# BREAK THROUGH

Volume 15
Issue 51·2023

*Let's Digitalize Your Sustainable Future*

# Into DX & GX with AXILE 5-axis machining


## The Transformative Power of DX and GX Technologies

When the topic of sustainability arises, many companies promptly consider how they should act to ensure their operations minimize the impact on the environment and how each employee should take up the responsibility to reduce waste. One of objectives is to adapt to changes in the business environment through this innovative concept.

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Publisher Information | Buffalo Machinery Co., Ltd.
56, Lane 318, Desheng Road, Daya District, Taichung City 428417, Taiwan
+886 4 2560 3759 +886 4 2560 3769
info@mail.buffalo.com.tw
Editorial board | Pual Chang, Iris Chen, Karia Chen, Rex Chang


AXILE
www.axilemachine.com

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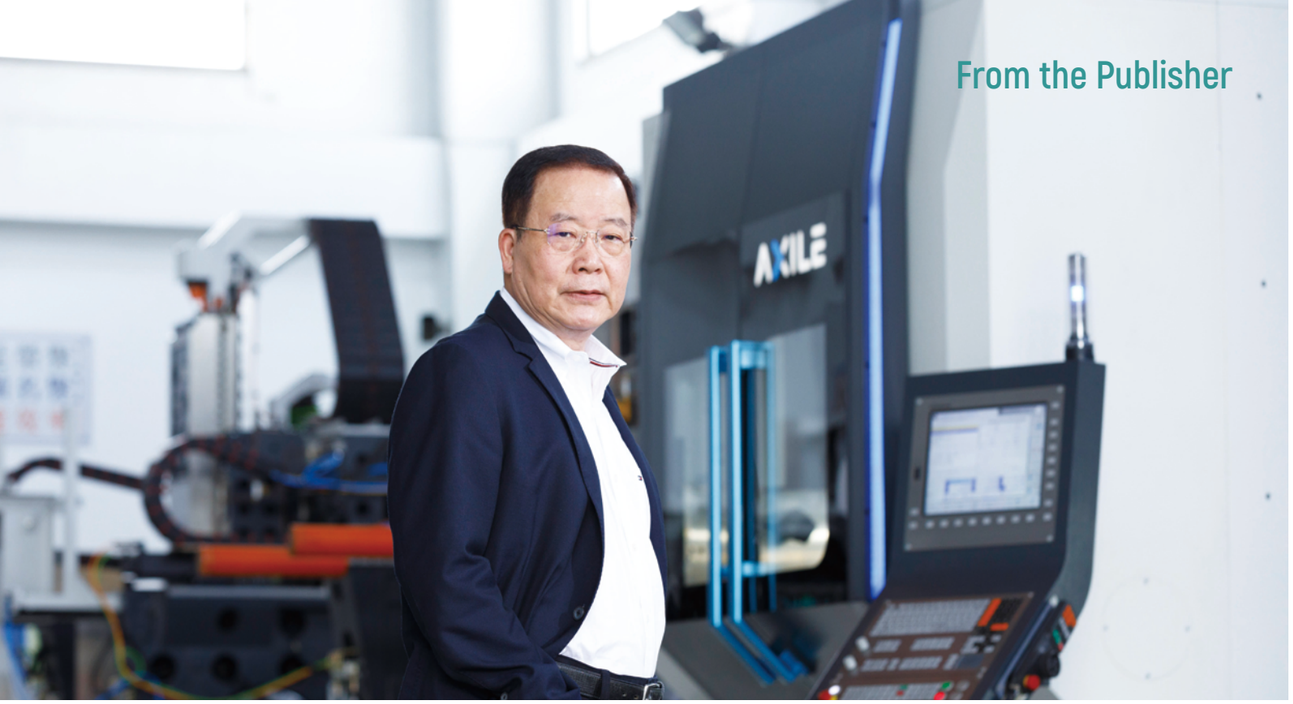





As 2023 draws to a close, certain industries are actively dedicated to developing eco-friendly products and striving to strike a balance between emissions and a sustainable future. However, others remain uncertain, covered in confusion about potential solutions. Buffalo Machinery, as a machine tool builder has swiftly devised its strategic plan. This plan focuses on the development of digital, intelligent, and automated products in alignment with global carbon-neutral policies.

Buffalo has initiated applied eco-design in its latest development projects, seamlessly integrating intelligent digital management. This strategic approach empowers us to achieve a more sustainable and efficient operational framework, enhancing our commitment to environmentally practices.

The EU Carbon Border Adjustment Mechanism (CBAM) plays a pivotal role in the EU's journey towards achieving its 2050 "carbon neutrality" goal. Initially proposed in September 2021, it has taken effect on May 17, 2023, with a transition period lasting from January 1 to December 31, 2025, before full implementation commences in January 2026. CBAM ensures that imported products into the EU also bear the cost of carbon emissions, thereby mitigating carbon emission spillover and leakage while safeguarding the competitiveness of EU-based enterprises.

The European market constitutes over 60% of Buffalo's sales, making it crucial for us to navigate the CBAM regulations to successfully market our products within the EU. Buffalo has implemented carbon inventory and product carbon footprint mechanisms. Additionally, Buffalo has developed an energy management system based on ISO 14955 to monitor real-time energy consumption and provide feedback on carbon emissions and associated fees. These measures can assist our clients in effectively managing energy consumption. Furthermore, Buffalo is committed to helping our clients engage with the ETS market, further strengthening our dedication to sustainable practices.

In response to market demands, Buffalo has not only expanded its capacity for eco-friendly products but also, in 2023 Q3, established a dedicated Digital Management Service department. This crucial department accelerates the development of digital intelligent software, seamlessly integrating advanced digital technology with professional software development and service models. These efforts enable us to provide intelligent products and services that perfectly align with market and customer needs. In this endeavor, Buffalo Machinery rapidly advancing towards digital products and embracing sustainable practices.

Dr. Paul Chang
President
Buffalo Machinery Co., Ltd.



# EVERYDAY APPLICATIONS OF DX AND GX TECHNOLOGIES

In recent years, DX (Digital Transformation) & GX (Green Transformation) have become a trend in manufacturing industry aiming for a more sustainable future. With the rapid development of the global environmental awareness, there are increasing demands for the development and production of green machines, which play an important role in the era of digitalization.

Achieving net-zero carbon emissions has become a focus for all industries while digital transformation is also of dominant importance.

Hence, companies have embraced carbon reduction strategies to mitigate their environmental footprint, while simultaneous leveraging digitalization to enhance efficiency and optimize processes, all in pursuit of sustainable management.

The key elements of DX (Digital Transformation) & GX (Green Transformation) include but are not limited to


## Energy saving is the key

This year was a year in which significant progress has been made in the conversion of digital transformation and environmental, due to the acceleration of the global move towards decarbonization and soaring energy prices.

As a result, increasing energy efficiency in industry is a key factor for the achievement of climate protection goals. In addition, low energy demand is becoming increasingly important for the economy in view of rising energy prices.

AXILE MACHINE is actively working to minimize greenhouse gas emissions associated with factory operations. Alongside our commitment to achieving carbon neutrality, we are expanding activities such as energy efficiency improvements and the use of renewable energy sources.

Thanks to our "ART™ Monitoring system", AXILE is redefining energy efficiency in manufacturing and supporting you on your way to energy efficient production. In order to fulfill these needs, AXILE have continuously developed our business model with new products and technologies;Several functions are graphically visualized on the screen of the ART system and can be operated easily and interactively. It shortens the process that was conventionally performed at the site, such as

- estimation and program generation
- increases the machine operation rate
- reduces losses and errors due to manual intervention
- enables long-term automatic operation by combining with an automation system

Now, we have realized the digital transformation (DX) at the manufacturing site. Whilst also addressing the green transformation (GX) on the environment side.

## Bask in DIGITALIZATION achievement

AXILE is devoted to the products innovation and upgrade to ensure that the products are always on the trend and meet the market demands.

In 2023, the successful conclusion of AXILE's exclusive events, such as:


**[1]**
Let's Revolutionize Your Business- Discover the Benefits of Automation and Digitalization
**- held in June, Germany**


**[2]**
Open House at ICHI SEIKI
**- held in July, Singapore**

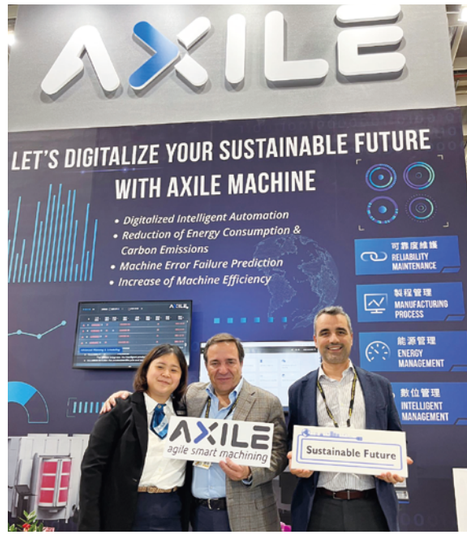
**[3]**
EMO HANNOVER 2023 Exhibition & Exclusive Dealer's Seminar on Innovation and Collaboration
**- held in September, Germany**

These events marked a significant milestone in strengthening the relationship between AXILE and our new valuable distributors. It's brought together new dealers who were eager to explore the immense benefits of automation and digitalization in the machine tool industry. It was an incredible opportunity to share knowledge, inspire, and motivate sales teams to embrace the power of digitalization.

Among these events, AXILE delved into the outline the plan of digital transformation (DX), digital management, and digitalized machines. Showcased how embracing automation and digitalization can unlock the doors to Industry 4.0 and contribute actively to the sustainable future outlined in the EU Green Deal and Asia. Besides, we redefined our 5 axis machine with enhanced energy-saving performance. These products will be called "i-series". "i" stands for Industry 4.0 and Intelligent management. We offer the "i" machine versions equipped with ART digital technology to embrace smart manufacturing and digital intelligent management in order to remain agile in a fast changing environment. These products reduce power consumption and simultaneously increase machining performance.

As for the EMO Exhibition and Open House event in Singapore, we have witnessed enthusiastic participation from diverse industrial sectors, including Aerospace, Die & Mold, General Job Shop, Medical, as well as representatives from the educational and government sectors. It means a lot to AXILE MACHINE and our distributors, it's a great chance to view each industry's unique pain points, by delivering Agile Smart Machining through our 5 axis machines, automation solutions, and advanced smart manufacturing technologies.



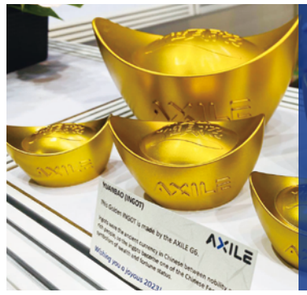



## Aiming for environmentally friendly manufacturing

### Think out of the box

AXILE MACHINE has implemented in advance and truly believed that the operational sustainability of a company is where the future lies. And this can only be achieved through the support of digital intelligence tools and systems to help make information transparent, and decentralize decisions, that people are incapable of executing with high efficiency and effectiveness in the long term.

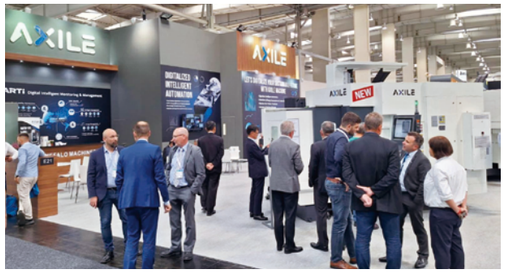

Little gift for TIMTOS 2023: YUANBAO (INGOT)




Ingots were the ancient currency in Chinese between nobility and rich people, so the ingots become one of the Chinese Feng-Shui symbolism of wealth and fortune status.

### Development of Eco-friendly Products and Technologies

AXILE is placing a strong emphasis on the development of green technologies and eco-friendly products. We aim to lead the transition to a low-carbon society by improving the energy efficiency of our products and enhancing resource efficiency. To contribute to the decarbonization of society as a machine tool manufacturer, AXILE believe it is important to reduce power consumption when using machines in our customers' factories.

