For Members of the Quality Engineering Research groups

Robust Quality Engineering Magazine

~This is the place where members can freely exchange their ideas and gain knowledge~

Autumn 2023 First Issue

< Participating Research Groups>

Hokkaido Taguchi Method Study Group, Nagano Quality Engineering Research Group, Chubu Quality Engineering Research Group, Shiga Quality Engineering Research Group, Kansai Quality Engineering Research Group, Hiroshima Quality Engineering Research Group

*Hereafter “Quality Engineering Research Group” is referred to as” QERG.”

*The original copy of this magazine is in Japanese.

【**How to use**】
1. Click on the title to display the article.
2. Click "Back to Contents" on the right side of each page to go back to Page 2 CONTENTS.

CONTENTS

Back to CONTENTS

On the Launch of the First Issue of “the Quality Engineering Magazine for Members of the Research Group on Quality Engineering”

Taro Tetsumi, Chairman of Kansai QERG (Mitsubishi Electric Corporation)

What is the purpose of the Quality Engineering Research Group? Since there are people from all walks of life, I do not intend to impose this on anyone, but I believe it is to contribute to the realization of a better society by providing useful information to our members and member companies.

So, are we contributing as much as we wanted to? In my personal opinion, it is not enough, and it seems to have continued to weaken since Dr. Genichi Taguchi ceased his activities.

So, has the world changed and is quality engineering obsolete? I don't think so. However, it seems that the number of problems that can be solved by quality engineering alone has decreased.

In the case of my workplace, it would only be an extra hassle if it is not accompanied by business process improvements. Not surprisingly, I can hardly remember seeing any information dissemination focused on process improvement from the point of view of quality engineering. In order to make a greater contribution to society, I think it is necessary to disseminate information that takes these factors into account. This is a personal thought, but I hope to send out this kind of information that companies and society want now through this Magazine.

This kind of information dissemination may be the role of the Quality Engineering Society Journal. However, the journal only reaches members of the Quality Engineering Society. There are many non-Quality Engineering Society members in local Research Groups. We would like to develop this magazine together with you as a medium that more people can easily access. Sep.2023

What is a Honmamon (real/genuine) engineer (1)

Kazuhiko Hara, Advisor of Kansai QE Research Group

There was an NHK morning drama about a cooking expert called "Honmamon(real/genuine)," which I like very much. On another occasion, several members of the Shiga QE Research Group and I had a discussion on the subject of "What should an engineer be like?". Here, too, we discussed in depth what an engineer should be.

Recently there have been a series of corporate scandals, and many managers and others in charge have become persons who work for salary and have lost the purpose of being business people, and their evasion of responsibility is appalling. It has long been said that "the problem is the difference/gap between the ideal and the reality." However, in the past, there was no appropriate way to evaluate the magnitude of the problem, so we have repeatedly played "whack-a-mole" whenever a problem occurred. I recently went to consulting to a company, and they were struggling to figure out how to squash the problem at hand. Yet, they had studied a bit of quality engineering and were trying to solve the problem using the L16 orthogonal array in a classical design of experiment with smaller the better.We study many analysis methods such as management techniques (SQC, VE, design of experiment, multivariate analysis, reliability engineering, etc.) and simulations, but we use them without understanding their original purpose, so they do not solve essential problems. In this regard, even in quality engineering, only the methods are often imitated and used incorrectly without understanding the concept of quality engineering. The purpose is not to use methods, but to solve problems.

Therefore, I would like to talk about what I consider a "real engineer" in my own way in several parts.

1) Be an engineer with Tansiki (Insight with execution)

Engineers learn quality engineering or unique technology but fail to apply it on the job because it has not been elevated to the level of insight that can be applied. However, many engineers, no matter how insightful they are, succumb to pressure from their boss and return to conventional work practices. I believe that those who can persuade their boss and actively involve the engineers around them in

promoting quality engineering are "tansiki" engineers. The other day, Mr. Kawabuchi, who has just become the president of the Football Association of Japan, spoke of his feelings about the situation, and it was " be defeated and then give up" (a phrase from one of the Five Classics). Even if you have few allies, I believe that the condition of a "true engineer" is to believe in your own path and to continue to have the passion to carry it out on your own.

I live by the motto, "A Life of Doraku and Kyokudo (Enjoy the Way, Master the Path). Each person's path in life is different, but I think it is important to live a life that considers "for what" or "for whom. My idea of "the path" is "the path to quality engineering," which places the pursuit of corporate profits based on customer satisfaction and global environmental protection as its first priority. We must not be driven by corporate positions or the pursuit of short-term profit from the beginning,. Once you become a master of this path, you must be prepared to die at any time. To achieve this, it is important to involve your boss and the engineers around you in your self-realization. We believe this is the basic attitude to become a "real engineer.

2) Be an engineer who can think about how it should be and how it wants to be.

Recently, it is noticeable that some executives and politicians are discussing short-term issues without considering the ideal image of the company or the nation. Likewise, there are indeed many engineers who conduct R&D in a problem-solving manner. Since "a problem is the difference between the ideal and the reality," quality engineering defines the ideal function or target level and conducts development activities (problem minimization) to reduce the distance from the reality. I believe that the most important thing for engineers to think about at that time is "for what" or "for whom".

(1) What do customer want? (What features and performance do they expect?)
(2) What do not customer want? (Does it satisfy the customer's conditions of use?)
(3) Do you consider global environmental protection? (Do you destroy nature through pollution, waste, etc.)
(4) On top of that, are you working to ensure the company's profitability?

We don't want it to be research for research's sake, design for design's sake, or testing for testing's sake; we want it to be research, design, and testing for our customers. It is important for engineers to be out in the field more, listening to customers voice and hearing customer complaints. It's about "the customer satisfied," not "satisfying the customer."

3）Be an engineer who can create systems.

The first job of an engineer is to create a system that satisfies the themes of the business strategy, but when I visit companies recently and talk to managers, I find that many engineers are unable to create systems. For engineers, whose education up to now has been based on an examination system in which a single answer of 1 + 2 = 3 is enough to pass the examination, it is not unreasonable to think that they can build a system by imitation and consider it a good product as long as it passes a set standard. For them, it is a difficult task to devise the best system that satisfies their functionality from among many systems. Companies are required to quickly come up with an answer to □ or ○ such that □ + ○ = 3. However, the range that can be explained by theory is limited, so many engineers give up if they do not find an answer within that range. Quality engineering cannot create systems, but it is the role of quality engineering to evaluate invented systems, so it is necessary to evaluate many systems in parameter design to find the best answer. In developing Light intensity modulation direct overwrite (LIMDOW), they created a revolutionary system by extending the parameter design to areas that could not be scientifically proven. However, even in this case, it is a prerequisite that the phenomenon can be elucidated from a scientific standpoint regarding "function." It is individual skills and unique technology that create the system, and development cannot succeed without proving the "certainty of technology " through robust design by evaluating the functionality of the system. One of the requirements is to have a broad knowledge and insight into related technologies as well as one's own field of expertise, and to be able to generate many ideas with a wide selection of systems that satisfy the desired functions. For this purpose, it is important to improve "experience and sense. Expertise and quality engineering evaluation are the two wheels of a car, and development cannot be successful without either. That’s about it.

