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~

Summer 2024 Issue

< Cooperative 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.

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Preface for Robust Quality Engineering Magazine Spring Issue.

Norio Shirokoshi, Organizer of Central RQERG (Harmonic Drive Systems Inc.)

Thanks to the efforts of enthusiastic Kansai volunteers, the fourth issue of the Magazine is now available. Although I am not sure if I am right person to write the preface to this issue, I would like to contribute as an engineer.

Previously, I could not find out how to reconcile cost and quality, how to determine pass/fail criteria for design verification, or what to do to reduce problems in the marketplace. In 2014 I came across Robust Quality Engineering and Robust Quality Engineering gave me a way of thinking that led me to solving these problems. Nine years have passed since then, and although the problems at hand have not been solved due to the lack of competence on the part of those who use it, I believe that I have gained a direction to work in.

Concepts such as "quality loss function" and "tolerance design"-that is, the clean idea that quality is based on a cost foundation-are the reason I think Robust Quality Engineering is good. The idea is that even if one out of a million mass-produced products is defective, it should not be because it is one defective product out of one for the customer who bought it. A company is nothing if it does not survive, and I, as a member of it, would appreciate a concrete idea that is feasible rather than a slogan of zero defects. On the other hand, it can also be taken as an admission of defectiveness, so I am wary of talking about this with someone who is not familiar with Robust Quality Engineering, as they may be offended.

Now, Robust Quality Engineering is not popular for some reason. One reason may be that it is difficult to accept the idea that defects are unacceptable at all costs. However, a further consideration is that some engineers are interested in and value a narrow range of cause-and-effect relationships. For example, if the results of a one-factor experiment are well explained by a single regression, they find value in it and are satisfied. But then the multi-factor interaction is unknown, i.e., the market conditions that the multi-factor affects cannot be considered, but they are not interested in that now because it is a future event. I think this is an extreme example, but not inapplicable. The result is that the company is forced to deal with market problems, which puts pressure on the original development work. This is where the problem finally arose. Is it not because engineers cannot connect "an effective development method to prevent market problems" and "Robust Quality Engineering as a method to assure market quality"? I am trying to break such a vicious circle, but I have no influence to begin with and am struggling on my own.

Finally, I would like to introduce the situation of the Central Robust Quality Engineering Research Group. Everyone is participating for various reasons, such as spreading the concept within the company and improving business operations. In the course of their involvement, they influence each other, learn from each other, and enhance each other's skills, and everyone, including myself, seems to find the time spent in the Research Group rewarding and happy and full of vitality. I think this is the small significance of our existence as a Research Group.

At the very least, I learned from Robust Quality Engineering the concept of "function," the idea of considering techniques to measure it, and the idea that many control and noise factors can be statistically handled to ensure reproducible experiments without having to reveal interactions. Robust Quality Engineering has made my development work more enjoyable.

That’s about it.

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Generative AI and MT System

Shoichi Teshima, Chairman of Hokkaido TMRG (AngleTry Associates)

Over the past year or so, "Generative AI," including ChatGPT, has become a major topic of discussion. The central technology used there is Deep Learning. Deep Learning is a technology developed from Artificial Neural Networks (ANN), which can process vast amounts of data. Technologies such as Natural Language Processing and Transition Learning have been added to this process to create ChatGPT. There are other generative AIs for audio and images that are available for free, and many people may be surprised at their capabilities.

By the way, ANN, which boomed around 1980, began to show its functional limitations and its fever died down before the year 2000. Not to exploit this gap, Dr. Genichi Taguchi proposed the MT system in 1995*. I happen to have been an ANN user since 1992, and as soon as MT was proposed, I immediately compared its functions with ANN. It was then found that MT produced clearer decision results with less computational processing. An example of the comparison, which I think should be described as "crisp and clear," can be found in the first issue of this Magazine.

Now, after the ANN boom subsided, various research efforts continued, and the result was the emergence of Deep Learning, which has been around since 2010. It surprised the world with its triumph over professional chess players and its topical application of cat image recognition. Researchers and companies around the world have been pouring their efforts into this research, leading to the birth of generative AI. In other words, we have come that far in just over a decade since the birth of Deep Learning.