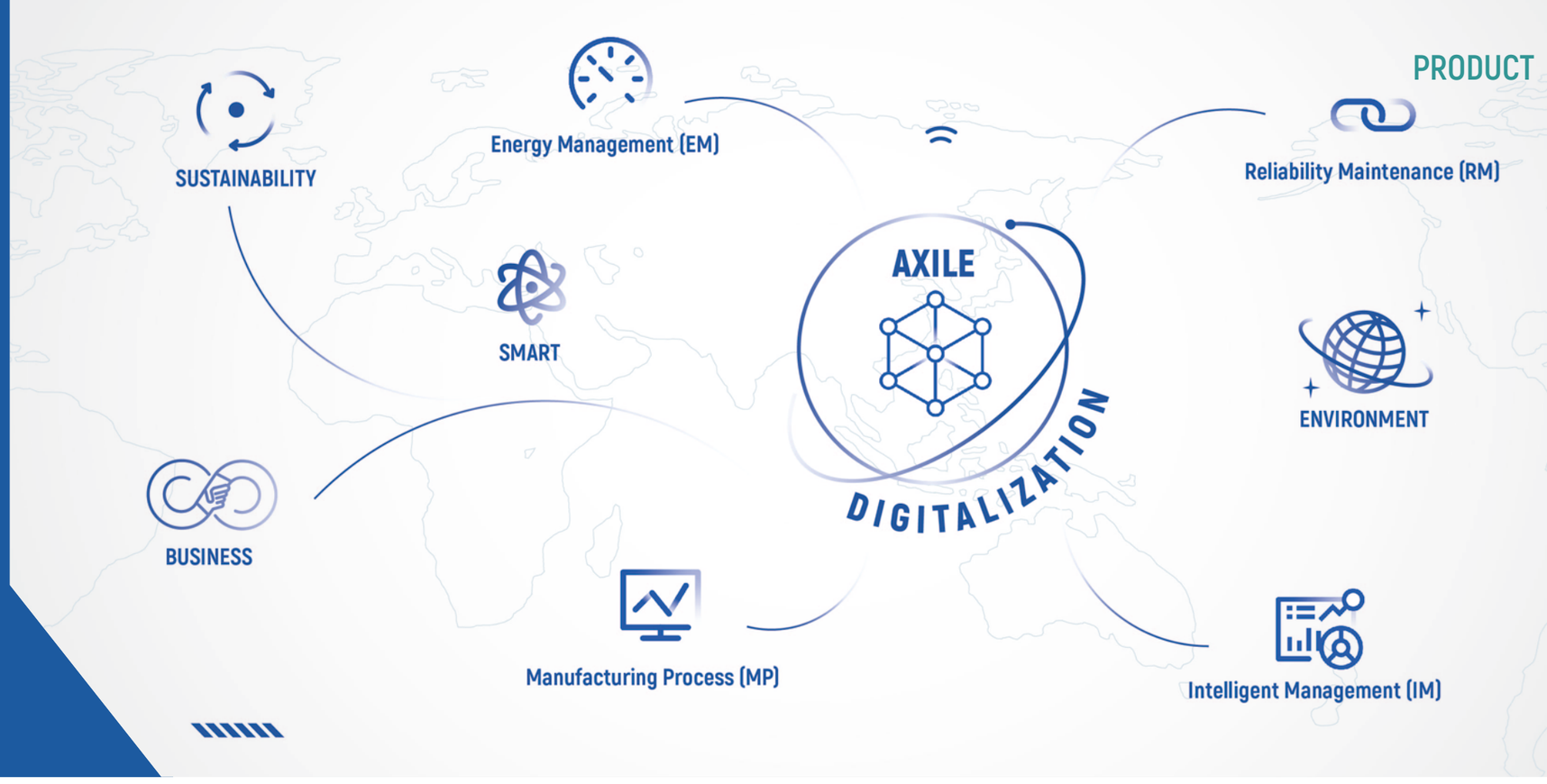



At AXILE, we're committed to addressing climate change and focusing on the development of eco-friendly products and technologies. We prioritize the improvement of environmentally friendly production processes and energy-saving in our 5 axis machines.

We'll continue crafting the best machines & technology to make your dreams a reality, effortlessly and swiftly. Together, we've embarked on an incredible journey in 2023, exploring wonderful moments that light up our path. We will focus on product development looking ahead to the next generation and contribute to the development of environment.

# Advancements in Smart Manufacturing:

## The Role of the ART™ System in Industry 4.0




From the perspective of Industry 4.0, the future of manufacturing lies in intelligent automation. To excel in the competition when it comes to upgrading production, actively embracing and consistently implementing smart manufacturing is the best way to maintain a competitive edge.

To achieve agile smart machining and crucial competitive advantages, AXILE has developed the ART™ system, capable of achieving round-the-clock automation and empowering operators to manage and strategize through data analytics.

The ART™ system monitors all wearing components, energy consumption, as well as fluids like lubricants and coolants, providing real-time status updates on the machine and its components and predicting potential issues in the future. AXILE's ART™ system empowers manufacturers to make informed decisions, optimize operations, and significantly enhance production efficiency. This is precisely what Industry 4.0 emphasizes to meet the demands of sustainable operations.

ART™
*Intelligent Monitoring Technology*

It's clear that digitalization offers a wide range of advantages and benefits, from enhancing competitiveness to meeting environmental sustainability goals. The integration of digital technologies is indeed a strategic necessity to thrive in today's rapidly evolving industrial landscape. AXILE embraces these changes can position themselves for long-term success and growth while providing more efficient and high-quality products to meet customer expectations.


## Trends in Smart Manufacturing and Energy-Efficiency Carbon Reduction

The European Union (EU) is set to officially conducted its landmark Carbon Border Adjustment Mechanism (CBAM) in 2026. CBAM is a significant initiative by the EU aimed at ensuring imported products meet the EU's environmental standards while driving European businesses towards more eco-friendly production practices. This move will have profound implications not only for Europe but also for the global trends in smart manufacturing and energy-efficient carbon reduction.

The EU's CBAM plan involves carbon pricing, which means importers will have to pay for carbon allowances to offset the emissions generated during the production of their products. This will encourage manufacturers to focus on energy efficiency and promote the adoption of smart manufacturing.

Smart manufacturing is a concept built on data and automation, with its core goal being to achieve higher production efficiency while reducing resource waste and carbon emissions. This trend will rapidly rise against the backdrop of CBAM because businesses will be under economic pressure to adopt greener production methods. The concept of smart manufacturing encompasses automated robotics, Internet of Things (IoT) devices, and big data analytics, all of which will help businesses gain a better understanding of their production processes and take measures to reduce their carbon footprint.

Furthermore, CBAM will incentivize businesses to invest in renewable energy and energy-efficient technologies. Under the budget of CBAM, European businesses will be more motivated to seek out and adopt environmentally friendly technologies, which not only contribute to achieving climate goals but also enhance production efficiency and competitiveness. This includes innovative energy-saving technologies and more efficient production methods.

CBAM will also contribute to establishing greener supply chains. Companies will begin to scrutinize their supply chains to ensure they also meet environmental standards. This could push suppliers and partners to adopt more sustainable practices, resulting in a more environmentally friendly supply chain.

In summary, 2026 will be a year of rapid development in the trends of smart manufacturing and energy-efficient carbon reduction. The CBAM plan will be a key driver in this development, compelling businesses to meet higher environmental standards while increasing production efficiency and competitiveness. For the global manufacturing industry, this is an opportunity that cannot be ignored, as it can lead us towards a more sustainable future.

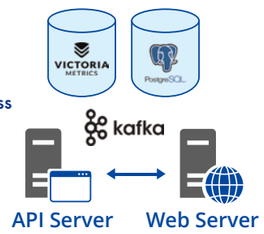
## Establishment of the Digital Management Department

AXILE is committed to digital management and green sustainability initiatives. The company has integrated cutting-edge digital technologies to automate and digitize its internal processes.

In 2023, AXILE expanded its technical division and established a Digital Management Department, which is dedicated to the development of software for Industry 4.0 and smart manufacturing.

## Software Architecture Adjustment

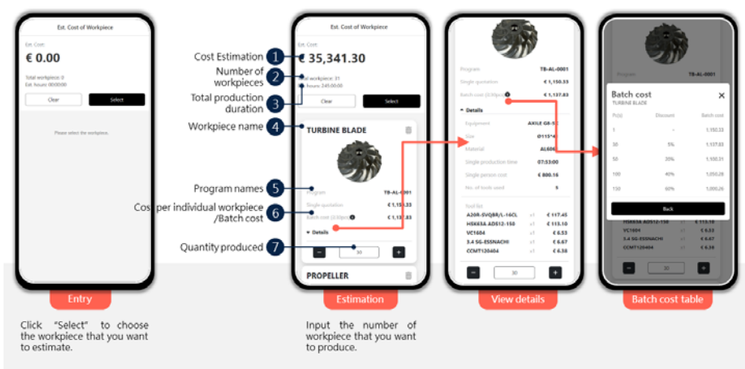
The software architecture has been adjusted, which is divided into a frontend-backend separation for software development. The frontend will use JavaScript and the React framework, while the backend will use Python. The database being used is PostgreSQL. This design is currently aimed at facilitating future integration with mobile apps, which can be developed with compatibility using the React framework. The frontend-backend design also takes into consideration the scalability for future compliance with OPCUA and potential integration with other brand machines and software systems.

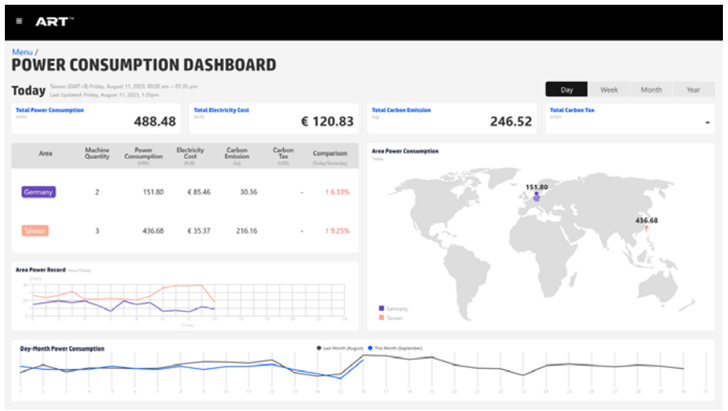
| Architecture | Service | Data Storage |
|---|---|---|
| Current   | • **Web + API Server:** PHP + JS | • **Relation-DB:** MySQL<br>• **No-SQL DB:** mongoDB |
| In Progress   | • **Web Server:** React<br>• **API Server:** Python FastAPI | • **Relation-DB:** PostgreSQL<br>• **No-SQL DB:** mongoDB<br>• **Time Series DB:** VictoriaMetrics<br>•**Message Queue:** Kafka |

## Optimizing ART Functions with User-Friendly Interfaces

### 1. Machining Cost Calculator

In consideration of the customer's need for business cost quotations, ART has designed a Machining Cost Calculator to address its cost requirements. Customers can input relevant cost data parameters for workpieces they have designed previously into this tool. By using this functionality, ART allows customers to calculate the cost of similar workpieces machining approximately, serving as a reference for quotations when new workpieces are introduced.



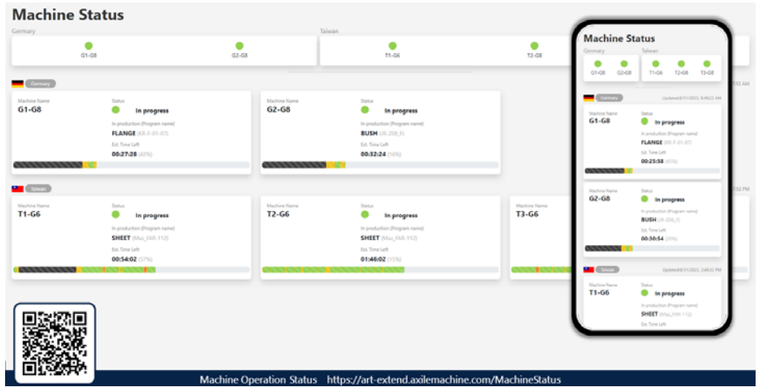




### 2. Power Consumption Dashboard

In response to the European Union's plan to implement the CBAM to reduce carbon emissions, we have developed a new feature within the Energy Map tool to address carbon emissions issues. This feature will provide a comprehensive statistical analysis of electricity consumption, carbon emissions, and associated costs. It enables customers to quickly calculate and improve energy efficiency in their machinery, facilities, and factories worldwide. This enhancement empowers customers to enhance the competitiveness of their products in green design and manufacturing.

### 3. Machine Status

ART™'s basic functions include monitoring the machine's operations, standby mode, and identifying any abnormalities. ART aims to optimize these functions, allowing customers to monitor machine status not only through the machine's HMI but also via various interfaces like computers, tablets, and mobile devices. In the future, ART will introduce an additional feature related to machine utilization rates. This feature will enable customers to use ART™ to track the efficiency time of their production workpieces, estimated completion times, as well as production efficiency by shift. This enhancement aims to provide more immediate and digitized control over costs and expenses.




## Enhanced Manufacturing Efficiency

AXILE's manufacturing services are strategically tailored to focus on the aerospace, die & mold, semiconductor, and medical industries, where it can offer the highest value-added benefits. By harnessing advanced monitoring, analysis, and talent cultivation, AXILE aims to provide digital management services that significantly enhance value for customers. As a total solution provider, AXILE's goal is to steer the domestic industry towards the realm of digital intelligent manufacturing and services.

In conclusion, AXILE digital intelligent automation solutions are designed to revolutionize manufacturing operations, offering a strategic edge to customers. AXILE is dedicated to enabling more efficient production, increasing profitability, and fostering the growth of the industry as a whole through our commitment to innovation and excellence.

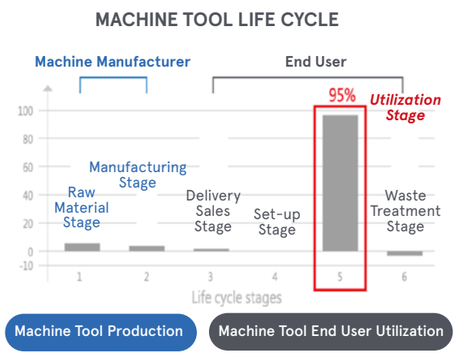
# How can AXILE support manufacturers in achieving sustainable production levels

## AXILE focuses in designing and manufacturing machines in compliance with new standards

The saving potentials from the adoption of appropriate Eco-design technologies have been shown to be significant. The analysis of the Energy Efficiency of the machine tool itself during the development/design phase is mandatory. Machine tools are designed to work with a large variety of materials – in particular metal. They are extremely complex products and contain thousands of parts – including bearings and pins, sheet metal enclosures, belts, etc. From raw materials to recycling – sustainability is firmly integrated into all structures and processes of AXILE machines.

