ideal for finishing long distance high-hardness materials above 50 HRC.

"Initially, we also discussed developing customized cutting tools for this specific project, but it quickly became clear that our standard cutting tools should be able to do the task," said Jørgensen.

The OSG end mills were able to provide high-quality machined surface even at high-feed rate while maintaining the strict accuracy required by the fuel cell project. However, as milling progressed, it became clear

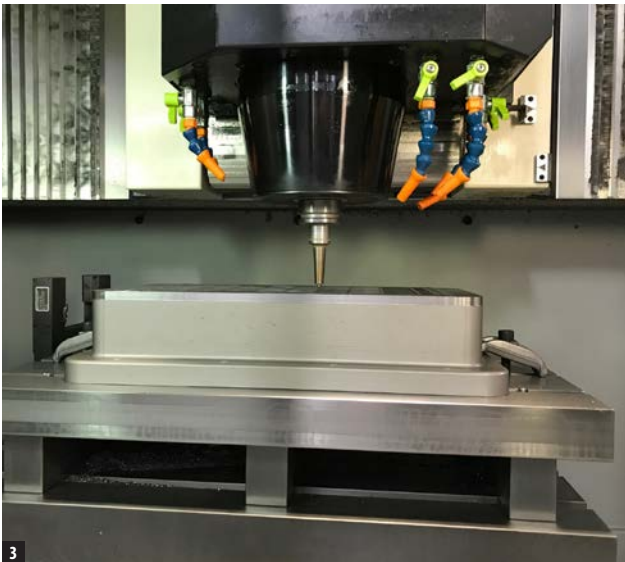
that the machines milled with a variation, for which Hjerno Tool Factory's technicians could not account the reason.

For quite some time, it was believed that the variance was caused by a mechanical problem in the machines or in the cutting tools. However, it was later discovered that there was an inaccuracy in the advanced CAM system that Hjerno Tool Factory uses.

Specialist Summit in Denmark

In order to resolve the inconsistency, Hjerno Tool Factory called for assistance from all over the world. Shortly after, various stakeholders of the project – Hjerno Tool Factory, OSG, Makino and the CAD/CAM supplier – all met up at Hjerno Tool Factory's headquarters in the Danish town of Odense.

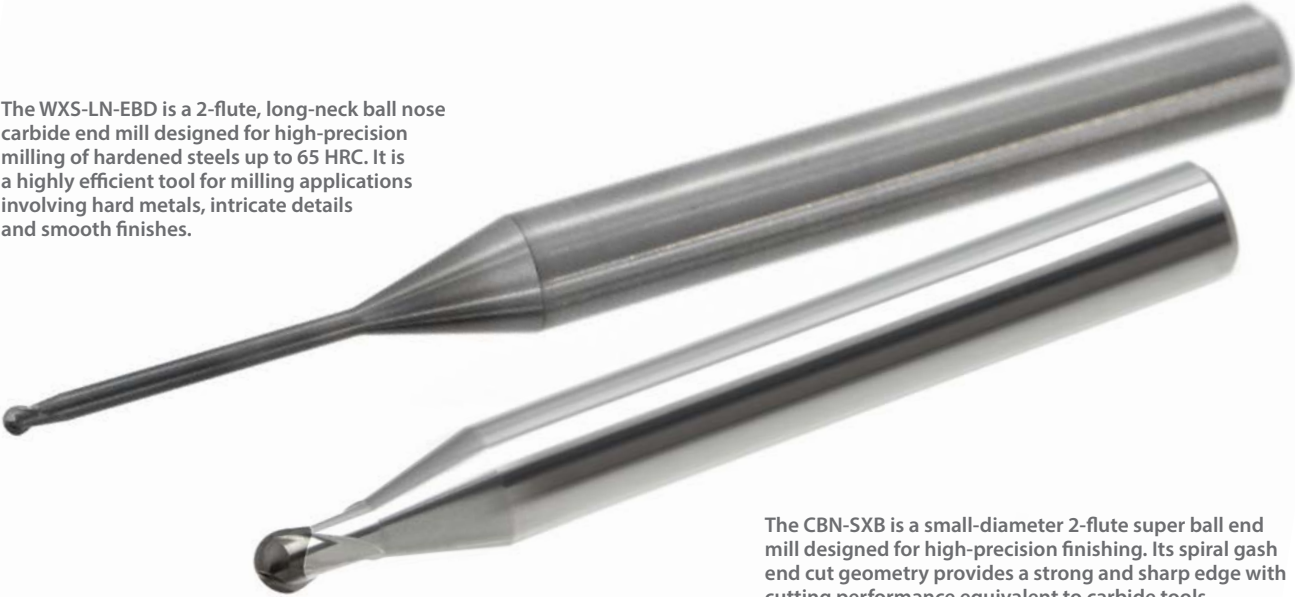
The system developer ended up spending 14 days in Denmark, where he recoded the entire program structure so that the CAD software could handle the extremely large files. At the same time, OSG and Makino's specialists developed new suggestions for milling optimization.