Back to CONTENTS

An Old Tale from Quality Engineering Research Group No.1: "See the trees, but not the forest" - the generic function of pig farming

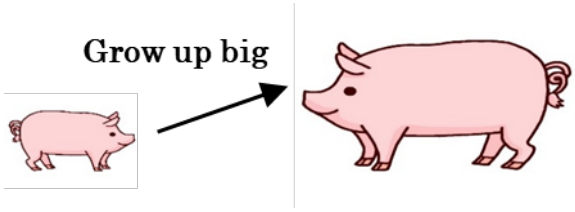
Hiroshi Shibano Advisor of Kansai QERG (TM JISSEN JUKU)

My first encounter with quality engineering was through in-company training, but at that time I was not interested in quality engineering. It was not until several years later, when I joined the Chubu QERG, that I found it truly interesting. In the almost 30 years since then, I have participated in many Research Groups and learned the interest and effectiveness of robust quality engineering. I will introduce selected episodes from them, and I hope you will enjoy them as stories like old tales.

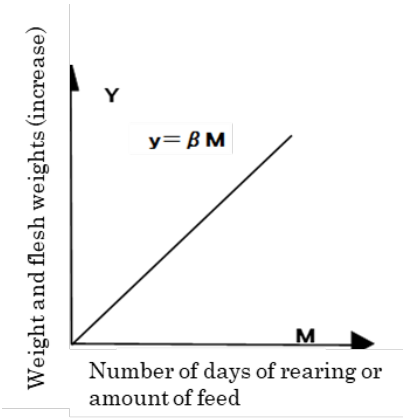
I am sure you are all familiar with the phrase "see the trees and not the forest". This phrase warns against getting caught up in the immediate and surface phenomena, not noticing the essential things, and failing to see the big picture. As a young man, I was admonished with these words many times by my bosses and seniors at work, but I never understood what they meant, and more often than not, I rebelled against them. I felt that if we did not solve the problem at hand first, we would not be able to move on. I must have been an overconfident and cocky young man. I am ashamed of myself.

I had an event that made me realize my mistake and renewed my way of thinking. It was related to pig farming, and Dr. Genichi Taguchi gave a talk at the Chubu Robust Quality Engineering Research Group as a case study of his teaching in Taiwan. I would like to introduce it to you as one of my old stories, because it is a case that is still applicable today.

At that time, the pig farming industry in Taiwan was struggling to dispose of pig excrement. If excrement is not carefully processed, it will produce a foul odor, causing complaints from nearby residents. However, careful disposal is costly and increases the burden on the contractor. In response to this difficult problem, Dr. Taguchi pointed out that the first priority should be to raise pigs large in a short period of time, rather than thinking about how to dispose of excrement. At first glance, the guidance seems misguided and long-winded, and the person in charge of raising the issue must have been surprised. However, this is guidance on the importance of improving generic function. Do you consider the generic function of pig farming? The generic function of pig farming is not to dispose of excrement.



If the entire pig farming industry is a forest, the excrement problem is a tree. Raising pigs large in a short period of time is the essence of the pig farming business, which enriches the entire forest and grows many trees (cost reduction, shorter delivery times, increased production, etc.), including the excrement problem. However, the opposite is not true. Trying to grow just one tree is often rather detrimental to the forest as a whole. Solving the excrement problem will not change pig production, will not shorten delivery times, and will most likely increase costs. The solution to one problem causes a new problem, so-called whack-a-mole. To avoid this, Quality Engineering recommends prioritizing the improvement of generic functions. We encounter various problems in our daily work and are pressed to deal with them as soon as possible, but if we keep in mind to look at the forest as a whole and not just the tree in front of us, we will find essential solutions that are different from the past.



For reference, the Chubu Quality Engineering Research Group at that time defined the generic functions of pig farming as shown on the right. How would you define it? Please consider it in your Research Group.

That's about it.

Back to CONTENTS

MT System and Deep Learning

Shoichi Teshima, Chairman of Hokkaido Taguchi Method Study Group (AngleTry Associates)

Dr. Genichi Taguchi said around 2000, when the existence of MT Systems was being established, that "engineers who use pattern recognition will have to choose MT or the others." Today, three-layer structure Neural Networks have evolved into Deep Learning with many hidden layers and the ability to handle vast and complex data. And applied technologies such as ChatGPT have been created. However, there are many examples of application of MT Systems, which have a simpler structure and can diagnose the cause of an abnormality especially in the field of manufacturing.

This paper describes the author's views on the similarities and differences between MT Systems and Deep Learning, including examples of actual analyses, and introduces recent applications.

1. Definition of Machine Learning and Artificial Intelligence

The definition of machine learning is not so clear. The term was coined in the 1950s and positioned machine learning as any computation that relies on a computer, including regression analysis. Artificial Intelligence (AI) is a recent development and a hot topic, but the term itself was presented in the 1950s. AI is a technology that makes intelligent decisions on human beings' behalf, such as recognition and prediction.

Artificial Neural networks (ANN), which mimic the neural circuits of biological organisms, boomed in the 1980s, and it was hoped that full-fledged AI would finally become a reality. ANN learned patterns through repetitive tasks, just as a child learns to write. However, its capacity was limited because it was only a three-layer structure, and the boom subsided.

It was 1995 when Dr. Taguchi presented the MT System. The MT System is a means of pattern recognition using statistical mathematics, and is naturally a member of the machine learning. MT Systems are one more form of AI, since their application areas overlap with ANNs. In 1987, Dr. Tatsuji Kanetaka applied the Mahalanobis distance to health checkups2), which is said to be the first case of the MT System.

Deep Learning (DL) was introduced in 2006 and is now scalable to dozens of layers or more, whereas previous ANNs had three layers. It is still fresh in our minds that the need for rule-making was on the agenda at the G7 Hiroshima Summit in May 2023, as the ability to handle vast and complex data and even the risk of its use has become a concern.

The relationship between machine learning, artificial intelligence, and statistical analysis is shown in Figure 1. Artificial intelligence includes support vector machines (SVM), decision trees and so on, and cluster analysis ect. as statistical analysis theory.