ISO 14955 addresses the energy efficiency of machine tools during the use stage, which corresponds to the working life of the machine tool. The standard focuses on the relevant energy users to achieve a higher environmental performance without losing in technical possibilities. AXILE fully complies to ISO14955 standards, ensuring that its products and services meet energy efficiency and environmental standards.

The New Machinery Regulation (Regulation (EU) 2023/1230) was published on 29th June 2023. It is expected to enhance trust in digital technologies including AI, human/robot collaboration, connected and self-learning machinery and hence increase their uptake. AXILE relies on Umati and OPC UA as the global interoperability standard and participate to the standardization work which takes place in several joint working groups with various sectors of machine building industries.

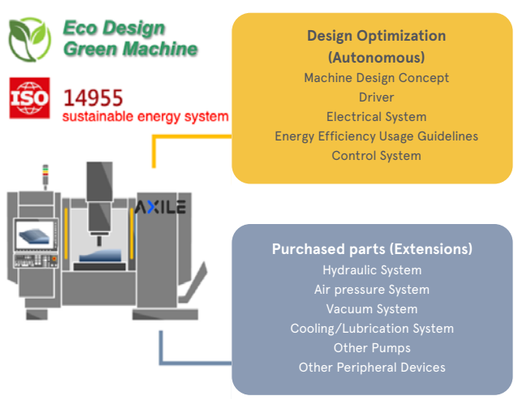



## AXILE machines have the capacity to monitor accurately and optimize the energy efficiency during the machining phase

Machine tools consume an enormous amount of energy during machining. Reduction of energy consumption during the machining phase is extremely important to improve the environmental performance. AXILE key goal is to achieve high performance cutting by increasing the material removal rate and product quality combined with a decrease of the cost of resources and energy.

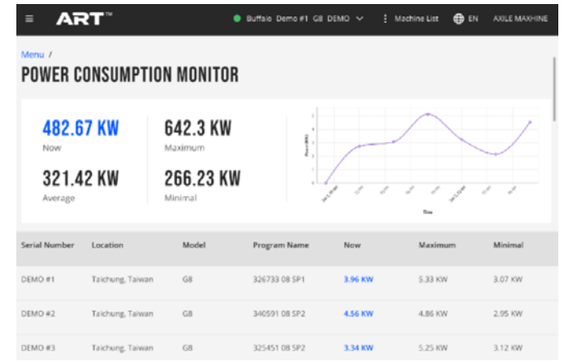
Experimental investigations on the energy and resources balance of milling processes showed that an increase in cutting speeds and feed rates yield significant savings in the total cost of machining including the energy costs. High speed and agility are the core concept of AXILE machine configuration being the unique manufacturer in the market with standard spindles at 20,000rpm rating.

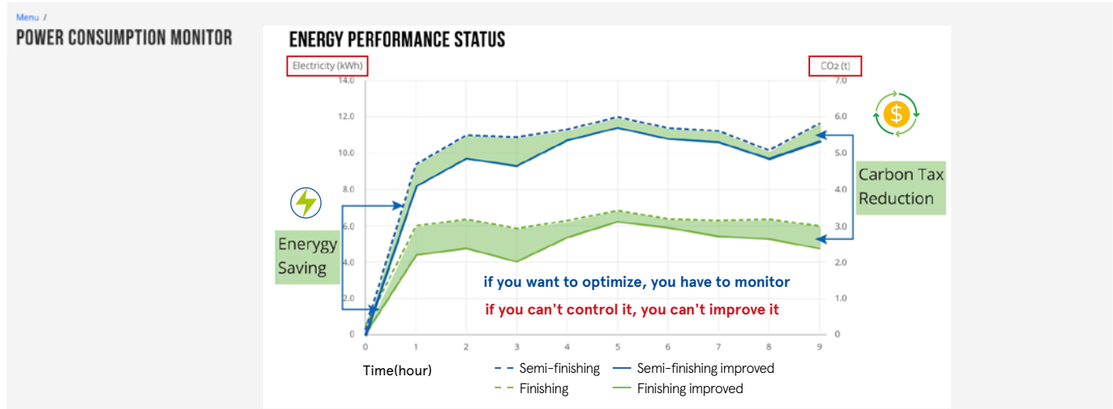
However, like for many other factors, performance can only be improved if it is monitored properly and reported in a clear and user-friendly format. The AXILE ART™ system is an online tool designed for managers to remotely monitor machine status, displaying a 24-hour record of machine operations for a period. It delivers round-the-clock monitoring of each machine's energy consumption and usage conditions, providing the data required to optimize energy efficiency and experiment new strategies to improve the results.




The above app monitors and reports the energy usage and efficiency of each individual machine, delivering information to users in an intuitive format. Based on strategies derived from this data, machinists can make daily adjustments to machine operations to achieve maximum energy efficiency and lower costs while reducing carbon emission for each workpiece being produced on AXILE machine tools.

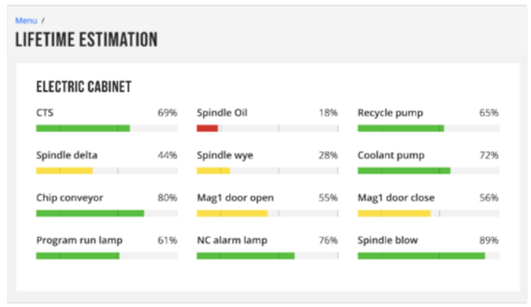
Digital intelligent machines equipped with ART™ can perform statistics, analysis to improve processing conditions for operators and managers to understand the machine performance and take the immediate actions to optimize the machine utilization and its power efficiency.




## AXILE roadmap to sustainability in the high-end machine tool world

Over the last couple of years AXILE pushed to emphasis on the benefits of digital management based on our i-series machine line. This line offers the opportunity to achieve sustainable manufacturing via accurate data management, enabling calculate each individual machine components lifetime. The concept of circular economy describes a model in which products and their components are used for as long as possible and thus kept in circulation. When the component has reached the end of its useful life, it can be maintained and repaired, and be reused after its initial phase of use, which is only possible via an accurate monitoring of the component's life cycle.




With the analytic data, components' failure can be predicted two weeks prior. Therefore, managers can arrange maintenance services and restocking of components to ensure operations are always on track. Besides, the analyzers can help reduce the heat raise issues through real-time monitoring of the wearing component, pneumatic, and hydraulic conditions.

By improving the efficiency of the machine tools within your outfit, energy can often be saved, which is highly important in terms of sustainability. Accurate data collection is also likely to improve the speed of other aspects of the manufacturing process, therefore saving time and energy in the long run, creating a more sustainable model and improving workflow.

Employee talent development and well-being is also part of AXILE priorities. By providing a safe and inclusive working environment we believe this will be fostering our skilled workforce.

AXILE's commitment to innovation and technology is a cornerstone of its sustainable performance. The company will keep promoting sustainable manufacturing practices, reducing the environmental impact of each customers production processes.

# Diagnosis of Unbalanced Tool Operation for Force-Sensor-Integrated Motorized Spindles

Yi-Lin He
Buffalo Machinery CO., LTD., Taichung City, Taiwan
r47@mail.buffalo.com.tw

Hsun-Fu Chiang
Buffalo Machinery CO., LTD., Taichung City, Taiwan
r43@mail.buffalo.com.tw

Paul Chang
Buffalo Machinery CO., LTD., Taichung City, Taiwan
paulchang@mail.buffalo.com.tw

*Abstract* — The motorized spindles enhance the productivity in medical, die/ mode, and the aerospace industry. High reliability ensure low carbon footprint. Many technologies and sensors are developed to monitor the improper operation of the motorized spindles. In this paper, One Class SVM is investigated to monitor and detects the unbalanced tool operation. And new feature is found to increase the model accuracy.

*Keywords—piezo-electric force sensor, high-speed motorized spindle, diagnosis, One Class SVM*

## I. Introduction

In 2013, the industry 4.0 are introduced in Germany to enhance the productivity Suggestion: "Industry 4.0," is a strategic initiative launched by the German government in 2013. The initiative is part of the country's high-tech strategy, which aims to revolutionize the manufacturing industry by leveraging advanced technologies and enhance the productivity [1]. One of the production enhancements is to reduce machine downtime, therefore the machine diagnosis and fault detection play an important role in industry 4.0 production line.

The high-speed motorized spindle is applied to increase the productivity with a speed range from 18,000 rpm to 200,000 rpm. The ultra-precision angle contact bearing is one of the key components in high-speed motorized spindle. However, the bearing service time is limited by the preload, lubrication condition, undesired vibration load [2], which induces an additional and undesired mechanical force on bearings. For example, if the tool insert is broken during machining will cause a large centrifugal force to decrease the bearing lifetime. As a result, the detection is needed to diagnosis the unbalanced tool operation.

The force-sensor-integrated spindle is presented to measure cutting force and a dynamically compensated sensor system with Kalman filter [3],[4]. Because sensor output contains the spindle structure vibration characteristic, the [3],[4] design Kalman filter to eliminate the influence of structural modes on the force sensor.

The [13] developed the force-sensor-integrated motorized spindle to diagnosis the unbalanced tool. In this paper, longer time base sensor data is collected and tested to improve the system performance in spindle application

## II. System Block Diagram

### *A. The Motorized Spindle with Force-Sensor Ring*

The study spindle unit is shown in Fig. 1.(a). Dependent on the requirement of bearing service time and stiffness, the tandem bearing arrangement is selected to keep the cost effective and better cutting performance. The force sensor is located between the front bearing #1 and #2 as a bearing spacer. There are four sensors placed at every 90 degrees, monitoring any abnormal bearing motion. The FS ring is composed of four piezo-electric elements and four dummies. The sensor sensitivity is -4 pC/N

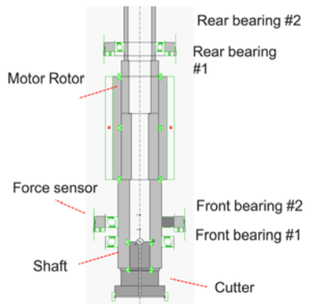



Fig. 1 The illustration of a high-speed motorized spindle and the force sensor location. The whole geometric of motorized spindle with two front and two rear bearings, motor is assembled in the middle of shaft. The figures source is supported from the Buffalo Machinery co. ltd.

### *B. Piezo Electrical Sensor Characteristic and Signal Conditioner Charge Amplifier*

The spindle manufacturer suggest that the spindle bearing operation temperature is under 50~60°C. Basically, it is dependent on the spindle design, the bearing cage material, bearing cooling, and the bearing lubrication condition. The bearing operation temperature is, limited by the phenolic-made retainers, around 130°C. The maximum operating temperature of 120°C could reasonably cover the operating temperature. The four sensors sensitivity for position #1~#4 are 4.026 pC/N, 3.998 pC/N, 3.960 pC/N, and 4.074 pC/N [13]. The signal conditioner is shown in Fig. 2. The detail circuit parameters design can be found in [13]. The low-3dB frequency is decide by $f_{LOW,3dB} = \frac{1}{2\pi R_1 C_1}$ [5]. The higher-3dB frequency is decided by capacitance C3 and resistance R4, i.e. $f_{HIGH,3dB} = \frac{1}{2\pi R_4 C_3}$ .
In motorized spindle industry application, the circuit parameter design consideration, 3-dB frequency selection and frequency appearing in failure bearings, are illustrated in [13].

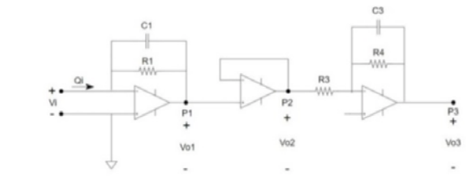



Fig. 2 The two-stage signal conditioner for piezo-electric sensor. The first stage and 2nd stage are a charge amplifier and voltage follower respectively, and the final stage is an invert amplifier.

## III. Measurement Campain Feature Extraction, and Preparation Samples

### *A. The Consideration of Vibration Magnitude and Definition the Positive/negative Samples*

To measure the vibration level, the vibration meter, G-TECH type vPOD, is selected in this experiment and one accelerometer is mounted on the spindle surface. There ISO 17243-1 suggests the vibration magnitude of 0.7mm/s is good vibration level for a ball bearing spindle and power is higher than 5kW[9]. The 0.4mm/s vibration magnitude is selected to distinguish the positive samples and negative samples.

### *B. Experiment setup for Unbalanced Tool*

#### *(a) Measure Campaign and Result.*

An eight-inserts HSK-A63 cutter is selected as the study tool. As shown in Fig. 3, the positive sample data is from the one normal cutter, negative sample data is prepared from the two abnormal cutter. In this experiment, to prevent irreversible damage occurs to the bearings, only a vibration-acceptable 4,000rpm is tested The fundamental frequency and second harmonics frequency of 4,000rpm shaft speed, is calculated as 66.6Hz and 133.3Hz.