Several months of non-stop precision machining was required of Hjerno Tool Factory to machine eight molds for fuel cell power stack separator plate membranes with extreme tolerance requirement in 59 HRC tool steel. The production time required for each plate varies from two to four weeks depending on complexity.



Hjerno Tool Factory Managing Director Aage Agergaard. Photo courtesy of Hjerno Tool Factory.



The WXS-LN-EBD is a 2-flute, long-neck ball nose carbide end mill designed for high-precision milling of hardened steels up to 65 HRC. It is a highly efficient tool for milling applications involving hard metals, intricate details and smooth finishes.

The CBN-SXB is a small-diameter 2-flute super ball end mill designed for high-precision finishing. Its spiral gash end cut geometry provides a strong and sharp edge with cutting performance equivalent to carbide tools.

The team efforts have proven to be a tremendous success. From then on, Hjerno Tool Factory's machines stayed within the required tolerances, which enabled it to complete the fuel cell mold plates with superior quality. The customer, a Swedish manufacturer of fuel cells, was so pleased with the final result that they placed another long-term order with the Danish factory afterward.

A major take-away from this fuel cell project was that the milling machine is not always the one to blame.

"It is always incredibly easy to place the blame on the milling machine because that's where the symptoms of a disease appear," said Hjerno Tool Factory Tool Maker Kristian Jessen Hansen. "This project has really helped us to not only gain a far better understanding of how to optimize the use of our milling machines, but also to spot the built-in weaknesses of a CAD/CAD system," said Hansen.

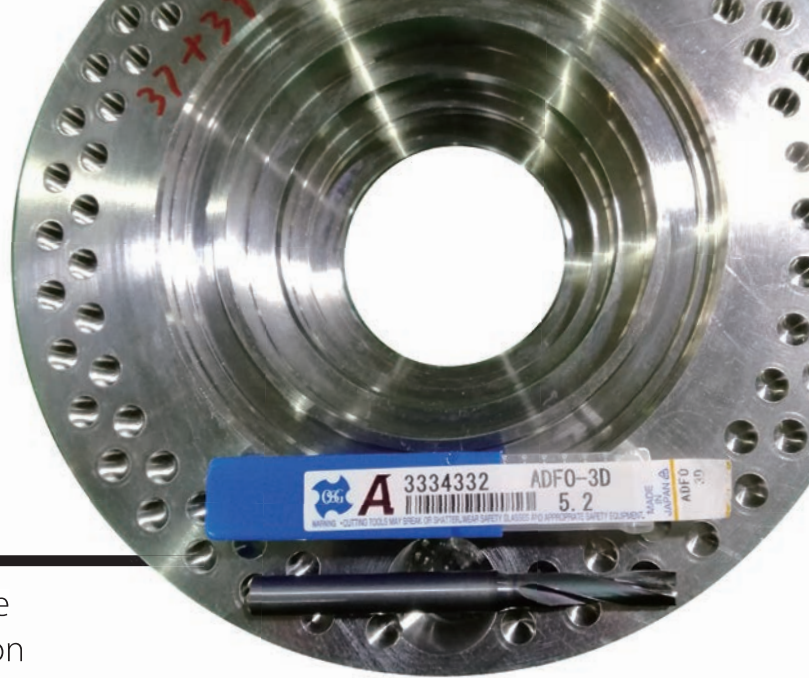
For OSG Scandinavia, the fuel cell project served to prove that a tight-knit relationship between supplier and customer is vital, when tolerances and competencies are put to the test.

"Although we have worked together with Hjerno Tool Factory for the past 15 years, it is on projects like this one that you really come to recognize the know-how and expertise of your partners," said Jørgensen.

