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Foreword

Recommendation of UFB

MIZUTANI Masayoshi*

A bubble consists of a liquid envelope containing air. Bubbles have been used since ancient times in a variety of industries, including cleaning, cosmetics, food, and medicine[1]. But did you know that the wave of miniaturization has recently extended to include such bubbles? Invisible bubbles of nanometer order, called ultrafine bubbles (UFB), are now widely used and have just started to show their effects.

The designation of these bubbles is defined by the International Standard Organization (ISO) according to their size. Bubbles with a diameter of 100μm or more are defined as non-fine bubbles and smaller bubbles as fine bubbles[2]. Among the fine bubbles, those 1μm or larger are called microbubbles (MB), while those smaller than 1μm are called ultrafine bubbles (UFB), as mentioned above[3]. Liquids containing MB can be visually identified by their whitish color. This phenomenon is often observed in hot springs and baths. On the other hand, UFB are difficult to identify visually because they are clear and colorless. So why have these tiny, invisible bubbles received so much attention? This is because these bubbles have different properties depending on their size[4]. UFB in particular have several attractive properties.

Firstly, it is known that the surface potential of UFB is between around -30 mV and -40 mV according to measurements using electrophoresis equipment[5]. It has been also shown that the surface potential is almost independent of the bubble diameter[5]. In other words, bubbles smaller than a certain size are basically charged negative. These electric (chemical) characteristics seem unexpectedly useful in industry. For example, they apparently deliver cleaning performance. We are increasingly seeing examples of UFB being used in showers and laundry. Based on the explanations and illustrations shown on the web and in commercials, it might be expected that the negatively charged nature of UFB is the main reason for their use.

There is another possible reason. Tiny bubbles such as UFB can produce physical and/or chemical effects when they collapse (or abruptly shrink) in a liquid. Many researchers have demonstrated the generation of microjets as a mechanical effect[6] and the generation of hydroxyl (OH) radicals as a chemical effect[6]. These properties are expected to be useful for antimicrobial activity and sterilization. In fact, the effects of OH radicals have been demonstrated in various fields, including dental treatment, and their commercialization has been promoted. I have a hunch that, if the generation of OH radicals can be successfully controlled with UFBs, their use would expand to even wider areas.

Of course, UFBs have many other attractive properties, but we should not forget that the phenomena associated with them occurs in the extreme micron range, as explained above. The principle and mechanism of these phenomena have not yet been clarified in many respects, including how UFBs use their properties to produce such effects. That is why I have relied quite heavily on vague expressions like "expect" and "have a hunch", which are qualitative terms that are difficult to use in academic papers. In short, UFB are very attractive, but there is a lot that is not clear. That is why it is really interesting to study them.

Naturally, applications of UFB also include industrial fields. We have seen increasingly more people who attempt to use "unknown" UFB as fluids for grinding, polishing, or other machining processes. Among them is Mr. Yousuke Hatayama from KYB. He, as a working doctor in the laboratory I lead, has conducted research together with me on how UFBs behave, what happens and how they can be applied during machining

*Professor, Tohoku University
Green Goals Initiative Research Center for Green X-Tech
Graduate School of Engineering, Biomedical Engineering

(grinding). What I want to emphasize here is that Mr. Hatayama is proposing a completely new mechanism that does not rely on the so-called "established theories" presented by many researchers so far. I think you are now interested in his research and recommend that you read his dissertation thesis. His ideas on other points have also started to be officially recognized from the academic viewpoint and published in the Journal of JSAT (The Japan Society for Abrasive Technology)[7] and the Journal of JSPE (The Japan Society for Precision Engineering)[8].

Just adding very small bubbles of nanometer size to the fluid for machining will change the behavior of the machining and may even clean the piping and sterilize the fluid for machining. I would like to definitely recommend the use of UFB.

The Japanese title (UFBのすゝめ) of this Foreword is based on An Encouragement of Learning, the famous book written by Mr. Yukichi Fukuzawa, who founded Keio University, from which I graduated. The English title has been adapted to reflect the meaning of the text.

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Editorial

Deep Learning Based Technology for Diagnosis of Production Equipment Abnormalities

CHIDA Yuichi*

1. Introduction

It is expected that abnormality diagnosis and prediction technologies will be developed for production equipment whose unexpected failure can significantly affect production schedules. Meanwhile, deep learning (DL) technologies have advanced rapidly in recent years and are expected to be applied to abnormality diagnosis and prediction for production equipment[1]. Very important points of these technologies are the quality and quantity of data used to build a diagnostic model. In other words, sufficient data must be obtained for both normal and abnormal times. Furthermore, if the differences between the two sets of data are clear in terms of characteristics, it would be easier to identify abnormalities. In many cases, however, abnormalities occur infrequently and data for abnormal times are usually not available. This makes it difficult to diagnose and predict equipment abnormalities. To solve this problem, it is necessary to choose an approach to artificially generate abnormality data by consulting the probability distribution of data for normal times or an unsupervised learning approach such as that based on an auto-encoder[2]. Our research group is also working on these approaches[3),4)]. This paper presents examples of the application of these approaches and real examples of their application at production sites.

2. Artificial Generation of Abnormality Data and Abnormality Detection by Multi-labeled Deep Learning Networks[3]

This section introduces how to detect abnormalities in the operation of parts cleaning equipment. In the parts cleaning process, parts are cleaned by two or more operations. Here, with a focus on any changes in the operating time of the processes, the possibility of abnormality detection is discussed. In other words, if the time taken to complete a work process deviates from its standard, this indicates that there is a problem in the process that should be detected earlier. In this case, it would be sufficient to focus on the operating time of each process if the individual processes were completely independent of each other. However, in cases where a process affects its related processes, a more appropriate abnormality detection may be possible by using a structure that can consider the mutual relevance, rather than recognizing them as independent processes. A multi-labeled deep neural network (ML-DNN) can then be applied[3].

ML-DNN is a binary classification method for data from two or more output layers of a deep neural network (DNN). The configured ML-DNN receives the input of the operating time for two or more operations in the parts cleaning process and represents the possibility of an abnormality in each operation by binary data output (normal or abnormal). When considering the output for all the operations, this is a matter of binary classification of multiple outputs to which ML-DNN can be applied. This allows us to detect which operation has the abnormality, while taking into account the mutual influence between the different operations in the parts cleaning process.

In this case, it is necessary to train the ML-DNN with a sufficient number of normal and abnormal data sets. In reality, abnormal data is difficult to obtain, while normal data is available from the data collected during normal operation. To solve this problem, we have selected the approach of obtaining the data distribution in normal times, artificially setting values that deviate from the distribution as abnormal data, and training the ML-DNN based on these data.

Fig. 1 shows an example of probability distribution results obtained from a histogram of the time taken to complete an operation within the cleaning process. Since the histogram is not as simple as a probability distribution, it is necessary to build a probability distribution model. This time, however, we decided to use a normal distribution as the most convenient way. Assuming it is a normal distribution, we determine the mean μ and the standard deviation σ. Since the

* Professor, Academic Assembly (Institute of Engineering), Shinshu University

probability of occurrence of data outside the range of μ ±3σ is about 0.3%, it is assumed that data within the range of μ ±3σ are normal and data in the range between μ ±3σ and μ ±8σ are abnormal. This probability distribution is used to artificially generate abnormal data. The abnormal data is then used to train the ML-DNN. The data collected during normal operation is used as normal data for the ML-DNN.

The data sets generated in this way were used to train the ML-DNN to build an abnormality detection system. As a result, we successfully confirmed that the ML-DNN can achieve a correct response rate of 99.6% for abnormality detection. On the other hand, a regular DNN showed a correct response rate of 98.2%. Therefore, the ML-DNN has proven its superiority[3]. We are considering applying a mixed Gaussian or other probability distribution model in the future.

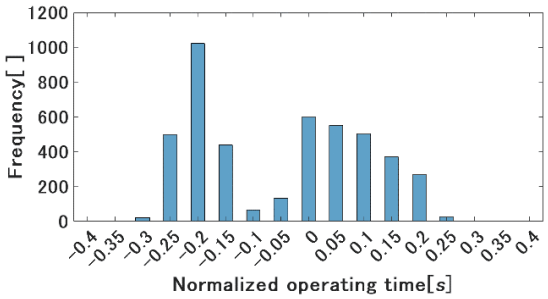

Fig. 1 Histogram of operating time[3]

3. Abnormality Detection Using Both Spectrum Characteristics and Auto-Encoder[4]

This section presents an example of considering the detection of abnormalities in a high-pressure pump in parts cleaning equipment[4]. Since the pump may have pressure data that is significantly affected by its drive frequency, it is effective to adopt an approach based on the frequency spectrum obtained by Fourier transform. We then subjected the time series data to Fast Fourier Transform (FFT) to determine the frequency characteristics and tried to detect abnormalities according to changes in the frequency spectrum. However, again, the problem is that it is not easy to obtain data during abnormal times. We then used an auto-encoder[3] based method, which is a type of unsupervised learning.

An auto-encoder does not necessarily need abnormality data. It is possible to train it only with normal time data to configure an abnormality identifier. Specifically, a network structure as shown in Fig. 2 can be set up to provide an $\hat{X}$ output that reproduces the input by encoding and decoding. In this case, the distance in data values between the input and the output is set as a loss function and the auto-encoder is trained so that the loss function is minimal. If the auto-encoder can be properly trained using this method, the loss function will be a somewhat small value when normal time data is input. Next, a threshold is set using the low loss function as a guide. Now the auto-encoder can judge the situation as normal if the loss function obtained from the input data is lower than the threshold, or abnormal if it is higher than the threshold. We have adopted this idea to simultaneously configure the auto-encoder and set a threshold to configure an abnormality identifier.

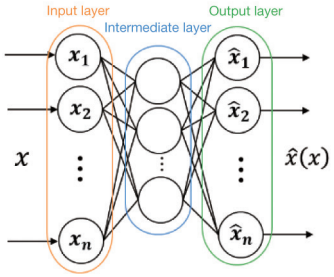

Fig. 2 Auto-encoder[2]

The input to the auto-encoder is the frequency spectrum data of 127 points obtained by FFT. The sum of the squares of the differences between the input and output of the auto-encoder is set as the loss function. On the other hand, the frequency spectrum data for abnormal times, which were required for the evaluation, were created artificially by processing part of the normal time data. In other words, the frequency spectrum data for abnormal times was created by increasing or decreasing some of the frequency spectrum values in the normal frequency spectrum data.

The auto-encoder was configured using the procedure above and its performance was verified. The results are shown in Fig. 3. The grey graph (right scale) represents the frequency spectrum and the red graph (left scale) the abnormality detection rate. The horizontal axis indicates the scaled frequency. The abnormality detection rate for the entire frequency range in Fig3. is approximately 83%, which means that the auto-encoder can detect most abnormalities. However, the abnormality detection rate is locally poor at a frequency of about 0.8. Similar poor performance can also be seen around frequencies of approximately 1.5, 1.8, and 2.3. At these frequencies, the frequency spectrum of the normal time data has a larger amplitude, which may lead to the poor accuracy in detecting amplitude changes at these frequencies.

This may be because at frequencies with a large amplitude, even the normal time data contained shifted frequency values as shown in Patterns 2 and 3 in Fig. 4, rather than converging to a single frequency value as shown in Pattern 1, making it difficult to detect changes in amplitude values for the spectrum in these frequency ranges. To solve this problem, it is appropriate to treat the different frequency spectrum patterns shown in Fig. 4

as the same pattern. We therefore decided to add another abnormality identification function to the auto-encoder for the specific frequency ranges where the abnormality detection rate was low.

We then switched to the abnormality identification flow shown in Fig. 5. Here, if the auto-encoder produces a normal result, an additional judgement is performed to determine if there is a possibility of an abnormality in the frequency ranges with poor detection accuracy. A frequency bandwidth has been set for the poor accuracy frequency ranges to cover all neighboring frequency peaks even for Patterns 2 and 3 in Fig. 4. The sum of the power spectra in the bandwidth was used to determine the presence or absence of an abnormality. This procedure begins by determining the sum of the power spectra in the set bandwidth for the normal time data. The next step is to determine the distribution of the power spectral values using the histogram. Assuming a normal distribution, the mean μ and the standard deviation σ are determined. As in Chapter 2, a threshold value was set assuming that data values within the range of μ ±3σ are normal, based on which a discrimination between normal and abnormal would be made. This method was applied to each of the frequency ranges (including approximately 0.8, 1.5, 1.8, and 2.3 in Fig. 3) where the auto-encoder often made an incorrect judgement. In other words, once the auto-encoder judges a normal situation, another judgement takes place around the frequency of 0.8. If that is judged normal, another judgement is made in the frequency range around 1.5, and so on. The target frequency range was shifted sequentially in this way for discrimination purposes. The results of the performance check using the method above are shown in Fig. 6. Using the same data as in Fig. 3, the abnormality detection rate for the entire frequency range was improved from 83% in Fig. 3 to approximately 92%. Fig. 6 shows that the abnormality detection accuracy in the frequency ranges with poor detection rate in Fig. 3 has also been improved.

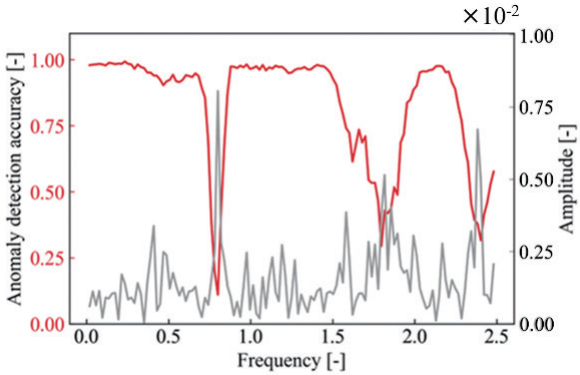

Fig. 3 Frequency data and abnormality detection rate (before improvement)[4)]

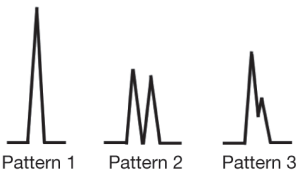

Fig. 4 Typical examples of frequency peak patterns[4)]

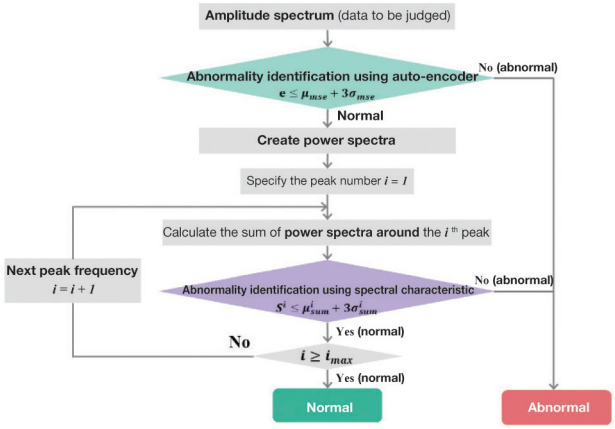

Fig. 5 Abnormality detection procedure[4)]

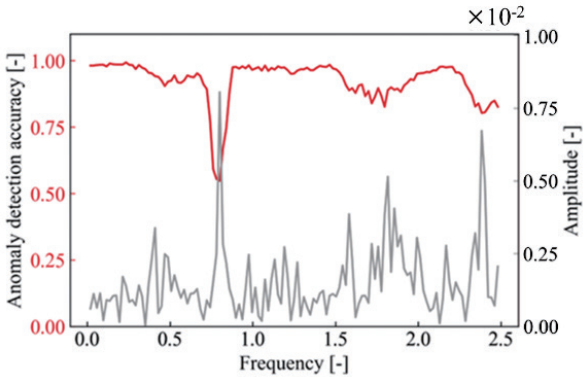

Fig. 6 Frequency data and abnormality detection rate (after improvement)[4)]

4. Examples of Application at Production Sites

A verification test was conducted to determine whether the abnormality detection system using the ML-DNN mentioned in Chapter 2 was effective for actual operation of production equipment. The test was conducted by the System Development Office, Digital Transformation Improvement Div., KYB Corporation. Specifically, operating time thresholds that can be easily controlled in the field were set and used to monitor any events that exceeded any of the thresholds. When such an event actually occurs, the ML-DNN is performed. If the result shows an equivalent abnormality, the ML-DNN should be able to detect abnormalities during actual operation.

The number of events exceeding the thresholds was visualized for easy identification using a business intelligence (BI) tool called Tableau, as shown in Fig. 7. The data was reviewed periodically. As a result, the phenomenon of an increasing number of abnormalities in

the "lateral release of the work clamp" action was observed twice in a given period. The fact that this abnormal phenomenon occurred twice during the period is also evident from the control chart shown in Fig. 8. The same data was used to run the ML-DNN as shown in Fig. 9 for comparison. This confirmed that the abnormality trend was identical between the two.

The actual equipment was checked against the data. Locations associated with the "lateral release of the work clamp" action were examined to find any abnormalities. As a result, Abnormality 1 was found to be air leakage from the air tube (Photo 1) and Abnormality 2 was found to be deterioration of one of the air tubes (Photo 2). The defective parts were replaced. It was also confirmed that the abnormality data was eliminated after replacement.
We are preparing for commercialization in FY2024 or later of the abnormality detection for high-pressure pumps using both the spectral characteristics of their pressure data and an auto-encoder. We also plan to continue verification of effectiveness for vibration and acoustic data.

5. Conclusions

This paper has introduced abnormality detection and prediction technologies for production equipment using DL data such as multi-labeled deep neural networks and auto-encoders. These technologies can be applied to cases where little abnormality data is available. Key elements in these cases include a signal processing technique used to extract characteristic values to be focused for abnormality detection. It is also important to identify abnormality factors of the equipment and discuss how their impacts appear. In this context, implementation of these technologies is equivalent to building a model of the target equipment and conducting failure diagnosis or prediction depending on how far the actual equipment is away from the model. These technologies are called system identification[5] in the field of control engineering. The knowledge of system identification technology can also be applied to the construction of technology for the diagnosis of abnormalities in dynamic systems.