The vibration measurement result of normal cutter is the lowest vibration values, 0.07mm/s. The measurement result for 7 chip-left and 1 chip-left are 0.41mm/s and 0.45mm/s[13]. In [13], in all the experimental, the removed chip is fixed at same position on tool. In this paper, to extend the sample space, the removed chip is chosen by four degrees, on the force sensor 0°, 90°, 180°, 270°.

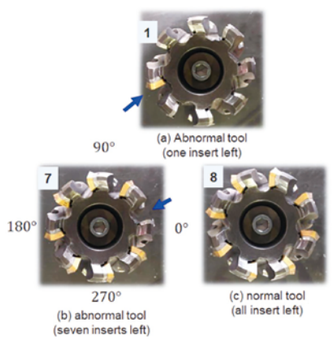



Fig. 3. the cutter for three different experiment setups

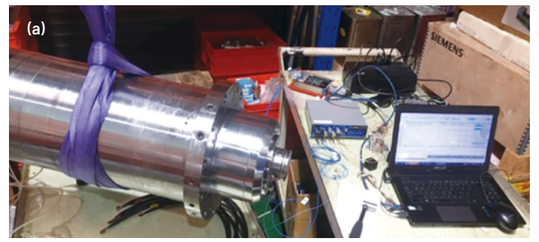
#### *(b) Frequency response of force-sensor-integrated spindle*

The mechatronics device is composed of an electronics circuit, mechanical structure and transducer. In this paper, the piezoelectric harmer is applied and measured the system input force. The system output is the force sensor signal in voltage, as it is amplified from charge to voltage. Fig. 4 shows the setup hardware. The frequency response analysis software and DAQ are developed by m+p international.

The measurement result shows in Fig. 5, the four frequency response curves are so close; showing the complete sensor output is nearly identical. As shown in Fig. 5, The X3 point indicated the 1st response frequency is 298Hz. It's flat frequency range 0~150Hz, except for the 60Hz electric interference is involved. Hence, the improper operation frequency may make the entire signal, i.e 1st revolution frequency of the spindle and its harmonics will be interfered by the electric interference. The testing frequency needs away from 60Hz. It is reasonable to select an operation frequency that is under 55 Hz and higher than 65Hz. This is the reason that the maximum speed of 4,000rpm is selected mentioned in section III. Part B, part a)

#### *(c) Data prepareation and measured Spectrum*

Fig. 6 shows the FFT result of the measured signal. The spindle is driving at 4,000rpm without movement. Every test condition is running for 10 minutes. More extended time intervals would allow for the measurement of more detailed signals. In the beginning, sensor vibration is higher, and then goes down. It reveals that the machine is getting stable. Then, the oil and grease is well lubricating the machine component. All components are heated by the machine friction itself and joules loss.





(a) the hardware of sensor-integrated motorized spindle, DAQ and laptop

(b) the piezoelectric harmer and the indication of harm location, it is under the spindle, and harm from earth to the spindle nose(the tool is clamped)

Fig. 4. Measurement setup of frequency response

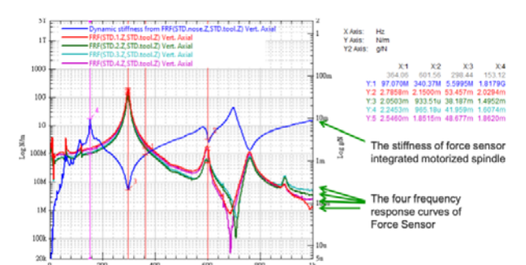
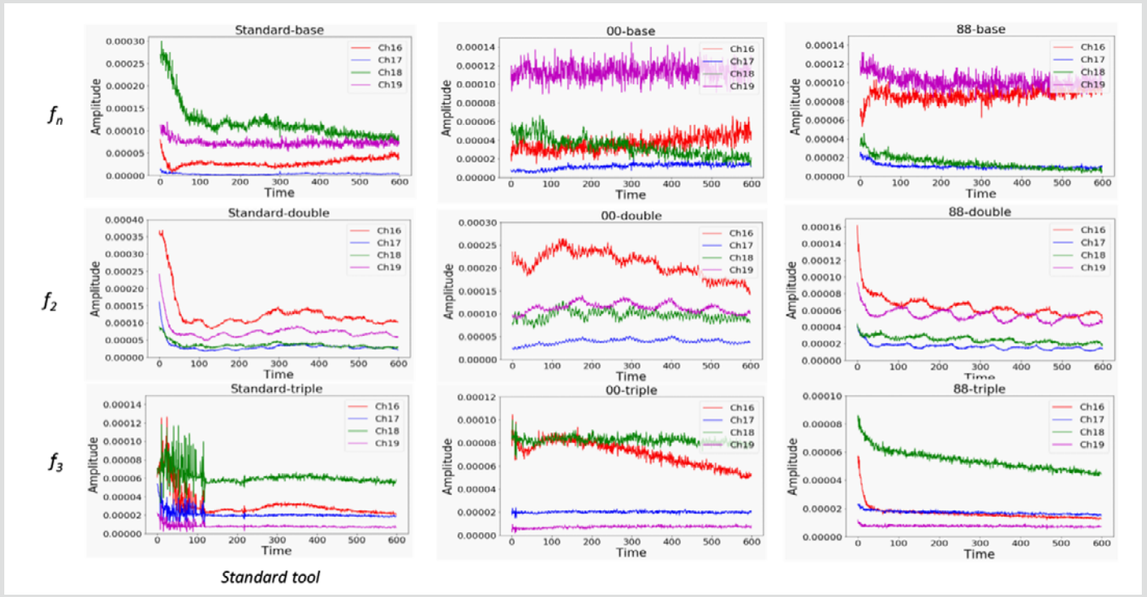



Fig. 5. Measurement result of frequency response.

(a) Normal tool, as shown in Fig. 3 (a).




(a) Abnormal tool, as shown in Fig. 3 (b).

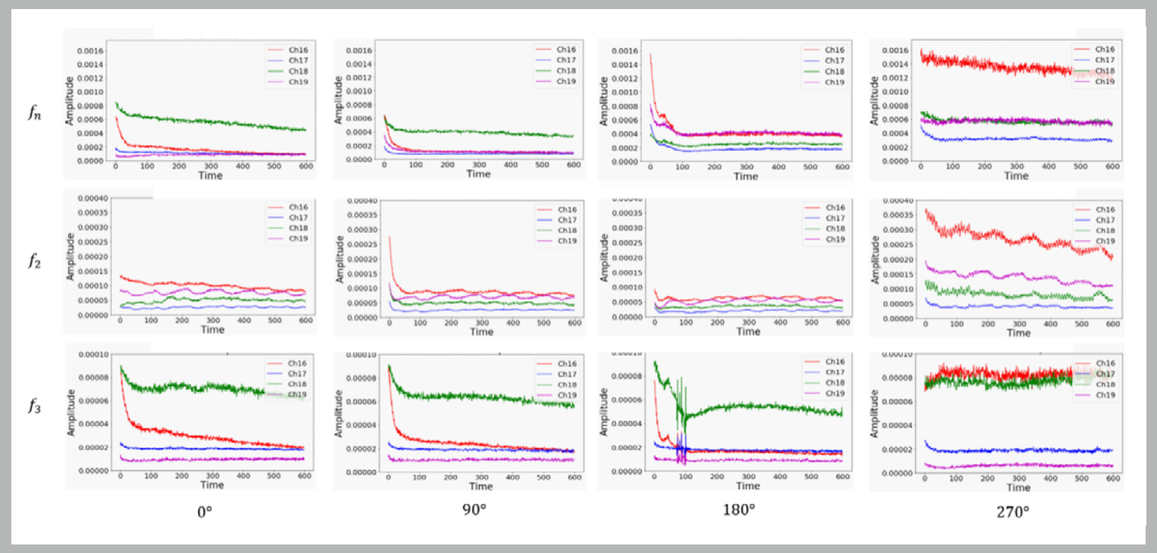



Fig. 6. The FFT result of measured signal, the 1st, 2nd order, and 3rd order frequency is drawn.

## IV. The Investigation of the OCSVM for Diagnosis of Unbalanced Tool Operation

### *A. Study Flowchart*

Firstly, there are four force signals from the force sensor that will calculate the FFT, and then choose the 1st order, 2nd order, and 3rd order frequency for every CA signal.
The principal components are extracted by the PCA technique. The first N-high variance ratios of principal components are chosen as a feature, to train the one-class SVM model.

The tested data will be labeled as a training set. The training set is to train the OCSVM model. The validation set to validation the model quality and performance. The Testing set is to test the model specificity with an available abnormal sample.

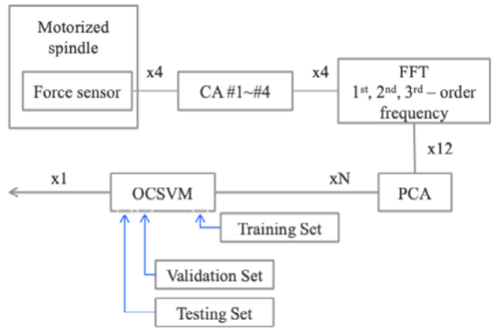



Fig. 7. The algorithm block diagram

### *B. Principal components analysis (PCA) and One-Class Support Vector Machine (OCSVM)*

The PCA is one of the techniques of dimensionality reduction for saving data memory. Meanwhile, it keeps the maximum covariance of data by selecting the first few principal components.
The mechanical vibration is not total defined, it means that there may be much unexplored data. Only the normal operation data and a few pre-defined abnormal operation data can be obtained.

The one-class SVM algorithm, which is not like regular SVM, cannot maximize the margin between two classes [11]. The OCSVM is proper for the most of data are positive samples. In this study, a one-class support vector machine is used for novelty detection [10]. The kernel decides the algorithm performance and is dependent on the data and the number of features [12]. In this paper, the Gaussian radial base function (RBF) is selected.

## V. Result and Discussion

The variance ratio values of PCA are shown in TABLE I. The Variance ratio of 1st principal component is 0.71414, the 2nd one is 0.10767, and the 3rd one is 0.06908. So, the first three components take 90% variance to this data set.

In this paper, the analyzed part result for feature N, N =3, N=8, and N=12, are shown in TABLE II, TABLE III and TABLE IV. The range of the model parameters, v and $\gamma$, is shown in figures, v=0.002~0.182, $\gamma$ =0.75~1.65. As shown in TABLE II, the serval parameter pairs, e.g. v=0.002 and $\gamma$ 1.15, can find a 100% accuracy result, but for the testing set the accuracy is down to 89.4%. It means that model (N=3) existing 10% probability missing abnormal tool. In addition, the variance ratio cannot be a factor to evaluate the model.

Fig. 8 gives an intuitively view, the yellow particles represent abnormal data. The yellow particles distribution are wide. Some yellow particles are in the hyperplane, i.e. in a red circle. In the OCSVM model for N=8 and N=12, the model performance is fine, and all testing data can be detected successfully. Few parameters are set as follow: v=0.002 and $\gamma$ 1.05, v=0.002 and $\gamma$ 1.35.

**TABLE I. The Key Values of PCA**

| Component | Variance ratio | Component | Variance ratio |
|---|---|---|---|
| 1st | 0.71404 | 7 | 0.00586 |
| 2nd | 0.10767 | 8 | 0.00388 |
| 3rd | 0.06907 | 9 | 0.00146 |
| 4th | 0.05999 | 10 | 0.00122 |
| 5 | 0.02695 | 11 | 0.00058 |
| 6 | 0.00894 | 12 | 0.00034 |

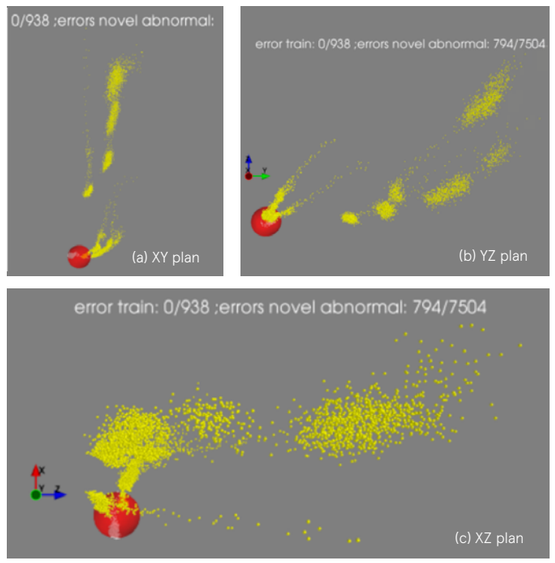



Fig. 8. The scatter plot of the analysis result. Model parameter for PCA3 A1 (v=0.002 , $\gamma$ =1.15)