Hjerno Tool Factory prides itself in precision, professionalism and uncompromising quality. It is a forward-thinking company that continuously invests in new production facilities and tooling solutions in order to provide the best results for its clients.

"The wonderful thing about projects that are technically challenging is that we learn to raise the bar of our company," said Hjerno Tool Factory Managing Director Aage Agergaard. "To succeed, you just need stamina and persistence."

Quality Meets Efficiency



ADFO flat drill streamlines flat-bottom hole processing in stainless steel part production

Vis Huang
OSG Shanghai

OSG's ADFO-3D completed the cutting trial with high scores in a scrap stainless steel workpiece at Sichuan Nick Seal Manufacturing in Sichuan province of southwestern China.

Drilling is one of the very first operations in hole-making. The quality of hole is especially critical when secondary operations, such as threading, is required. When working on expensive and time-consuming parts, choosing the most optimal drill for the application can make a significant impact to the bottom-line.

Tool selection is made based on a number of factors, including the configuration of the workpiece, material, cutting environment, the manufacturer's specific requirement, etc. For parts and small batches with multiple materials, manufacturers in general prefer more versatile drills to simplify tool management. For medium to large quantity processing, application-specific drills are preferred as they are able to achieve higher efficiency and tool life.

Special holes, such as flat-bottom holes, can be a challenge for manufacturers who seek both quality and efficiency. For instance, in the drilling of inclined surfaces, a guide hole is usually required in order to minimize the shifting of the hole position. In cross-hole drilling, the drilled hole is typically finished with a milling cutter to minimize burrs. Although quality requirements are met with these conventional methods, multiple steps and tools are required, which hinder processing efficiency.

Sichuan Nick Seal Manufacturing Co., Ltd. located in Chengdu City in Sichuan province of southwestern China, was in seek of processing improvement in the production of stainless steel parts involving the drilling of flat-bottom holes. Founded in 2008, Sichuan Nick Seal Manufacturing's key products and services include

general part manufacturing, mechanical repair, pumps, valves, compressors and machinery manufacturing. As a long-time partner of OSG, Sichuan Nick Seal Manufacturing reached out to OSG applications engineer Yukai Zhang to improve the efficiency and hole quality of their stainless steel application.

The part in question is an element used for mechanical seal, which Sichuan Nick Seal Manufacturing has been producing for about two years using a Haas vertical machining center. It requires the drilling of six 5.2 mm diameter flat-bottom holes at a depth of 4 mm in SUS304. Tolerance must be maintained within +/- 0.1 mm. The average batch comes in 20 to 30 pieces. Sichuan Nick Seal Manufacturing used to manually grind conventional twist drills into flat drills to lower tooling cost. However, the lifespan of the handmade drills was short, and the product quality was unstable. Poor surface finish and occurrence of burrs were especially problematic. Upon a detail evaluation of the application, Zhang recommended OSG's ADFO-3D carbide flat drill with oil hole for internal coolant to tackle the challenge.

The ADFO is the oil hole type offering from OSG's recently expanded ADF multi-purpose flat drill series for inclined surfaces and counterboring applications. The ADF series is currently available in three styles to meet market demand – the ADF standard style, the ADFLS long shank style, and the ADFO with oil holes for internal coolant. With the additional oil hole configuration, the ADFO is designed to excel in stainless steel applications.

Machining a flat hole traditionally required the use of an end mill and a drill. OSG's ADF carbide flat drill enables one-step drilling without requiring a starter hole to shorten machining time and simplify tool management. The ADF's unique balanced point form improves precision and minimizes the shifting of the hole position. Its sharp cutting edge geometry results in low cutting force to minimize burrs even in thin plates. With a wide chip room configuration, trouble-free chip evacuation can be achieved. Furthermore, with the addition of OSG's proprietary EgiAs coating, tool life can be prolonged with excellent heat and wear resistance. The ADF series is engineered for a wide variety of drilling applications including inclined surfaces, curved surfaces, counterboring, eccentric holes, thin plates, etc. It is suitable for materials such as carbon steel, alloy steel, hardened steel, cast iron and stainless steel.

In order to demonstrate the excellent chip separation capability and stability of the ADFO-3D carbide flat drill, Zhang set the program to machine 76 holes continuously on a scrap workpiece at a hole depth of 5 mm. The cutting condition was set at a cutting speed of v_c 39.2 m/min (2,400 rev/min) and a feed per revolution of 0.063 mm.