The generative AI, however, has its own practical challenges at this point in time. Mitutoyo City in Kagawa Prefecture has developed a prototype system using generative AI with the cooperation of the University of Tokyo to improve citizen services (2024.5.1 Yomiuri Shimbun morning edition). However, the correct response rate was 94% and could not be improved further, as incorrect answers were given when asked how to dispose of trash. I myself sometimes ask questions on ChatGPT, but the answers are often mixed with unnatural information, and reliability is not yet there.

The reason for the lack of reliability is not known, but Deep Learning, the pillar technology, is a black box. In other words, "Why did you get the result you did?" "Why did you judge it to be an anomaly?" you will not get an explanation that can be interpreted by a human being. Perhaps this nature is also the reason why ChatGPT is incomplete. If this situation continues, the heat will cool as the ANN boom once subsided, and the contours of what can and cannot be done will emerge.

In the automotive world, the world has realized that EVs, which were considered the most environmentally friendly, are actually not the optimal solution, and the value of HVs (hybrid vehicles), for which Japan has been steadily accumulating technologies, is being reevaluated. The same situation will probably occur in the field of artificial intelligence. In other words, there is a strong possibility that an era of segregation will come, in which Deep Learning will be used for tasks that require the processing of complex and enormous amounts of information, and technologies based on statistics, such as MT systems, will be used for manufacturing tasks in which engineers are directly involved.

The MT system is a white box AI that is superior to Deep Learning in terms of interpretability (transparency). It is also far less computationally intensive and leads to robust decision-making results. Dr. Taguchi said, "The pattern technology of the world will be MT or nothing else," but I believe that a somewhat different pattern will be drawn in the AI world.

*Dr. Taguchi named the MT system in the Robust Quality Engineering Society Journal in 1995 (vol. 3, No. 4), but the use of the Mahalanobis distance dates back to the 1980s.

That's all

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The truth of Robust Parameter Design (2)

- Interaction between control factors is necessary to improve stability-

Katsuyuki Ota, Kansai Advisor of QERG(ITEQ International LTD.)

In the previous issue, I showed an example of a calculation in which a slight change in the setting of the noise factor can change the optimum combination. This calculation example is by no means a special case; it can occur in many cases. The signal-to-noise ratio is only an evaluation of stability in the noise assumed by the evaluator, and even if the condition that maximizes the signal-to-noise ratio is chosen exploratively or from among all combinations, it is not guaranteed to be strong even under unexpected noise conditions.

2.1 Robust design against unexpected noise

A system is robust against unexpected noise if its output (function's robustness and response) does not change when various other noise conditions are added to the system, not just the assumed noise conditions.

Noise factors affect output because environmental factors such as temperature and wear, which are noise factors, change dimensions and physical properties, which are levels of control factors. All of the system's parameters are control factors, noise factors, and Noise Factors." (R&D Strategy 1),p79)

This can be understood from the procedure for setting the noise factor in the RPD of the simulation. (See Section 1.2 in the previous issue.) From the system's point of view, the control factor and the noise factor are the same, only their level values and widths are different.

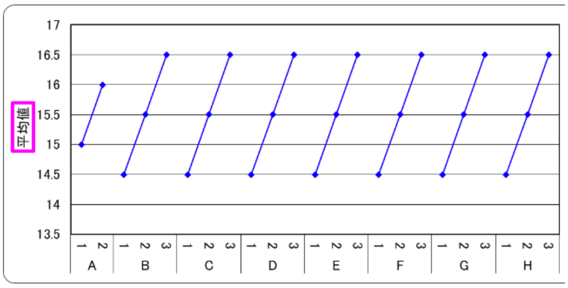
If, after investigating many parameters in a system, you find that there are no control factors that can change the output, no factors that are useful for control (much to the engineer's dismay), then you have found a robust condition. And the more parameters you investigate, the more likely you are to be robust against unexpected noise.

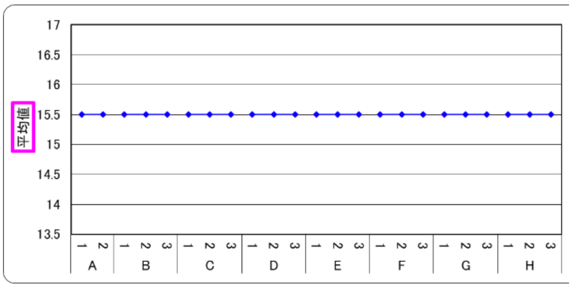
A concrete example will illustrate this. For a certain set condition of 8 parameters of a certain system, the level is changed by an appropriate width (tolerance level) before and after the level of each factor, assigned to L18, and the output is shown in a response graph. This is, so to speak, tolerance design using an orthogonal array. The results of the two ways are shown in Fig. 2.1, and Fig. 2.2.