**TABLE II.** The One Class SVM Accuracy – Select 3 Features (N=3)

(a) Result of Validation Set

| ν \ γ | 0.75 | 0.85 | 0.95 | 1.05 | 1.15 | 1.25 | 1.35 | 1.45 | 1.55 | 1.65 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.002 | 99.8 | 99.8 | 100 | 99.8 | 100 | 99.8 | 99.8 | 99.8 | 99.8 | 99.8 |
| 0.022 | 97.9 | 97.9 | 97.9 | 97.9 | 97.9 | 97.9 | 97.9 | 97.9 | 97.9 | 97.9 |
| 0.042 | 95.6 | 95.5 | 95.6 | 95.7 | 95.7 | 95.7 | 95.6 | 95.7 | 95.6 | 95.7 |
| 0.062 | 93.9 | 93.9 | 93.9 | 93.9 | 93.8 | 94 | 94 | 93.9 | 93.9 | 93.9 |
| 0.082 | 91.6 | 91.4 | 91.5 | 91.6 | 91.5 | 91.5 | 91.4 | 91.6 | 91.5 | 91.5 |
| 0.102 | 90.1 | 89.7 | 89.7 | 89.8 | 89.9 | 89.9 | 89.9 | 89.9 | 89.8 | 89.7 |
| 0.122 | 87.4 | 87.4 | 87.4 | 87.4 | 87.5 | 87.7 | 87.8 | 87.7 | 87.6 | 87.7 |
| 0.142 | 86.2 | 86.4 | 86.4 | 86.2 | 86.2 | 86.2 | 85.4 | 85.4 | 85.4 | 85.4 |
| 0.162 | 83.8 | 83.8 | 83.9 | 83.9 | 83.8 | 83.8 | 83.9 | 83.8 | 83.8 | 83.7 |
| 0.182 | 81.8 | 81.9 | 81.8 | 81.8 | 81.8 | 81.8 | 81.8 | 81.9 | 81.9 | 81.9 |

(b) Result of Testing Set

| ν \ γ | 0.75 | 0.85 | 0.95 | 1.05 | 1.15 | 1.25 | 1.35 | 1.45 | 1.55 | 1.65 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.002 | 89.4 | 89.4 | 89.4 | 89.4 | 89.4 | 89.4 | 89.4 | 89.4 | 89.4 | 89.4 |
| 0.022 | 96.1 | 96.1 | 96.1 | 96.1 | 96.1 | 96.1 | 96.1 | 96.1 | 96.1 | 96.1 |
| 0.042 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 0.062 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 0.082 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 0.102 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 0.122 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 0.142 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 0.162 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 0.182 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

**TABLE III.** The One Class SVM Accuracy – Select 8 Features (N=8)

(a) Result of Validation Set

| ν \ γ | 0.75 | 0.85 | 0.95 | 1.05 | 1.15 | 1.25 | 1.35 | 1.45 | 1.55 | 1.65 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.002 | 99.8 | 99.8 | 100 | 100 | 100 | 99.8 | 100 | 99.8 | 99.8 | 99.8 |
| 0.022 | 97.9 | 97.9 | 97.9 | 98 | 98 | 97.9 | 98 | 97.9 | 97.9 | 98 |
| 0.042 | 96.2 | 96.2 | 96.3 | 96.2 | 96.2 | 96.2 | 96.3 | 96.3 | 96.3 | 96.3 |
| 0.062 | 93.8 | 93.8 | 93.7 | 93.8 | 93.7 | 93.9 | 93.7 | 93.9 | 93.8 | 93.8 |
| 0.082 | 92.3 | 91.7 | 91.7 | 91.7 | 91.8 | 91.8 | 91.6 | 91.6 | 91.5 | 91.6 |
| 0.102 | 90 | 90 | 90 | 89.9 | 90 | 89.9 | 89.9 | 90 | 90 | 89.9 |
| 0.122 | 88 | 88 | 87.7 | 87.8 | 87.7 | 87.8 | 87.6 | 87.7 | 87.7 | 87.8 |
| 0.142 | 85.9 | 85.9 | 85.9 | 86 | 85.9 | 85.9 | 85.9 | 85.8 | 85.8 | 85.9 |
| 0.162 | 83.8 | 83.9 | 84 | 83.9 | 83.8 | 84 | 84 | 83.8 | 84 | 83.9 |
| 0.182 | 81.8 | 81.8 | 81.8 | 81.8 | 81.8 | 81.8 | 81.8 | 81.8 | 81.8 | 81.8 |

(b) Result of Testing Set

| ν \ γ | 0.75 | 0.85 | 0.95 | 1.05 | 1.15 | 1.25 | 1.35 | 1.45 | 1.55 | 1.65 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.002 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 0.022 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 0.042 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 0.062 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 0.082 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 0.102 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 0.122 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 0.142 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 0.162 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 0.182 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

**TABLE IV.** The One Class SVM Accuracy – Select 12 Features (N=12)

(a) Result of Validation Set

| ν \ γ | 0.75 | 0.85 | 0.95 | 1.05 | 1.15 | 1.25 | 1.35 | 1.45 | 1.55 | 1.65 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.002 | 100 | 99.8 | 100 | 100 | 100 | 100 | 99.8 | 99.8 | 99.8 | 100 |
| 0.022 | 98 | 97.9 | 98 | 98 | 97.9 | 98 | 97.9 | 98 | 97.9 | 98 |
| 0.042 | 96.2 | 96.2 | 96.1 | 96.1 | 96.1 | 96.3 | 96.1 | 96.3 | 95.9 | 95.9 |
| 0.062 | 93.7 | 93.9 | 93.8 | 93.9 | 93.8 | 93.8 | 93.8 | 93.8 | 93.9 | 93.8 |
| 0.082 | 92 | 91.8 | 91.8 | 91.7 | 91.7 | 91.5 | 91.6 | 91.6 | 92 | 91.8 |
| 0.102 | 90 | 90 | 89.9 | 90 | 90 | 90 | 90 | 89.9 | 90 | 89.9 |
| 0.122 | 87.8 | 87.8 | 87.8 | 87.8 | 87.7 | 87.7 | 87.6 | 87.7 | 87.7 | 87.7 |
| 0.142 | 85.2 | 85.1 | 85.2 | 85.2 | 85.1 | 85.6 | 85.5 | 85.6 | 85.5 | 85.5 |
| 0.162 | 83.8 | 83.8 | 83.8 | 83.8 | 83.7 | 83.9 | 83.9 | 83.7 | 83.8 | 83.8 |
| 0.182 | 81.8 | 81.8 | 81.8 | 81.8 | 81.8 | 81.8 | 81.8 | 81.8 | 81.8 | 81.8 |

(b) Result of Testing Set

| ν \ γ | 0.75 | 0.85 | 0.95 | 1.05 | 1.15 | 1.25 | 1.35 | 1.45 | 1.55 | 1.65 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.002 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 0.022 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 0.042 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 0.062 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 0.082 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 0.102 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 0.122 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 0.142 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 0.162 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 0.182 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

## VI. Conclusion

The developed hybrid model, i.e. PCA and OCSVM, is successfully to diagnosis the unbalanced tool operation. In this paper, we exam the 1~12 features to build the OCSVM model. Too few feature, like 3 features the too much data of testing set cannot be detected. This study find 8~12 features model is better for detection, and better model accuracy.

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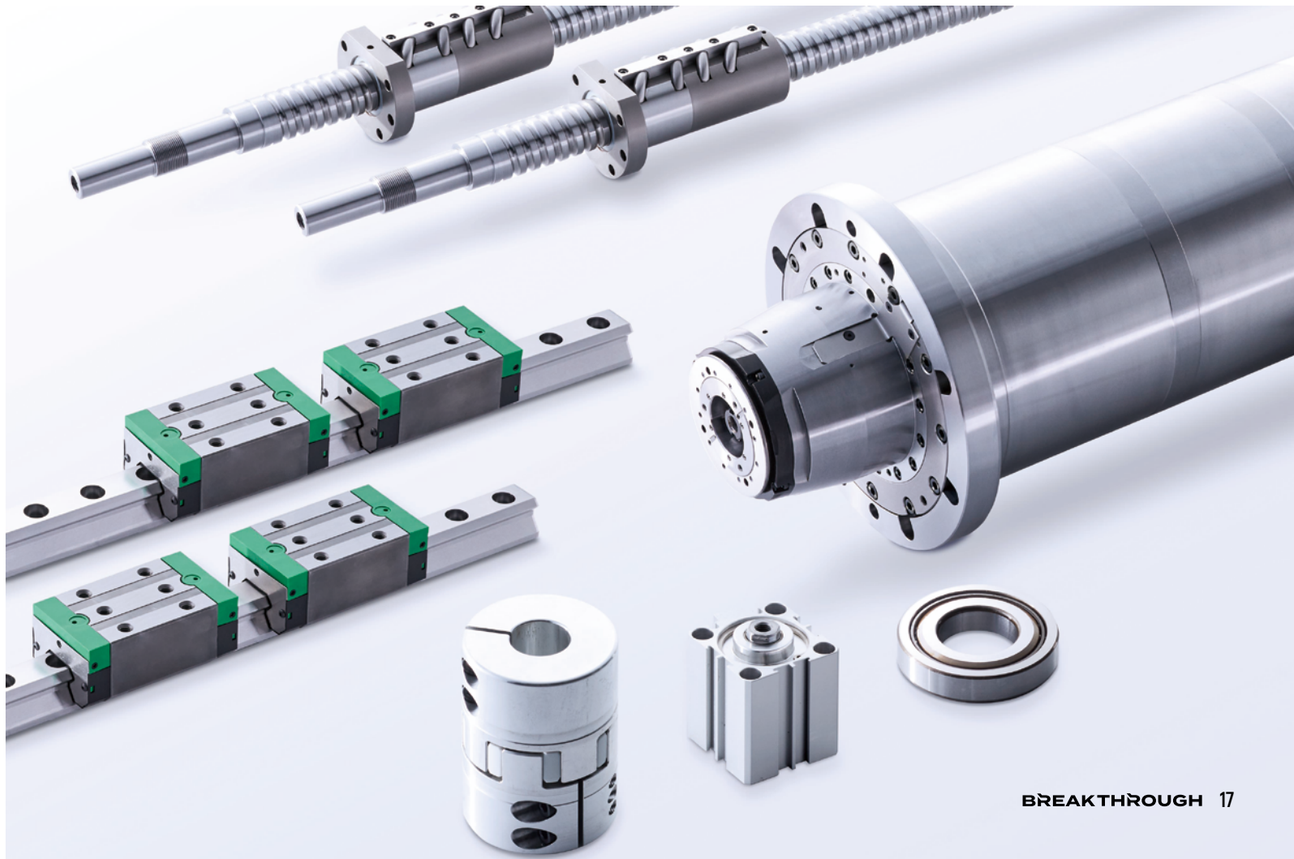



# ETG Group's Partnership with AXILE: Elevating CNC Machine Tools and Sustainability in the UK and Ireland

At the ETG Group, the philosophy is to make engineers champions...! The company is recognized as one of the UK's leading CNC machine tool and turnkey solution provider.

Our product portfolio includes some of the world's leading brands in the machine tool, sheet metal processing and manufacturing solutions.

Our cutting-edge technologies and application experts are focused upon delivering solutions for your requirements. A combination that is the benchmark in a diverse range of industry sectors, from automotive and EV to aerospace, medical, power generation and more.

## About ETG Group

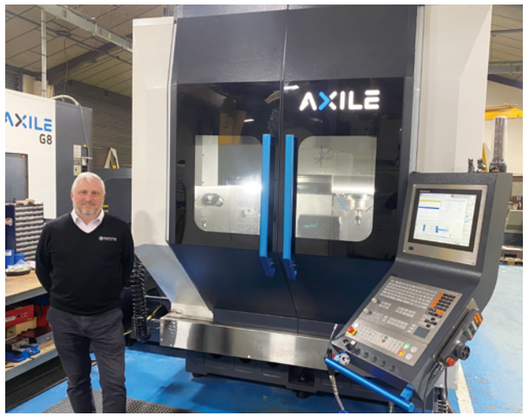
There are three divisions in the ETG Group; ETG UK, ETG Ireland and Hyfore Workholding, each has a clear objective, but all ensure the end-user receives the highest level of service.

We conduct our business activities throughout the United Kingdom and Ireland. ETG's Headquarters in Wellesbourne, Warwickshire deliver UK operations, and the whole of Ireland is served from Newbridge, Co. Kildare.

The Engineering Technology Group (ETG) are proud to be supported by world-class UK technical partners. They are happy to make their products, technology and services available to anybody using our facilities, and are invaluable when proposing turnkey solutions.

Instead of standard service contracts we offer Support Agreements, this allows our customers to subscribe to a number of hours per year, allowing them to spread their service liability and achieve reduced costs, for not only for PM service requirements but for technical and applications support.

Service and spares are a key department in the company, our Support Agreements have 4 levels ranging from Bronze (50 hours per year) to Platinum (300+ hours per year) and give customers significant savings on hourly rates and spare part costs over those without any level of support.




## Exciting Partnership with AXILE in the UK and Ireland

The opportunity to represent the AXILE brand in the UK & Ireland is potentially a huge benefit to both parties. AXILE is getting greater market exposure through our sales and distribution channels whilst having confidence that the ETG service network, which is second to none in the UK, will fully support both new and existing customers. From an ETG perspective, the AXILE brand and its G and DC Series perfectly complement our existing product lines by filling niche areas in our expansive portfolio. The build quality and performance are exemplary and the digitization technology available through the ART™ Monitoring System is undoubtedly unique in what it can offer.

Global warming has been on the radar for many years, how the issue should be tackled has been talked about endlessly and debated by world leaders for years. A legally binding international treaty on climate change was adopted in 2015 and entered into force in November 2016.