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Fig. 7 Number of abnormal events exceeding the threshold

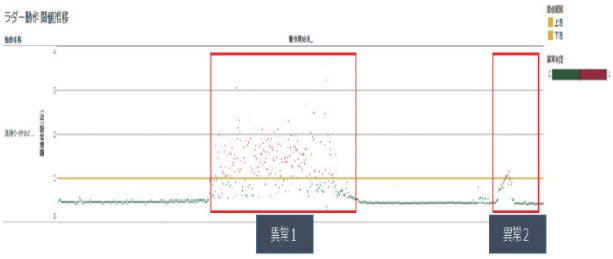

Fig. 8 Abnormality detection graph using control chart

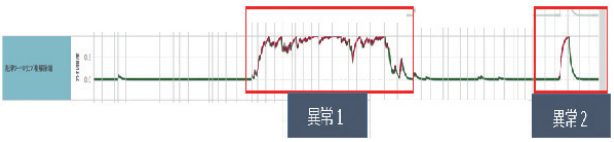

Fig. 9 Abnormality detection graph using ML-DNN

Photo 1 Abnormality 1 (air leakage)

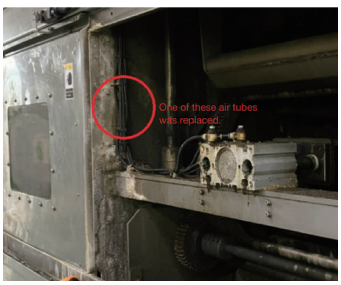

Photo 2 Abnormality 2 (deteriorated tube)

Technology Introduction

In-house application of XR (cross-reality) technology for realizing digital twins

OGAWA Atsushi・YONEHARA Yasuhiro・KONISHI Masahide

1 Introduction

The Internet of Things (IoT) technology has made remarkable progress in recent years. We are now able to collect, link, and display data, including numerical data and images, from a wide variety of things, further increasing the speed of information exchange. In addition, the use of wearable devices has transformed not only things or objects, but even people's life rhythms and biometric information into data. This has led to the creation of new products and services. As one of these new ways of using this type of data, Cross Reality (XR) technology, which represents (visualizes) data collected in the real world, has gained attention. This technology allows us to create new experiences by merging information from the real world with that from a virtual world.

As IoT and XR technologies have advanced in this way, the spotlight has also turned to digital twins [1], which duplicate the environment equivalent to the real world in a virtual world. The digital twin enables real-time monitoring and simulation, allowing us to verify in a virtual world the possibility of anything happening in the real world. The verification results are fed back to the real world using the XR technology, leading to efficient development and maintenance.

In response to these changes in the industrial structure, KYB is promoting digital transformation (DX) to change the way work is done using digital technology, to create new ideas and businesses in the fields of technology, quality, and manufacturing, and ultimately to improve quality and productivity. This paper mainly introduces current initiatives for using digital twins.

2 Digital Twins

Digital twins can be realized by combining many different technologies. Typical technologies include the above-mentioned IoT and XR technologies, the 5th Generation (5G) mobile communication technology that can reflect data collected with these technologies in real time without delay, Artificial Intelligence (AI) technology that can efficiently analyze large amounts of collected data, and Computer Aided Engineering (CAE) technology that can implement real-time simulation in a quasi-real environment in a virtual world.

The use of digital twins has already begun. One example is PLATEAU [2], a Japan-wide urban digital twin realization project led by the Ministry of Land, Infrastructure, Transport and Tourism (MLIT). These PLATEAU 3-dimensional urban models are open to the public. This open data is available to everyone and is used for a variety of initiatives.

The realization of digital twins makes it possible to safely replicate in a virtual world harsh conditions or destructive tests that are difficult to implement in the real world. We consider digital twins to be an important technology for the transformation of work using digital technology in KYB. Recently, KYB has focused on the use of AI and IoT technologies but has not yet started to work on XR technology. Then, we have carried out research and implementation of XR technology this time.

3 XR Technology

XR technology is a general term for a group of technologies that can create spaces for people to vicariously experience augmented reality (AR), virtual reality (VR), and mixed reality (MR).

AR technology is used to read the real world and display the results overlaid with virtual information, allowing people to experience an augmented real world. VR technology allows people to experience a virtual world created entirely with computer graphics (CG) as if it were a real world. MR technology, which is positioned as an intermediate between AR and VR, can allow people to experience a virtual world that is highly integrated with the real world through interactions between the real world and virtual information. For example, MR enables direct manipulation of objects reflected in a virtual world, including expansion, contraction, and overwriting of information. However, recent advances in image processing technology have led to an increasing number of contents that use a combination of AR, MR, and VR technologies. It has become difficult to draw a clear line between these technologies.

XR technology promises to be applied to many fields including remote work support, technology transfer/training, and layout study. It is expected to be used by utilizing the characteristics of MR, AR, and VR technologies. Table 1 shows examples of XR technology applications.

Table 1 XR technology applications

Type	Example of application
AR	Customer satisfaction improvement through product experience
MR	Work support with a combination of reality and CG
VR	Training program based on virtual experience with full CG

These XR technologies, which were originally developed for and used in the entertainment and sales promotion fields, have recently begun to find more applications in industry. One reason for this penetration is that compatible equipment has advanced to a level that meets market needs. Another reason is the established communication environment, which enables high-speed mass data transmission and improves real-time quality. In addition, the improvement of the remote working environment can encourage people to use XR technology as a remote communication tool.

With the above background in mind, we first selected AR/MR from the XR technologies. For testing purposes, we applied the technology to remote support tools, which are increasingly in demand due to the proliferation of remote work. Furthermore, we have been working on the development of content using highly flexible AR/MR for its future application to various settings in the company.

4 Compatible Devices

The use of XR technology requires compatible devices. For remote support and AR/MR content delivery, we used smartphones, tablets, and smart glasses. Smart glasses are wearable glasses that provide hands-free operation with good visibility. Fig. 1 shows an example of smart glasses.

Recently, smart glasses have evolved in several ways, including significant performance improvement, miniaturization and weight reduction, and adaptation to MR. Despite the high price, the performance improvement has led to an increase in their application in industry. As XR devices have become more powerful, the development of their software has become more active. Many software programs are being developed to provide remote support, operator support, and other various functions.

Fig. 1 Smart glasses

5 Use Case: Remote Support

Remote support is the real-time support of site operations from a remote location by sharing voice and image data over a network. We used a remote support tool to communicate between KYB sites. In addition to videophone conversations, the tool allowed us to give visual instructions to site workers by using AR technology. In this way, we achieved a smooth exchange of information even between remote locations.

Of course, this type of information exchange is certainly inferior in terms of the amounts of information that can be obtained by actually traveling to the site, as implied by the concept of "the actual place, the actual parts". Nevertheless, for remote places to which frequent travel is difficult, the use of this type of tool allows convenient communication. In fact, we have confirmed the high effectiveness of the tool, including the ease of obtaining the latest information about the site. It is better to use the tool and on-site communication on a case-by-

case basis, instead of depending on only one way.

6 Use Case: Application of AR/MR Content

6. 1 Creation of AR/MR content

This time we developed AR/MR content using an AR content creation tool and tested the content by displaying it with smart glasses. Fig. 2 shows the process of using AR/MR content. To provide valuable information using AR/MR displays, you need to develop an idea of what you want to realize. You should also draw pictures and graphics to embody and communicate the idea. Next, you prepare the necessary data based on the idea. The data can be a 3D CAD model, a scanned model, document files, or image data. You can then place the prepared data in a virtual world and explore how the content should appear from different perspectives including layout. Fig. 3 shows a conceptual image of content creation in a virtual world. Finally, you reflect the created data in the real world. After verification, you can move on to the delivery phase. After that, it is desirable to collect the knowledge gained from the delivery phase from time to time and update it regularly.

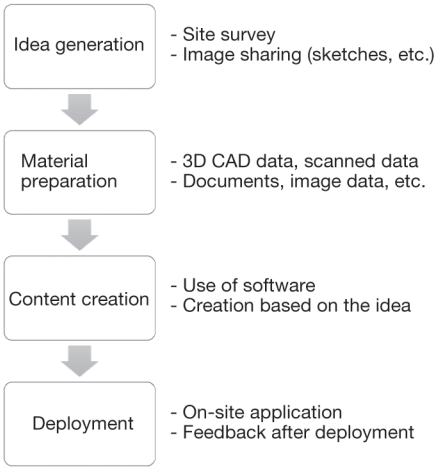

Fig. 2 Content creation process

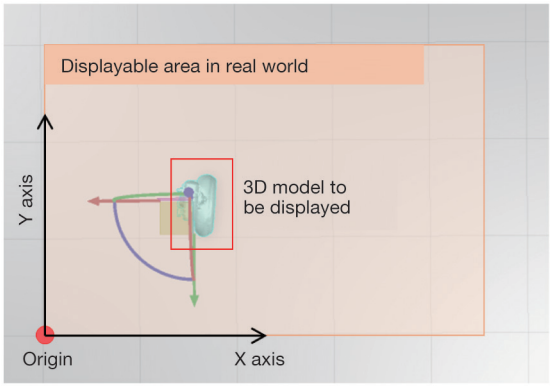

Fig. 3 Content image in virtual world

6. 2 Product Display on KYB Virtual Plant Tour

In KYB's virtual plant tour, which was held as one of its recruiting events for students, the company implemented the visualization of 3D models using AR/MR displays, instead of the conventional exhibition using actual products. The 3D model exhibition covered hydraulic damper (oleo struts), which are KYB's basic product. Fig. 4 shows the model created by 3D scanning.

In fact, the display of 3D data can hardly provide feelings of weight and quality. However, unlike the exhibition of real products, this data representation does not require us to worry about the weight of the product to be exhibited or the traffic line when transporting in the exhibition hall. Virtual products can be positioned at any angle in a given space, even in the air. In addition, the same virtual product can be viewed anywhere, not only in a specific physical place such as an exhibition hall, thereby enabling people to share information smoothly. Moreover, the virtual product displayed from the data can be easily rotated so that people can view the product from different angles without moving themselves. This means that if you use the technology effectively, you could deepen your understanding of the structure of the product more than through an actual exhibition. Those who experienced the AR/MR content gave positive comments, including that they could easily visualize the actual size of the product and easily understand the structure.

This application demonstrated that the AR content creation tool can provide an adequate level of 3D model visualization for smooth information sharing and deeper understanding of product structure.

Fig. 4 AR/MR display of the product (oleo strut)

6. 3 Virtual Product Display at KYB Museum

As a substitute for exhibiting the actual large hydraulic cylinder manufactured at Gifu South Plant, its 3D model visualization was made using the AR/MR display in the KYB Museum. Fig. 5 shows the 3D model of the hydraulic cylinder.

In fact, it was difficult to find a place to exhibit the cylinder in the KYB Archives building, as its installation space is limited due to its large size (5 m long) and weight (about 10 tons). This problem was solved by the AR/MR technology, which allowed the display in any given space, which led to the product display using this technology. To make the display more appealing, the 3D model was overlaid with animation to visually express how the hydraulic cylinder works. Fig. 6 shows an example of the animation. Those who viewed the content commented favorably on the life-size display of the model, which was enhanced by the animation.

This application proved that AR/MR display of large products that are difficult to display in a showroom can provide an effective presentation, and the addition of animation can make the display more appealing.

While this 3D data projection was basically a substitute for an actual display, it will be necessary to consider combining actual product displays with data projection to achieve an even better display that incorporates the best of both, as a measure to make it more appealing in a limited space. We believe that information display connected to the real world will help people understand better and find problems earlier.

Fig. 5 AR/MR display of the product (hydraulic cylinder)

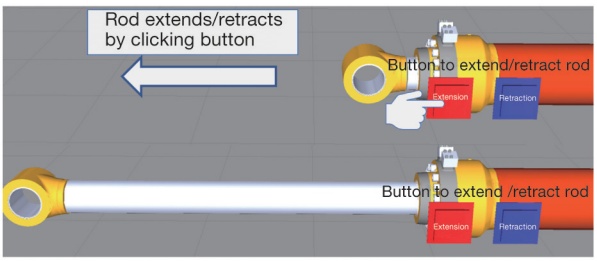

Fig. 6 Example of animation

7 Prospects

We have conducted a trial use for research and implementation of the XR technology and verified that it can be used in various settings and applications. The following describes what we are trying to use the technology for internally.

7. 1 Equipment Layout Planning

XR technology will be applied to equipment layout planning. We will use the technology to pre-design equipment layout in a virtual world and use the result in the real working environment to verify the layout.

7. 2 Operation/Training Manual Development

XR technology will be used to promote the electronification of paper-based documents. By using expressions that utilize the characteristics of XR technology, we will create digital versions not only of instruction manuals but also training materials.

8 In Closing

As part of the digital twin activity, we conducted research and testing of the XR technology and realized that the technology can provide various improvements.

Based on the results of this trial use, we will actualize this initiative and promote technology dissemination for a full-scale use.

Finally, we would like to take this opportunity to express our sincere gratitude to all those who have provided substantial support and cooperation in promoting this activity.

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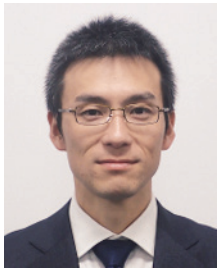
Authors

OGAWA Atsushi

Joined the company in 2012.
Electrification unit advanced development Sect., Basic Technology R&D Center, Engineering Div.
Engaged in research of new technologies and research & development of construction machinery systems.

KONISHI Masahide

Joined the company in 2012.
Mechanical Component Engineering Sect., Basic Technology R&D Center, Engineering Div.
Engaged in research of new technologies and research & development of vibration/noise related technologies.



YONEHARA Yasuhiro

Joined the company in 2007.
Section Manager, Electrification unit advanced development Sect., Basic Technology R&D Center, Engineering Div.
Engaged in research of new technologies and research & development of construction machinery systems.

Technology Introduction

Construction of an MAG small A2 line

CHEN Wei

1 Introduction

The MAG[Note 1)] small A2 line[Note 2)] is designed to produce its core product MAG-33 (Fig. 1), which is positioned as a key product for the company's cost reduction activities. In addition to cost reduction, it is also necessary to reduce variable costs and internal processing costs for the A2 line. In the company's assembly lines, labor costs account for a large percentage of the combined labor, operating, and equipment costs (Fig. 2). To achieve cost reduction, reducing labor costs is effective. In addition, as the birthrate declines and the population ages, the future shortage of labor on the production lines is becoming an issue of concern. To cope with this problem, it is necessary to reduce the burden on workers and promote automation.

On the other hand, the A2 line should be compact to satisfy the customer need for higher production capacity while it has to be installed in a limited space since the hydraulic pump/motor processing and assembly lines were put together at Sagami Plant located in Sagamihara City.

Fig. 1 Drive motor with reducer (MAG-33)

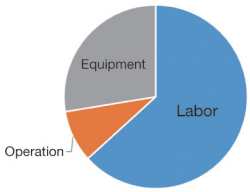


Fig. 2 Assembly line cost distribution (labor, operation, and equipment costs)

Note 1) An acronym for Motor Axial piton Gear box.

Note 2) An abbreviation of Assembly Line.

2 Purpose

To achieve the target internal processing cost and construct an assembly line using automation and digital technology without relying on human skill.

3 Targets

Table 1 shows the related target values:

Table 1 Target values

Item	Target (from conventional level)
Space	40% lower
Productivity by results	30% higher
Labor, operation, and equipment costs	18.9% lower

4 Requirements

[1] Development of new technologies for assembly automation
- Off-the-shelf components shall be used.
- Assembly of heavy components shall be automated in a small space at low cost.

[2] Development of automated data collection technology for hydraulic fluid contamination information
(Improving traceability: To follow customer demands)
- A system shall be built in collaboration with data analysis experts.
- Automated measurement shall be realized using advanced particle counters [Note 3)].
- The introduction cost shall be equivalent to that for existing equipment.

Note 3) Particle number measurement device

5 Overview of the Line

The MAG small A2 line is a high-mix and low-volume production line consisting of parts cleaning, assembly, and inspection (for air tightness and performance) processes (Fig. 3).

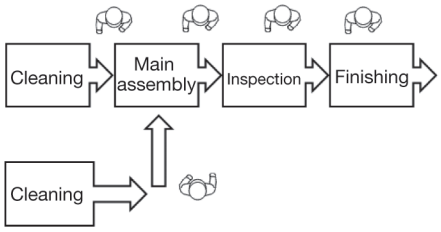


Fig. 3 Block diagram of assembly line

6 Activities

6.1 Development of New Technologies for Assembly Automation

6.1.1 Introduction of Automated Assembler for Housings and Flange Holders

This process assembles five parts (Fig. 4): a housing, an angular bearing, two floating seals, and a flange holder. The process involves lifting of the heavy housing (approx. 15 kg).

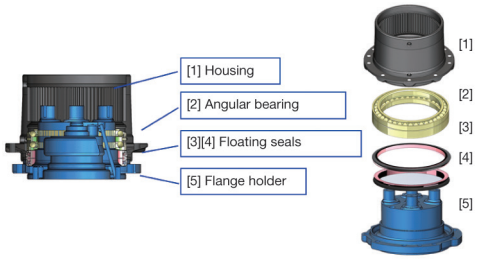
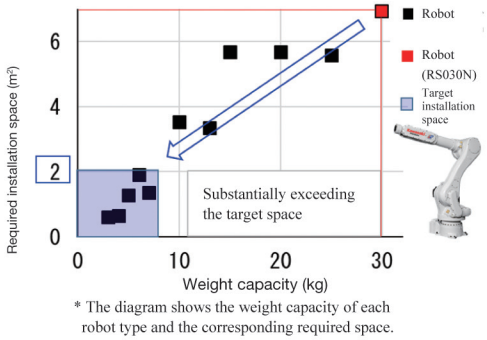


Fig. 4 Parts to be assembled

Traditionally, the heavy part was assembled manually (Photo 1). To improve safety and quality, we considered automating the manual task. At first, we studied the use of a heavy parts assembler robot, but the resulting robot was too large to be installed in the target space and cost significantly more than budgeted (Fig. 5). Therefore, we adopted a basic automation concept that the heavy parts assembler should have a simple structure. Based on this concept, we developed and introduced a simple structure assembler that can assemble heavy parts only by linear movement of its electric cylinder. Finally, we achieved the automation of heavy parts assembly with compact, low-cost equipment (Photo 2).