Fig. 2.1 shows a case in which there are many factors useful for control. Although tuning of output is possible with any of the factors, the tolerance of each factor must be small to stabilize the output. Even if the product can be shipped under strict control, there is a high possibility that the output will change after shipment due to the customer's usage conditions or deterioration. A design that requires strict control is not a robust design.

Fig. 2.2 shows the case where there were no factors to help control, and although tuning factors cannot be used with these factors to tune the output, they can make the tolerances wider. Furthermore, it is likely to be robust to customer usage conditions and degradation after shipment. You may think that it is not possible to adjust the outputs, but you can set the signal factors in advance, or you can choose a factor with a large contribution, taking cost into consideration. In that case, it is better to do it with a single factor.

Robustness to unexpected noise can be determined not by the signal-to-noise ratio, but by the process average response graph (difference in effects) of the output.



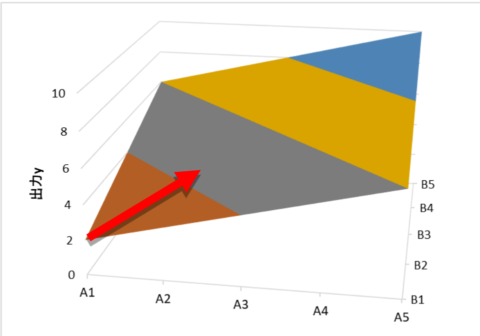


If Fig. 2.1 is the initial state, then the purpose of the RPD is to change the response graph to the state shown in Fig. 2.2. In Fig. 2.1 and Fig. 2.2, there are 8 parameters, so the optimization is performed in a 9-dimensional space including the output y, which cannot be illustrated. For the sake of clarity, we will use two parameters.

2.2 Stabilizing Output by Using Interaction

Hypothetically, there are two control factors A and B. The behavior of their outputs is investigated and shown in a contour plot (contour map).

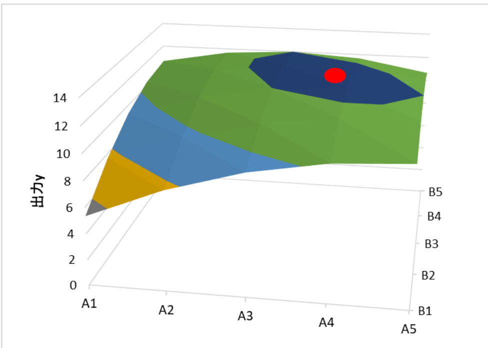
Case 1: There is no interaction between factors A and B and the main effect is linear.



<Fig. 2.3> Contour without interaction

In Fig. 2.3, if A1 and B1 in the left foreground are the initial conditions, the output is in a state where a change in either level of A or B will result in a significant change. Furthermore, the same is true for the diagonal direction (red arrow) where the changes in A and B are combined. No matter which point on this contour diagram is selected, the width of the change is the same, which means that no improvement in robustness is possible.

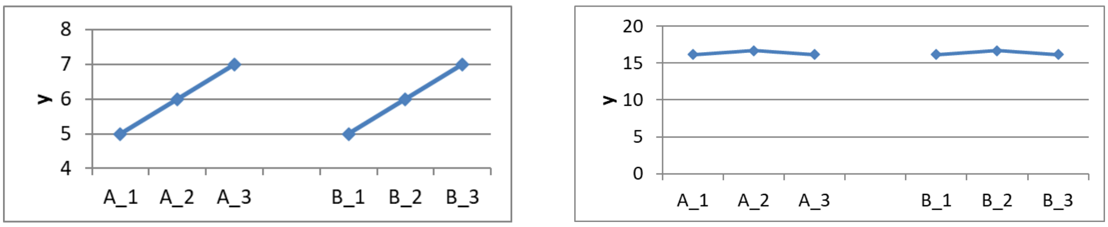
Case 2: When there is an interaction between factors A and B.