AXILE as a machine tool builder with a solid digital management background, understands the need to integrate environmental and economic aspects into its operations and we here at the ETG Group support this ideal.

We understand that accurate information management allows managers to understand machine performance and take immediate actions – optimizing machine capability, arranging maintenance, and making better future investment plans – regardless of location.

We will look to promote, through the ART™ proprietary analyzer, these KPI's to improve our customers' efficiency in both manufacturing process technology and environmental considerations.

## Forging a Strategic Alliance

We look forward to a long and prosperous partnership with AXILE in the UK and Ireland, supplying and supporting world class machine tools to our industry.


# ICHI SEIKI PTE LTD - GOING BEYOND EQUIPMENT TO PROVIDE METALWORKING ENGINEERING SOLUTIONS



Founded in 1988, Ichi Seiki Pte Ltd began our journey as a company focused on the sales and maintenance of machine tools for the precision engineering industry in Singapore. With a strong dedication to high-quality service, Ichi Seiki rapidly gained widespread customer recognition, and became the exclusive distributor of top tier machine tools originating from Taiwan, as well as Mitsui High-Tec surface grinders from Japan, and Colchester & Harrison lathes from the UK.

In the mid-90s, Ichi Seiki expanded into Malaysia and mainland China (Shanghai and Suzhou), to meet the machine tools equipment and servicing needs of Singapore-headquartered customers who were setting up new manufacturing operations in these locations. Our teams in Malaysia and China have now matured to meet the needs of their respective domestic markets independently.


## From equipment supply to engineering solutions

With the rapid advancement of technologies in the precision engineering sector, from CNC controllers and CAD/CAM programming to automation and digital manufacturing in recent years, Ichi Seiki recognises that our role must go beyond the sale of machine tools, to becoming an engineering solutions provider and partner to our customers. This entails helping our customers to optimise their work processes using the best-fit equipment and tools, improving production efficiency, product quality and competitiveness.

Playing our part in the global response to climate change, Ichi Seiki is now taking the lead to introduce sustainable machining in our markets, to help customers understand how to optimise energy efficiency and reduce the carbon emissions associated with their production processes.

## Partnership with AXILE to enter a new era of sustainable machining

In our continuous efforts to keep our product range updated with the latest cutting-edge technologies, Ichi Seiki crossed paths with AXILE. The two companies share a passion for staying ahead of the curve and introducing new technology that will help customers meet growing stringent requirements when it comes to speed, accuracy, quality, and sustainability.

The robust design and superior specifications of AXILE machines allow users to achieve high-speed, high-efficiency machining. In addition, ART is a powerful digital management tool for data collection and analysis, surpassing the capabilities of generic monitoring software. The Predictive Service and Energy Monitoring modules allow users to receive alerts 2 weeks in advance of major component breakdown, and to track energy consumption associated with discrete machining processes.

In July 2023, Ichi Seiki and AXILE held a 3-day event to officially launch AXILE products in the Singapore market. The AXILE team spent quality time sharing about forward-looking Digital and Sustainable Machining concepts with over 50 top tier machining companies in Singapore.

## Commitment to engineering excellence

Our in-house team of 7 highly skilled engineers have over a hundred years of collective experience under their belts, with proven track record of troubleshooting and effectively resolving electrical and mechanical machine faults. It is a strong testament to AXILE's vision for engineering excellence, that our engineers have expressed interest and excitement to bring the capabilities of AXILE products to our customers.

Ichi Seiki is commitment to engineering excellence, serving customers that manufacture critical components for industries such as aerospace, electronics, semi-conductor, medical, automation, oil & gas, and electric vehicles. Ultimately, the advanced equipment and solutions we provide, are used to make products that better the daily lives of people around the world. We will continue to promote the latest technologies and support our machine tools partners in their continuous R&D efforts to improve quality and provide breakthrough solutions to precision engineering companies in Singapore and beyond.

SIEMENS

# Sustainability with Siemens SINUMERIK ONE - the first digital native CNC

**Author | Machine Tool Department of Siemens Taiwan**

SINUMERIK ONE, the digital native CNC, brings your ideas to life. SINUMERIK ONE is the leading-edge CNC system for highly productive machine tools. For unprecedented new opportunities, ideas and business models. For faster innovation based on the seamless interaction of the virtual and real worlds. What's more, SINUMERIK ONE represents much more than just a powerful hardware innovation.

## The benefits of SINUMERIK ONE at a glance

### Maximize productivity

SINUMERIK ONE is setting standards in machining speed and quality. The CNC system maximizes the productivity of machine tools through top PLC and CNC performance. The integrated SIMATIC S7-1500F PLC delivers up to 10 times faster PLC cycle times than its predecessor. SINUMERIK ONE makes machine tools more productive, and thus faster, more flexible, and more efficient.

### Innovate faster

Speed is becoming a crucial factor throughout the product lifecycle of a machine and therefore in the engineering process as well. SINUMERIK ONE helps optimize engineering processes based on consistent, end-to-end workflows, thanks to complete integration into the TIA Portal. This saves time and money.

### Excite digitalization

The data from the TIA Portal provides the basis for the digital twin of the automation system: Create MyVirtual Machine. This digital twin makes it possible to engineer the machine even before the real-life prototypes are available. This means that tasks can be transferred from the real world to the virtual environment, which significantly shortens the time to market. It fundamentally changes the way we work.

### Discover a new way of thinking

Run MyVirtual Machine, the digital twin of the machining process, optimizes the machine tool's capacity utilization, thus minimizing unproductive times at the machine and consistently moving them to the work preparation phase. This creates room for new approaches. With the right business model, the digital twin can also help generate new business for all aspects of the machine tool.





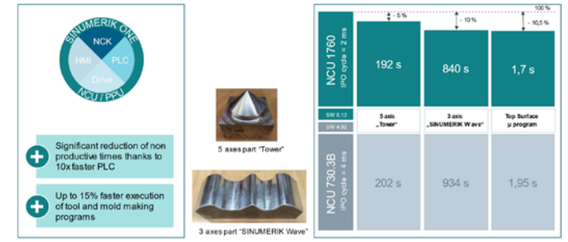
### Enhanced performance

SINUMERIK ONE is optimized for performance. Thanks to its innovative system architecture, the system puts on a convincing performance resulting in outstanding productivity. Especially in the field of highly demanding mold making, productivity increases in the double-digit percentage range can be achieved depending on the specific machine. Innovative software functions leverage the potential of the latest processor technologies and enable various processing functions to run in parallel without impacting the performance.

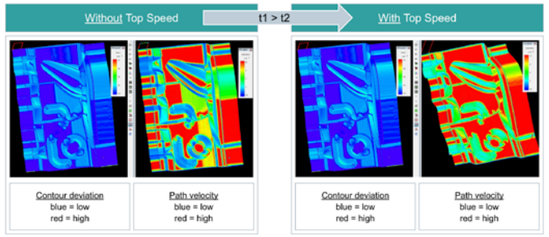
### How to boost productivity with SINUMERIK ONE

How do machines with SINUMERIK ONE significantly and sustainably increase the productivity of the production environment? And further, how do machines with SINUMERIK ONE help machine tool users to be well prepared for the requirements of the future? Watch the video to learn more.

How to boost productivity with SINUMERIK ONE - YouTube




Up to 15% faster execution of tool and mold making program than before




Top Speed -Significant reduction in processing time

### Reduced idle times

SINUMERIK ONE produces a significant improvement in performance as far as idle times are concerned. The powerful, integrated SIMATIC S7-1500F PLC significantly reduces process idle times, e.g. for changing tools on the machines. These all add up to significant potential time savings during processing. The result is increased productivity on the shop floor.

### Shorten machining times

The proven Top Surface mold making function has now been expanded to include Top Speed for maximum surface quality in the shortest possible machining time. With Top Speed, SINUMERIK ONE achieves high contour fidelity even at high traversing speeds on the path. This allows faster machining of free-form surfaces with the same surface quality.


SINUMERIK ONE - innovations of SINUMERIK Operate


IT Security as central architectural element

### Secure communication

Communication around machine tools is becoming more and more important. On the one hand, to supply the machine tool with orders. On the other hand, to retrieve information about the status and performance of the machine. This requires not only high-performance, but also secure communication channels. With OPC UA 3.0, SINUMERIK ONE supports the current and now widely used standard for vertical Ethernet communication in industrial plants.

# SIEMENS

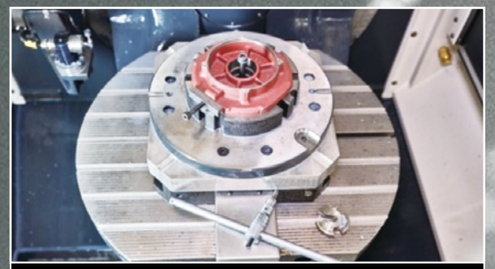
# READY FOR SUSTAINABILITY IN INDUSTRY!

**Efficient use of resources**

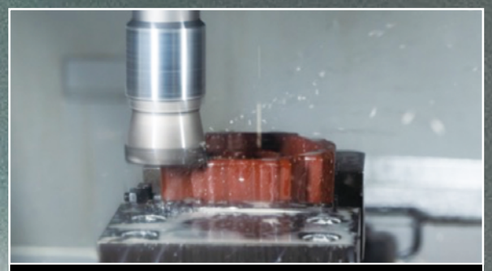
Sustainable production with the Digital Twin, camera-based machine protection and dynamic tool management

Deep dive: Protect MyMachine /3D Twin

Deep dive: Run MyVirtual Machine



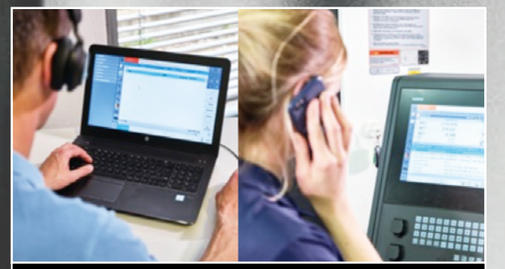
Deep dive: Protect MyMachine /Setup



Deep dive: Adaptive Control & Monitoring

**Reduction of energy consumption & CO2 footprint**

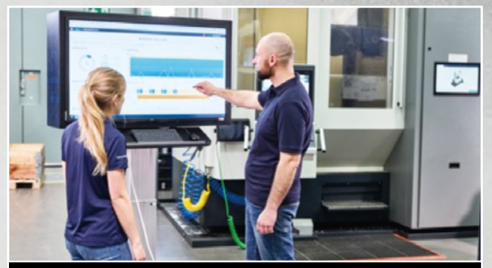
Intelligent energy management, transparency over the machine states and implementation of remote services



Deep dive: Manage MyMachines /Remote

Deep dive: SINUMERIK Panels

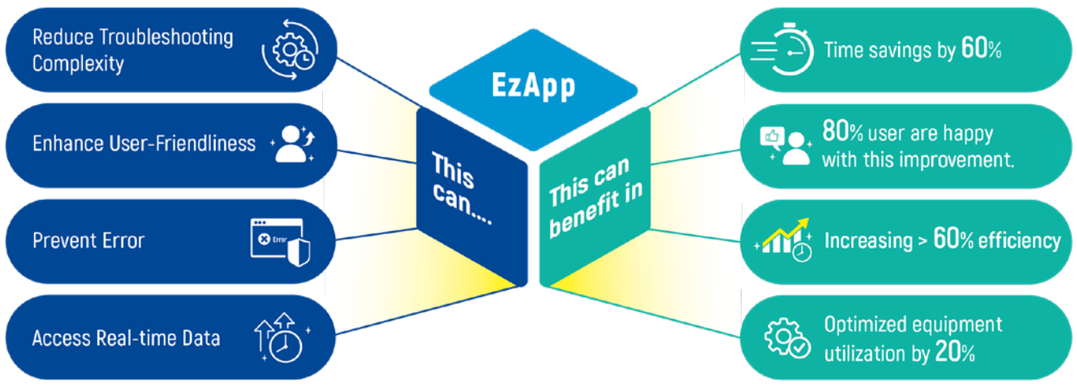

Deep dive: SINUMERIK CTRL+ETwin



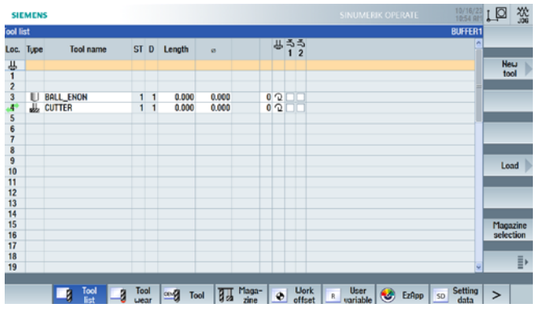
Deep dive: Analyze MyPerformance /OEE

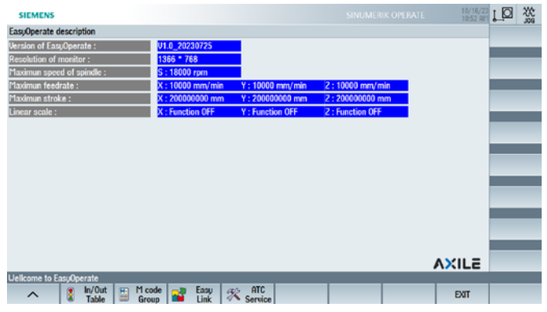
*Breakthrough acknowledges Siemens for their contribution of the content and photos.*

# User friendly interface EzApp on SIEMENS controller created by Buffalo Machinery



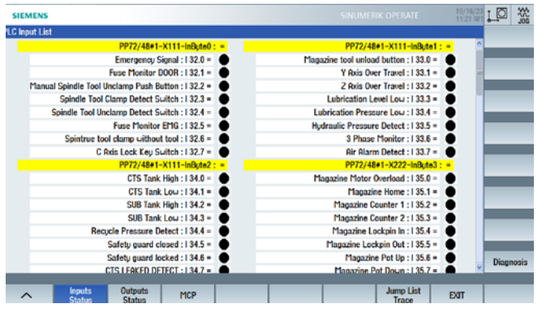

EzApp is an operational solution software designed by Buffalo Machinery base on Siemens controller. EzApp is serves as a platform aimed at reducing the learning time for unexperienced users. Its primary purpose is to enhance operational friendliness, intuitiveness, and convenience to assist end-users in four distinct areas.