Photo 1 Manual lifting



* The diagram shows the weight capacity of each robot type and the corresponding required space.

Fig. 5 Weight capacity and required space of robots

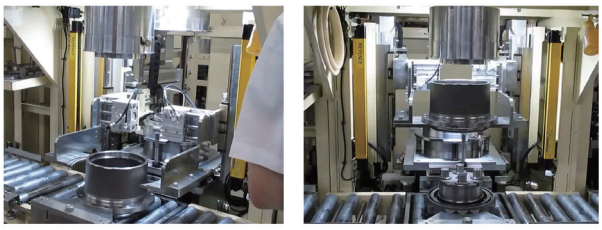


Photo 2 Automation of heavy parts assembly

6.1.2 Introduction of Automatic Plug Height Measuring Device

A claim was made that the sprocket could not be mounted to the drive motor because the plug was protruding from its seat on the sprocket mounting surface (Fig. 6). As a countermeasure, a step to measure the height of the plug with a dial gauge was added to the tightening error prevention system. However, this manual measurement process eventually resulted in variations in handling time, measurement time, and measurement results.

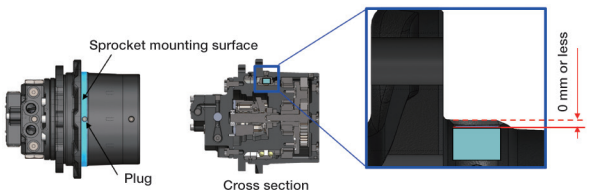
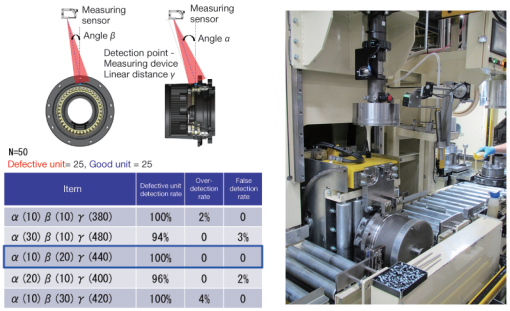


Fig. 6 Overview of plug protrusion

We then attempted to automate the plug height measurement process. The challenge was that the line produced a variety of motor products with different plug heights and positions. However, we were able to

automate the plug height measurement process without increasing the number of devices or installation space by determining the optimal plug installation angle and height using a commercially available laser sensor (Fig. 7).



Item	Defective unit detection rate	Over-detection rate	False detection rate
α (10) β (10) γ (380)	100%	2%	0
α (30) β (10) γ (480)	94%	0	3%
α (10) β (20) γ (440)	100%	0	0
α (20) β (10) γ (400)	96%	0	2%
α (10) β (30) γ (420)	100%	4%	0

Fig. 7 Automated plug height measurement

6. 1. 3 Sequential Setup of Performance Tester

The line was analyzed for downtime to improve line availability (Fig. 8). The result showed that setup time accounted for 41.4% of the downtime. In particular, the setup of the performance tester was a bottleneck, indicating the need to eliminate unnecessary setup time.

In order to improve the setup of the performance tester, a work study was conducted, and it was found that it took a long time to eject the products, which resulted in a loss of time (Fig. 9).

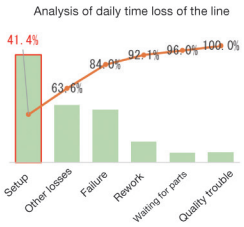


Fig. 8 Downtime analysis

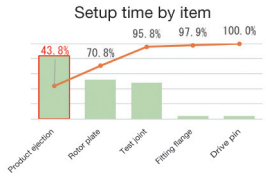


Fig. 9 Breakdown of setup time

For performance testing, the product is coupled to the shaft of the performance tester before being rotated with a pressure oil supply. The tester measures the speed, torque, pressure, and other parameters of the rotating product to determine the performance. The product can be coupled to the tester shaft by inserting the pin of the product's drive pin fixture into the hole of the rotor plate fixture attached to the shaft (Fig. 10). When connecting a different size product, the rotor plate fixture setup must be changed.

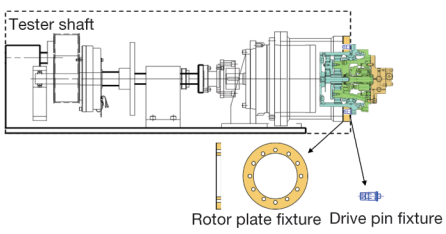


Fig. 10 Tester shaft and product

The performance tester is equipped with two shafts in order to reduce machine cycle time. While one product is being tested on one shaft, another product can be connected to the other shaft for alternate performance testing. The rotor plate fixture is located in a small space at the end of the performance tester's conveyor (Fig. 11). This means that the rotor plate fixture cannot be set up without ejecting the product from the tester, shutting down the equipment, and entering the tester for the setup change. Thus, the performance tester is not designed for sequential setup changes.

We then discussed how to achieve the sequential setup changes (Table 2).

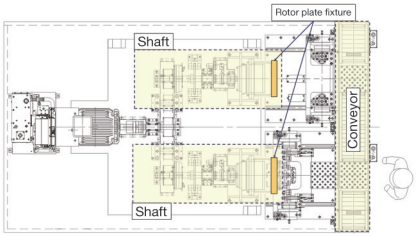


Fig. 11 Overview of performance tester

Table 2 Measures to achieve sequential setup changes

No.	Measure	Consideration for commercialization	Commercialization
1	Install a safety fence between the shafts to allow a setup change even while testing with the other shaft.	The safety fence may interfere with the test joint fixture moving between the two shafts.	×
2	Allow one type of rotor plate to accommodate all products.	Commercializable, although the structure of the drive pin fixture needs to be modified.	○
3	Automatic setup of the rotor plate	Automation has demanding space/cost requirements because the installation of this heavy object requires tightening operations.	×

As a result, we decided to use the drive pin fixture to accommodate products of different sizes. The drive pins to be inserted into the rotor plate were designed to have the same pitch so that one type of rotor plate fixture could accommodate all products. The drive pins were manufactured to have different pitches of the hole for product fixing to accommodate products of different sizes (Fig. 12).

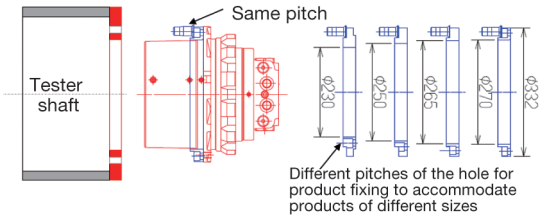


Fig. 12 Drive pin fixture [1]

In addition, we designed and fabricated another drive pin fixture with strength and weight optimized to maintain operability. This drive pin fixture has three holes for product fixing in the same manner as the conventional counterpart (Fig. 13), allowing the operator to complete the fixing within the same time as before.

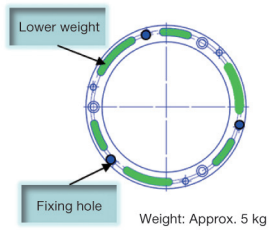


Fig. 13 Drive pin fixture [2]

By eliminating the setup changes of the rotor plate fixture and eliminating the product ejection for setup changes, we reduced setup time (Fig. 14) and achieved sequential setup changes of the tester.

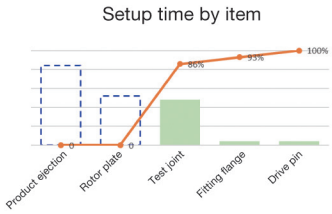


Fig. 14 Breakdown of setup time (after improvement)

6. 2 Development of Automatic Data Collection Technology for Hydraulic Fluid Contamination Information

6. 2. 1 Reduction of Fluid Contamination Analysis Time

Contamination of the hydraulic fluid in the performance tester is measured manually once a day. Measurements are recorded and maintained manually. It is desirable to measure product contamination for all units and use the measurement data to determine filter change frequency and ensure traceability, but it is difficult to measure all units by the conventional measurement method. We then discussed automating all units measurement with a new particle counter. However, there was no track record for the measurement accuracy of the new particle counter, which needed to be verified before implementation (Table 3).

Table 3 Comparison of particle counters

Particle counter	Conventional	New
Measurement method	Manual	Automatic
Measurement frequency (time/day)	1	220
Price (thousand yen)	3,000	1,500
Traceability	×	○
Measurement accuracy	○	?

The verification revealed that the measurement results of the new particle counter did not match those of the reference particle counter. The probable cause was that the new particle counter had a short measurement time in order to complete a measurement of all units. It was believed that the short measurement time resulted in variations in contamination from the products. We then worked to improve the measurement accuracy.

Specifically, we measured the contamination three times at the time of the product performance test while the hydraulic fluid was flowing into the return line (Fig. 15). The results were averaged within the PLC[Note 4)] to successfully reduce variations in product contamination. As a result, the new particle counter achieved automated measurement with the same accuracy level as the reference particle counter.

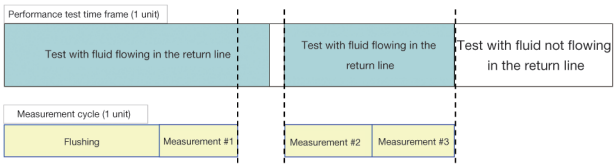


Fig. 15 Measurement averaging

We were also able to collect contamination data for each product. By analyzing the collected data, we were able to predict the right time to change the filter. In addition, with the support of the Production Innovation Div. in August, we successfully built a system that can write equipment data into the MES [Note 5)] (Fig. 16), thus increasing the human resources capable of building an MES at the Sagami Plant.

We will link the fluid contamination measurements with the dimensional data of machined parts and consider how to reduce the time for identifying products assembled with defective units.

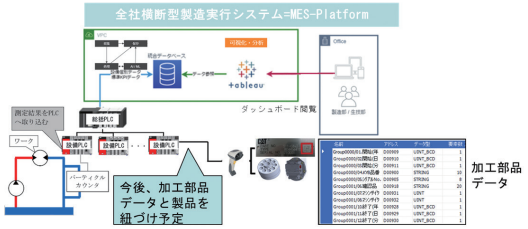


Fig. 16 MES system

Note 4) A control device used to control equipment and facilities.

Note 5) An acronym for Manufacturing Execution System.

7 Results

The results of the activities are shown in Table 4.

Table 4 Results of activities

Item	Target	Result	Mark
Space	40%	41%	○
Productivity by results	30%	30%	○
Labor, operation, and equipment costs	18.9%	19.5%	○

8 Conclusions

By horizontally expanding a low-cost, small-space automated assembly technology for heavy parts and using a small robot for light parts handling, we were able to build a compact, fully automated assembling machine. In addition, we achieved higher traceability of the key items of production and quality, and established a data collection and analysis base that enabled big data analysis. With the collected data, we will carry out activities to further improve productivity and quality.

9 In Closing

I would like to take this opportunity to express my sincere gratitude to the departments that have cooperated and to all those who have provided guidance and support in constructing this line.

Author

CHEN Wei

Joined the company in 2018.
Production Engineering Dept., Sagami Plant, Hydraulic Components Operations.
Engaged in design of assembly process and introduction of assembly equipment.

Technology Explanation

Development of a next-generation quality data management system

FURUKAWA Akira

Abstract

In recent years, Digital Transformation (DX) has been attracting attention worldwide. All sorts of industries, including manufacturing, finance, and information technology, are working on DX.

However, few companies in Japan have achieved adequate results with DX, and they lag behind their U.S. counterparts. One reason for this is the existence of legacy systems. Legacy systems are becoming less maintainable due to increased system complexity and data bloat, which increase system operating costs. In addition, it is difficult to improve and integrate these systems with other systems to drive DX, so there is a need to break away from legacy systems.

KYB also has many legacy systems and spends many man-hours on their operation and management. It is also difficult to utilize data linked with other systems to promote DX.

To solve these problems, we developed a next-generation quality data management system by renewing a legacy quality data management system. We believe this next-generation system will be a revolutionary low-cost system in terms of both cost and man-hours required for operation and management, and have developed the system based on this concept.

This paper describes the functions of the developed system, the migration method from the legacy system, and the development and operation system for continuous operation of the system.

1 Introduction

In recent years, DX has been attracting attention worldwide. All sorts of industries, including manufacturing, finance, and IT, are working on DX. Many companies in Japan have also launched DX initiatives. The proportion of these companies reached 69.3% in FY2022[1)].

However, few companies in Japan have achieved customer value creation or business model transformation through DX, while their simple digitization has had some effect. They lag behind their U.S. counterparts in promoting DX in terms of both human resources and technology. There are several possible reasons for the lag in DX. Three typical causes are:

[1] Organizational problems
[2] Lack of human resources
[3] Existence of legacy systems

Regarding item [1], management has failed to present a direction to work on DX as a management strategy. There is no organization-wide scheme to involve employees in DX activities.

For [2], Japan faces a shortage of human resources that can be mobilized to use digital technology. In order to promote DX, it is necessary to effectively utilize digital technologies such as cloud and AI [Note 1)].

Item [3] means that the country has many legacy systems, which consist of old technologies and mechanisms. These legacy systems have become bloated, complicated, and turned into a black box, making it difficult to make improvements to drive DX. In addition, legacy systems require a number of IT engineer man-hours to operate, causing another problem that these engineers do not have time to make improvements.

Therefore, it is essential to first eliminate these causes in order to promote DX.

KYB Corporation also has activities to promote DX. As a function to promote DX, the Digital Transformation Improvement Dept. was established in 2019[Note 2)] and has

been working on various efforts. First of all, the company has built the KYB-IoT Platform on the Amazon Web Services (AWS) cloud itself as a base to utilize data[2]. On this base, we are working on the development of a preventive equipment maintenance system as DX in the production field[3], and the application of AI technology to the development of mechanical components of shock absorbers (SA) as DX in the product development field[4]. In addition, the company is working to develop human resources skilled in digital technology[5]. A company-wide scheme for promoting DX is almost ready.

However, the company has not yet launched an effort to break away from the legacy systems and still spends many man-hours on their operation and management[Note 3]. Another problem with these systems is that they were built for individual optimization. It is therefore difficult for them to use data and develop new functions in conjunction with other systems to promote DX.

To solve these problems, we renewed the conventional quality data management system, which was one such legacy system, to develop a next-generation quality data management system. We believe this next-generation system will greatly improve the failure/disaster control and provide diversified analysis by linking with other multiple systems. This will be a revolutionary low-expenditure system in terms of both cost and man-hours required for operation and management. Specifically, we have developed the next-generation quality data management system based on the following concepts:

[1] Develop a cloud-based system that is resilient to failures and disasters and reduce operational and management time.

[2] Reduce developer workload with low-code development tools and eliminate reliance on human skills for post-development maintenance.

[3] Identify and resolve problems earlier by detecting system abnormalities (error handling and illegal operation).

[4] Facilitate data linking between different systems through data aggregation and integration.

[5] Automate the system configuration management with IaC[Note 4] and testing and deployment with CI/CD[Note 5], preventing update errors and eliminating reliance on human skills for administration and development.

Note 1) An acronym for Artificial Intelligence.

Note 2) The Digital Transformation Improvement Dept. and IT Planning Dept. were unified into the Digital Transformation Improvement Division in April 2023.

Note 3) KYB has traditionally developed itself various systems in the production field. These systems have been operated by the Digital Transformation Improvement Dept.

Note 4) An acronym for Infrastructure as Code. Refers to building system infrastructure using codes.

Note 5) An acronym for Continuous Integration/Continuous Delivery. Refers to an approach to software development that uses automation in the processes of building, testing, releasing, and deploying software through the use of dedicated tools to achieve efficient development, labor savings, and earlier reflection in the production environment.

2 Overview and Challenges of the Conventional System

This section describes the conventional quality data management system. This system collects and accumulates quality information, including product processing conditions and test measurements collected by equipment and testers. Through the information, operators can identify changes and trends in measurements and use them for daily quality control and traceability in case of failure. This system has been introduced to six sites inside and outside Japan that produce power steering and/or CVTs[Note 6]. More than 20 years have passed since the first system was introduced at one of these sites.

Note 6) An acronym for Continuously Variable Transmission.

2. 1 System Configuration

Fig. 1 shows the block diagram of the conventional system. The system puts together files that record quality data collected from various equipment units on an on-premises server, partially formats the data on the server, and stores it in a relational database (RDB) for centralized management. The RDB can be accessed with dedicated software developed in-house, allowing operators to view performance data and register master data necessary for the system. The RDB is based on an Oracle database. The software used to view performance data and register master data was developed in-house using Microsoft Visual Basic .NET.

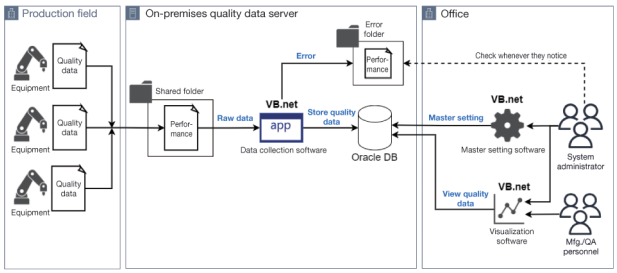


Fig. 1 Block diagram of the conventional system

2. 2 Challenges of the Conventional System

The conventional system has the following challenges:

[1] Increased man-hours and costs to operate and manage the system
- Man-hours and costs have increased due to regular server updates and maintenance and responding to aging issues.
- RDB licensing and maintenance costs have increased.
- Many man-hours have been spent adding functions and fixing problems due to the absence of the original developers and the inadequacy of documents.

[2] Inadequate failure/disaster response
- The system will inevitably shut down if the server or RDB fails due to the lack of a redundancy of the system.
- The system may not be recoverable in case of a natural disaster because there is no backup in a geographically remote location.