<Fig. 2.4> Contour with interaction

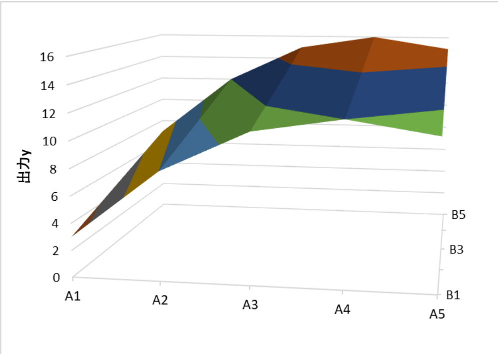
In Fig. 2.4, assuming that the initial state is A1 and B1 in the left front, the output changes significantly in response to changes in the level of A and B. However, in the vicinity of A4 and B4 (red dots), the slope is slower, and the output changes little in response to changes in the level of A and B. However, in the vicinity of A4 and B4 (red dots), the slope is slower and the output changes less in response to changes in the level of A and B. Thus, the interaction of control factors can improve robustness by creating a curved surface.

The initial state response graph and that after optimization must change if stability can be improved.Fig.2.5



<Fig. 2.5> Response graphs for initial and after optimized conditions

Case 3: No interaction and a nonlinear main effect on A.



<Fig. 2.4> Contour without interaction and Non-linear main effect

It is possible to produce a curved surface without any interaction and with a nonlinear main effect. In Fig. 2.5, the surface looks like a conical surface with curvature in only one direction. Assuming that A1 and B1 are initial conditions, if we choose the level of A4, it will be stable for changes in the level of factor A. However, for changes in the level of factor B, it will be stable for changes in the level of factor B. However, the stability cannot be improved for changes in the level of factor B. If noise factors other than A are added, there will be no effect. If multiple factors are studied and there is no interaction between factors, the possibility of an interaction for an unexamined factor is considered to be smaller than if there is an interaction between factors. In that case, the effect of noise added to the unexamined factor cannot be ameliorated by this nonlinear factor A. When stabilized in a system with interactions, as in Case 2, there is a high likelihood that there will be interactions for unexpected noise, and the effect of noise added to the unchosen factor may also be mitigated Case 3 is more favorable for improvement to stability to unknown noise than Case2, because the effect of the noise factor must be affected by the noise factor with its nonlinearity to be effective.

Robust design for unexpected noise is to use the interaction and nonlinearity of multiple factors to create a curved surface in the response of the output and to find broad, gentle slopes or hills where the gradient is small.

The optimum combination is a single point on the surface, which is a combination of multiple levels of control factors and the use of interactions. In areas of high stability, both the main effect and the interaction are small.

2.3 Optimization in a response graph

A method of optimizing RPDs using simulation models has been proposed to search for optimal levels by iterating sequential robust parameter design with smaller intervals between level values. One example of this method, "Optimization of Component Responses to Improve Crash Safety Performance by Simulation, "2) is presented.

Perform robust parameter design by decreasing the interval between the level values from the initial conditions to create a factorial response graph. Select the level at which the response (in this case, the signal-to-noise ratio) of each factor is the largest (the first time).Next, considering the slope of the response graph, determine the levels to be explored, including the selected level, and conduct a robust parameter design again, selecting the level that is the largest as before (the second time). Repeat this process until the response can no longer be maximized. In this case study, six robust parameter designs were performed. ＜Fig.2.7>

Looking at the changes in this response graph, we can see that the gain differences for each factor were large at the beginning, but gradually the gain differences disappeared, and by the sixth time, the gain differences had almost disappeared and there were no factors that were useful for improvement.