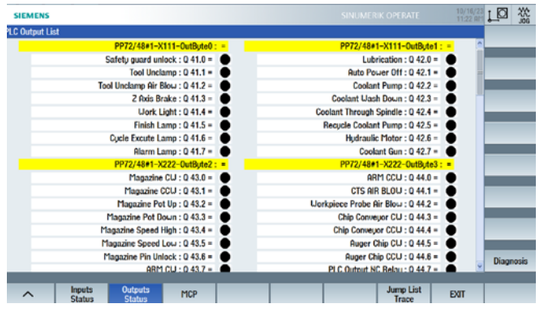



## Time savings up to 60% by Integrating IO multi-Information

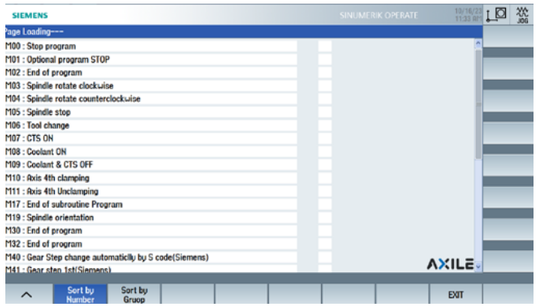
Integrating IO signal information into one screen which including the real-time status, indexing addresses, function definitions, wire numbers and hardware pins. Users can easily verify IO information by scrolling through the screen in **2 minutes** eliminating the need to reference electrical diagrams in **5 minutes**.

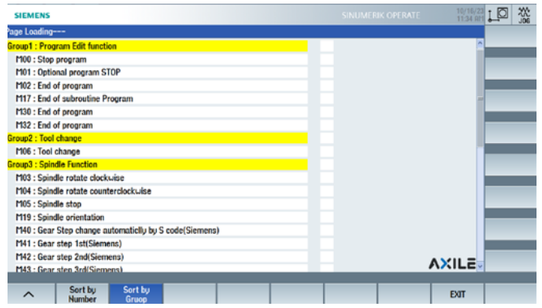



## 80% users are happy with quick M function index

M function is integrated into a single screen to facilitate quick online searches for users. Among the 10 first-time users, 8 of them were able to successfully operate the index table for finding the corresponding functions of the M code. There are two convenient search options: (1) Number sorting and, (2) Function sorting. This eliminates the need for users to write down programming commands on a memo or stick them to the side of the monitor to aid in remembering.

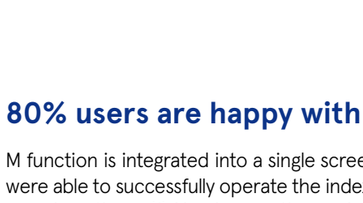


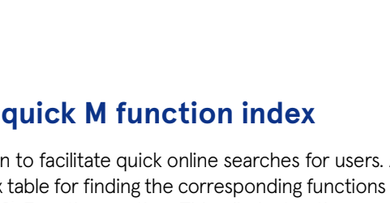



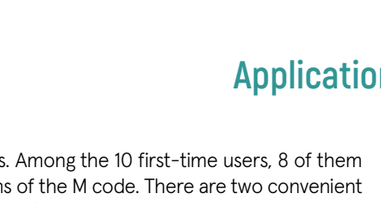

## Parameters link by conversational interface increasing 60% efficiency

Parameter adjustments are necessary during manufacturing, delivering or machine disassembly. Configuring parameters for each function can be a complex procedure, especially for non-developers. Sometimes, the same function may rely on different parameters depending on the controller (Ex SINUMERIK 828Dsl/One) or individual paths or axes.

Our technical code **increase 60% efficiency by One-Page Setting or One-Click Setting** which integrates all function into a single screen linked to their corresponding background parameters. This approach is applicable in three scenarios: setting the position for ATC, disassembling linear scales, and adjusting analog spindle (spindle analog) functions.



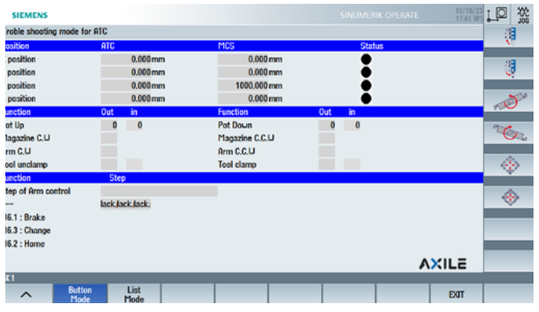



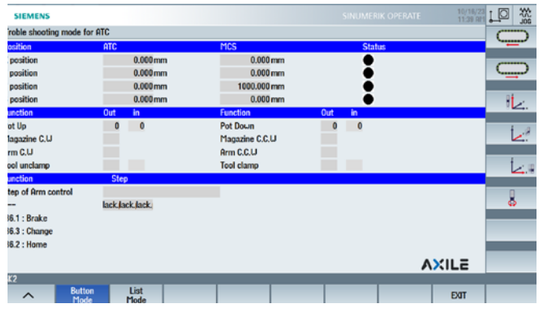




## Space saving by 20% in a visual guide of troubleshooting based on Graphic User Interface

Many users are worried about troubleshooting complex system failure, such as tool change failures. Even when detailed procedures are provided in documentation, the risk of errors due to lack of skill or accidental touches remains significant. Therefore, our top priority is designing a visual and mistake-proofing guideline and dashboard for troubleshooting.

The graphic softkeys are more instinctive than symbolic physical keys and incorporating invisible softkey functions can guide users step by step and prevent accidental touches. By optimizing shortcut key configurations, you can conserve key space. Specifically, utilizing 12 buttons can minimize the control panel area by a minimum of 90cm$^2$, effectively reducing the overall size of the operation panel by at least 20%. In addition, dashboard will provide real-time data for immediate judgment and decision-making.



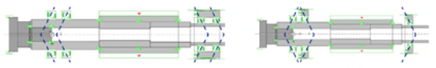
# ASTORI- Motorized Spindle

## 1. Bearing health sensor for I4.0 application

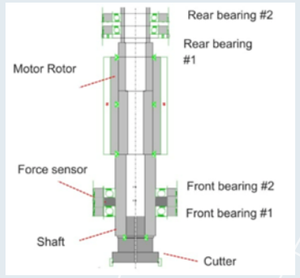
- The feature of bearing health sensor
- High resolution
- High sensitivity and linearity
- Optimized mechatronics design

**DESIGN OF BEARING ARRANGEMENTS**

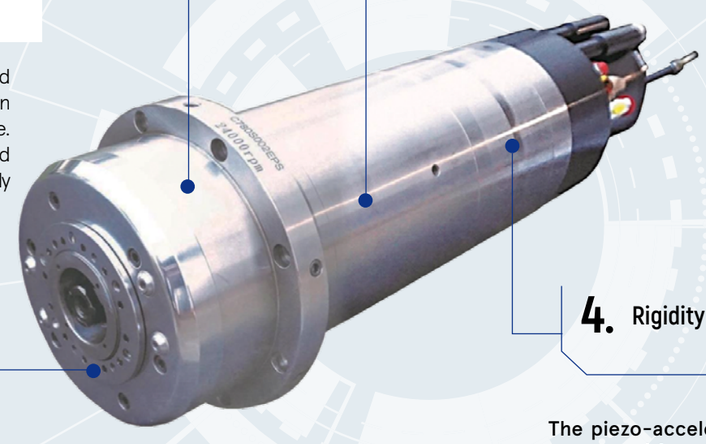
| Bearing Arrangement (BA) | | | System rigidity | | Loading Capacity | |
|---|---|---|---|---|---|---|
| Abb. | Name | Symbol Front/Rear | Axial | Radial | Axial | Radial |
| | | | | | | |
| BA#1 (big-O) | tandem arrangement | << / ~>> | 200 | 153 | 200 | 192 |
| BA#2 (Small-O) | back-to-back arrangement | <~> / ~> | 108 | 148 | 83 | 222 |




> ASTORI spindle is designed with optimal bearing arrangement. For axial rigidity, Big-O's bearingarrangement design is 2 times higher than small-O bearing arrangement design.For radial rigidity,Big-O's bearing arrangement design is 3% more than small-O bearing arrangement design.




The sensor ring is compressed between two front bearings in motorized spindles, in this case. All signal appears from damaged bearings can be measured directly without other mechanical part.



## 2. Tool-Tip Positioning Control (TPC)

**-45 min/day ≈ save 25 days/year**

DISPLACEMENT METER ▶ AMPLIFIER ▶ MPU ▶ CNC

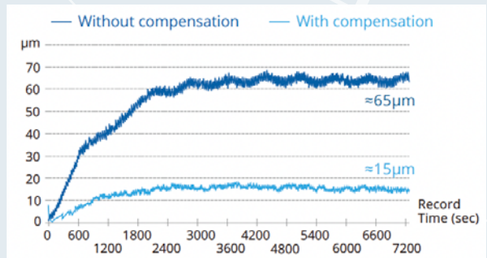
compensation command

- ▶ HIGH ACCURACY
  Directly measuring expansion
- ▶ REAL-TIME COMPENSATION
  Electrical type sensor
- ▶ BETTER SURFACE FINISH
  5-6 times accuracy improved

| Day | 5 working days/month | Year |
|---|---|---|
| -45min | 45minx22days= 990min (15 hours) | 990minx12month= 11,880min(198hours) |

**8 hours of work per person ≈25 working days saved!**

**In addition to accuracy, it also increases efficiency & productivity.**




With compensation, the displacement of tool tip is reduced from 65μm to 15μm.

**ACCURACY IMPROVED *5~6 TIMES***

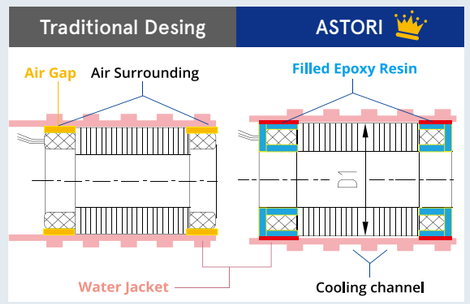
## 3. Design Optimization Motor

**10% Efficiency**

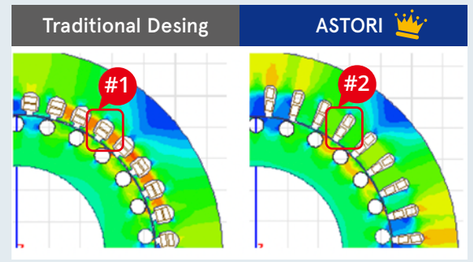
**Optimizing the Efficiency of Astori Spindle Production**

1. Increasing coolant contact area by **20-35%** ( as indicated in red, refer to picture [1-2] ), resulting in a **10%** improvement in thermal-conduction efficiency.
2. Upgrading the stator design, Refer to picture [2-2] to increase the sectional area, so higher copper filled.
3. Analyzing slot geometry and silicon steel plate material to reach optimal solution.

[1-1] [1-2]

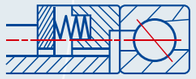



[2-1] [2-2]




(A) Stator Design #1 (B) Stator Design #2

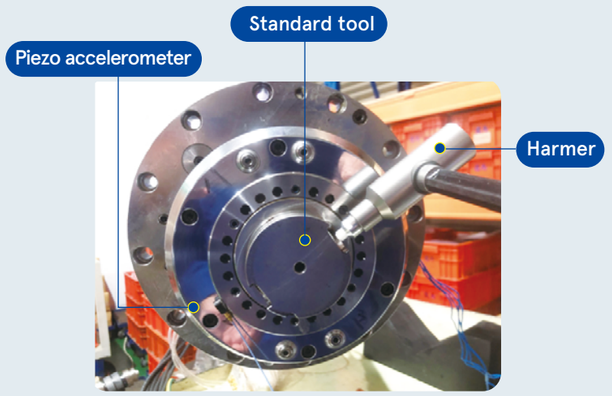
## 4. Rigidity Analysis

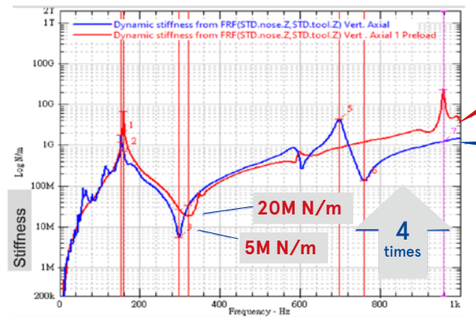


**30% Preload Force**

**The piezo-accelerometer and piezo-harmer is the sensor and force input, respectively.**

- the piezo-harmer hit on the shaft of spindle, clamped with standard tool
- the piezo-accelerometer could observe how the shaft vibrate.
- the characteristic of frequency response can be identified the quality of spring-preloaded bearings.