Before the trial, the technical staff from Sichuan Nick Seal Manufacturing were hesitant with the parameters recommended by Zhang. However, knowing the capability of the ADFO flat drill, Zhang persuaded the production team.

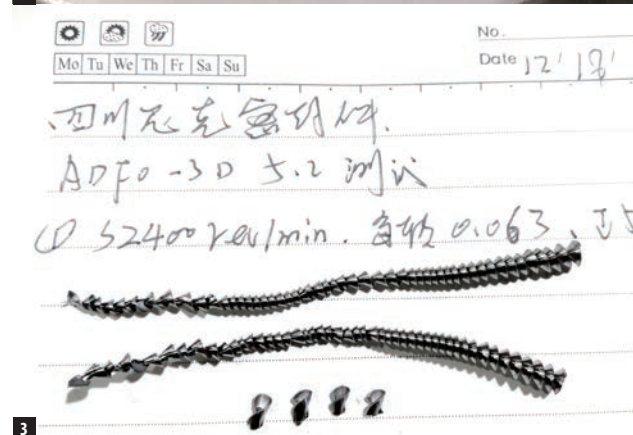
As predicted, the result of the trial drew everyone's attention with exceptional low cutting resistance and superior chip evacuation. After machining all 76 holes. The technicians from Sichuan Nick Seal Manufacturing could not be more satisfied with the efficiency, surface integrity of the hole, burrs of the hole, and the amount of wear on the tool.

Sichuan Nick Seal Manufacturing reports that the ADFO has accelerated operation efficiency by 2.5 times. The feed rate of the previous tool used was 60 mm/min. The ADFO was set at 150 mm/min. By employing OSG's ADFO, Sichuan Nick Seal Manufacturing is able to maintain its high-quality standard while streamlining production process with fewer tooling and procedures to provide greater values to its clients.

1. Sichuan Nick Seal Manufacturing's mechanical seal part requires the drilling of six 5.2 mm diameter flat-bottom holes at a depth of 4 mm in SUS304. Tolerance must be maintained within +/- 0.1 mm. The trial cut took place on a scrap workpiece as pictured.

2. The ADFO flat drill was set at a cutting speed of v_c 39.2 m/min (2,400 rev/min) and a feed per revolution of 0.063 mm.

3. The ADFO flat drill was able to demonstrate exceptional chip breakage capability during the cutting trial by producing short and compact chips versus the previous tool's elongated chips.



Rethinking the Process

Taking productivity to the next level with OSG Phoenix indexable drill series

Kelly Zago

OSG Canada

Success in hole-making is dependent on various factors, such as the machine tool, coolant, workholding, toolholder and the cutting tool itself. Furthermore, the ability to identify the best cutting parameters based on each and every unique work environment is vital to performance. Excessive small feed rates may increase wear on the cutting edge, which can reduce tool life. On the other hand, large feed rates mean more material is being removed, which can increase torque and thrust. Higher than necessary feed rates may lead to higher heat generation, which can result in premature tool failure. Heat generation control is a key factor in the drilling of any material because it can significantly influence tool life. Speeds and feeds must be adjusted accordingly based on the condition of the work material.

In large-size hole-making, where holes are generally larger than one inch in diameter, an indexable drill is generally a more economical choice due to its high speed steel body with carbide inserts design. At Metalium's Sainte-Julie plant in Canada, over 25,000 metric tons of drilled parts are shipped annually, with hole sizes ranging from 0.625 inch to 2.5 inch in diameter that are processed by indexable

drills. A single part can require up to three weeks to manufacture, according to Metalium Production Manager Nelson Albert. Metalium's Sainte-Julie office employs 124 staff and has approximately 60,000-square-feet of production floor space. In the summer of 2019, Metalium plans to expand its facility to 200,000-square-feet.

Metalium is a Canadian distributor of structural steel components, supplying large structural steel parts to rail, bridge and building developments. Founded in 1978 as Rimousky Metal, then renamed to Rapid Metal and to its current name in 2003, Metalium has over 200 employees in eastern Canada. Metalium operates eight regional offices and 10 warehouses across Québec and the Atlantic provinces. Some of the services offered by Metalium include plasma or fire cutting, saw cutting, complete aluminum and steel inventory, inventoried plates, shot-blasting machine, and more.