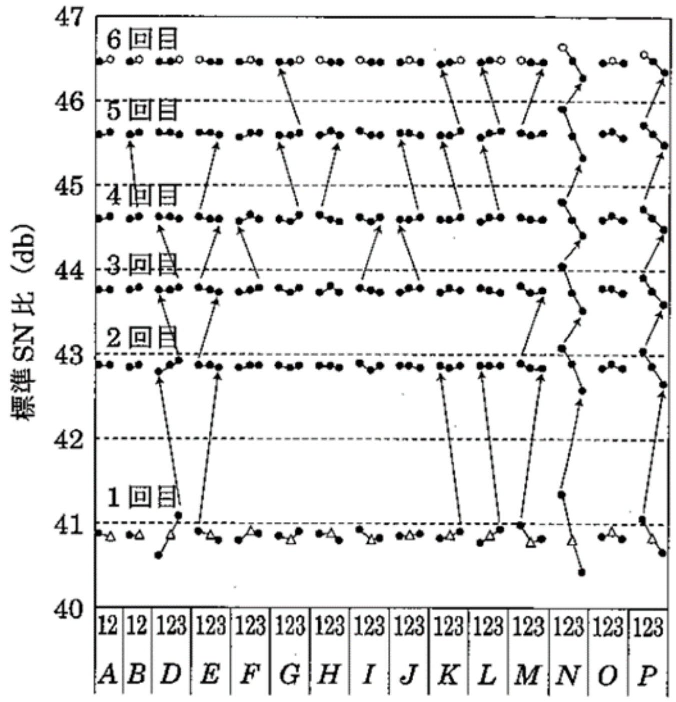


図6　1～6回のSN比の要因効果図

< Fig. 2.7> Response graph for reference case

For factors N and P, it can be seen that the gain differences have also decreased significantly from the first time.

After six rounds of optimization, the output, the response, is in a state of small change even when the level of the control factor changes. Since the "effect of noise" is "a change in output due to a change in the level of the control factor," "the output does not change with a change in the level of the control factor" means that the output is "stable against noise.

The gradual climb up the surface created by the nonlinearities created by the interactions shown in the previous section results in a nearly flat state with no gain in the response graph. Think of this as the goal of optimization in robust design.

In such cases, the more factors that are used as much as possible, the better the countermeasure against unexpected noise can be. In this example, the signal-to-noise ratio is used as a response, but there is no need to be concerned about it as one of the response values. We are not recommending here that this sequential optimization is a good optimization method.

2.4 For optimization against unexpected noise

The value of the signal-to-noise ratio is a measure of stability against noise assumed by the engineer and is not a measure of stability against unexpected noise, but it is considered one type of unexpected noise and is used for confirmation experiments.

Improving stability to unexpected noise requires interactions and nonlinearities by many factors, and the use of multidimensional surfaces by them. Since the optimum combination will eventually be fixed, it does not matter if there are interactions. Without hesitating to complicate the system, aggressively increasing the number of control factors will increase the potential for improvement to stability.

1)Genichi Taguchi: Strategy of Research and Development (Japanese Standards Association, 2005)
2)Makoto Abe: Optimization of Component Responses to Improve Crash Safety Performance by Simulation, (Robust Quality Engineering 2004 No.4 vol.12)

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Taguchi Glossary explained in the style of Kazuhiko Hara (1)

Kazuhiko Hara, Advisor of Kansai QERG

Dr. Genichi Taguchi left behind many useful words on manufacturing and technological development. These words have been passed down through the generations in the form of the Taguchi Glossary, but their interpretation varies from person to person depending on who hears and understands them. Here, we would like to introduce the Hara way of interpretation to you. We would be grateful if you, the readers, could give us your opinions.

(1) Don't let engineers choose the theme
(2) Technological innovation increases unemployment
(3) Engineers do not know that there are numerous solutions
(4) Engineers do not take responsibility

1) Don't let engineers choose the theme

It is normal for engineers to think only of problem-solving themes. Themes are that managers (technical managers) should select themselves and give to their subordinates for innovation (technological innovation), considering the future of the company. It is the role and responsibility of the manager to clarify the objective of the theme, consider specific tactics, make the selection of design concept, conduct function's robustness Assessment and robust design, and manage the progress and performance of the project.

2) Technological innovation increases unemployment

If you are working on a problem-solving theme, you need a lot of engineers, but if you shorten the development period by efficient development through Robust Assessment of function's robustness and robust design in technology development, you can reduce not only the number of engineers, but also the number of personnel for trouble shooting, which means more unemployed people.

Therefore, the extra engineers should work on innovation topics. The reality, however, is that overtime work is increasing not only because of problem solving but also because of inefficient design work. When the U.S. was founded, the majority of its citizens were farmers. Today, 2% of farmers produce 200 times as much food as they did then due to increased productivity. The unemployed are now academics, engineers, lawyers, etc.

3) Engineers do not know that there are numerous solutions

Scientifically minded engineers believe that 1 + 2 = 3 is correct. They believe that there is only one correct answer to manufacturing in society. Since science is about elucidating phenomena (aligning theory with nature), there is only one true answer, but since technology is about using phenomena to create artificial things (aligning theory with nature), there are innumerable answers. “Science and technology are two different things" (Saburo Honma, professor emeritus at the University of Tokyo, from the Yomiuri Shimbun (May 3, 2000).