[3] Difficulty in promoting the use of data
- It is difficult to link the system with others because it was built for individual optimization.
- The technology is outdated with inefficient processing because the system was designed more than 20 years ago.

3 Requirements

This section describes the requirements for a new system to be viable by solving the challenges of the conventional system:

[1] The system should be built on the KYB-IoT Platform along with a corresponding AWS-based cloud.

[2] System reconstruction should be made to provide an optimal mechanism, rather than just cloud migration.

[3] Conventional core functions should be maintained, while those that cannot be easily used should be improved.

[4] Horizontal expansion and function addition/maintenance should be easy.

[5] The RDB should be transferred from the commercial DB to an OSS[Note 7)] based database.

Requirement [2] needs some additional information. AWS proposes a set of cloud migration strategies called "the seven Rs"[6]. These migration strategies are listed in Table 1 in order of difficulty. Among them, the most difficult strategy, namely Refactor, is what we are trying to achieve in this development project. This strategy requires a long time for development but can be expected to bring the most effect from cloud migration.

Table 1 Seven cloud migration strategies

Migration strategy	Outline
Refactor	Redesign applications to take full advantage of cloud-centric functions.
Replatform	Move specific components to a cloud-based service.
Repurchase	Perform cloud migration by purchasing SaaS and application packages.
Rehost	Move the conventional on-premises configuration directly to cloud infrastructure.
Relocate	Move the conventional on-premises configuration directly to the VMWare Cloud on AWS.
Retain	Keep the system as-is without cloud migration.
Retire	Retire the system.

Note 7) An acronym for Open-Source Software. Refers to free software whose source codes can be freely modified and distributed.

4 Development of a New System

4. 1 System Configuration

Fig. 2 shows the block diagram of the newly developed system.

While the production field is untouched, the following field, surrounded by a red line, has been reconstructed.

A Microsoft Azure virtual server is used to aggregate quality data files collected from various equipment units. This is the only IaaS[Note 8)] among the resources built in the cloud. This was because data collection without changing the processing on the equipment side required a Windows server as for the conventional system. Since KYB has built several Windows servers on Azure, this system also has an Azure-based server for integrated management. This server is mainly used to cache quality data files and then transfer them directly to AWS.

The process of storing collected quality data for centralized management has been built on AWS. Most of the processing uses AWS managed services, although their details are not shown in the Figure. This reduces the administrator's workload and makes the system configuration resilient to failures and disasters.

For reference, Fig. 3 shows a comparison of RDB management between the conventional and new systems.

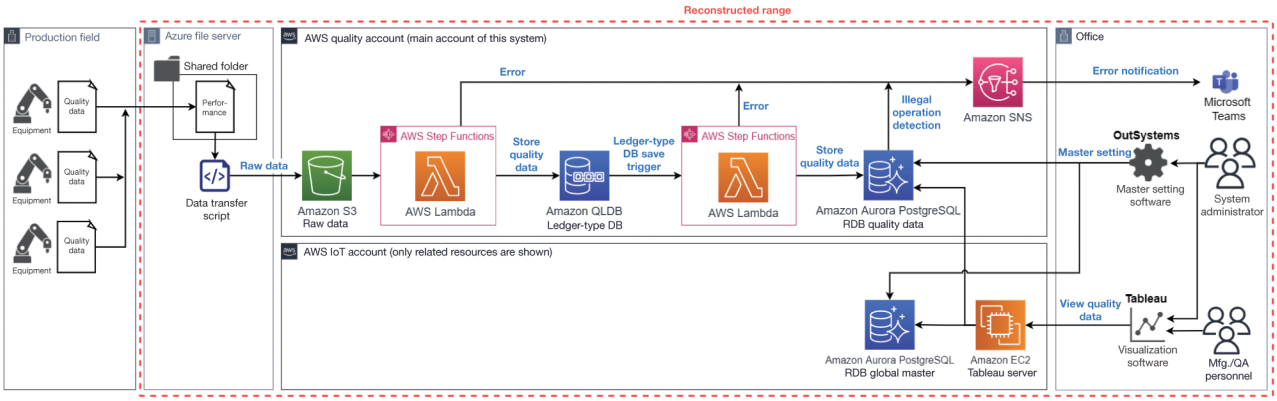


Fig. 2 shows the block diagram of the newly developed system.

The new system eliminates the management of servers, networks, and DB middleware, substantially reducing the administrator's workload.

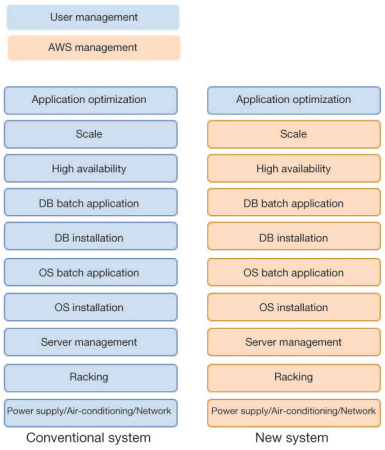


Fig. 3 Comparison of responsibilities for RDB building, operation, and management

We have redeveloped a visualization software that allows users to view collected quality data and a software for setting master data required by the system by using low-code development tools[Note 9] called Tableau[Note 10] and OutSystems[Note 11]. Both tools enable easy software development with a small number of source codes mainly through drag-and-drop actions, which significantly reduces the development man-hours from the conventional level. For more information about the developed software, see Section 4.5.

This development project consists of six main specific activities as below. Each is described in the following sections.

[1] Data Migration
[2] Data storage and management
[3] Detection of errors and illegal operation
[4] Development of visualization software
[5] Development of master setting software
[6] Improvement of data linking

Note 8) An acronym for Infrastructure as a Service. Refers to cloud services that provide infrastructure.

Note 9) A tool used to develop software with minimal source codes.

Note 10) A Business Intelligence (BI) tool provided by Salesforce that enables visual analysis with a variety of graphs and charts.

Note 11) A low-code development platform provided by OutSystems that enables development of various applications including Web and mobile applications.

4. 2 Data Transfer

Before the new system is put into operation, the data accumulated in the conventional system must be transferred to the new system. Instead of directly transferring the data from the conventional configuration, this development project transferred the data with the following modifications:

[1] The database type was changed from Oracle to OSS PostgreSQL.
[2] The configuration and names of schemas and tables were changed.

Reasons for change [1]:

- Choosing the OSS DB reduces the licensing and maintenance costs.
- The transfer was relatively easy because the PostgreSQL has many data types and functions that are highly compatible with those of Oracle.
- The PostgreSQL can deliver high performance.

Reasons for change [2]:

- The conventional DB needed to be reviewed in terms of configuration, as its bloated data caused lower performance.
- The data storage method was unified with a view to future integration with other systems.

The data transfer process is shown in Fig. 4.

First, the on-premises Oracle data was transferred to Amazon RDS for Oracle. After partial data processing, AWS Database Migration Service (DMS) was used to

transfer all data to Amazon Aurora PostgreSQL (Aurora PostgreSQL). Additional data processing and conversion was also performed on Aurora PostgreSQL to complete the data transfer in the intended configuration.

This data transfer method involves a simple procedure that transfers all the data at once but requires the system to interrupt some functions during the data transfer to avoid updating data other than the data being transferred. Of course, there are other methods where the system only needs to be interrupted for a short time, but the transfer work will be correspondingly complicated and difficult. Finally, we used this data transfer method with the simple procedure because this system could accept several days of system interruption.

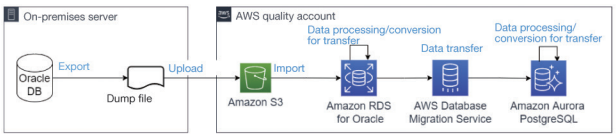


Fig. 4 Data transfer process

4. 3 Data Storage and Management

Quality data collected from the equipment is important information used to prove the quality and performance of the products. In this development project, the data storage system is designed to eventually store data in two databases: Amazon Quantum Ledger Database (QLDB) and Aurora PostgreSQL. QLDB is a full managed ledger-type database where data, once stored, cannot be physically modified even by the administrator. Aurora PostgreSQL is a high performance, managed RDB built by AWS for use in the cloud that achieves higher performance and availability than regular RDBs.

Storing quality data in the QLDB prevents physical alteration of the data, thus providing a tamper-proof data management system. However, QLDB is primarily intended to be used for data storage and management and can hardly provide such complex data retrieval as seen in the conventional linking of multiple information sets. We then designed the system to store quality data also in RDB Aurora PostgreSQL so that users can access Aurora PostgreSQL to retrieve data. The master data needed to operate the system is also managed in Aurora PostgreSQL so that it can be modified as circumstances require.

The two different types of databases are used in this way to ensure data management that achieves both tamper prevention and data retrieval.

4. 4 Notification of Processing Errors and Illegal Operation

Quality data is checked for proper format and information before it is stored in the databases. The data storage process takes place only after the data has passed the final check. Of course, the conventional system also provided this kind of data checking function, which, in case of error, moved the corresponding file to an error data folder. However, the conventional system did not notify the occurrence of errors, resulting in a delayed response in some cases.

For the new system, we then developed a processing function to notify Microsoft Teams (Teams) of the occurrence of errors. Fig. 5 shows an example of screens containing messages notified to Teams[Note 12]. These messages allow the user to identify in which file for which equipment the error has occurred. In addition, clicking on a URL on the message screen will display the master setting software described later. Using the software, the user can download the file with the error to respond to the error. This error notification and response mechanism has been used to solve the conventional problems.

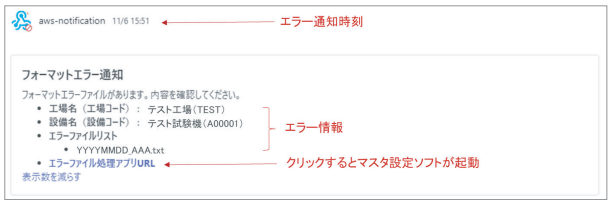


Fig. 5 Example of format error messages to Teams

The notification function has also been deployed to make Aurora PostgreSQL tamper-proof. As described in section 4.3, data stored in QLDB cannot be tampered with even by the administrator, so no specific measures are required. However, the data that the user sees is the RDB on Aurora PostgreSQL. If data in the DB is manipulated, it is a problem. On the other hand, Aurora PostgreSQL provides strict access management that prevents data modification by general users, which means that data tampering never occurs during regular use. However, if the administrator's credentials are stolen and used to access Aurora PostgreSQL, data can be tampered with.

Then we designed the system to notify Teams that any quality data stored in Aurora PostgreSQL has been modified or deleted, or any operation that could lead to data addition or illegal connection has been performed by an irregular user or from an irregular location. Fig. 6 shows an example of screens containing messages notified to Teams[Note 13]. These messages allow the user to identify who performed what operation for what, when

and where. Based on this information, the user can determine whether or not an illegal operation has occurred and then take action if necessary. In addition, the user can compare the data with the data stored in the QLDB, if necessary, to determine whether or not data tampering has occurred and to determine the true value of the data.

Note 12) The messages shown in the Figure are only examples and may differ from the actual ones.

Note 13) The messages shown in the Figure are only examples and may differ from the actual ones.

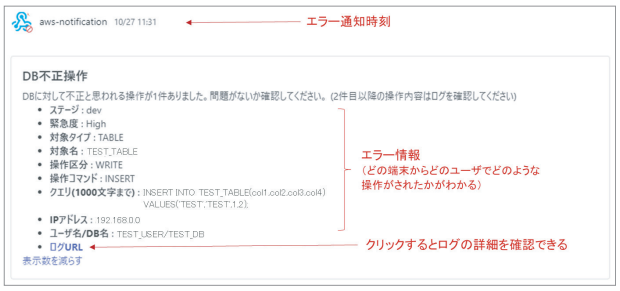


Fig. 6 Example of DB tampering messages to Teams

4. 5 Development of Visualization Software

To visualize the collected quality data, we developed a visualization software using Tableau. Below are some of the screens of the developed software.

4. 5. 1 Measurement Data Display Screen

This screen shows how the collected quality data changes over time using graphs and tables (Fig. 7)[Note 14]. From this screen, the user can determine the trend of quality data for daily trend management, including identifying abnormal data or data that may become abnormal in the long run.

Note 14) Some information that should not be disclosed has been intentionally deleted or shaded.

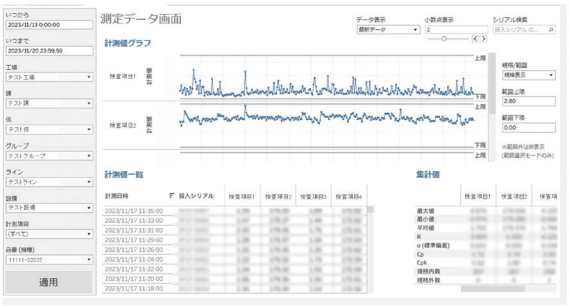


Fig. 7 Measurement data display screen

4. 5. 2 Histogram Display Screen

This screen displays the histogram of collected quality data (Fig. 8)[Note 15]. On this screen, the user can check the variation of the quality data to identify any abnormal data for daily trend management.

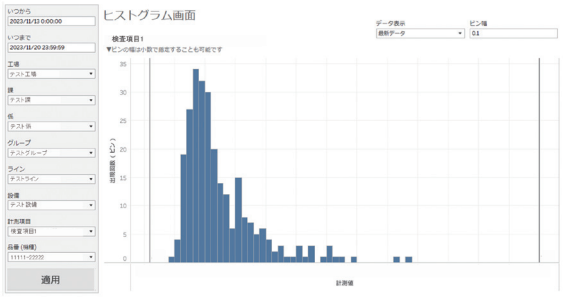


Fig. 8 Histogram display screen

Note 15) Some information that should not be disclosed has been intentionally deleted or shaded.

4. 5. 3 Traceability Search Screen

This screen provides an at-a-glance view of the assembly and subassembly information associated with a product's serial number (Fig. 9)[Note 16]. If a problem occurs, the user can identify the related parts from the serial number to determine the scope of the problem.

Fig. 9 Traceability search screen

Note 16) The data shown in the Figure are only examples and may differ from the actual ones.

4. 6 Development of Master Setting Software

We have developed the master setting software using OutSystems to allow registration of master data necessary for system operation and to support correction of any data format errors. Below are some of the screens of the developed software.

4. 6. 1 Quality Inspection Items Master Registration Screen

This screen is used to register inspection items for specific quality data to be collected (Fig.10)[Note 17].

Registration can be done on this screen to initiate the collection of new data or to change inspection items in the middle of a data collection session.

Note 17) The data shown in the Figure are only examples and may differ from the actual ones.

Fig. 10 Quality inspection item master registration screen

4. 6. 2 Form Error File Processing Screen

This screen is used to identify files that were found to be in error during the format check process prior to saving data, and then to re-upload or delete these files if necessary, as described in Section 4.4 (Fig. 11)[Note 18]. The screen provides an at-a-glance list of erroneous files, from which any file can be selected and downloaded. The user can examine the file to correct errors and re-upload the file. The master setting software provides access rights for each screen, and this screen can only be accessed by designated administrators. This screen also records the operation history. An incorrect operation, if any, can be then traced.

Note 18) The data shown in the Figure are only examples and may differ from the actual ones.

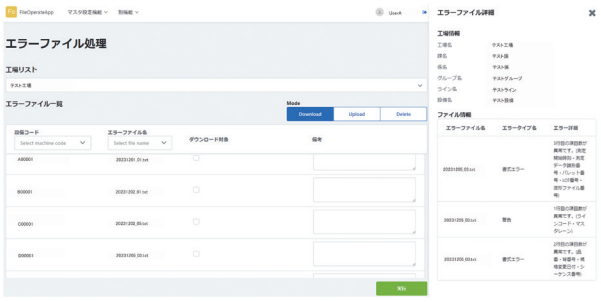


Fig. 11 Format error file processing screen

4. 7 Improvement of Data Linkage

In the conventional quality data management system, the master information was managed by individual systems. Even if different systems collected information about the same line, the systems could hardly link their data with each other because their line control units were different. We then created a global master table to manage the master information of plants, lines, equipment, and others that may be used by multiple systems, and built a mechanism for centralized management (Fig. 12). This mechanism allowed different systems to obtain information from the same line and equipment, thus improving the data linkage between them.

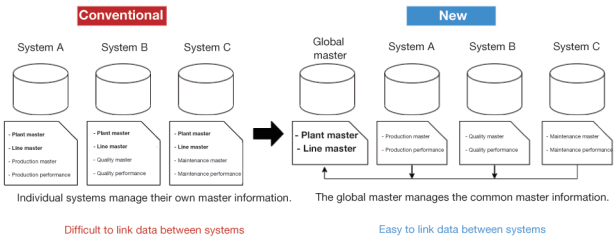


Fig. 12 Improvement of data linkage

At the time of writing this paper, this newly developed global master system has not yet achieved data linkage with other systems. However, the link will be made not only with the quality data collected by this system, but also with manufacturing, equipment maintenance, and other information to enable diversified data analysis. This is expected to contribute to higher quality and productivity.

5 Efforts for Continual Development and Operation Scheme

5. 1 Multi-account Cloud Operation

KYB has started to provide comprehensive services with multiple systems built on AWS. To ensure that the systems with different access rights under different service environments are operated securely, the company provides multi-account operation by assigning a separate AWS account to each application.

Fig. 13 illustrates this multi-account management and operation scheme. AWS Organizations is used to provide integrated account management, preventing the omission of minimal settings (such as log collection for security and auditing) for certain accounts. In addition, AWS IAM Identity Center is used to provide single sign-on so that each account can only be accessed with appropriate privilege.

Multiple accounts were created individually because this system handles quality data that requires even tighter access control. In addition, different accounts have been assigned to the development and production environments with different access rights. For example, developers are allowed to read and write data with the development environment account but are not allowed to write with the production environment account. These separate accounts are used to ensure proper access

control to prevent developers from accidentally shutting down the production system and other problems.