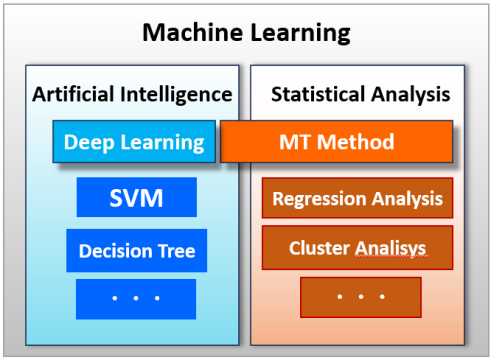


Figure 1. Positioning of MT Systems and Deep Learning in machine learning

2. Features of MT methods and Deep Learning in manufacturing

The following items are important when machine learning is used for manufacturing process monitoring (predictive maintenance) and product inspection.

-Processing speed for real-time monitoring and inspection, and rapid learning
-Recognition accuracy to be sensitive to abnormalities and their signs
-Diagnostic ability to identify the cause of abnormalities
-Ease of understanding the process for engineers
-Updatability to seasonal and other environmental changes

With respect to complexity, deep learning has by far the strongest capabilities. However, the MT Method has superior properties in these matters that are important in manufacturing and monitoring. The actual application fields for each are shown in Figure 2. The horizontal axis is the scale of the pattern and the vertical axis is the computational cost (memory required and amount of data to be prepared).

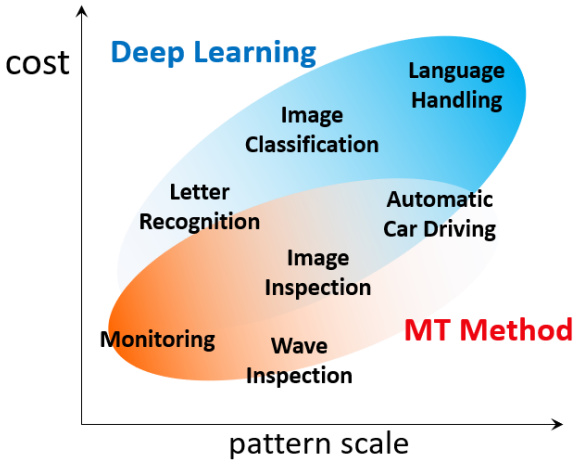


Figure 2. Application fields of MT method

3. Differences in structure and properties

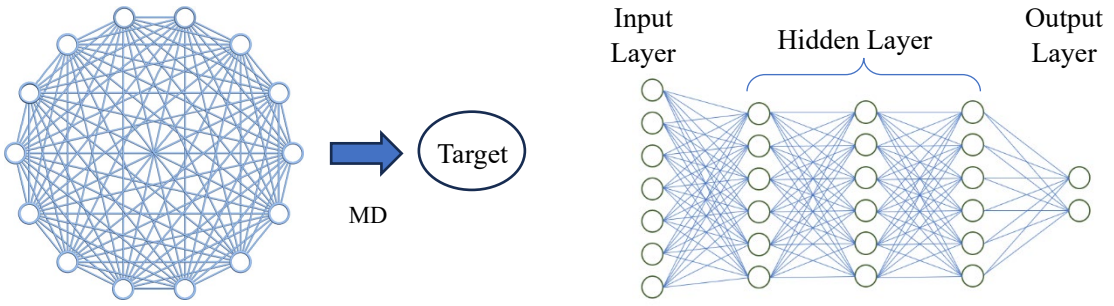
3.1 Structure of the MT Method

The MT method has the network structure shown in Figure 3(1). The circles indicate the item (14 in this case) and the line indicates the correlation between the items. We call it the "ball of correlation". Only normal data are learned on the ball in the MT method. From the center of the ball, Mahalanobis distance (MD) to the object or target is calculated. And if the distance is far (more than 4), it means that the object is different from the normal pattern. Since patterns that have not been learned as normal patterns are judged as abnormal, the MT method can also detect "unknown abnormalities" that have never been learned before.

3.2 Structure of the Deep Learning

Deep Learning has a structure consisting of an input layer, a hidden layer, and an output layer as shown in Figure 3(2), where the circles indicate brain neurons in humans and the lines indicate the strength of the connections between the neurons. The number of circles in the input layer is the number of items. The input and output layers are given known data, called " teaching data," and the strength of the connections is determined through over thousands of iterations.

The process of becoming intelligent through learning from teaching data is similar to how a child learns letters. The number of layers and number of neurons in the hidden layer is set at the user's own choice. In other words, the number of hidden layers can be 10 or 100 or more, and the number of cells is arbitrary. This is also a major difference to the MT method, where the structure of the MT method is uniquely determined.



(1) MT Method (2) Deep Learning

Figure 3. Structure of MT method and Deep Learning

3.3 White box and Black box

The MT method can diagnose the cause of abnormalities. It is possible to identify which items differed from normal, were out of balance, or had a correlation disturbance. For this reason, the MT method is known as a white-box AI.

In contrast, DL is not good at presenting diagnostic results that are easy for engineers to understand and interpret. This is one of the reasons why DL is called a black box; it is smart, but has communication difficulties. These concepts are illustrated in Figure 4. With a white box, it is immediately obvious how to react to an anomaly.

These differences are due to the network structure. We can understand the ball of correlation, which in turn helps us understand abnormal diagnostic results. In contrast, DL simulates the structure of the brain, and learning proceeds in such a way that errors become converged. No one can explain the strength of the connections between neurons at the end of learning. It is the same as the fact that studying Einstein's brain does not tell us why he was a genius.

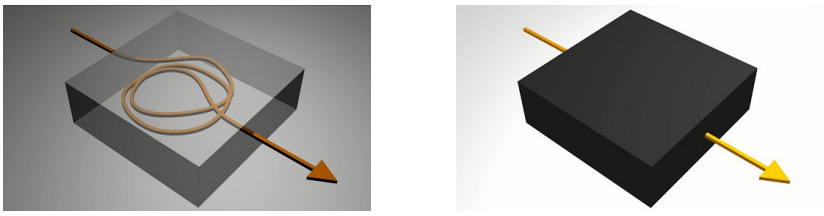


Figure 4. white box and black box

3.4 Differences in properties

(1) Training(teaching) Data

The MT method learns only normal situations, while DL learns multiple situations in many cases. In the manufacturing field, there are many normal data, but anomalies are rare and exists even unknown. In other words, it is impossible to cover all abnormalities, and the concept of the MT method, which reacts to "anything but normal," is reasonable in manufacturing fields. Furthermore, less data needs to be prepared for training. In DL, it is common for a single network to learn many patterns. This makes it powerful for image, text, language, or game issues.