(Technology has an objective.) There is only one ideal function (true value), but there are countless ways to approach the ideal, and it is the engineer's role and responsibility to consider the economically optimal answer. Robust Quality Engineering considers off-line and on-line design to draw an ideal function that meets the objective, create the means to achieve the ideal function, and create a design that minimizes the sum of the loss due to variability in the ideal function and the investment cost, and achieves a good balance between the two.

4) Engineers do not take responsibility

The majority of the causes of problems in the market (safety factor = functional limit/shipping standard of 4) are 94% design responsibility and only 6% manufacturing responsibility. In the past,

however, after "functional design" of standard conditions, the "function design" is followed by a pass/fail determination of defective rate and failure rate through tests and inspections determined by the standard, and then the process is handed over to manufacturing for production.
Since the product is shipped with only process quality ensured, if a problem arises in the market, the problem is solved by partial adjustment work of the entire design and manufacturing process. Therefore, the locus of responsibility for problems is not clear.

In Robust Quality Engineering that does not cause trouble to others, preventive measures are taken at the design stage with "Robust Assessment" to make the product more resistant to market environmental conditions and noise of degradation, so that even if trouble occurs, the cause of the trouble and responsibility for it are clear. The "functional limit" is the limit of adverse effects of LD50 in terms of environmental conditions of use and noise of deterioration, and is determined at the design stage.

That's all.

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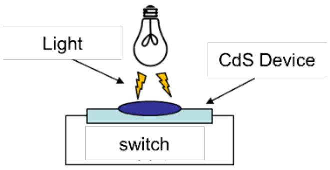
An Old Tale from Quality Engineering Research Group (4)

- Generic Function of Switching element -

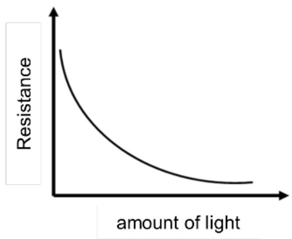
Hiroshi Shibano, Advisor of Kansai QERG (TM JISSEN JUKU)

This is an episode that took place some time after I joined the Central Robust Quality Engineering Research Group. This theme itself had already been studied and one direction had been indicated as a result, but another way of looking at it and another way of thinking was discussed. The target system is a switch that utilizes the response of CdS (cadmium sulfide) as an optical semiconductor. Figure 1 shows an overview of the system.



< Figure 1 CDS optical switch>

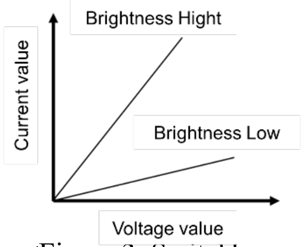
CdS has high resistance in the dark and current is difficult to flow, but when exposed to light, the resistance decreases and current flows easily. This is shown in the graph in Figure 2.



< Figure 2: Light sensitivity characteristics of CDS >

The Research Group discussed the generic function of an optical switch (product) that utilizes this response, and I participated in the discussion with interest because of my own experience working with this switch.
The discussion points in the Central Robust Quality Engineering Research Group can be summarized as follows.

1) Response as an optical semiconductor (Figure 2) is the generic function.
2) Since the function as a switch is to pass (cut off) an electric current, the generic function is shown in Fig. 3. Light intensity is treated as the second signal or indication factor. There are pros and cons to both views, and various opinions were exchanged at the Research Group.



<Figure 3: Switch's generic function >

At the time, I was of the 1) type, but the idea of 2) was novel and intriguing to me. I was interested in the idea of 2). In Robust Quality Engineering books, there are examples of generic function 2), so from the Robust Quality Engineering point of view, it seems to be a good idea to use 2) as the generic function. What is your opinion on this? Please discuss it in your research group.

Of course, generic functions other than (1) and (2) above are also acceptable; the

That’s about it.