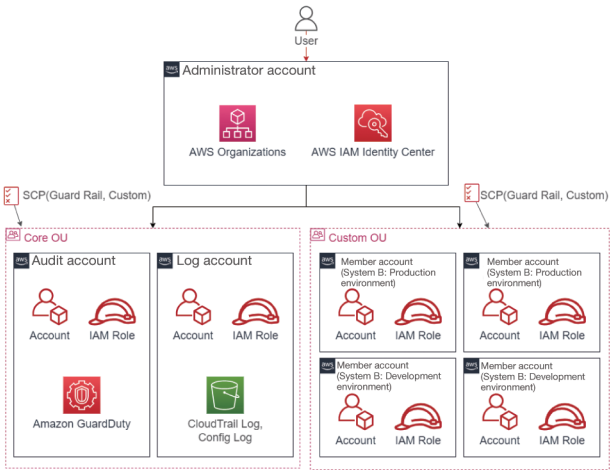


Fig. 13 Multi-account management and operation

5.2 System Development with IaC

In view of future developability and maintainability, this development project uses IaC for system development. In system construction, the use of IaC increases the efficiency of reuse, reduces human errors due to manual execution, facilitates version control, and realizes a CI/CD mechanism that enables automation of processes including testing to deployment. (Version control and automation of processes up to deployment will be explained in the next section).

In this development project, workflows and applications built with AWS Step Functions, AWS Lambda, or other services (including the data storage described in Section 4.4) were created using the Serverless Framework, while databases, networking, and security-related infrastructure were built using HashiCorp Terraform.

5.3 Automation of Testing and Deployment with CI/CD

Using IaC facilitates version control. In this development project, a source code version control tool called GitLab is used to control versions of the applications and infrastructure described in Section 5.2. GitLab includes a CI/CD feature that is used for testing of source code pushed into the Git repository and for deployment to AWS Clouds. Fig. 14 shows the source code flow from creation to deployment to AWS Clouds Note 19).

The first step is to create a source code. A feature branch that contains the current version of the source code is created in Gitlab, and work is performed in that branch. When the work is done, the source code is pushed to the feature branch, and then a merge request is made to the develop branch. At this point, GitLab

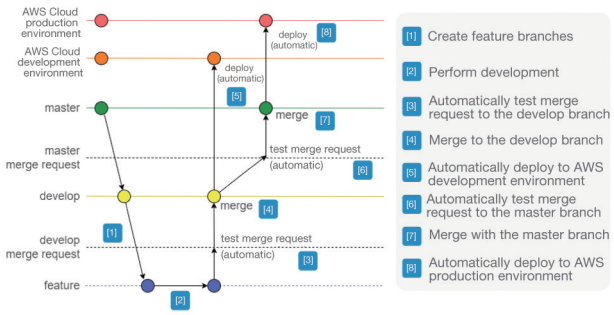


Fig. 14 Workflow from development to deployment using GitLab

automatically verifies the source code to make sure there are no problems. After that, the administrator performs a manual check, and if there are no problems, performs the merge. At the same time as the merge, the deployment task to the AWS Cloud is automatically executed, and the applications and infrastructure described in the source code are finally deployed to the development environment in the AWS Cloud. In addition, when merging from the develop branch to the master branch, automated testing and deployment tasks are executed in the same way, and finally the applications and infrastructure are deployed to the production environment in the AWS Cloud. By performing the above sequence of steps from development to deployment to the AWS Cloud, we can eliminate work errors and reduce the number of man-hours required.

Note 19) The Company's Git management is based on Git Flow Note 20). We merge the develop branch into the master branch without using the release branch.

Note 20) One of the workflows for effective version control and development proposed by Vincent Driessen.

6 Prospects

This new quality data management system was actually implemented at one site and put into full operation as of December 2023. It has not yet produced any remarkable results in this short period of use, but it has gradually started to show effects, including a reduction in the number of man-hours for management due to the elimination of on-premises servers and a reduction in the number of man-hours for daily work due to added functions. From now on, the system will be expanded horizontally to the remaining five sites, completing the migration from the legacy quality data management system.

In addition to this system, KYB has many other legacy systems. By leveraging the insights gained from this development project, we will sequentially perform the

cloud migration or re-architecture of these systems to complete the exit from all kinds of legacy systems.

In fact, just breaking away from legacy systems will not facilitate DX. By simultaneously achieving data linkage with other systems and building a data analysis base using AI, we will activate the use of data and promote DX, contributing to higher productivity and higher quality.

7 Concluding Remarks

This development project has successfully built the next-generation system to greatly improve the failure/disaster control, provide diversified analysis by linking with other multiple systems, and revolutionarily reduce both cost and man-hours. As a result, this new system has resolved many problems of the conventional legacy system, gaining a beachhead from which to promote DX.

However, the migration from the legacy system is only a preparation for DX improvement. We will continue to pursue DX improvement by laying the groundwork and developing functions for continuous data utilization.

Finally, I would like to take this opportunity to express my sincere gratitude to all those in related departments who have provided substantial support and cooperation for this development project.

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Author

FURUKAWA Akira

Joined the company in 2005.
System Development Sect., Digital Transformation Improvement Div.
Engaged in building of cloud-based IoT platforms and development of production systems.

Product Introduction

Development of a performance and quality improvement structure for ϕ37-mm upside-down front fork

SUZAKI Kei

1 Introduction

In the recent Indian motorcycle market, bikes of 150 cc or above, called the premium segment, have been growing in demand due to the rising income of the population (Fig. 1). As a result, many motorcycle manufacturers have been actively developing products for the premium segment. For the front fork (FF), which is highly related not only to performance but also to appearance design, demand for the upside-down type Note 1) with an upscale image has increased.

In 2021, KYB started mass production at KMSI (KYB Motorcycle Suspension India Pvt. Ltd.) of a small-sized upside-down FF (with φ37 mm inner tubes) for the low-displacement class vehicles in the Indian market. For this FF, we developed a new structure to further improve the performance and quality in this project, which is outlined below.

Note 1) An FF with larger outer tubes that are attached to the vehicle for greater rigidity, rather than the upright type with inner tubes that are attached to the vehicle.

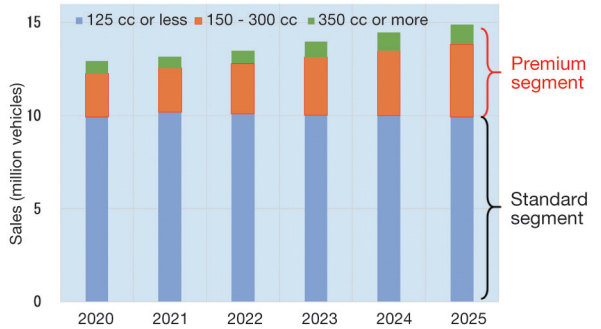


Fig. 1 Results and estimates of sales volume by vehicle displacement

2 Development History

Due to space constraints, the φ37 mm-upside down FF currently being mass-produced at KMSI has a bottom shock absorber mechanism (to absorb the impact through the suspension at its full stroke) using cushion rubber (Fig. 2), rather than a hydraulic compression stop (HCS) with high absorption energy.

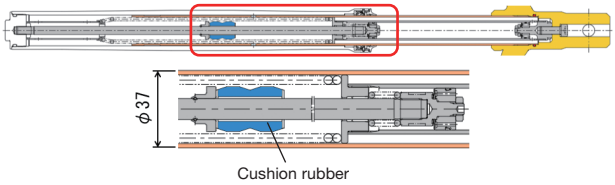


Fig. 2 ϕ37-mmupside-down FF bottom shock absorber mechanism

However, in the Indian market where it is common for riders to ride on poorly paved or unpaved roads, or to ride a motorcycle with three or more passengers (Photo 1), bikes cannot absorb the bottom shock with the FF with cushion rubber alone. This is compensated for by other design elements, including the load capacity of the springs, the compression ratio of the internal air, and the damping force on the compression side. In order to respond to various market demands, we thought that an HCS that could generate a high load capacity was a necessity, and then decided to develop one that could be mounted even on the φ37-mm upside-down FF.

Photo 1 Road condition in the Indian market

In addition, the connection between the inner tubes and the axle bracket (Fig. 3) is quality assured by inspecting for chips in the O-ring groove and by airtight-testing for oil leakage (Photo 2). These are necessary to eliminate concerns that any chips remaining in the O-ring groove at the end of the axle bore may damage the O-ring and cause oil leakage, and that if the cast axle has a communicating blowhole, it may leak oil when pressure is applied.

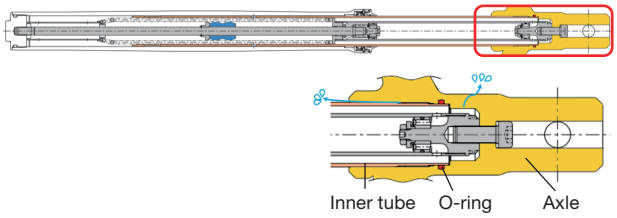


Fig. 3 Connection between inner tube and axle

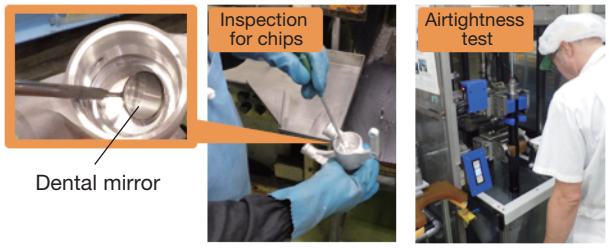


Photo 2 Inspection and test

3 Performance Improvement Structure

This section describes the HCS mechanism for the φ37-mm upside-down FF.

3. 1 Target Setting

By focusing on the weight of the vehicles to which the inner tube sizes will be applied, we determined the HCS load capacity required for the φ37-mm upside-down FF from the weight ratio. While the 400 cc class vehicle using a φ41-mm upside-down FF has a weight of approximately 200 kg, the 150 cc class vehicle using the φ37-mm upside-down FF has a weight of approximately 160 kg (Table 1). As a result, we set the required load capacity of the HCS for the φ37-mm upside-down FF to be 80% of that of the HCS for the φ41-mm upside-down FF (at the damper speed of 1.0 m/sec).

In fact, while the φ41-mm upside-down FF has an HCS on each of the right and left damper assemblies, the φ37-mm upside-down FF must concentrate its damping function on one side due to cost constraints and other factors. This means that a single damper assembly must provide twice the load capacity of an HCS. Therefore, the HCS for the φ37-mm FF must have 1.6 times the load capacity of the HCS for the φ41-mm FF.

Table 1 Comparison of vehicle specifications

FF size	φ41-mm upside-down	φ37-mm upside-down
Displacement	400 cc class	150 cc class
Vehicle weight	200kg	160kg

3. 2 Structure Study

3. 2. 1 Existing HCS Mechanism for ϕ41 mm FF

As shown in Fig. 4, the existing HCS mechanism for the φ41-mm FF has a structure in which a stop piece mounted on the piston rod slides with the piston rod and enters the case in the latter half of its stroke to form a high-pressure chamber, generating a damping force with an annular clearance between the outer surface of the piece and the case bore.

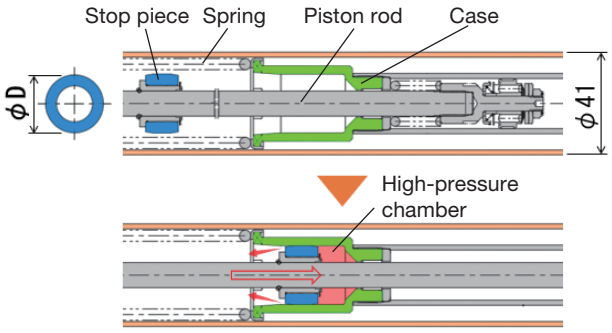


Fig. 4 Existing HCS mechanism for φ41-mm FF

3. 2. 2 Downsizing the Existing HCS Mechanism for ϕ41-mm FF

When the existing HCS mechanism for the φ41-mm FF was downsized for the φ37-mm FF, the compression area decreased because the size of the stop piece depends on the spring bore. As a result, the load capacity dropped by 60% from the level of the HCS for the φ41-mm FF, and the target was not achieved (Fig. 5).

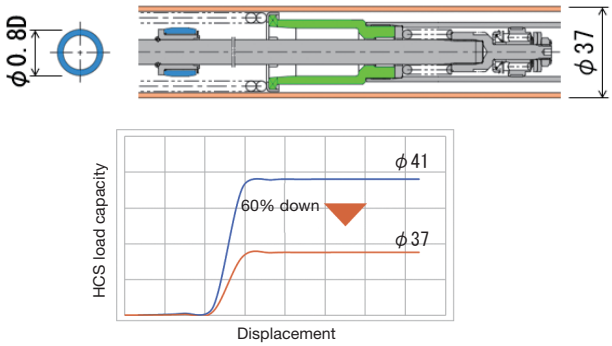


Fig. 5 Downsized existing HCS mechanism for φ41-mm FF

Next, we tried to increase the load capacity by reducing the clearance between the stop piece and the case. However, this approach inevitably led to tighter part tolerances for the clearance, resulting in a higher variation in the load capacity of the HCS (about 1.5 times that of the HCS for the φ41-mm FF). Another concern was that the stop piece could interfere with the case when it rapidly entered it.

3. 2. 3 New HCS Mechanism for ϕ37-mm FF

We then redesigned the HCS so that the stop piece is located inside the case, eliminating the dependence of the piece size on the spring bore size. This new design made it possible to mount the HCS on the φ37-mm FF while maintaining the required pressure area of the stop piece, thereby achieving sufficient load capacity generation of

the HCS (Fig. 6).

In this mechanism for generating the HCS load capacity, during the second half of the stroke, the stopper fixed to the piston rod pushes the piece already installed in the case to form a high-pressure chamber, generating a damping force. In the return stroke, the creation of a vacuum is suppressed by the petal-shaped bore of the piece, which is intended to ensure oil passage. In addition, a return spring has been added to help the piece quickly return to the initial position.

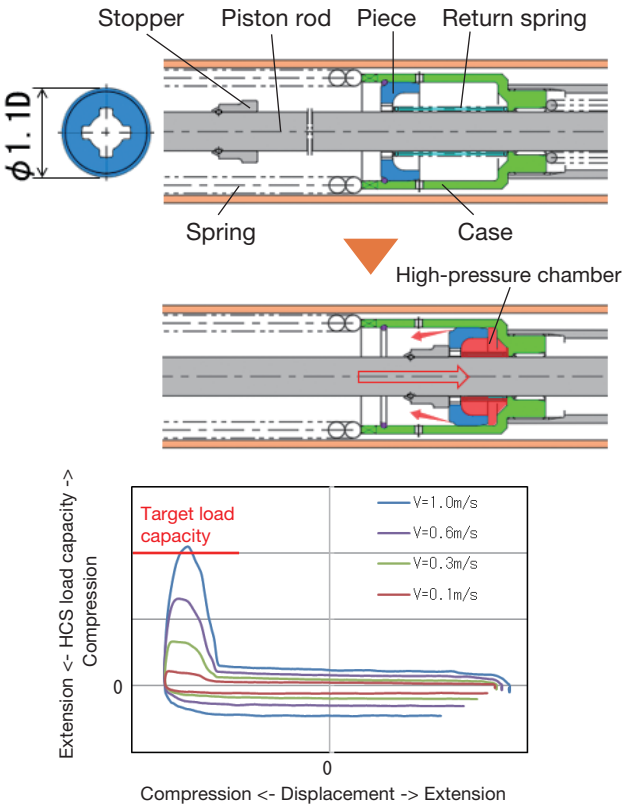
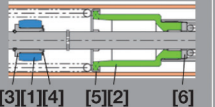
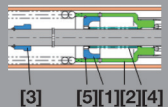


Fig. 6 New HCS mechanism for φ37-mm FF

3.3 Costs

Compared to the existing HCS mechanism for the φ41-mm FF, the new HCS mechanism resulted in a cost reduction of approximately 23% due to the lower number of parts used (Table 2).

Table 2 Comparison of parts list

Existing HCS for φ41-mm FF	New HCS for φ37-mm FF
	
[3][1][4] [5][2] [6]	[3] [5][1][2][4]
[1] Stop piece	[1] Piece
[2] Case	[2] Case
[3] Piece holder	[3] Stopper
[4] Washer	[4] Return spring
[5] Spring sheet	[5] Stop ring
[6] Washer	
Total six parts	**Total five parts**

4 Quality Improvement Structure

This section describes the structure for improving the connection between the inner tube and the axle.

4.1 Approaches

To create an oil-leak proof robust structure we decided to eliminate the O-ring groove of the axle and modify the axle construction to have no pressure.

4.2 Structure Study

4.2.1 Conventional Structure

There are concerns that any chips remaining in the O-ring groove at the end of the axle bore may damage the O-ring and cause oil leakage, and that if the cast axle has a communicating blowhole, it may leak oil when pressure is applied. Therefore, inspection of the O-ring groove for chips and airtightness tests are performed to ensure quality. The contact surface between the bolt used to tighten the cylinder comp. and the axle is sealed by inserting a copper packing (Fig. 7).

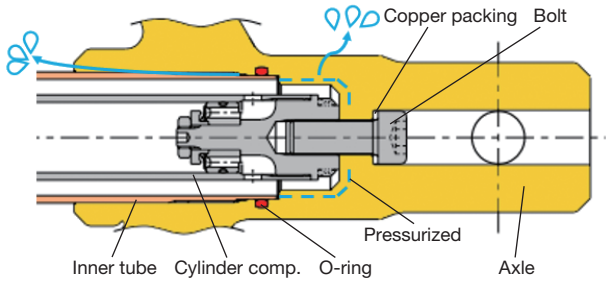


Fig. 7 Conventional structure of the connection between inner tube and axle

4.2.2 Proposed Additional Structure with Ring Collar

In this proposed structure, a collar is added as a new part to seal the inner tube bore, eliminating the O-ring groove of the axle. However, the axle is still pressurized and may leak oil if it has a communicating blowhole. Therefore, it is necessary to ensure quality by performing an airtightness test (Fig. 8).