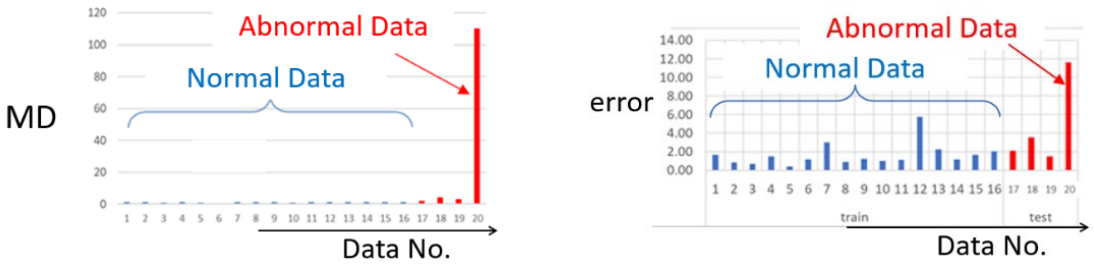
Deep learning also has a structure (autoencoder) that learns only normal data. However, the network size is large and the computational load is considerably larger than the MT method.

(2) Sensitivity to abnormalities

The most important aspect of using AI in manufacturing is the clear detection of anomalies. Figure 5 shows the character pattern recognition results3), with 1 to 16 on the horizontal axis side representing the training data and 17 to 20 the unknown data. Among the unknown data, 17-19 are normal and 20 are abnormal.

As can be found in Figure 5, in the MT method, the MD (degree of abnormality) of the training data is generally small, while it is extremely large in the abnormal patterns. In contrast, DL discriminates between normal and abnormal, but the numerical value in the case of abnormality is not so large, that is, the discrimination is not as clear.

In the author's experience, the MT method is often superior in terms of sensitivity to abnormalities. The difference in sensitivity was felt when the same problem was solved using the neural network and MT methods, and the feeling is still the same today. The reason for this may be that the structure of the MT method is simple and the amount of information is reduced to the essential minimum.



(1) The sensitivity in the MT method (2) The sensitivity in the DL

Figure 5: Sensitivity to normal and abnormal

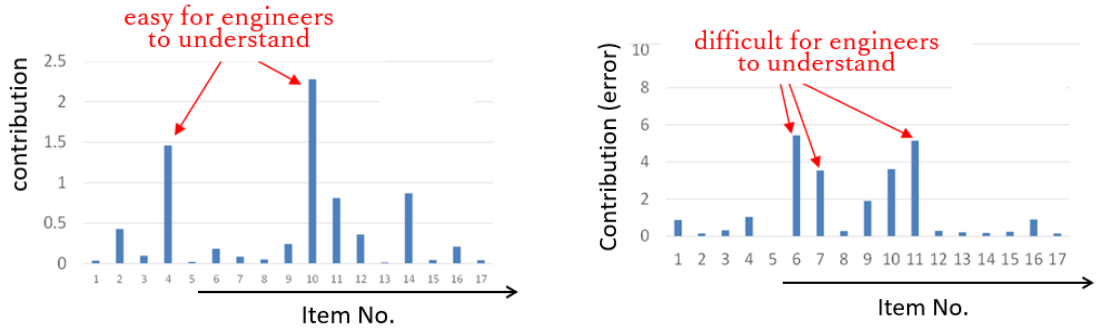
(1-16: teaching data, 17-20: target data with 20 being abnormal)

(3) Cause diagnostics of abnormal

The two bar graphs in Figure 6 show the results of the cause diagnostics of MT method and DL

(autoencoder). The horizontal axis is the data item number, and both results are for the same abnormal data.

The left graph shows that items 4 and 10 are the major causes in the MT method. These two items were understandable as the cause of the anomaly. The reason is that the correlation between them was found to be out of balance.Four items are high in the DL graph on the right, but they are not easy for us humans to understand. This is because DL is learned by a "DL brain," which has different rules from human brain.



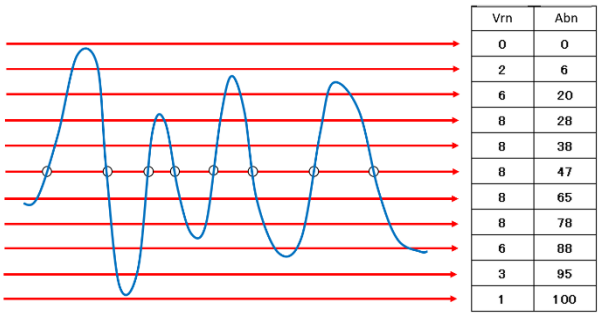
(1) MT (2) DL

Figure 6. Results of diagnosis of causes of anomalous data

4. The features for differential and integral characteristics

The MT System proposed by Dr. Taguchi includes another important technique “feature extraction.” It is an idea to extract "differential and integral features" from patterns4), and has unique effectiveness, especially as a method to extract features of waveforms. Back in 1995, Dr. Taguchi defined the MT System (MTS) as a method combining the Mahalanobis distance and the properties of differential and integral features5).

An overview of the features is shown in Figure 7, where multiple horizontal lines are set on the waveform, the number of intersections of each line with the waveform is the differential feature, and the sum of the lengths over which the waveform exists is the integral feature. These features allow simple extraction of the frequency, amplitude, shape, and other characteristics of the waveform.



Vrn	Abn
0	0
2	6
6	20
8	28
8	38
8	47
8	65
8	78
6	88
3	95
1	100

Figure 7. Differential and integral characteristics extracted from waveforms

The idea of calculus properties is explained in Dr. Taguchi's editorial with figures. The author did not understand what it said at first, but after thinking about it for a few days, he understood it, and later applied it to image inspection and presented it at the Society for Quality Engineering6). In Deep Learning, feature is said to be automatically generated in the network, but when actually working with waveforms, features such as frequency, amplitude, skewness, etc. are obtained in advance. Therefore, it may be a suitable way to use calculus characteristics in addition to these feature values.

5. Case studies

Two current applications of the MT System will be introduced.

5.1 Visual inspection of aluminum die-cast products

Many parts for automobile engines are die-cast aluminum products, in which high-temperature molten material is formed under high pressure. And, the following defects may then arise.

-Burr: material protrusion that appears at the die pressure welding area
-Wrinkles: wrinkles caused by stagnation of the flow of melted material
-Pin breakage: pin fixed to the mold side is broken and remains on the product side
-Chipping and cracking: mostly on the ridges of the product
-Other defects: scratches on circular bosses, scratches during die-cutting, and so on

For these inspections, a 6-axis robot is used as shown in Figure 8. A camera attached to the end of the robot captures images of all required locations from 360° and determines whether or not each location is defective.