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Nagano QERG Activity Record

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

The 14th Annual Robust Quality Engineering Practice Exchange Conference
Date: February 2nd 2024
Place: Shiojiri Incubation Plaza (Shiojiri, Nagano)
Number of participants: 25
The contents are as follows:
1. Greetings from Setsuya Masuda, Vice President, Nagano RQEG

2. Presentations on Robust Quality Engineering practices: 3 of them
1)Improving Roundness in Thin Bracket Turning Using Robust Parameter Design.
2)A Study on Commuting Time by MT System
(Yukiya Masuda, Masuda Engineering Consultant Office, Inc.)
3) Analysis of surface roughness curves using the MT system
(Takeo Chigono, Nagano Prefectural Industrial Technology Center)

3. Special Lecture "Evaluating AI with MT"
(Shigeomi Koshimizu, Advanced Institute of Industrial Technology)
After introducing AI (Machine Learning/Deep Learning) and MT method, he presented the results of discriminating images of game characters generated by AI using MT method. It was very interesting to see that the results were not much different from those obtained by human judges.

The 11th Research Group in 2023
Date: March 8th 2024
Place: Nagano Prefectural General Industrial Technology Center, Precision, Electronics and Aerospace Technology Division (Okaya, Nagano) and online (Webex)
Number of participants: 14
We discussed about following two issues and had a special presentation.
【Case Studies】
1. "Observe trends in response graphs by switching the "columns" to which control factors are assigned. (Setsuya Masuda, Masuda Engineering Consultant Office, Inc.)
In a simulation of a firearm, we compared the response graphs for various columns of the L9 orthogonal array when assigning control factors to the L9 orthogonal array. The results showed that the trend of the response graph changed depending on which control factor was assigned to which column. In some cases, nonlinear components appeared.

2. Analysis of surface roughness curves using Signal Catcher"
(Takeo Chigono, Nagano Prefectural Industrial Technology Center)
Roughness parameters obtained from the measurement results of surface roughness standard specimens were analyzed by the MT system to search for parameters that can discriminate processing methods. The results showed that Rsm (average length of the roughness curve) and Rsk (skewness) were influential in the roughness curve discrimination.
We also attempted to estimate another parameter from one parameter using the T method and found that it could be estimated with high accuracy.
For the analysis, we used Tanaka Seimitsu Kogyo's "Signal Catcher" in addition to our own software, which enabled us to perform more advanced analysis, such as GA, which is difficult to perform with our own software.

【Special Presentation】

Introduction of upgraded functions of Signal Catcher ver3.0 -Multi-channel functions and their effects (Tsuyoshi Ishizawa, TANAKA ENGINEERING CO.,LTD.)

He introduced the details of the upgraded version of MT System's software, Signal Catcher. The addition of a multi-channel function has enabled improved discrimination accuracy.

Ad hoc Research Group

Date: April 12th 2024

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

Number of participants: 11

We discussed about following two case studies:

【Case Studies】

1. MT method calculation for a small number of reference data

(Advisor: Yukihiro Iwashita)

In the MT method, if the number of data n as a criterion is smaller than the number of variables + 1, the inverse matrix cannot be calculated. The basic idea is to increase the number of data for the criterion, but in order to utilize a small amount of data, we examined possible methods of calculation in such cases. As a result of applying the following methods to the case study, it was found that (1) the mean-squared deviation method, (2) the method using a combination of correlation matrices of n-1 or less, and (3) the method of setting the correlation coefficient with a small absolute value to 0, had greater discriminative power than (1) the mean-squared deviation method.

2. Robust Quality Engineering, which "does not focus on checking for reproducibility."

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

From the "Study on Condition Setting Considering Gain in Confirmation Experiments," which will be presented at RQES2024S, it became clear that it is necessary to conduct confirmation experiments under conditions that maximize gain in both signal-to-noise ratio and sensitivity in order to check the reproducibility of gain. Therefore, we sought a method to roughly check reproducibility only under optimum combinations, without placing emphasis on checking the reproducibility of the gain.

2024 General Meeting and 1st Research Group

Date: April 12th 2024

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

Number of participants: 12

We had a general meeting and discussed about following three case studies:

【General meeting】

The business report for FY2023 and the business plan for FY2024 were approved. the number of members this year is 16 (regular members: 10, special members: 3, advisors: 3). 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. "Is the degree of agreement between experimental and estimated values in an orthogonal array experiment related to the magnitude of reciprocity?"

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

Do "experimental values from orthogonal array experiments" and "estimated values from response graphs" agree? We tested this question in two cases. When the interaction between the control factors was small, they agreed. On the other hand, they also agreed when the interactions were large. From the above, it is clear that the agreement between the experimental values and the estimated values in the orthogonal array experiment is high regardless of the size of the interaction.