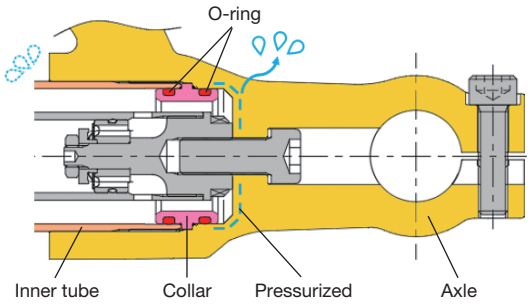


Fig. 8 Proposed additional structure with a ring collar

4.2.3 New Structure of Connection Between Inner Tube and Axle

We improved the above structure by changing the ring

collar to a plate collar and by attaching the cylinder comp. to the collar, not to the axle, and by inserting the collar between the inner tube and the axle. These improvements made it possible to eliminate the O-ring groove of the axle and to create a structure in which the axle is not subjected to pressure (Fig. 9).

This structure made it possible to completely eliminate the causes of chips remaining in the O-ring groove of the axle and the oil leakage due to a communicating blowhole.

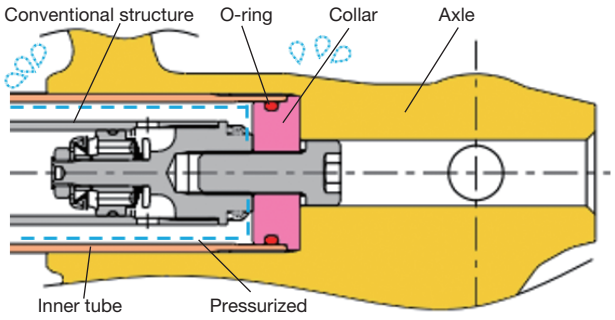
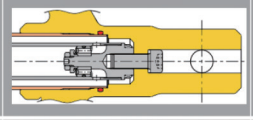
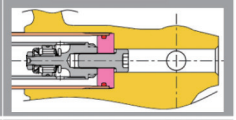


Fig. 9 New structure of the connection between inner tube and axle

4. 2. 4 Costs and Labor

While the addition of the collar to the conventional structure results in higher costs, the elimination of the O-ring groove check for chips and the airtightness test allows for significant productivity improvements (Table 3).

Table 3 Comparison of costs and labor

Item	Conventional structure	Improved structure
		
Cost	O-ring groove cutting tool cost	Collar added
Inspection labor	O-ring groove chip check Airtightness test	O-ring groove chip check eliminated Airtightness test under discussion for elimination

5 Conclusions

We have developed an HCS mountable on the φ37-mm upside-down FF, thereby achieving both riding comfort during regular riding and bottom shock absorption performance. We also solved the problem of lower productivity due to failures in airtightness tests by modifying the FF structure (Fig. 10).

While developing this product, we received an inquiry from BMW Motorrad for a new electric vehicle (Photo 3). We then evaluated the φ37-mm upside-down FF using this structure.

In terms of the bottom shock absorption, the product passed the steering stability test, which helped us win the order. We started mass production in September 2023 and have continuously achieved zero airtight leakage in the connection between the inner tube and the axle until today (December 2023).

Photo 3 BMW CE02 with FF using this structure
* CE02 is a trademark of BMW Motorrad.

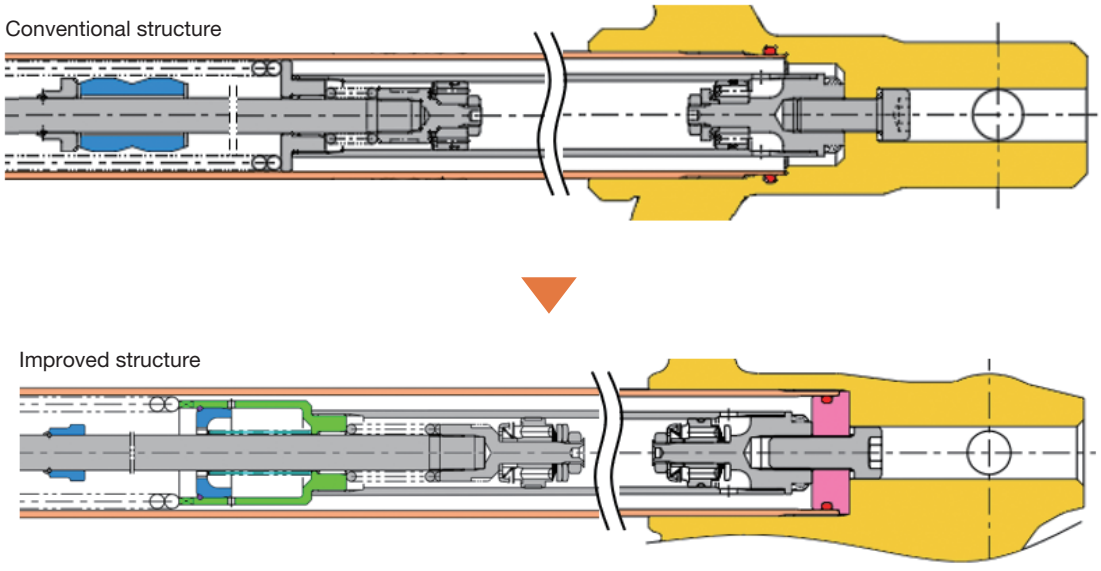


Fig. 10 Performance and quality improvement structure for φ37-mm upside-down FF

6 Future Plan

We will expand the FF product to other inner sizes and introduce it to other production sites. For the HCS mechanism, the inner tube will be enlarged (from φ37 to φ41, φ43, etc.) and the spring bore will be enlarged accordingly. The use of a spring seat is being considered to provide a bearing surface for the spring (Fig. 11). The spring seat, if added, will also serve as a stop for the piece, making it possible to eliminate the snap ring.

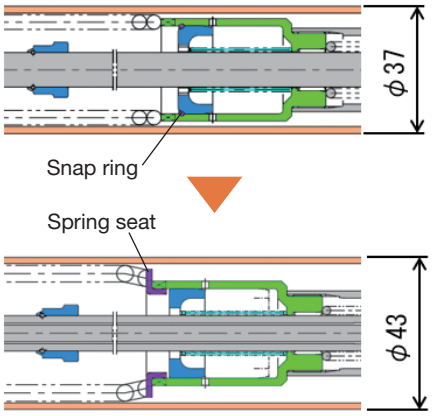


Fig. 11 Structure for another size under consideration

The improved connection between the inner tube and the axle allows the component to be placed in a cartridge without the axle. This will simplify the assembly process and hopefully further improve productivity (Fig. 12).

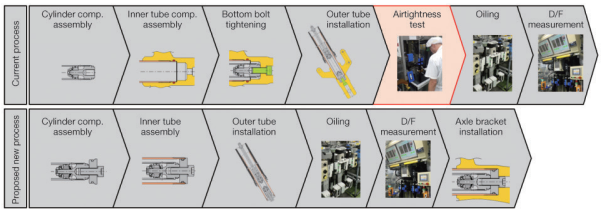


Fig. 12 Proposed improvement of assembly process

7 In Closing

Finally, I would like to take this opportunity to express my sincere gratitude to all those in related departments who have provided support and cooperation for this product development project, as well as to all those in KMSI.

Author

SUZAKI Kei

Joined the company in 2019.
Engineering Dept., KYB Motorcycle Suspensions (KMS)
Engaged in design and development of motorcycle suspensions.

Introduction

Japan Mobility Show postscript

MIZUNO Mami　TAGUCHI Yoko

1 Introduction

The Japan Mobility Show 2023 (JMS) was held in October 2023 after JMS was renamed from the Tokyo Motor Show. The Tokyo Motor Show used to be held every two years. The last show was postponed due to the COVID-19 pandemic. Last year's JMS was therefore held after an interval of four years (Photo 1).

It was the first time KYB had exhibited at the show in six years, since 2017. KYB applied for the show on January 31, 2023, which was the application deadline. We felt that the company was rather hesitant to be an exhibitor, in part because it had not participated in the show for several years.

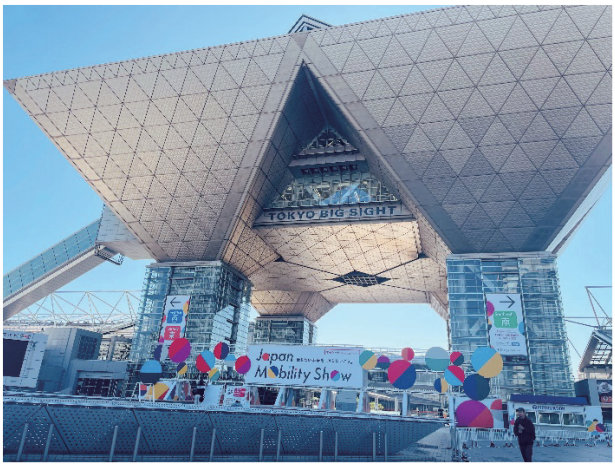


Photo 1　JMS held at Tokyo Big Sight

2 Mobility Show

The automobile industry has entered a once-in-a-century period of great change. The number of visitors to the Tokyo Motor Show, which reached 2 million in the early 1990s, has been on a downward trend since the global financial crisis in 2008. It dropped by more than half to as low as 770,000 in 2017.

The Tokyo Motor Show was then renamed with the intention of sending a message of the future of mobility from Japan to the world after coming through the global financial crisis and COVID-19 pandemic, and to create a new future of Japan together with new colleagues including visitors to the show, startups, and other industries beyond the framework of the automobile industry, under the themes of "from cars to mobility" and "from Tokyo to Japan".

The JMS 2023 was visited by 1,112,000 people, exceeding the target of one million set by the Japan Automobile Manufacturers Association (Photo 2). It has long been said that the automobile industry enters a once-in-a-century period of great change as mentioned above. Last year's JMS was an inviting event to demonstrate the future of the automobile industry.

The concept of the show was to have "a place to think about the future together". With the three key words of FUTURE, GREEN, and DREAM, the JMS 2023 expressed the intention to provide a place to think about the future of not only mobility but also the entire Japanese industry and environmental conservation focusing on carbon neutrality, and to allow everyone, from children to adults, to have a dream.

Photo 2　Visitors queued to enter the JMS site

3 Exhibitor after a Long Time

To be an exhibitor in the JMS 2023, we made various preparations including selecting the exhibition committee members, determining the concept, and determining and making the showpieces. Actually, we had a lot of difficulty in making all these preparations because we had not been an exhibitor for a long time.

For example, when forming the committee, it was necessary to start with the selection of departments to participate in the exhibition, partly because the company was reorganized after the previous participation (in 2017). In addition, the majority of the selected committee members had not even visited the Tokyo Motor Show. We felt that the committee was groping in the dark to discuss what to exhibit. At the same time, this meant that we did not have to follow any precedents, so we could think of everything from scratch. We remember now that we enjoyed the preparations by expanding our imaginations, which was quite rewarding.

Our concept of the exhibition was based on the concept of the JMS organizer (Fig. 1). We took sufficient time to develop perspectives related to the three key words.

For each of the key words FUTURE, GREEN, and DREAM, we discussed what we could do with KYB's technology based on objective evidence to narrow down exhibit concepts and showpieces. The committee then selected three key slogans: Create the Future, Global Friendly, and Life of Your Dreams, and defined KYB's exhibition concept as "Contribute to and represent the value of securing living space and mobility in a new mobility society" (Fig. 2).

Fig. 1 Concept of JMS organizer

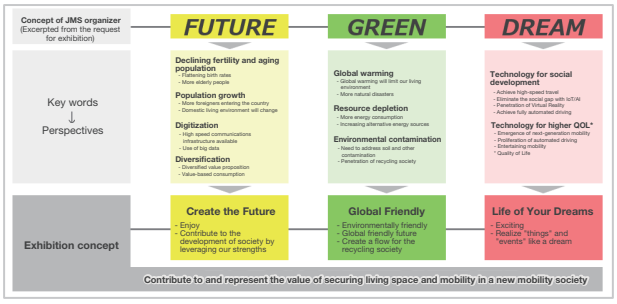


Fig. 2 KYB exhibition concept

4 Uphill Battle of Preparations

It was the end of March 2023 when the internal committee members for JMS began their work. The committee had promotion members consisting of leaders and implementation members in charge of practical work.

4. 1 Appeal of the Reborn KYB

The first hurdle in the preparation stage was to determine the concept of the booth and what to exhibit.

Although the committee consisted mainly of members from the Suspension Business (SA Business), we wanted to provide an exhibition of various businesses rather than SA Business alone, since JMS represented a "mobility show". Therefore, we gathered as much information as possible about our product line and latest development status.

Since the purpose was to exhibit at the show, we also collected information about the society/world trend from many literature sources. Being careful not to overemphasize the fact that we are an automobile component manufacturer or our products using hydraulics, we tried to freely imagine "how good if such a thing exists" not only in the mobility field, but in other various fields including service, environment, and education.

We finally decided on the concept at the end of May 2023. It actually took two months to discuss, review, report, and reach internal agreement. As we introduced the above three key slogans for the company's exhibition concept, we established the three themes: Create the Future as a commitment to future challenges, Global Friendly as an initiative to protect the environment, and Achieve the Life of Your Dreams to show our intention to provide technologies for social development and higher quality of life.

The booth concept was determined as the "Kayaba Playground" with the wish of having the company appeal to everyone, regardless of whether they knew KYB or not. Our concept words include the meaning of enjoying various "places" to make them better and to provide safety, security, and joy. We brought the concept words with the company name to the forefront partly because we wanted to let people know that the company name in Japanese was officially changed from KYB to Kayaba in October 2023.

4. 2 Making of Showpieces

The difficulty in the concept determination at the beginning resulted in a tighter schedule for the creation of showpieces (the original schedule also had no allowance even if the concept was smoothly determined).

After the concept was finalized, we tried to crystallize the showpieces. That is, we decided what to exhibit and where to place them in the booth.

The following is a list of our exhibits:

1. Full active suspension demonstration
   (HYMER motorhome equipped with full active suspension for ultimate ride comfort)
2. SustainaLub
   (Static display of the biodegradable fluid under development. Presentation of the cases of its use in the hydrogen-fueled Corolla race car and the KYB rally team vehicle participating in the Japanese endurance race Super Taikyu).
3. Shock absorber experience machine with smartphone
   (Product/service that allows visitors to remotely adjust the damping force of the shock absorber via a smartphone to control driving comfort).
4. Pascal's Law feeling machine
   (A machine that allows visitors to feel how they can lift up a heavy object with little force by using hydraulic power)
5. Hands-on corner to operate a syringe excavator
   (A machine that allows visitors to learn about hydraulics while playing with a syringe that replaces the cylinder and pump assemblies of an excavator)
6. Hands-on corner to experience the shock absorber function on wheelchairs
   (Visitors can ride and compare wheelchairs with and without shock absorbers to experience the difference in ride comfort between them).
7. Hands-on shock absorber assembly corner
   (A hands-on corner for visitors to actually assemble a shock absorber. Valves that are actually used in mass-produced vehicles are available and have been adjusted to have a clear housing so that visitors can see the inside).

We were able to provide such a variety of exhibits despite the short period of preparation. This was definitely the result of the enthusiasm and energy of the committee members and the generous cooperation of people inside and outside the company.

The committee members played their own roles, and each team promoted the preparations of the various exhibits. We remember that we had a hard time completing each exhibit.

The common difficulty for all exhibits was "how to show". We tried to build the booth for the exhibition with our wish to let all visitors, whether young or old, male or female, get to know KYB. In other words, we wanted to create a booth where even small children could learn about KYB while enjoying the exhibits, rather than reading serious explanations.

KYB employees already have some knowledge of hydraulics. Without taking this for granted, we worked through trial and error to determine the best "how to show" for the basic knowledge of hydraulics and KYB's latest technology.

For example, in the hands-on shock absorber assembly corner, we checked whether the assembly instructions were easy to understand and modified them by asking people around us to try the assembly over and over again. For the hands-on corner to experience the shock absorber function on wheelchairs, we revised the damping force specifications many times so that an unlimited number of visitors could feel the difference. Even a week before the date of carrying-in the showpieces, they remained unconvincing. The members discussed what to change and where, exchanging opinions until late into the night (Photo 3).

The next day, people from the departments of the members who had deliberated late into the previous night came to the showpieces under production to think together and participate in prototyping. The "Playground" color wheelchair (Photo 4) was surrounded by a lot of people coming and going, including employees, section managers, and even department managers. When we saw them all helping us, our hearts were filled with excitement.

Photo 3 Members stuck gawking at the showpieces after 8:00 p.m.

Photo 4 Wheelchair for “Playground”

5 The "Playground" Booth Came Alive with Visitors

We managed to complete the showpieces by the end of October, when the JMS was held at the Tokyo Big Sight.

In a word, we "enjoyed" the exhibition while the preparations were "hard".

5. 1 Smooth Operation through Cooperation among Members

While waiting for the opening of the JMS, we were worried about whether our booth would attract visitors, what kind of booths other companies would have, and whether the KYB exhibits would be far off the mark. When we saw the finished booth, our concerns were allayed. Our booth was almost perfect, which allowed us to welcome visitors with confidence.

Although we had no major problems, some of the showpieces were broken, partly because of the long period of 12 days on show at the JMS. In addition, we broke into a cold sweat when the tablet screen held by the presenter blacked out during the demonstration.

By working on repairs and buying time in case of problems, our attendants were able to deal with visitors as circumstances demanded during the period without making them feel dissatisfied. When a problem arose, we shared information with the Gifu area plant, Sagami plant, and members at the head office. They all made efforts to purchase additional repair parts and make the necessary supplies even from remote places.

5. 2 Popularity across Generations

The "Kayaba Playground" booth attracted many visitors.

Although the exact number of visitors to the KYB booth could not be determined due to the crowded booth, at least 4,127 visitors answered the questionnaire. It is estimated that around 12,000 people, including flux visitors, played at and enjoyed the "Kayaba Playground".

The visitors included the press, families of parents and children, college students who are car enthusiasts, and people who just happened to be passing by. We felt that the "Kayaba Playground" concept was effective while we were at the booth.