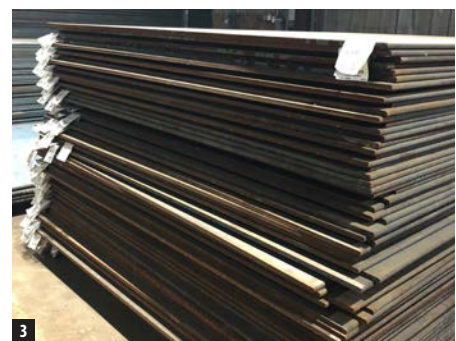
In early 2018, Metalium's regional plant in Sainte-Julie, Québec, Canada, was seeking a more cost-effective method to produce approximately one million holes annually, in various diameters and depths. The most

1. Metalium is a Canadian distributor of structural steel components, supplying large structural steel parts to rail, bridge and building developments.

2. At Metalium's Sainte-Julie plant in Canada, over 25,000 metric tons of drilled parts are shipped annually, with hole sizes ranging from 0.625 inch to 2.5 inch in diameter. A single part can require up to three weeks to manufacture.

3. Components processed by Metalium are commonly made of steel in grades 44W, 50W, 50AT and 50WT.

4. Metalium's regional offices in Sainte-Julie, Québec, Canada, were seeking a more cost-effective method to produce approximately one million holes annually, in various diameters and depths using indexable drills.



common materials of these components are steel in grades 44W, 50W, 50AT and 50WT. The challenge to their objective was limited horsepower equipment and unstable drilling conditions.

Before OSG, the drilling business at Metalium was split between two major cutting tool providers. Metalium was experiencing extended downtime for tool changeover with one of the competitors' modular drills, resulting in expensive delays to production. The insert screw of the second competitor's exchangeable-tip drill would often heat to the point of melting, resulting in severe damages to the expensive drill bodies.

Upon a detailed evaluation of the application, OSG Canada's Sales Engineer Patrick Lafontaine recommended the following; the PXD exchangeable head drill in 3xD and 5xD in diameter sizes of 0.625 inch to 1.25 inch, with the XP3425 grade exchangeable head for steel applications. Lafontaine also recommended the PD indexable drill 3xD and 4xD in sizes of 16 mm to 60 mm, with the XP9020 grade insert, ideal for steel and stainless steel applications.

The PXD exchangeable head drill is engineered for high efficiency large-diameter drilling. This series features OSG's proprietary mounting system to allow the exchangeable head to be securely mounted without screws. The PD indexable drill features a unique flute design with high precision finish and integrated chip breaker. This series is engineered for efficient and stable hole-making up to 5xD. The PD indexable drill series offers a broad insert

lineup to accommodate a wide range of work materials, such as steels, stainless steels, cast irons, aluminum alloys and non-ferrous metals. Both the PXD exchangeable head drill and PD indexable drill are a part of OSG's original indexable tool brand – OSG Phoenix, backed with years of experience and expertise cultivated during the development of round shank tools since 1938.

Lafontaine worked diligently with Metalium to identify the optimum cutting conditions of the OSG drills using the Sainte-Julie plant's unique equipment and setup on three different machining centers by Voortman, Sector and Machitech. He found that reducing the heat (rpm) and increasing the chip load benefited the tool life of the PXD exchangeable head drill; while the opposite was true on the larger diameter PD indexable drills, where he increased the rpm and reduced the chip load. This fine tuning gave Metalium the tool life and surface finish they required, but without the changeover downtime and damaged body issues of the competition. With the perfect combination of reliable tooling and proper cutting parameters, Metalium is able to take its productivity to the next level in performance and quality.


The PXD exchangeable head drill is engineered for high efficiency large-diameter drilling. This series features OSG's proprietary mounting system to allow the exchangeable head to be securely mounted without screws.



⁵ From left, OSG Canada Sales Engineer Patrick Lafontaine and Metalium Production Manager Nelson Albert.

AM-EBT & AM-CRE

Carbide End Mills for Additive Manufacturing Applications



The AM-EBT ball type carbide end mill and AM-CRE radius type carbide end mill are designed for the roughing of additive manufacturing applications and mold overlay surfaces. Unlike conventional processing, where an object is formed by removing excessive materials, additive manufacturing deposits materials layer upon layer to create an object, which is a process similar to 3D printing. By utilizing 3D data, short delivery time and low production cost are made possible.