2. "MT method calculations when the number of reference data is small (second)."

(Advisor: Yukihiro Iwashita)

At the previous Research Group, we proposed the "d-MT method" and the "p-MT method. We confirmed that this method can be computed even if the number of reference data is smaller than the number of feature variables, that it can avoid multicollinearity, and that it has better discrimination ability than the mean-squared deviation method, through examples. We also compared this method with the multi-MT method.

3. "Eco-Systems Realized by Robust Quality Engineering and LCA - with Introduction of NICE Activities"

(Advisor: Satoru Tokida)

Mr. Tokida explained why "carbon neutral" and "circular economy," which we often hear about these days, are necessary, focusing on climate change, and proposed to use a good combination of Robust Quality Engineering and the Life Cycle Assessment (LCA) method, which is a method for evaluating carbon emissions. Although there are no specific examples of implementation yet, it is thought that it can be used without too much difficulty, and it is no different from designing an experiment, such as defining functions, noise, and control factors, and evaluating the results. He also reported that carbon emissions are equivalent to energy consumption and that carbon emissions can be expressed in terms of cost, which is quite similar to the concept of quality in Robust Quality Engineering.

*NICE=Nagano Industrial Promotion Organization

Recorder: Setsuya Masuda, Masuda Engineering Consultant Office, Inc.

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～News from Robust Quality Engineering Research Groups～

◆From Kansai QERG◆

1. Joint Research Group of 4 Districts (10th floor conference room of the Osaka Branch of the Nikkan Kogyo Shimbun + remote co-location)

On Friday, May 10, a joint Research Group was held by the four regions (Hiroshima, Shiga, Chubu, and Kansai). In the morning, Yukinobu Hattori (Hattori Quality Technology Institute) gave a keynote lecture, and in the afternoon, each region presented its research. Mr. Hattori's keynote speech was titled "The Importance of Quality Control Education and Human Resource Development," and he spoke passionately about the importance of quality control education and human resource development based on his own experience. After the Research Group meeting, a reception was held, as is customary every time, to promote exchanges among the members of the various regional Research Groups.

2. 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	¥2,000	-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	¥1,000	-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.

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English lecture available

◆Invitation for companies wishing to give a lecture◆

Why Robust Quality Engineering?

～ From Success in Optimization to Success in Technology Development and commercialization~

Based on the framework of the speaker's own experience, Robust Quality Engineering is effective today and will continue to be effective in the future. From failures to successes, the content of this seminar is unparalleled. The contents of the lecture will resonate with engineers, managers, and those unfamiliar with Robust Quality Engineering.

(1) Speaker: Mr. Tetsuo Hosokawa, Representative of QE COMPASS (formerly Ricoh Company, Ltd.)
(2) Lecture content: (1 hour and 30 minutes including Q&A)

1. Origin as an engineer
   Startup of new business with new technology
   Experienced shipment stoppage immediately after assignment
   Market quality is determined at the technology development stage.
   My state of mind at that time

2. Failures experienced by Japanese manufacturing companies in the past
   The decline of the semiconductor business as seen in the field
   Ideal and ideal direction of management
   What happened to many companies that promoted Robust Quality Engineering
   Robust Quality Engineering is a Means to an End
3. Thinking in terms of functions, then mechanisms
   Commercialization is absolutely impossible with this approach.
   The concept of noise factor gave me an intuition that "this is it.
   I hit the limit of my own way of doing things.
   I was completely blanked out by Dr. Yano's question.
   The concept of function allows us to grasp the totality of the system. I could grasp the total system with the concept of functionality.
   Can you market the system with that?
   PDSA cycle of system design was established.
   Overcame two crises at the start of mass production
   Successful commercialization
   The latest Robust Quality Engineering

4. Expectations for you
   The concept of function is useful outside of the technical field.
   Robust Quality Engineering is a Golden Opportunity for the Devil

Q&A

(3) Lecture fee: Please contact the following address if your company is interested in giving a lecture. We will be happy to provide you with a quotation.
(4) For applications and inquiries, please contact

Contact: Hiroto Funayama, ITEQ International, LTD.
TEL：052-917-0711　E-Mail：hirotoitoh@iteq.co.jp

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◆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