Figure 9 shows an example of wrinkle inspection, with the left image normal and the right with wrinkles, and also an inspection results, that is, graphs of the Mahalanobis Distance (MD). The MT method requires only a few normal images to be prepared. The features extracted from the normal images are trained. After extracting features from the target image in the same way, the Mahalanobis distance is calculated, and a judgment is given as to whether the image is good or bad based on a predetermined threshold value.

Figure 8. Image capturing with a robot

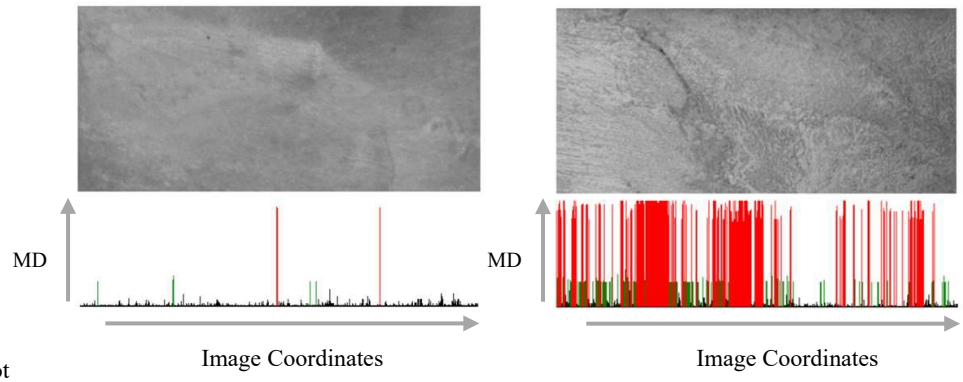


Figure 9. Inspection results of normal

5.2 Demand Estimation for Electricity

The power used in facilities such as factories and large-scale stores is managed so that the accumulative power consumption in 30-minute increments does not exceed the contracted value. Exceeding the contracted value will not cause power supply to be cut off, but on the other hand will result in a significant increase in the contracted rate for the following period.

The monitoring of power values is done while estimating whether the power at the 30-minute breakpoint, or power demand, does not exceed the contracted amount, as shown in Figure 10. Simple estimation methods were used so far, resulting in situations where the contracted value was about to be exceeded at the end of 25 minutes and some equipment was shut down in a hasty manner. In the case of large-scale stores, electricity consumption varies depending on the outside temperature and the number of visitors to the store, so accurate estimation using these variables is necessary.

Multiple regression analysis is a method of obtaining estimates from multiple variables, but while it is a good fit to known data, it is not very accurate in estimating unknown data that will occur. Furthermore, the regression coefficients obtained are often not appropriate.

Dr. Taguchi proposed the T method (1) to solve the disadvantages of multiple regression analysis. The method was proposed to accurately estimate the unknown phenomena that will occur. And, Makoto Maeda proposed MSR (Multiple Single Regression) 7), an improved version of the T method (1) in 2017.

And the T method (1) and MSR greatly improved the estimation of electricity demand. DL was also applied, but the results were almost identical to those of multiple regression analysis, and the T method (1) and MSR were more reasonable.

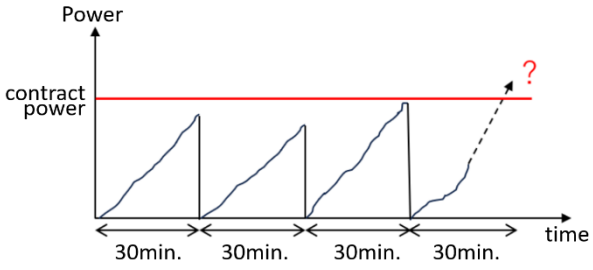


Figure 10. Power Demand Monitoring Waveforms

6. Conclusion

The author used neural networks until he came across the MT method. However, when the same problem was solved using the MT method, the results were shown to be more "crisp." CRISP, which can be called the resolution to discriminate normal from abnormal, is an indispensable feature in the field of manufacturing.

And the feature extraction technique of differential and integral properties (variation and abundance) has greatly expanded the field of application. As shown in the case study, it could also be used for image inspection, enabling more effective defect detection than Deep Learning.

Some fear that the development of DL will give rise to a technology called Generative AI, which will even take away human intellectual work. However, as described in this paper, pattern recognition techniques based on statistical mathematics, including MT Systems, have various advantages, including in terms of normal/abnormal resolution. The MT System also requires more technician engagement than DL. Decisions such as what sensors to install and where to install them, how many seconds to sample every second, etc., can only be done by the engineer. AI would not be an object to be feared, but to be actively used. The author believes that generative AI could also be used as a tool to make MT Systems easier to use.

As this manuscript was being prepared, news of an explosion during an Epsilon rocket burning experiment reached me (July 14, 2023). The MT System should have been positioned as a core technology for rocket autonomous diagnostics for the first launch in 2013, and earlier, Quality Engineering should have been incorporated to improve launch reliability. Not only rockets, but there have been many incidents that have upset the reliability of the products of manufacturers.

Quality engineering, including MT Systems, can result in shortcuts and has the power to train engineers. We hope that engineers involved in manufacturing will go back to the basics and use the Quality Engineering, that is Taguchi Methods, as one of their steady technical development tools.

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In the end, I would like to add that Dr. Taguchi's article published in the Journal of Quality Engineering (1993-) is still very useful after 30 years, and expands the range of our engineers' perspectives.

Back to CONTENTS

Nagano QERG Activity Record

Posted by Chigono Takeo, Secretariat of Nagano QERG (Nagano Prefectural General Industrial Technology Center)

Date: April 14th 2023
Place: Nagano Prefectural General Industrial Technology Center, Precision, Electronics and Aerospace Technology Division (Okaya, Nagano) and online (Webex)
Number of participants: 12
We discussed about following four issues:

【Case Studies】

1. What happens when the signal-to-noise ratio increases to noise factors?

(Yukiya Masuda, Masuda Engineering Consultant Office,Inc.)

We showed what happens to the noise before and after doing the robust parameter design. After parameter design, the system becomes more robust against noise.

2. Consideration of MT method for production line application

(Tomoko Hadama,TAIYO KOGYO CORPORATION)

Considering to apply MT method to monitor sensor data and detect abnormalities such as mold breakage and wear. The discriminative ability of the genetic algorithm as a means of feature selection was discussed.

We received advice on how to make decisions when using sample lines as feature values. Although we have not yet verified this on a production line, we would like to improve it for practical use so that it can be applied as an option when it is difficult for operators to make judgments.