The AM-EBT ball type carbide end mill features a robust 3-dimensional negative geometry optimized for large depth of cut. The AM-CRE radius type carbide end mill is available in

6-flute or 8-flute configuration. OSG's AM series end mills are recommended for materials in hardened steel, pre-hardened steel, stainless steel, heat-resistant alloy additive manufacturing applications and built-up welding parts.

The AM-EBT and AM-CRE are coated with OSG's original DUREY coating. The super heat resistant layer and ultra-fine periodic nano-layer structure of the DUREY coating provides superior toughness while maintaining high heat resistance and abrasion resistance. The DUREY coating also suppresses chipping in high hardness milling and enables long tool life even in the milling of built-up welding parts with large depth of cut.

OSG Phoenix PZAG

Counterbore Cutter



The OSG Phoenix PZAG is a versatile series of indexable end mills and facemills that are ideal for counterboring and plunge milling. The PZAG features a 180-degree flat bottom edge that is specially designed for counterboring. Furthermore, its unique chipbreaker geometry enables the creation of small and compact chips for optimal chip evacuation. Since counterboring requires uninterrupted cutting,

superior chip separation capability is crucial. The PZAG's perfect chip control ability makes it the ideal tooling choice for counterboring of large parts.

The PZAG straight shank counterbore cutter is available from diameter 14 mm up to 48 mm. The PZAG bore type counterbore cutter is available from diameter 54 mm up to 82 mm. The PZAG indexable series is suitable for mild steel, carbon steel, alloy steel, hardened steel, stainless steel, tool steel, cast iron and ductile cast iron.

AE-VML with Chipbreakers

New Long Flute Chipbreaker Style Added to Anti-Vibration Carbide End Mill AE-VMS Series

The AE-VML long flute chipbreaker end mill has been added to OSG's AE-VMS anti-vibration carbide end mill offering, a series designed to attain an all new level of milling efficiency coupled with superb finish quality suitable for a variety of milling applications.

Large chip accumulation can be problematic for long-hour and high chip removal side milling, trochoidal milling, and pocket milling with long flute length end mills. The AE-VML long flute chipbreaker end mill features a notched profile along the cutting edge that break down long chips into small and manageable pieces for optimal evacuation by air or by cutting oil.

By eliminating large chip accumulation, high-speed uninterrupted machining can be made possible. The AE-VML long flute chipbreaker end mill is especially effectively for materials with a tendency of producing long and stringy chips.

Available in square, radius, stub length, long neck, long flute and long flute with chipbreakers, the AE-VMS series is designed to accommodate a wide range of milling operations including slotting, side milling, helical milling, contour milling and ramping in stainless steel, cast iron, carbon steel, alloy steel and hardened steel.



CM-RMS & CM-CRE

High Efficiency Ceramic End Mills for Machining Heat Resistant Alloys

OSG's ceramic end mill series employs an optimum ceramic grade ideal for high-speed machining at high temperatures in difficult-to-machine materials such as Inconel 718, with roughing efficiency surpassing carbide end mills. Two types of ceramic end mills are included in the series – the CM-RMS peripheral cutting edge type and CM-CRE end cutting edge type. The CM-RMS features optimum flute geometry to enable smooth chip evacuation even in aggressive cutting conditions. Its negative cutter form increases cutting edge rigidity to enable long tool life. The CM-RMS is available in 4- or 6-cutting edge

specification to accommodate individual application needs.

The CM-CRE does not only excel in flat surface milling, but also in 3D applications, such as the machining of blades. Its large-diameter specification reduces the risk of breakage during machining and enables optimum cutting speed without being restricted by the capability of the machining center. The CM-CRE is regrindable and can be reincarnated by cutting away the used portion.



Taiho Tool Mfg. Co. Celebrates 50th Anniversary

Taiho Tool Mfg. Co., Ltd. (Taiho), OSG Corporation's subsidiary in Taiwan, celebrated its 50th anniversary with a crowd of over 800 guests at the Grand Hi-Lai Hotel's Arena Banquet Hall in Kaohsiung City on the evening of May 10, 2019. In addition to the 398 OSG employees, more than 400 clients and business partners from around the world gathered in Kaohsiung City in celebration of Taiho's special milestone.