**130%** preload force

**100%** preload force

This is helpful tool, due to the visualization of measurement data, the Quality Unification become possible.

Take the figure as an example, the 30% preload force deviation cause the 4 times logarithm of stiffness deviation from 5M N/m to 20M N/m.

# JC. Architecture & Design's Transformational Journey:

## Leading the Green Building Revolution

*- Exclusive Interview with Johnny Chiu, Founder of JC. Architecture & Design*

**People –**
JC. Architecture & Design
Johnny Chiu

As the founder of JC. Architecture & Design and OUT Scholarship, Johnny is fluent in turning concepts into real-life work. Recognized for his fresh perspective, Johnny is the first Taiwanese designer to win the World Architecture Festival / INSIDE World Interior of the Year.

His adventure touches various disciplines and speaks through remarkable projects such as The Moving Kitchen, Bloom Chair, A Little Museum Store and Penghu Ferry.

Johnny has also appeared at many acclaimed design acts and universities, participated in podcasts, and given talks at events namely the World Architecture Festival.

JC. Architecture & Design founded by Johnny is a multidisciplinary design firm full of aspirations and eagerness to bring design into every aspect of our life.

## START WITH CONFIDENCE & COLLABORATION

**Transformation in the Design and Construction industry, through re-setting space as the starting point of imagination**

In recent years, JC. Architecture & Design has emerged as a standout player in the field, and this transformation can be attributed to the pivotal moment brought about by the COVID-19 epidemic. The industry's transformation can be traced back to 2020, following the outbreak of the pandemic.

Simultaneously, Taiwan has been actively engaging in international bidding, bringing renowned international architects and interior designers into urban planning with an aim to enhance Taiwan's global recognition. Unfortunately, the pandemic put a hold on this initiative as several countries implemented strict border closures.

Nonetheless, "we seized [this] opportunity to evaluate our own design capabilities," shared Johnny.


**Reimagining Taiwan's railways aesthetics with The Future**

*The letter that started it all*

One of the opportunities that led to the transformation of design in Taiwan was attributed to the Taiwan Railways Railcar Project, namely "The Future".

In February 2019, the Taiwan Railways Administration (TRA) released photos of the previous train, which left the public implausible. Hence, Johnny wrote an open letter expressing his willingness to work on the makeover of the Taiwanese railways' tourist train. However, all his appeals fell on deaf ears. Eventually, through a friend's connection, he managed to establish contact with TRA's internal team and tirelessly presented design proposals. Finally, he gained approval from the governmental agency to take on the task - resulting in the grand launch of "The Future" at the end of 2020.

Traditionally, Taiwanese railway doesn't represent design – it represents safety, punctuality and accuracy. Despite that, Johnny's team reused old materials and added inventive approaches to redefine and promote Taiwan's railways, shifting the general's views on design.

The original interior design of The Future

Taiwanese people also frequently believe that foreign materials and resources are typically valued higher than those from their own. For this reason, JC.'s team was determined to changing how people see the native assets.

The Future carried on the conventional orange shade of the train's exterior and infused Taiwan's scenery into the carriage, making the ride a journey filled with ever-changing stories. This is also Johnny's way of telling his childhood memories, turning it into an experience that can be shared with others.

The Future - an unforgettable design that has brought Taiwan's railways to the international platform, won its first global recognition through Japan's GOOD DESIGN Award in 2020, for Transportation Design category.

Interior of The Moving Kitchen
- A culinary journey, part of The Future

**Stories aren't written, they aren't made up**

Stories are lived; they are simply transparent articles of real life communicated through designs.

JC. Architecture & Design focuses on using design to create new scenes in its projects. Johnny strives to create a seamless connection between live and lifestyle, which encompasses brand culture and appeals to people on a personal level, as well as nearby businesses and the community at large. Moreover, to restore equity to each site and its functions, the team often employ natural and recyclable materials.

In Johnny's team, each member has defined their distinct roles and responsibilities in every project they work together. Through collaboration, they complement one another's strengths, and each team member is given the freedom to succeed in their own fields.

## LIVE WITH YOUR HEART

**Never stop exploring!**

*Unlocking greater freedom through simple and smart designs for enhanced utility*

During the interview, we could feel the inspirations behind Johnny's aims to maximize the utility of a building's structure. It is clear that his children have motivated him greatly.

JCA Living Lab is an experimental living laboratory, housed within a renovated 90-year-old building that was once left to history. It is the embodiment of Johnny's philosophy and a project close to his heart. All was inspired by the vision of designing a space for children to grow in a healthy environment.

Envisioning through an educational concept, he hopes the children can explore things openly rather than defining them as absolutes. There is an exploratory freedom made possible by design that is impossible in any modern apartment building. From the vines in the garden to the red exterior ladder that leads to the roof area, different areas are arranged on different levels to exude a living style that encourages exploration.

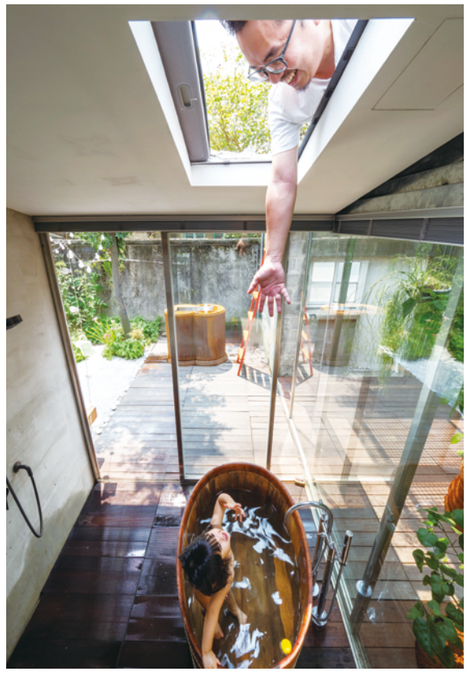
Bringing life into the contemporary revitalization of historic buildings is not just a rebirth of old houses, but the continuation of lives developed in a contemporary context within the framework of aged abodes.

## PROBLEMS ARE HIDDEN OPPORTUNITIES, AND CONSTRAINTS CAN BOOST CREATIVITY

**Find the best opportunities within constraint**

Located in the Da'an District of Taipei City, Happier Café reinvented the conventional image of a coffee shop. If one steps inside for the first time, it's unlikely that they recognize this space as a café immediately. At first glance, it resembles a world within the pages of a book, a realm perfect for daydreaming, contemplation, and conversation. It is both a café, akin to a small art gallery, a lost paradise in the midst of the urban jungle, and a serene haven for free-spirited meditation and relaxation.

Turning the impossible into possible, Happier Café is a project that allowed him to communicate with the world, by "only having your own discussion," told Johnny.



With a small budget, the limitation actually gave him a lot of space to develop, and it also made him reflect on Taiwan's industrial manufacturing and product presentation.

In fact, this served as a reminder that we should harness Taiwanese materials.

At once, an important concept that JC.'s architects and designers wanted to deliver was to create sparks by putting Western and Eastern elements side by side. Though they speak different languages, together, both can be displayed to exhibit the same ideal.

Instead of overengineering the transformation process, the design team should leave some room for flexibility within the spaces. This approach allows people to cultivate more of their creative visions within these areas, ultimately altering the spaces into dynamic stages of constant change.

Design is connected to culture and meets all functional and emotional needs. Therefore, let's modify the overloaded city and adapt smarter ways to create temporary spaces for alluring scenery while continuing the original cultural context. In the process of change, the true beauty and colors of things will unfold themselves and invite others to appreciate the authentic self.


## WHAT FILTERS DO YOU USE TO VIEW THE WORLD ?

**Greatness is not a result, it's a practice**

Johnny holds a deep respect for his team, acknowledging the significance of each member, regardless of their role or status. He emphasized that everyone plays an indispensable part in achieving their goals.

Furthermore, Johnny shared how some families initially didn't fully support their children's career choices, considering them unimportant and impractical. However, through public recognition that each project received, these differences were bridged, opening a common ground for conversations and discussions.

He underlined the importance of perspective, stating that it matters greatly how you view something. Regardless of your occupation or title, the most valuable contribution to society is using your professional expertise to bring positive changes.

## PUT YOURSELF OUT THERE & MAKE DREAMS HAPPEN

**Being able to help students is a great thing!**

Back in the day, Johnny was once a recipient to scholarships. Understanding how, to a great extent, these opportunities can allow students to go out and explore, he started the OUT Scholarship as a way to bring Taiwanese students to see the world and vice versa, international students to visit Taiwan.

OUT Scholarship is not just the company's effort, it is combined with other endeavors in various fields, together practice corporate social responsibility (CSR). It is not just a sponsorship, but also an educational guidance provided to students in the form of apprenticeship.

Students are invited to seize this opportunity to do things on different levels, with a leading example shared by Johnny:

*“One of the recipients went to nursing homes in the Netherlands to conduct fieldwork on how senior living facilities function.*
*During the process, she also brought Chinese culture to the elderly and taught them to make dumplings together.”*

With that being said, by understanding a city’s park design, beer culture, baseball stadium planning and other plans, it allows us to see the relationship between culture, city and design - and OUT Scholarship is here to provide students a means to see the world through their own eyes!

OUT
Observe · Unexplored · Travel
Scholarship

The core purpose is to provide Taiwanese students who major in architecture, interior and structural design in college with the opportunity to travel and observe the world from a young point-of-view. Let them to absorb wisdom, widen perspectives, enrich life experiences, and embrace an internationalized viewpoint that inspire design. The OUT Scholarship awards students 100,000NT$, encouraging them to travel and adopt the global standpoint.





## TO INFINITY AND BEYOND

**Johnny encourages everyone to visit Asia and experience its designers and designs**

The revitalization of aging communities plays a vital role in Taiwan's urban improvement, impacting not only the city's overall quality but also serving as a crucial measure for assessing the comfort of the living environment.

Johnny expressed his desire to introduce JC. Architecture & Design to the world, emphasizing how Taiwan's design prowess is expanding and gaining momentum.

He aims to raise awareness about the importance of local thinking and hopes that people will come to realization that Taiwan excels not only in manufacturing but also in the field of design.

In our daily lives, Johnny aspires to incorporate more design elements that enhance the user experience and promote a genuine enjoyment of living spaces. As the interview came to an end, Johnny even contemplated his design dream - the development of a "space hotel", “Let's rock the world of design, from the ground to outer space!” - said him.

Following the interview with Johnny, we found his stories to be incredibly vivid, infused with natural imagery, determination, and sparks of inspiration. We were deeply moved by his desire to contribute positively to Taiwan.

“Believing in oneself is a crucial part of change. Believing in the beauty of Taiwan, believing that Taiwan has the potential to shine on the international stage, and as long as we start, we will always be on the path of problem-solving.”

# 2024 EXHIBITION CALENDAR

**January 30 - February 1**

EXPO MANUFACTURA 2024 / MONTERREY, NUEVO LEON, MEXICO
- Protecnic de México, S.A. de C.V.
- Fabrica de Maquinas y Accesorios S.A. de C.V.

**April or May**

OPEN HOUSE / QUERETARO MEXICO
- Protecnic de México, S.A. de C.V.

**May-June**

OPEN HOUSE / QUERETARO MEXICO
- Fabrica de Maquinas y Accesorios S.A. de C.V.

**June 18-20**

EXPOMAQ / LEON GUANAJUATO, MEXICO
- Protecnic de México, S.A. de C.V.
- Fabrica de Maquinas y Accesorios S.A. de C.V.

**September**

OPEN HOUSE / Protecnic's Technical Event / QUERETARO MEXICO
- Protecnic de México, S.A. de C.V.

OPEN HOUSE / Monterey, NL. MEXICO
- Fabrica de Maquinas y Accesorios S.A. de C.V.

**October 9-10**

MEXIMOLD / QUERETARO, MEXICO
- Protecnic de México, S.A. de C.V.

**October**

OPEN HOUSE / Puebla, Pue. MEXICO
- Fabrica de Maquinas y Accesorios S.A. de C.V.

**May 14-17**

Elmia Verktygsmaskiner Exhibition
- Mekana Maskin AB

**October**

OPEN HOUSE Värnamo
- Mekana Maskin AB

**March 19-21**

Konepaja / Tampere Exhibition and Sports Centre, Finland
- Insinööritoimisto Ismo Lindberg Oy

**October 1-3**

Alihankinta / Tampere Exhibition and Sports Centre, Tampere, Finland
- Insinööritoimisto Ismo Lindberg Oy

**March**

Kielce trade fair/ STOM Kielce, Poland
ITT - Technika

**May 7-10**

Industry Days, Budapest, Hungary
- Optimum Hungaria Kft

**Q3**

OPEN HOUSE / SINGAPORE
- ICHI SEIKI PTE LTD

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