3.B break condition setting

(Satoshi Moriya, KOA Corporation)

In the individual segmentation of rectangular resistors, the selection of the segmentation belts and rough conditions were selected in the L18 experiment. This time, more detailed condition selection was performed in the L9 experiment. The control factor was the setting conditions of the dividing machine, noise was the new and old dividing belt, and the response was the incidence of defects when the machine was divided.

Since the conditions had been roughly set, there were only one or two combinations of L9 that resulted in the occurrence of defects. Since the factorial effect graph was created based on such results, some factors were V-shaped, but good results were obtained in the reproduction experiment under the conditions selected as the optimum combination after creating response graphs for each type of defects.

4. “Examination of Periodic Maintenance Formulas”

(Advisor Yukihiro Iwashita)

The formula for periodic maintenance described in the book Quality Engineering Course 2 and other books calculates the optimum maintenance time assuming a change in stress d of d^2=a*t. To accommodate other patterns of change in d, we calculated the optimum maintenance interval when d = a*t^b. By measuring the change in d and approximating b with a power function, we can obtain the optimum maintenance interval according to the pattern of change in d.

Date: May 12th 2023
Place: Nagano Prefectural General Industrial Technology Center, Precision, Electronics and Aerospace Technology Division (Okaya, Nagano) and online (Webex)
Number of participants: 15
We had a General Meeting and discussion about following three issues:

【General Meeting】

The report for FY2022 and the plan for FY2023 were approved. The number of members this year: 16 (regular members: 11, special members: 6, advisors: 1), Special member: 6, Advisor: 1. A total of 11 meetings are scheduled. The activities will include "Case Study Presentations (rotating among

members)," "Joint Research Groups," and "Lecture Meetings.

【Case studies】

1. "Evaluation of Quality"

(Satoshi Tsuneda, NISSEI PLASTIC INDUSTRIAL CO., LTD.)

The definition of quality in Robust Quality Engineering, the derivation of the loss function, and how to determine tolerances using the loss function were explained. It is necessary to determine tolerances economically in order to balance losses before and after shipment.

2. "Reconsideration of the effect of multicollinearity and generalized inverse in MT method"

(Masataka Nagaoka, HIOKI E.E. CORPORATION)

Although the MT method is said to have a multicollinearity problem, we conclude that the MT method does not have a multicollinearity problem because the calculation of the vector linear transformation by inverse matrix at the Mahalanobis distance is different in nature compared to the calculation to estimate the partial regression coefficient in a regression analysis. Also, in some cases, we have tried to calculate the Mahalanobis distance using a generalized inverse matrix for rank-dropped data, and we have shown that the unit space in this case is the same as that calculated with a normal inverse matrix, leaving one column each with an absolute value of 1 for the correlation. Then, when the signal data is discriminated in this state, the Mahalanobis distance in the direction of the reduced dimensionality is shown to be zero.

3. "On the Possibility of Pre-registration Method of Interaction ~Using the appearance of all combinations between two factors in an orthogonal array~"

(Shinano Kenshi Co., Ltd. Tsuji Nozomu)

Using the fact that all combinations between the two factors appear in the orthogonal array, we tried to conduct a preliminary check to see if there is any interaction between the two factors before checking the reproducibility of the gains. However, it is not possible to determine how much of this effect is due to the fact that the two factors are total between the two factors, but the other factors are unfixed. Therefore, it is not possible to determine whether we can say that we have a good idea of the interaction.

In light of the above, one of the members suggested that we try to see what the graph would look like in a simulation or the like when the interaction is small.

Date: June 2nd 2023

Place: Nagano Prefectural General Industrial Technology Center, Precision, Electronics and Aerospace Technology Division (Okaya, Nagano) and online (Webex)

Number of participants: 15

We discussion about following three issues:

【Case studies】

1. "Controlling for "variation" and "mean" using response graphs ~four patterns of factorial effect charts~." (Masuda Engineering Consultant Office,Inc.)

The factorial effect graphs for the signal-to-noise ratio and sensitivity (mean) are divided into four patterns and animated to illustrate how the variability and mean change when the level of the control factors is changed.

2. "Is it possible to check the size of the interaction even with a one-factor experiment? ~We can check the interaction by conducting a confirmation experiment! But...~"

(Yukiya Masuda, Masuda Engineering Consultant Office, Inc.)

Even in one-factor experiments, it is possible to check for interactions between control factors by conducting confirmation experiments. If the interaction is small, there is no difference between a one-factor experiment and an orthogonal array experiment. However, if the interaction is large, the orthogonal array experiment has the advantage of obtaining "optimum combinations" or "conditions close to optimum combinations" (including the interaction between the two factors).

3. "Evaluation of Quality (2) - History of SN ratio"

(Satoshi Tsuneda)

He reported on how the SN ratio has evolved from 1952, when it first appeared, to the 1970s, when it became the basis for the modern SN ratio. Starting with telephone intelligibility using the omega transformation, Mr. Tsuneda introduced methods of determining the SN ratio by applying it to telecommunications, methods of comparing quality, and the SN ratio for first- order calibrations in measurement methods using orthogonal polynomial expansion. In all of these cases, the value before taking the logarithm was found to be the "dispersion ratio," and I felt that this helped me to understand the essence of the SN ratio. Next, I would like to research and summarize SN ratios from the 1980s to the present day.

Date: July 14th 2023
Place: Nagano Prefectural General Industrial Technology Center, Precision, Electronics and Aerospace Technology Division (Okaya, Nagano) and online (Webex)
Number of participants: 11
We had discussion about following one issues and one Special Lecture:

【Case studies】

1. “Use of Estimation Equations in Robust Parameter Design”

(Advisor Yukihiro Iwashita)

In robust parameter design, we studied the use of the T method to create an estimating equation and optimize it using a quality loss function. As a result, it was found that not only can optimum combinations corresponding to the objectives be obtained, but also the characteristics of the T method can be utilized. It was also found that optimum combinations can be determined from multiple quality characteristic data in a non whack-a-mole manner.

【Special Lecture】

1. “Introduction and Usage of Signal Catcher”

(Takeshi Ishizawa, TANAKA ENGINEERING CO.,LTD.)

Mr. Ishizawa introduced the MT system (MT method and T method) software "Signal Catcher" and explained how to use it. He analyzed a Research Group member's case study using the MT method and showed that it is possible to discriminate between the two methods. He gave a detailed lecture on waveform analysis, including how to characterize and analyze waveforms using the sample line and center-of-gravity methods.