1 Taiho Tool Mfg. Co., Ltd., OSG Corporation's subsidiary in Taiwan, celebrated its 50th anniversary with a crowd of over 800 guests at the Grand Hi-Lai Hotel's Arena Banquet Hall in Kaohsiung City on the evening of May 10, 2019.

Headquartered in Kaohsiung City, Taiwan, Taiho was formed with the merger of screw manufacturer Chun Yu Works & Co., Ltd. and OSG Corporation in 1969. Chun Yu Li, founder of Chun Yu Works & Co., was using OSG taps for its screw production at the time. Li was attracted by the high-quality threads created by OSG taps and decided to visit OSG Corporation in Japan. Upon meeting with OSG's founder Hideo Osawa, the two leaders shared mutual admiration and synergy, and launched a joint venture in Taiwan, which would ultimately become today's Taiho. Since then, Taiho has integrated the technologies of Japan and Taiwan to produce taps, gauges and rolling tools.

Taiho today employs a total of 538 staff and has three manufacturing plants in Taiwan and China.

Since 2011, Taiho has launched its very own drill reconditioning and coating business in addition to its existing core products and services. Taiho has also recently added carbide tooling as well as surface treatment to further expand its business domain. As Taiho celebrates 50 years of success, the company will strive to become the number one comprehensive cutting tool manufacturer in Taiwan and continue to contribute to the manufacturing sector worldwide.



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2. In celebration of Taiho's 50th anniversary, a special ice sculpture was made for the toast of the evening. Colored wine was poured into the ice sculpture to highlight the message of "OSG Taiho 50, Shaping a Better Tomorrow."

3. The Chio-Tian Folk Drums & Art Troupe, one of the largest and most professional performance art groups in Taiwan, performs at the opening ceremony of Taiho's 50th anniversary celebration at the Grand Hi-Lai Hotel's Arena Banquet Hall in Kaohsiung City on May 10, 2019.

4. Norio Ishikawa, President of OSG Corporation, gives a speech at Taiho's 50th anniversary celebration at the Grand Hi-Lai Hotel in Kaohsiung City, Taiwan on May 10, 2019.



3

OSG GmbH Recognized as Top 27 Supplier by Daimler

OSG received nomination for innovativeness at the 2018 Daimler Supplier Award



Ceremony of Daimler's 11th annual global supplier award in Stuttgart, Germany on February 20, 2019. Photo courtesy of Daimler AG.

Once a year, Daimler AG presents its prestigious Daimler Supplier Award in recognition of 10 suppliers with exceptional performance in the categories of quality, innovation, and partnership.

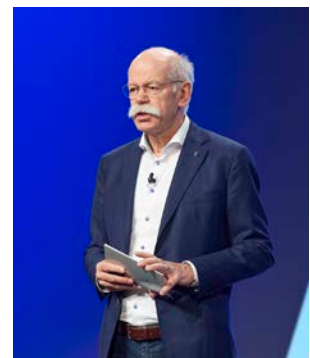
On February 20, 2019, under the theme of "Vision. Venture. Value.," members of the Daimler AG Board of Management and the heads of the Daimler procurement groups presented Daimler's 11th annual global supplier award to an audience of approximately 450 strategic partners and key suppliers from 30 countries in Stuttgart, Germany.

The awards are divided by three divisions - Mercedes-Benz Cars Procurement and Supplier Quality, International Procurement Services, and Global Procurement Trucks & Buses. Each division would present three awards for quality, partnership and innovation. In addition to the nine awards, there is also a special award, which adds up to a total of 10 awards. In total, 27 suppliers are nominated for the annual Daimler Supplier Award. OSG GmbH was one of the 27 suppliers to be nominated, receiving recognition for its

innovativeness in deep-hole drilling. Since 2013, OSG GmbH has been working closely with Daimler.

Although OSG was not selected as a winner, Daimler AG's Vice President of International Procurement Services Andreas Burkhardt commented that "OSG GmbH's innovative approach in deep-hole drilling for the drive shaft of the 9-speed gearbox is state-of-the-art. Until today, this product quality has not been achieved by any competitor."

OSG is the first Japanese cutting tool manufacturing company to be nominated and takes great pride in the recognition. OSG will continue its journey of innovation and will strive to ensure its clients' success by providing high-value added products.



Dieter Zetschke, Chairman of the Board of Management of Daimler AG and Head of Mercedes-Benz Cars speaks at the Daimler Supplier Award ceremony in Stuttgart, Germany on February 20, 2019. Photo courtesy of Daimler AG.