We received many positive comments, including "I enjoyed learning through different experiences", "it was good fun for a wide range of generations", "I saw what's inside the shock absorber that I normally couldn't see and understood how the KYB product works when I watched the movie comparing vehicles with and without damping force", and "the cheerful booth changed my image of somewhat serious parts manufacturers" (Photo 5).

Photo 5 Demonstration of active suspension operation

5. 3 Professional

The success of the KYB booth at the JMS could not have been achieved without the advice and cooperation of Quaras Inc. on many processes including booth design and operation.

Quaras generously supported us from the preparation phase to the end of the exhibition period, when we were in the dark about exhibiting at the Mobility Show (formerly the Motor Show) after an absence of six years.

The way the Quaras staff behaved and worked was really professional. We learned a lot and were amazed how they work as professionals while we saw them up close (Photo 6).

Photo 6 Commemorative picture after the end of the exhibition period (members who worked on the last day)

6 Showpieces Still Active after Exhibition

There were many requests internally to take the design wall and showpieces of the "Playground" booth, which were painstakingly created and enthusiastically used at the show.

It was decided that some of the showpieces would be

moved to the company's development center and KYB museum. We hope that the spirit of "Playground" will be passed on to the future.

7 In Closing

We received cooperation and support from many people beyond the AC Business Dept., including Public Relations & Investor Relations Sect., Executive Office Dept., Head Office, and Basic Technology R&D Center. Thanks to them, we were able to successfully complete the exhibition.

We, all members, would like to express our sincere gratitude.

We would also like to take this opportunity to deeply thank all those who have given us advice from time to time and all those involved.

Authors

MIZUNO Mami

Joined the company in 2007.
Engineering Administration Sect.,
Engineering Headquarters,
Automotive Components Operations

TAGUCHI Yoko

Joined the company in 2017.
Engineering Administration Sect.,
Engineering Headquarters,
Automotive Components Operations

Essay

Essay from expatriate in China

YAMAUCHI Kazuyuki

1. Introduction

I was a lone expatriate at KYB Industrial Machinery (Zhenjiang) Ltd. (KIMZ) in Zhenjiang City, Jiangsu Province, China for about two years and eight months from February 2021, which was in the midst of the COVID-19 pandemic that struck the whole world, until the end of September 2023, when the infection had subsided. At that time, the Chinese government enforced its zero-corona policy, which required all visitors to China, without exception, to be quarantined for a total of 28 days. After that, I started my expatriate life.

2. My 28 Days in Quarantine

First, I will show you how I lived during quarantine there.

When I flew to China, I had no choice but to fly from Kansai International Airport to Nanjing Lukou International Airport because only a few airports were open during the pandemic. I remember that there were few people in the Kansai airport building at that time, and only some of the restaurants were open. When I looked around after boarding the plane, I saw that the flight attendants and some passengers were wearing white protective clothing. There was an unusual, strange atmosphere in the cabin.

After arriving at Nanjing Airport, it took me quite a long time to leave the airport. I had to wait for the staff to check my PCR test results and health registration, which I had submitted in advance, and to take another PCR test. In addition, I had felt considerable anxiety about not knowing where to stay in quarantine until I arrived at Nanjing Airport, so I was relieved when I was directed to an acceptable hotel room.

Although hot food was provided three times a day for breakfast, lunch and dinner, I could hardly eat it because I am not keen on the spicy food specific to China. The instant food I brought from Japan and some food given by KMIZ helped me to endure the lonely, isolated life.

The Chinese New Year (Lunar New Year) came during my period in quarantine. As a special menu, shui jiao (boiled dumpling) was served for the day's dinner. It was delicious, but really heavy for my stomach. I fondly remember now that I had gastritis for a while.

Photo 1 A meal during my time in quarantine (special menu for the Chinese New Year)

3. Life in China

First, my experience of dining in China.

Since I am not keen on the above-mentioned spicy Chinese cuisine, I often went out to a Korean restaurant near my house and a truly Japanese-style yakitori restaurant in Zhenjiang City, where Japanese was understood. Drinking beer while watching baseball and football games on TV was the best way to enjoy my expatriation. It was quite good that I was able to enjoy various sports events in China, including the Tokyo Olympics, the FIFA World Cup, and the World Baseball Classic (WBC), which should have excited the Japanese nationwide.

Photo 2 Dining at a Japanese-style yakitori restaurant

China has advanced food delivery services. Food and goods are delivered from door to door by simply ordering

with your smartphone using apps. As the kind of person who likes to stay indoors, I really loved these services. However, on some weekends, thanks to such services, I did not leave my home at all. These may be services that are not good for your health.

Photo 3 Breakfast delivery

Photo 4 Delivery of grilled eel rice bowl

The next topic is shopping in China.

China has a communication app called WeChat, which is similar to LINE in Japan. This is one of the essential apps for living in China. Payment in almost all shops and restaurants is done with this app. China has gained an order of magnitude popularity of cashless payment compared to Japan.

This means that the battery life of your smartphone is critical and you must be extremely careful not to leave your smartphone behind.

However, this payment system is only available to those who have a bank account in China. It is unfortunate that foreign visitors without such a bank account cannot use the app.

On the other hand, mail-order application helped me a lot during my expatriation because it allowed users to buy even food sold in Japan, although the price was comparatively expensive.

4 . Work in China

During my expatriation, I was mainly involved in the process improvement efforts of the production line of Kayaba Cylinder Highpressure (KCH) hydraulic cylinders for use in 20 to 30 ton class hydraulic excavators, which are one of KYB's core products. The process improvement efforts included a horizontal deployment of improvements in Gifu South Plant, which is the parent plant. As the supervisor of the Production Engineering Dept. , I also supported original improvements made by KIMZ staff.

The KIMZ staff were highly motivated to improve. To be honest, I really had to try my best to follow the high level of their improvements and the high speed at which they were achieving those improvements. I felt very strongly that we, as expatriates, needed to model ourselves on them.

Among them, the first case of improvement by the Production Engineering Sect. was introduced at a production engineering presentation held during my expatriation. I felt proud at this event when such a memorable case was presented.

The presentation was made entirely in Japanese without an interpreter. KIMZ had many staff members who could speak Japanese in addition to the interpreters. That's why my Chinese didn't improve at all.

5 . Temporarily Coming Home after One Year

At the end of February 2022, I temporarily came back to Japan after a year to also receive the COVID-19 vaccination. At that time, the Japanese government mainly required visitors to Japan to:

- submit a PCR test result with negative confirmation obtained before leaving the previous country,
- not travel by public transportation, and
- stay at home (or in a shelter) for one week to monitor their health.

After arriving at Narita Airport, I had to drive a rented car for about 440 kilometers to Gifu Prefecture, where my house was located. Fortunately, there was no problem because I am a person who likes to drive, but I had some anxiety because:

- I was driving for the first time in a year,
- the Japanese lane is the opposite of the Chinese lane, and
- I had never driven on the Metropolitan Expressway (*Shutoko*) before.

While suppressing my haste, I drove even more carefully than usual. Finally, after about seven hours of driving, I arrived home safely.

After coming home to be back with my family again, I spent the time with them with love and respect. In particular, we could together enjoy some events that were not possible during the expatriation, including watching baseball games at a ballpark, going to an amusement park, and playing baseball and sweating it out at a children's sports activity that my eldest son belongs to.

During the temporary return, I basically worked by

telecommuting and sometimes reported to Gifu South Plant and Gifu East Plant to meet my colleagues after about a year to greet them and collect information about the latest improvement activities and others.

Such a pleasant time finally came to an end. After completing the COVID-19 vaccination, it was time to return to China.

Photo 5 Watching a baseball game at Vantelin Dome Nagoya

I knew that the next temporary return would be a year or more ahead. Needless to say, I felt lonely when I left my family. However, I will never forget that, as an expatriate with family left behind in Japan, this only increased my eagerness to work even harder than ever.

6 . Traveling in China

Let me change the subject and tell you about my travels in China during my expatriation. In June 2023, when the zero-corona policy was over and the COVID-19 pandemic had subsided, I visited Xi'an, Shaanxi Province, which is famous for the Terracotta Army. In September 2023, I was able to go to Datong, Shanxi Province.

In this essay, I will only describe the trip to Xi'an because space does not permit more. In June, China has consecutive holidays called the Dragon Boat Festival. By taking advantage of the holidays, I was able to travel with KIMZ staff for three nights. I had never gone out of Jiangsu Province, partly because of the effect of COVID-19 infection. I remember that I was excited to go out and learn about China, about which I knew little.

This was indeed China. Even domestic travel required us to take an airplane. It took us six or more hours by bullet train (equivalent to the Shinkansen in Japan). I felt how big the continent is.

When we arrived in Xi'an, the first thing we ate was local food. I felt that the food was different in taste from that of Zhenjiang. Since I had heard that wheat is more popular than rice in this region, I often found restaurants serving bread and noodles made of wheat.

On the first day, we enjoyed restaurant hopping while sightseeing in the city. When I saw the brightly lit downtown at night, I felt again that this was indeed China.

On the second day, I took a taxi to the Terracotta Army Museum. To be honest, I had only had the impression that the Terracotta Army was just a lot of arrays of stone statues, obtained when I read about it in a textbook during my school days. When I actually visited the Terracotta Army, I realized for the first time that it was the tomb of the Qin Emperor Zin Shi Huang. The visit made me think of reading The Romance of the Three Kingdoms thoroughly to learn much more about China, as I was not familiar with Chinese history originally.

Photo 6 A lit street in Xi'an

Photo 7 Terracotta Army

Partly because of the consecutive holidays, the inside of the museum was crowded with many tourists, which made it difficult for us to move forward. But it was good to learn about Chinese history.

For dinner, we had Biangbiang noodles , which are famous in Shaanxi Province for their Chinese characters with 56 strokes, which is the highest number of strokes in China. The noodles are pronounced "biang biang

mian", which is probably one of the typical characters that even Chinese people can read but not write.

Biangbiang noodles are a kind of mixed noodles without soup and are not as spicy as they look. The wide noodles can be mixed with chilies, Japanese pepper, and sweet and spicy thick sauce, and are very delicious.

On the third day, we climbed a mountain famous in China called Hua Shan, which is designated as a 5A-rated tourist attraction. I said "climbed", but of course we used the cable car. It was indeed a mountain considered as one of the Five Great Mountains of China . With the perfect weather, the scenery we saw from the mountain was so beautiful that I can still remember it clearly.

In fact, I was afraid to even walk on the ridge of the mountain because I don't like heights. I lost my footing at a typical photo spot without a fence, leaving me with unfortunate memories.

Photo 8 Biangbiang noodles

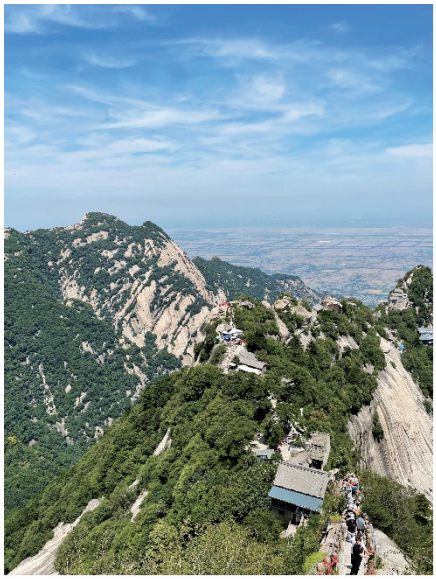


Photo 9 Scenery from Hua Shan

On the fourth and final day, we visited the Longmen Grottoes in Luoyang, which are listed as a UNESCO World Heritage Site. The grottoes are rock faces carved with Buddha statues. The stunning scene includes a large

Photo 10 Longmen Grottoes

Buddha statue over 10 m on the wall and many Buddha statues engraved in a cave. These statues were completed 1500 years ago. It is amazing that these statues still exist today.

7 . In Closing

My expatriation began with 28 days in quarantine, which I will probably never experience again in my life, and at first I was very afraid. But now I can remember that the two years and eight months passed in a flash.

During my expatriation, many people supported my work and life in China. I would like to take this opportunity to express my gratitude.

In addition, I sincerely thank those who held a farewell party many times just before my repatriation. I will never forget the taste of baichu, the typical Chinese liquor,

Photo 11 Dinner with staff of Production Engineering Dept.

Photo 12 Dinner with staff of Production Dept.

which I drank with the staff.

Finally, I have to say again that I was a lone expatriate, not taking my family with me to China. I left my two sons in Japan, both of whom are now in elementary school and increasingly able to take care of themselves. At the time of my departure, however, my older son was in the senior class of a kindergarten and needed a lot of looking after, and my younger son was at his most boisterous in the junior class of the same kindergarten.

I would like to express my gratitude to my wife for raising two such sons all by herself.

I would also like to thank the sons who tolerated their loneliness in the absence of their father, even though we talked every morning by video phone.

Author

YAMAUCHI Kazuyuki

Joined the company in 2005.
Administration Dept. (Cost Planning), Gifu South Plant
Took present post after working in Production Engineering Sect. of Gifu South Plant, and as expatriate at KIMZ (HC).

Essay

Essay from expatriate in Malaysia

KOIZUMI Tatsuya

1. Introduction

I worked for KYB-UMW MALAYSIA Sdn. Bhd. (KMSB) for three years from 2020 to 2023, involved in operations related to production engineering, maintenance, and safety functions. As an expatriate living in Malaysia I experienced many things.

This essay describes the COVID-19 pandemic status there, the Malaysian culture I felt, the differences between Malaysia and Japan, and some of my experiences there.

Photo 1 Central city of Malaysia during the COVID-19 pandemic

2. Quarantine under the COVID-19 Pandemic

My life as an expatriate began in quarantine. In 2020, the worldwide COVID-19 virus affected the lives of many people, including me who was supposed to be sent to Malaysia in early 2020. I initially had a difficult time getting my visa to Malaysia, but as soon as it was approved, I took a plane to Kuala Lumpur International Airport (KLIA). KLIA is a global hub airport where it usually takes about an hour for passengers to get through immigration and pick up their luggage. I remember that on the day I entered the country, it took about five hours to clear immigration. Basically, this was right after the global chaos began. Nobody knew what to do or what the rules were. Everyone was in the dark and completely confused. During those days, all passengers from flights entering Malaysia were not directed to the regular immigration lane but had to wait in a place like a special room next to the lane for their individual names to be called. Then they had to answer some simple questions to complete the immigration process. It took quite a long time to complete these steps. All the people there waited anxiously for a long time. Finally, I was able to leave the airport at the end of the day, but my quarantine began immediately after that.

The Malaysian domestic COVID-19 control rule applied during 2020 was that all visitors were uniformly separated for two weeks and then subjected to a COVID-19 test. Only those with negative confirmation were released. Accordingly, I also lived separately before taking the test at a nearby national hospital and was finally released from the quarantine.

Later, I had some opportunities to talk to Japanese people from other trading companies or vendors who had entered the country at around the same time I entered in 2020. When we knew that we had each entered Malaysia at that difficult time to start our life abroad, we developed a sense of togetherness as fellows who were in the same boat even though we were from different companies. I often met such people who looked back at those days with humor, saying "it was so hard back then".

3. Started Working by Telecommuting

After being released from quarantine, I began working for KMSB. However, the COVID-19 pandemic did not subside. In early 2021, the Malaysian government issued a lockdown (city blockade) order for the entire country. All types of industries (including services, manufacturing, and restaurants) were shut down, except for lifeline industries such as government offices and hospitals, forcing many people to stay home or work from home.

During the lockdown, strict rules were announced that basically prohibited citizens from going out and only allowed them to go out alone to buy some food within a

few kilometers of their homes. Anyone who violated the rules would be fined or imprisoned. So, we had no choice but to follow the rules.

Photo 2 Signboard on COVID-19 control in the factory

The announcement of the Malaysian government's control of COVID-19 was disseminated through social networking sites (SNS) and Malaysian-specific smartphone apps. In this way, the information was disseminated to and followed by all nationalities. We, living abroad, had to understand the announcement in Malay by translating it into English or Japanese. The Malaysian government announced COVID-19 control schedules, which specified the number of people to report to the factories and their working hours. According to the schedules, we had to determine who would be assigned or report to where, or to what process at what time. Production engineering did what it could: it ran the welding process as long as parts were available to prepare for production and transferred finished parts to the assembly process. However, the government's rules for running factories sometimes changed from "go" to "stop" in a week or two. In addition to production, logistics including delivery, acceptance, and ordering of parts were particularly disrupted. We had difficulties in coordination and communication almost every day.

Photo 3 Office being disinfected

My telecommuting was very busy as I used Microsoft Teams to have meetings with my bosses and department, although I was only involved in limited tasks such as discussing and documenting investment issues and improving physical distribution within the factory. The language we usually used with the Malaysian staff was, of course, English. I felt very strongly that it had been good to learn English in the ACTIVE training in 2016. Malaysia is a country where people speak English at a high level (English is often understood). With English, I could do almost 80% of the things that needed to be done both in the factory and in my daily life. During my three years in Malaysia, I had few opportunities to use Malay much. In fact, there were many occasions where I thought it would be better to speak Chinese for the purpose of work.

4. Malaysian Culture

4.1 Mixed Culture of Different Countries

Malaysia is generally considered to be an Islamic country. The population consists of about 70% Malay-Malaysians, about 20% Chinese-Malaysians, and about 10% Indian-Malaysians. Mainly these three cultures and some others are mixed together to form a hybrid Malaysian culture. Actually, I felt like I was living in three countries during my three years of expatriation. In 2022, Chinese-Malaysians celebrated the Lunar New Year in February and the streets were in a festive mood, while the Japanese celebrate New Year on January 1 to start a new year and have holidays.

Photo 4 Lunar New Year of Chinese culture

In April, Muslims have big events including Ramadan and holidays called Hari Raya Puasa. These are opportunities for many of them to go back to their home place (Kampung) or have a family gathering. On August 31, Malaysia celebrates its Independence Day (Hari Meredeka) with a large parade throughout the country.