Although the software is a paid version, Research Group members can use the demonstration machine free of charge, and we expect that there will be more presentations of the MT method in the future. (Noted by Yukiya Masuda, Masuda Engineering Consultant Office, Inc.)

Back to CONTENTS

~News from Robust Quality Engineering Research Group and others~

◆From Kansai QE Research Group◆

1. Report on the Training Camp

The camp was held for the first time in four years. The venue was Hotel Lodge Maishima, with 21 participants, and also, we had participants via web meeting. In addition to the customary theme discussions, there was a special speech by Shin Taguchi from ASI, a reception in the evening, and a magic show by a professional magician (Research Group member), which was a lot of fun.



2. Invitation to the Quality Engineering Symposium 2023

Subject: Exploring the Essence of Quality Engineering - Loss Reduction through Integration with MBSE/MBD
Date and Time: Friday, October 6, 2023, 10:00 a.m. - 5:00 p.m.
Forms: Face-to-face Osaka Venue: Nikkan Kogyo Shimbun Nishi-Nihon Branch 10F Conference Room
Remote System: Microsoft Teams
Participation fee: Free
Reception: Friday, October 6, 2023, 17:30-19:30 *Details of the venue and reception fee will be announced as soon as they are determined.
Contents:

10:00-10:10	Opening address; Taro Tetsumi, Chairman of Kansai QERG
10:10-12:00	Keynote Speech; Kazuhiro Aoyama, Artificial Engineering Research Center, Graduate School of Engineering, The University of Tokyo “Architecture and Management in System Design”
12:00-13:00	Lunch break
13:00-13:40	Invited Presentation; Nobuyuki Hagiwara, NSK Ltd. “Taguchi's design of experiments for optimizing optimum combination of heat treatment conditions of thrust bearings and exploring new response.”
13:40-14:15	From Chubu QERG; Takamitsu Yamanaka ROHM Co., Ltd. “Grid Search robust assessment by Using Machine Learning Models to Find Robust Optimal Solutions.”
14:15-14:50	From Kansai QERG; Hiroshi Shibano TM JISSEN JUKU “Increased robustness by using interactions between control factors.”
14:50-15:10	break
15:10-16:00	From Kansai QERG; Taiga Ezura RICOH COMPANY,LTD. “Technological Development of MEMS Processes through the Collaborative Use of Multiple Creation Techniques”
16:00-16:50	From Hiroshima QERG; Nobuhide Takeshige Mazda Motor Corporation “Reducing Social Losses in Mazda Vehicle Development - Part 2”
16:50-17:00	Closing Remarks; Taro Tetsumi, Chairman of Kansai QERG

*Themes and order of presentations are subject to change.

Organized by Kansai QERG
Co-Organized by The Kyoto Technoscience Center, Chubu QERG, Shiga QERG, Hiroshima

QERG

Supported by West Japan branch of THE NIKKAN KOGYO SHIMBUN, LTD. Japanese Standards Association, Union of Japanese Scientists and Engineers, Robust Quality Engineering Society, The Institute of Japanese Union of Scientists & Engineers, JADEITE Corporation, ITEQ International LTD.

3. Kansai Quality Engineering Research Group Membership Information

List of membership categories, annual fee, and membership benefits and subsidies

Membership Categories	Annual fee	Eligibility, benefits, **subsidies**, etc.
Regular Member	¥30,000	-Only the person himself -Subsidies for participation in various events, distribution of books, and other services are available.
Corporate Member	¥50,000	-Up to two persons can participate: the registered corporate member or the member's representative and one accompanying person. -Subsidies for participation in various events, distribution of books, and other services are available.
Senior Member	¥5,000	-Only by those who are 60 years of age or older -Subsidies for participation in various events, distribution of books, and other services are available.
Student Member	¥2,000	-Students enrolled in educational institutions such as universities (except trainees) who participate only by themselves -No subsidies for participation in events, distribution of books, or other membership services

■Services■

-Subsidies for Society events: Participation and accommodation expenses for the New Year's Party, Kansai Region Quality Engineering Symposium, and the Research Group Training Camp, etc.

-Subsidies for events held by the Research Group: Participation fees for events held by the Japan Society for Quality Engineering, Research Group-approved seminars and events.

-Past subsidies include: participation fees for the Quality Engineering Research Conference, Technical Strategy Research Conference, Corporate Social Activities, Quality Engineering Forum, and Introductory Seminar on Quality Engineering.

-Free distribution of books: Distribution of the Proceedings of the Research Group on Quality Engineering and newly published books related to quality engineering to Research Group members, etc.

■Payment Method & Term ■

Payment Method: Regular, Corporate and Senior Members can choose to pay their dues in a lump sum for the year (January-December) or in semi-annual installments (January-June and July-December).

or semi-annual installments (January to June and July to December).

■How to apply■

Please refer to the Research Group's website: https://kqerg.jimdofree.com for information on how to apply for membership. Please refer to the "How to Apply" page on the website of the association: 95.