OSG Around the World

Employee Interview with

Salvador Rivera

Profile

Company Location: Mexico

Position: President

Joined OSG: 2007

Motto: "Make every moment count"



Tell us about your work and experience at OSG.

I studied mechanical engineering in college and joined OSG Royco in Mexico in September 2003 as production engineer. After working for six months, I was offered with a scholarship for a master's degree in mechanical engineering in Japan. After completing my degree, I began working as a drill design engineer and production engineer at OSG Corporation in Japan for nearly four years. In December 2010, I returned to OSG Royco in Mexico to serve as technical support manager. As time goes by, I was promoted to general manager and manufacturing director. In December 2017, I took on the role of president of OSG Royco, overseeing all facets of the company with experiences that I have accumulated over the years.

Tell us about your daily routine.

My day begins at 5 a.m. I would usually arrive to the office before 7 a.m. to sort through emails and prepare for my day ahead. On a daily basis, I would attend meetings with colleagues and visit the factory to make sure everything is in order. I typically have three to five

meetings per day with staff, partners and clients. The rest of my time is spent working on pending issues and projects.

What is most challenging about your work?

The most challenging aspect of my work is trying to achieve goals while keeping all parties involved motivated and focused towards the same objective.



1. Rivera inspects a tool with a colleague at OSG Royco's Guanajuato Tech Center in Mexico.

What is unique about the Mexican division at OSG?

From a Mexican company point of view, OSG Royco is very strict towards punctuality and the 5S methodology. We try to establish an environment where all employees can voice their opinions on different projects. Another unique fact about OSG Royco is that our employees love chili. Our canteens offer chili for every single meal. We also place great emphasis on team work and would host annual year-end parties where all employees would gather together at the factory. Some of the celebrations can get as large as 500 people.

How do you spend time on your day off?

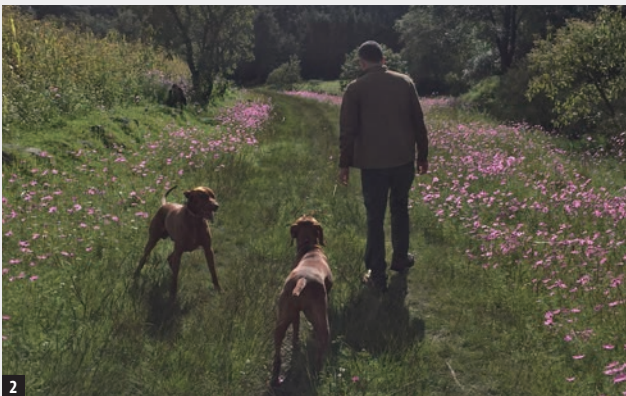
When I am not working, I like to take my dogs out for a long walk at the nearby mountains to get some fresh air and exercise. I also like to travel whenever I have the chance to. I love diving in particular, as it helps me relax and stay in sync with nature.

What is your favorite OSG tool?

My favorite OSG tool is the TRS 3-flute coolant-through carbide drill. Conventional 3-flute drills are most commonly used in the processing of materials with short cutting chips, such as cast iron and cast aluminum. Because 3-flute drills have a smaller flute size (chip room) than 2-flute drills, they are less frequently used in difficult-to-machine materials like steels. OSG's TRS is the world's first 3-flute drill for steels with patented flute shape that breaks steel chips into small, manageable pieces for easy evacuation, enabling ideal performance even in steels. This feature allows for increased feed rates up to 1.5 to 2 times faster than 2-flute drills. The TRS is a drill that can exceed customer expectation and challenge the traditional way of thinking.



The TRS "Mega Muscle" drill is the world's first 3-flute drill for steels. Patented geometry permits stable chip ejection, even with less chip pocket space inherent in 3-flute drills.



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2. During time off, Rivera enjoys taking his two dogs on a jog in the nearby mountains in Toluca, Mexico.

3. Rivera has two Vizslas. From left to right, 3-year-old Kumo and 6-year-old Hana.

4. Rivera takes a dive in Cozumel, Mexico. In addition to spending time with family, Rivera also enjoys traveling, diving and being in sync with nature.



shaping your dreams

The new standard for milling

AE-VMS

Anti-Vibration Carbide End Mill Series



scan for details