Photo 5 Malaysian National Monument

As the end of the year approaches, Indian-Malaysians celebrate a festival called “Deepavali” in November. The Bangsar area of Kuala Lumpur where I lived was densely populated with Indian-Malaysians. I sometimes saw many formally dressed Indian-Malaysian men and women in saris gathering to pray at a historic Indian temple near the condominium where I lived.

Photo 6 Deepavali Kolam

For additional information, the above composition of the Malaysian population is only approximate. Other Asian and European peoples also live in the country and their cultures have taken root. Also, the Lunar New Year, Hari Raya Puasa, and Deepavali do not necessarily fall in the same month of the Gregorian calendar each year, as the Gregorian, Lunar, and Islamic calendars have different lengths of the year.

4. 2 Different Languages

Malay is of course used on street signs and in the morning greeting in the department, and is also used in work conversations, whether the speaker is Chinese or Indian-Malaysian. Since I had many opportunities to hear the language almost every day, I naturally became able to understand some Malay conversation. However, I had almost no need to speak it in normal times, so I repatriated still being almost unable to speak Malay. With such language ability, I worked for some time in a strange way that when a KMSB staff member spoke to me in Malay, I spoke back in English.

Business partners related to equipment in Malaysia include many Chinese-Malaysians. As mentioned above, Chinese culture has taken root in Malaysia and Chinese is seen and heard very often. I would like to share with you an episode that is not exactly related to "Chinese"-Malaysians. When we were dealing with an equipment problem, we had a meeting through Teams with a Taiwanese manufacturer. An engineer from the manufacturer spoke only in Taiwanese, which was translated into English on the screen by another employee from the manufacturer's sales department. The interpreter did not know much about engineering and could not properly communicate the details of the problem to us, i.e. the KMSB members, in many cases. Then, the KMSB side called a Chinese-Malaysian KMSB staff member to translate firstly from Taiwanese into Chinese, then further into Malay or English to facilitate the meeting. However, that KMSB staff member also did not know much about engineering and could not communicate the detailed intention of the Taiwanese manufacturer's engineer well, so we remained confused. In the final stage of the meeting, I found out that the report that the Taiwanese manufacturer provided for us to share in the Teams meeting was written in Taiwanese (Chinese characters). Since I knew general Chinese characters and was able to understand technical matters, I was the first to get to the right answer. I then explained the results to the KMSB staff in English and successfully shared the information. In the end, we were able to finish the meeting without any problem.

At that Teams meeting, which mainly used Taiwanese or Chinese, I realized that working through interpreters was very difficult since I usually worked without one. It also made me think, "I wish I could also speak Chinese," considering the huge global population.

Malaysia is a country where Indian culture has also taken root. The streets are full of Indian restaurants, supermarkets, and temples. All the information presented to me on these streets was different from that in Japan, including visual information (= traditional colors and lights), auditory information (= sounds and people’s conversation on the streets), and taste & smell information (= incense and spices). All these things were a shock to me as a Japanese. When I came to know the Indian culture in Malaysia, I was convinced of the meaning of the typical saying, "Go to India, then your view of life will be changed".

5 . My Experience in Malaysia

The COVID-19 control regulations started to be gradually relaxed in mid-2021 to allow movement or travel within and outside the country under certain restrictions. I had visited a total of eight other countries for work or personal purposes, and it was the first time for me to travel in Malaysia. After the relaxation of the regulations, I was able to visit various places in Malaysia. Besides work, the country and culture of Malaysia gave me a lot of experiences.

This is a story about a trip to Penang in the northwestern part of Malaysia. That day, a Hindu festival called Thaipusam was being held. It is said that Thaipusam is a rare festival that is only held in two countries: Malaysia and Singapore. I was lucky to stumble upon such an event. I saw a festival that I had never seen before, where floats were paraded through the

city and coconuts were smashed on the ground to make the street sacred. Many people gathered at the lively and intense festival, which overwhelmed me. At the same time, they encouraged even foreigners like me to participate in the festival, saying, "Let's celebrate and dance together". Influenced by these people, I decided to actively participate in the festival.

When I was walking on a street in Penang after the main event, someone called me with a gesture like "come over here". Although I felt a bit scared, I walked towards the person who called me. I realized that I was being invited to participate in a custom of giving food to people at a festival, but such a thing can also be seen in countries other than Malaysia. In the beginning, I acted to decline the invitation because I was preoccupied that I might be brazen, but the generosity of the local people was enough for us from foreign countries to take up the offer. Rice, various curries, and soup were served on a plate like in a cafeteria. Of course, when I wanted to eat, there was no fork or spoon. For almost the first time in my life, I used my fingers to eat the curry. An Indian family next to me complimented me by saying, "Good!" Later, when I entered a Malaysian restaurant during a business trip together with KMSB staff, I remembered that experience and could eat the Malaysian food using my fingers without feeling anything wrong because I had experienced it many times before. I think the experience was very precious because it is a formal custom for them to eat with their fingers, namely, when you are in Rome, do as the Romans do.

Photo 7 Floats at a festival

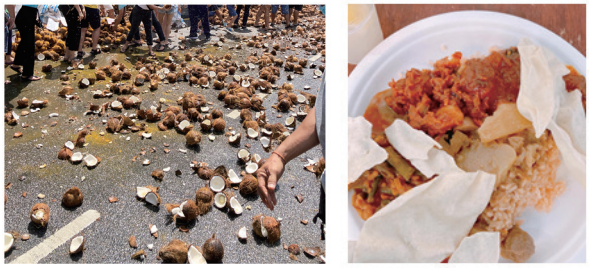


Photo 8 Coconuts and curry

Malaysia has a lot of tourist attractions. I was able to visit Melaka, which is famous for Nyonya food, Ipoh, where Chinese culture remains, Langkawi Island, and other places in between my assignments. Among them, my favorite place was Redang Island, which is located in the southeastern part of Malaysia. Redang has such a beautiful sea and beaches that it is said to be the most beautiful island in Malaysia, and I felt like I was on a tropical island. Redang was a place I liked to go to, so I visited twice in the short period of time after the recovery

Photo 9 Melaka and Ipoh

Photo 10 Redang Island

Photo 11 Animals and plants

Photo 12 Mosque

from the pandemic. In addition, what impressed me in Malaysia were the animals and plants that can be seen in ordinary cities. Because of the difference in climate between Southeast Asia and Japan, many of the plants and animals were new to me. Also, Islamic mosques were different in profile, size, and design from temples and shrines in Japan, which made me feel how big the world is.

On the other hand, Kuala Lumpur, where I lived, is the largest city in Malaysia and its capital. It is a metropolis full of famous buildings such as the Petronas Twin Towers, KL Tower, and Independence Square. Malaysia is also a country where racing culture has taken root, partly due to the presence of factories of domestic and Japanese car manufacturers for decades. MotoGP is still held at the Sepang International Circuit. During the week that MotoGP was held, a special event was held in the center of Kuala Lumpur. Also, when I traveled to Singapore, Formula 1 happened to be held there again after three years, as the COVID-19 behavior restrictions were relaxed worldwide. The city was full of F1 color, and the related events, which had been suspended, were almost fully restored in 2023 after several years.

In 2020, when I first entered Malaysia, all the events were canceled or banned, and we lived under many restrictions. Compared to that time, it felt like a moment when we had almost returned to the original world.

Photo 13 Petronas Twin Towers in MotoGP color

Photo 14 Formula 1 at Singapore

6. Work in Malaysia

In Malaysia, I was mainly responsible for production engineering. In fact, I was involved in a variety of areas, including maintenance, safety, and factory equipment management. Specifically, I consulted with accounting after ordering parts, paid taxes, handled equipment imports, and checked and coordinated physical distribution and truck schedules, which I do not normally do in Japan. I experienced these various tasks that are performed by other departments at the Gifu North Plant.

The Malaysian plant produces shock absorbers for four-wheelers and front forks and oil cushion units for motorcycles. I had never handled motorcycle products because I was in the four-wheeler department at Gifu North Plant, but I was in charge of both four-wheelers and motorcycles.

When I was sent to Malaysia, the economy had continued to grow and the demand for automobiles and motorcycles was increasing. The production capacity of the Malaysian plant could not keep up with the increasing demand. The company had a policy of making major investments in equipment because the plant could not increase production of so many product lines by simply transferring product models or changing the layout of the equipment.

For four-wheelers, I promoted capital investment and condition setting for many processes including plating, welding, assembly, and centerless grinding, as well as trial operation and safety deceleration. Since it was always impossible to complete the work alone, I promoted these tasks through close communication with KMSB members. For technical issues, I asked the Gifu North Plant for advice and successfully solved the problems. I was able to accomplish many tasks by working with the KMSB staff. I would like to take this opportunity to express my gratitude once again:

Terima kasih banyak

For motorcycles, we had a series of major investments, including plans to improve the nickel-chrome plating equipment and the OCU assembly process. Four-wheelers and motorcycles are similar, but not the same. They have different design concepts and drawings and are manufactured in different ways accordingly. In particular, I saw several processes I had never experienced before, including casting, capacitor welding, and snap ring insertion. There were some problems that I was able to solve with my experience, but many of them were beyond my ability to solve on my own. In the end, I received considerable support from the KMS staff. They kindly spoke with me on the phone and provided direct technical support to Malaysia several times. I would like to take this opportunity to express my gratitude to them.

Although I had so many issues to deal with that I spent my days at a dizzying pace, there was a moment when

the KMSB staff members were rewarded for their efforts. Production engineering of KMSB was awarded the Best Innovation Award (Group Award) for part of its operating results by the UMW Group, its parent company.

There was a dress code for the award ceremony. I did not have a set of formal Malaysian clothing and it was quite difficult to get the clothes. The local staff helped me to learn where to buy them and many other things.

Photo 15 Together with KMSB Production Engineering staff at the ceremony

7 . In Closing

I would like to thank all those with whom I interacted during my almost three years as an expatriate in Malaysia. I think it was fortunate that I was able to stay in Malaysia to work at the time when the world was gradually opening up from the closed circumstances of the COVID-19 pandemic. I also wish KMSB, which celebrated the 40th anniversary of its foundation in 2023, further development and progress.

Author

KOIZUMI Tatsuya

Joined the company in 2010.
Production Engineering Sect. No.1,
Production Engineering Dept.,
Suspension Headquarters,
Automotive Components Operations
Took present post after working as expatriate at KMSB.
Engaged in process design of automobile shock absorbers.

Glossary

Digital Twins

Refer to In-house application of XR (cross-reality) technology for realizing digital twins (page 7)

OGAWA Atsushi
Electrification unit advanced development Sect. Basic Technology R&D Center, Engineering Div.

1 Digital Twins [1),2)]

Digital twins are a concept proposed by Michael Greives of the University of Michigan in 2002. Digital twin technology uses data collected from the real world to recreate the environment of the real world in a virtual world, just like a twin, for various purposes including verification and improvement.

For example, digital twin models in a virtual world can be used to safely conduct failure tests that would be risky in the real world. This technology is expected to provide product optimization, work efficiency improvement, time/cost reduction, and other various effects.

2 Mechanism of Digital Twins

Fig. 1 shows a conceptual illustration of digital twins. A digital twin consists of a real world and a virtual world and the exchange of information between them. The role of the digital twin is to predict what might happen in the real world through simulation in the virtual world and to facilitate improvement. The digital twin process is shown below:

[1] Collect data from various types of equipment in real time by using IoT.
[2] Based on the collected and accumulated data, perform analysis and prediction in a virtual world by using AI and CAE.
[3] Feedback the results of analysis and prediction to the real world, and then take action and make improvement in the real world.

3 Features of Digital Twins

While digital twins are a type of simulation, they allow you to conduct simulation and evaluation under conditions that more accurately reflect the real world, using collected and accumulated latest data, compared to conventional simulation. In addition, their real-time function can be used to efficiently promote theoretical development such as model-based development (MBD). Digital twin technology is also helpful in quickly identifying problems, finding causes, and taking action in case of failure. In addition, the technology can provide improvements in various areas, including preventive maintenance by predicting signs of failure and taking action at the appropriate time.

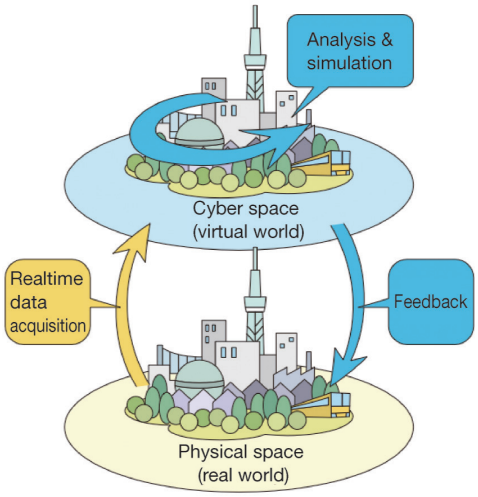


Fig. 1 Conceptual illustration of digital twins

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1) Website of the Ministry of Internal Affairs and Communications, JAPAN
https://www.soumu.go.jp/hakusho-kids/use/economy/economy_11.html
2) The Ministry of Internal Affairs and Communications, JAPAN: Study Report
https://www.soumu.go.jp/johotsusintokei/linkdata/r03_06_houkoku.pdf

Glossary

HCS mechanism

Refer to “Development of a performance and
quality improvement structure for φ37-mm upside-down front fork” (page 26)

KUBO Kiyoshi
KYB Technical Review Editor

1 What is the Hydraulic Stop?

The hydraulic stop (HS) refers to the general structure installed at the ends of the cylinder to absorb the energy of the shock absorber (SA) at the points where compression and extension are at their highest, by means of hydraulic power, thus preventing excessive impact.

The part of the HS that works when the SA moves to the compression side is called the hydraulic compression stop (HCS), while the part that works when the SA moves to the extension side is called the hydraulic rebound stop (HRS). An HS with both HCS and HRS functions is called a double hydraulic stop (DHS) (Fig. 1). Also refer to the article on the DHS included in the KYB Technical Review No.58.

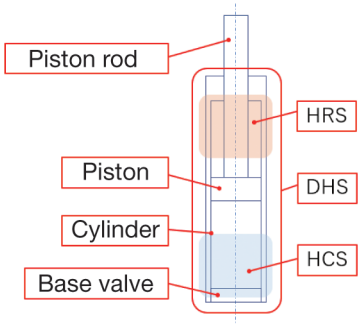
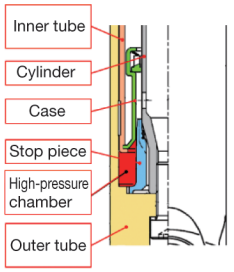


Fig. 1 Simplified structural illustration of DHS

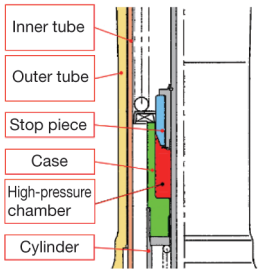
2 HCS Mechanism for Motorcycle Products

The motorcycle front fork (FF) uses the HCS as described in the product introduction paper. Fig. 2 shows typical HCS structures. Although these HCS types differ in geometry, they all have the same mechanism in which the stop piece enters the case in the second half of the stroke to increase the internal pressure to absorb the shock. In addition, they all have a check function to suppress the noise that may be generated when a vacuum is created in the case during the stroke to the extension side.

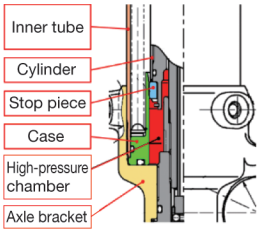
The HCS have different characteristics depending on the length of the parts and the conical shape of the orifice (Fig. 3). Several standard parts are currently available so that customers can select the optimum characteristics during on-vehicle testing.



(1) For free valves



(2) For cartridge dampers



(3) For air-oil separation dampers

Fig. 2 Motorcycle HCS structures

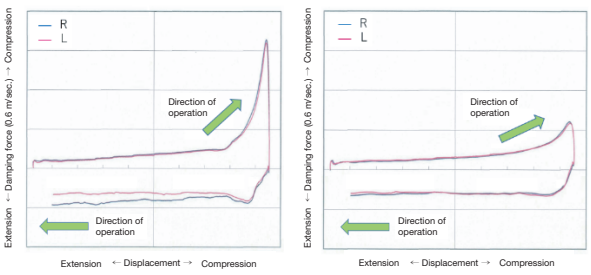


Fig. 3 Difference in HCS characteristics (damping force)

Editors Script

In recent years, ICT technologies such as AI, IoT, and big data have advanced dramatically, bringing about significant changes in society as a whole. For example, it is now possible to create a paper using generative AI such as ChatGPT. It is said that we will soon be in an age where we can use such generative AI for work in much the same way as we currently use Excel and Word. This Technical Review could also include an article written by generative AI several years in the future.
Each article has its own peculiarities to give the reader a sense of what is on the author's mind. This is one of the joys of the Review. I really hope that it will not be full of standardized articles, even if generative AI is used. (KAWASHIMA)

When I traced the history of KYB's electronic equipment products to update the History and Chronology panel displayed in the KYB Archives, I was vividly impressed by the social circumstances related to each product at that time. KYB has launched many products, including direct weaving machines for Nishijin fabrics, electric power steering, electronically controlled suspension systems, and vibration control systems for railroad trains. In this once-in-a-century period of great change, we are now called upon to solve the social problems facing the world through automation, electrification, and other trend technologies. The range of such actions is quite broad. With technologies that can only be achieved by KYB, I would like to work hard together to create a Technical Review that depicts a bright, vibrant future. (KABASAWA)

Last year was a memorable year for Takako Industries, Inc., where I work. The company celebrated the 50th anniversary of its foundation. Takako Industries has contributed to the hydraulic industry by designing and manufacturing pistons as internal parts of axial piston pumps, small piston pumps, and solenoid valves. Due to global warming and other issues, there will be an increasingly hard challenges on hydraulics. However, the advantages of hydraulics are still indispensable in all fields. We would like to continue to develop products that utilize the advantages of hydraulics to contribute to society and introduce them to the world through this Technical Review. (KAWANO)

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