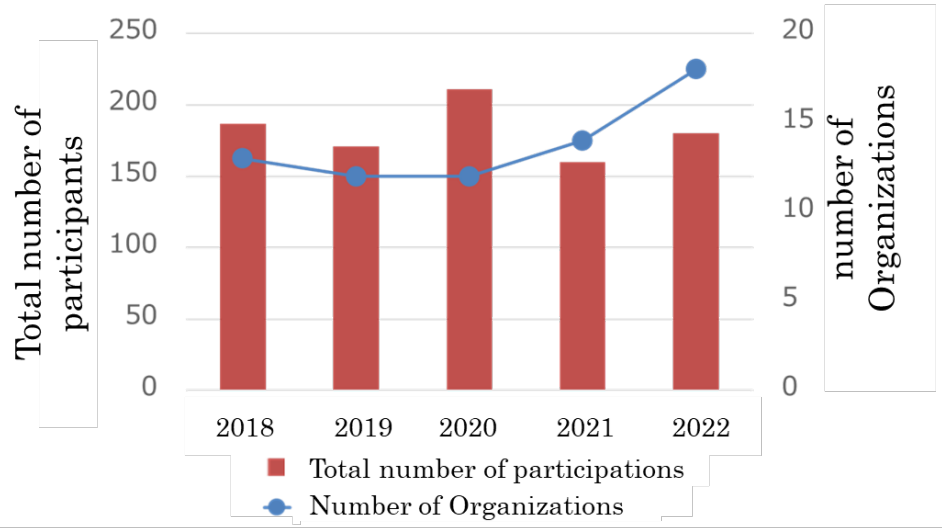
Back to CONTENTS

◆From Nagano QE Research Group◆

1. Overview of Nagano QERG

Name	Nagano Quality Engineering Research Group
Establishment	May 29th 1996
Members	17 organizations (as of May 2023)
Location	1-3-1 Nagachi-Katamacho, Okaya, Nagano, 394-0084 Japan Nagano Prefectural General Industrial Technology Center, Precision, Electronics and Aerospace Division
Home Page	http://nqes.web5.jp/index.html
Contact	Secretariat: Nagano Prefectural General Industrial Technology Center TEL：0266-23-4000 E-mail：nqes21_tgqdmqbmf@nqes.web5.jp
History	1996: Established to promote Quality Engineering in Nagano Prefecture. 1998 Lecture by Dr. Genichi Taguchi 2004 The 1st Three Prefectures (Hokuriku, Saitama, Nagano) Joint Research Group was held in Nagano Prefecture. 2005: Invited Dr. Genichi Taguchi to give a lecture in commemoration of the 10th anniversary of the foundation. 2016 20th anniversary
Purpose	The purpose of the Society is to contribute to the development of the industry by promoting the advancement of knowledge and engineered quality of Quality Engineering, its dissemination and exchange of information, based on the initiative of its members. (From the Constitution)
Main Events	-General meeting in May -Regular meeting: Once a month on the second Friday -Joint Meeting (Hokuriku, Saitama, Yamanashi, Nagano) -Co-organize following seminars With Nagano Industrial and Commercial Encouragement Organization. Introduction to Quality Engineering 1 day Basic seminar on robust parameter design 2 days MT system seminar: 1 day On-line quality engineering seminar: 1 day
Outline of Activities	Regular meeting Introduction of recent activities of members (one person's comment) Presentation of one or two Quality Engineering case studies Joint research on Quality Engineering
Membership	-Trial Participation is available: We are always looking for new members. In order for non-members to learn more about the activities of the Research Group, we also invite non-members to participate in the Research Group on a trial basis. If you wish to join, please contact us at the following address 【Contact】 1-3-1 Nagachi-Katamacho, Okaya, Nagano, 394-0084 Japan Nagano Prefectural General Industrial Technology Center, Precision, Electronics and Aerospace Division TEL0266-23-4000　FAX0266-23-9081

2. Number of Organization and total number of participants



17 organization this year(11 Corporations, 4 public institutions, 2 advisors)

3. Our Activities

-Regular Meeting

Case Study Presentation

・Discussion of each company's efforts, problems, etc.

one person's comment

・Introduction of recent activities of members

Joint Research

・Joint research on Quality Engineering

-Joint Research Group

・Joint research group held at HIOKI E.E. CORPORATION in 2018

-We are having join research group with Saitama, Hokuriku, and Yamanashi once a year
-Currently held via web

-Co-Organize following seminars With Nagano Industrial and Commercial Encouragement Organization

Introduction to Quality Engineering
・Introductory seminar for engineers and managers

Basic seminar on robust parameter design
・Practicing robust parameter design through paper airplane construction

MT system seminar
・Practical seminar on MT system with EXCEL

Quality Engineering Exchange Conference
・Lectures and Case Studies in Quality Engineering

3. Benefits of Membership

-Advice can be obtained

Through the presentation of case studies, you will be able to obtain accurate advice.

-Experience Quality Engineering

Through the presentation of case studies, you will be able to obtain accurate advice.

-Internet Service for Members

a mailing list and a members-only page.

Remote meetings via a web system.

-Free Quality Engineering Seminars

Members are free for QE seminar at Nagano Industrial and Commercial Encouragement Organization.

-Nagano Prefectural General Industrial Technology Center serve as the secretariat.

They create an environment that allows you to focus on the discussion.

Back to CONTENTS

◆Seminar infomation◆

From ITEQ International Ltd.

1. Practical Seminar on FMEA/FTA in Nagoya

Date & time: Oct.31st &Nov.1st 2023 Tow days 9:30-16:30

Comment from Teacher: This seminar is full of points on how to reduce market defects while utilizing FMEA/FTA. The course is based on the experience gained through practical development and consulting, and is designed to be convincing and practical, so that participants can learn the basics of FMEA/FTA and tips for practical use through lectures and exercises.

Place: WA Higasizakura room3(Nagoya higasi-ku higashizakura1-2-8)

Fee: non-member ￥52,800 (including Tax)／man QE research group member= ￥42,240(including Tax)/man

Target: Managers and practitioners in development, design, production engineered quality, and quality assurance departments

For more information, please visit the following URL.

http://www.iteq.co.jp/resource/seminar/koukai_seminar/2023/fmea2310j.pdf

2. Seminar on The Four major Methods of Quality Engineering (Online)

Date & time: Dec.7th ,8th ,21st,22nd 2023 Four days 13:00-17:00

*You can select the course you wish to take for each lecture content.

Contents: Dec. 7th: Robustness assessment to measure variability in function

Dec.8th: Function improvement through robust parameter design

Dec.21st: On-line quality engineering to measure the engineered quality of production processes and suppliers

Dec.22nd: MT system as an AI in the manufacturing field

Comment from Teacher: There are many effective methods in Quality Engineering. Among them, Robustness assessment, parameter design, on-line quality engineering, and MT method are the four major methods that form the core of Quality Engineering. In this seminar, you will learn the basics of these four methods and practice them through exercises in this groundbreaking curriculum. This will be very useful from improving development efficiency to improving productivity and ensuring product quality.

System: Microsoft Teams

Fees: All four days non-member ￥74,000 (including Tax)/man QE research group member=￥59,200(including Tax)/man

one day each non-member ￥20,350 (including Tax)/man QE research group member=￥16,280(including Tax)/man

Target: Engineers in development, design, production engineering, quality assurance department, and manufacturing department (Beginners in Quality Engineering are welcome)

For more information, please visit the following URL

http://www.iteq.co.jp/resource/seminar/koukai_seminar/2023/tm4_2312j.pdf

◆Notice from the Editor of this QE Magazine◆

If you are a Research Group that supports Quality Engineering Magazine and would like to make an announcement in the Quality Engineering Magazine, please contact the Quality Engineering Magazine Editor below.

Editor: Hiroshi Shibano from TM JISSEN JUKU: tm-shibano@tmjissen.com

Toshiharu Ehira from ITEQ International Ltd.: toshiharu.ehira@iteq.co.jp

◆Notice from Translator◆

This English version of magazine is a translation of the Japanese version. The translator is an

amateur translator and is a volunteer. Please understand that the translation may not be perfect in some places. If you find something in the translation that is so strange that it cannot be overlooked, please contact the translator below for the sake of other readers.

Translator: Hiroto Funayama from ITEQ International Ltd.: hiroto.itoh@iteq.co.jp