For Members of the Quality Engineering Research groups

Robust Quality Engineering Magazine

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Spring 2024 Issue

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*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.

Taku Koshiyama, Chairman of Shiga QERG (QEM LTD.)

First of all, let me tell you that I am a chairman of Shiga QERG but it is in name only.

My current work consists of ISO9001/ISO14001 audits and related seminars and consulting, and I am based in Tokyo. However, the basis of my thinking is Robust Quality Engineering, and through my work, I encourage a "RQE way of looking at things.

The "RQE perspective" has two perspectives, the first of which is generic function.

When we checked the environmental goals of a freight forwarder during an EMS audit, we found that the company used "fuel efficiency improvement" of vehicles as an indicator. Whether this indicator is effective or not can be easily determined from a "RQE perspective. Fuel economy is an indicator that is better when the vehicle is running without cargo, and is not an indicator of the freight forwarder's function.

Freight forwarders have traditionally had the following indicators: "utilization rate," "actual vehicle rate," and "loading rate. This is called the freight 3 rate, and it is the freight forwarder's generic function. The most detrimental environmental aspect is the wasteful use of fuel. The proper environmental management is to improve the freight 3 ratio and use the profits to invest in infrastructure that can reduce greenhouse gas emissions.

The second RQE perspective is the Noise Factor,

This is strongly related to the response to human error in a QMS. The January 2 2024 collision between a JAL and a Coast Guard plane at Haneda Airport is still fresh in our memories, and I saw an article in the Yomiuri Shimbun that caught my attention.

The content of the article is that air traffic control is based on the "principle of recognition," which states that the captain of the aircraft will implement the instructions given by the air traffic controller as they are given. People's perceptions are subject to variation under the influence of external and internal disturbances. The captain of the Coast Guard plane may have made a mistake in his perception of the disaster on the Noto Peninsula (external disturbance) because he was in a hurry (internal disturbance) to get to the aid as soon as possible.

This problem should not be blamed solely on the captain of the Coast Guard aircraft.
The real cause of this case is that the current air traffic control system is vulnerable to the Noise Factor of variations in human perception. If human perception were considered a Noise Factor, the system that monitors the landing craft for the presence of other aircraft on the runway could have been constantly monitored, or it could have been accompanied by an alarm tone.

I would like to continue to promote in my work the fact that the "RQE way of looking at things" can reveal the truth of the matter.

That’s about it.

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Format of data in MT system utilization

Shoichi Teshima, Chairman of Hokkaido TMRG (AngleTry Associates)

It was 1994 when Dr. Taguchi's article on the Mahalanobis distance began to appear in Robust Quality Engineering Journal(1). In 1995, he presented a pattern recognition method named MTS (2). Various calculation methods were subsequently presented as MT systems, such as the T method (1). The major difference between the 1994 and 1995 articles is that the 1995 article included feature extraction methods and expanded the scope of application to recognition of characters and waveforms.

This paper is described to help those who have data at hand and want to know how to use the MT system immediately. However, feature extraction is barely touched upon, and cases in which measured data can be analyzed directly are described. In addition, it is assumed that the calculation software is at hand. I would like to contribute the methods of feature extraction and data preparation to Robust Quality Engineering Magazine when the opportunity arises.

1. Data and format (1)

Many of you are probably at the stage where you can analyze the data at hand. You are probably thinking about whether this is the right data preparation and what the appropriate means of analysis is. The figure shows data from 200 healthy people collected for health checkups. A total of 17 items ranging from age to uric acid levels were measured for the physical examination. The purpose of collecting such data is to determine the health level of the examinees and the cause (name of disease) of unhealthy cases.

Variables →

Samples ↓

	1	2	3	4	…	16	17
No.	Age	Gender	serum total protein	serum albumin	…	urea nitrogen	uric acid
1	35	1	8	5.5	…	12	4.3
2	48	1	7.9	5.2	…	17	3.2
3	45	1	8.1	5.5	…	13	2.9
4	40	1	8.3	5.6	…	13	2.9
…	…	…	…	…	…	…	…
198	46	10	8.3	5.7	…	18	4.5
199	57	10	8.4	5.4	…	18	5.2
200	34	10	8.2	5.6	…	13	6.3

For data analysis, the variables are lined up in columns and the numbers for each individual (person) in rows, as shown here. This data format is the same whether the analysis tool is the MT system or another tool. The same is true for product inspections and equipment monitoring, where the variable names are simply the measured values of temperature, pressure, and so on.

	1	2	3	4	…	16	17
No.	Temperatu re	pressure	flow velocity	Compositio n A	…	Dimension A	Weight A

Is the measurement data in your possession organized in this way? If so, you can start analyzing the data immediately.

2. Data and format (2)

At this point, I would like to ask you to forget half of what I have said above. In the health checkup example, the objective was to determine whether the examinee is healthy or not, but there is a slightly different way of looking at the analysis. That is when there is an objective value (objective response) to be predicted, like predicting tomorrow's precipitation.

It has the form of data for multiple regression analysis in statistics. That is, the data format in such a case has a column of " objective response " next to the column of variables. In the example below, the film thickness data formed when the temperature, density, and other variables are varied is shown. In this case, the film thickness is the target property, and this actual data is used to estimate the film thickness when manufactured under other conditions.

	1	2	3	4	…	24	25	Objective Response
No.	Temp.1	Temp.2	Temp.3	Temp.4	…	Density	Velocity	膜厚
1	124	30.0	25	22	…	17	9.2	4.7
2	120	30.0	20	20	…	15	6.8	5.5
3	125	27.5	18	17	…	3	7.2	4.5
4	109	25.5	63	49	…	3	16.4	4.3
…	…	…	…	…	…	…	…	
198	110	29.0	77	59	…	3	2.2	2.6
199	112	32.0	75	58	…	3	1.4	2
200	121	28.0	8	11	…	3	6.8	6.9

3. What is the objective: classification or prediction?

Before starting analysis, it is necessary to decide whether the objective is classification or prediction (estimation). Since product inspections are to determine OK/NG, the objective is classification. Character recognition is also classification. Failure prediction and predictive maintenance of equipment and production lines are also classification problems, since the question is "whether the normal state is continuing or whether it is departing from the normal state. On the other hand, if you want to know what will happen in the future, such as one hour or one week from now, it is a prediction. Another example is the problem of estimating the response to the next production under different conditions, given the actual data produced under several different conditions.

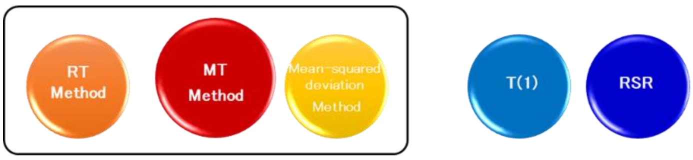
4. The computational functions of the MT system

The MT system provides several methods, the objectives of which are as follows

MT method, RT method, mean-squared deviation method ・・・ Classification

T method (1), MSR ・・・ Prediction (estimation)

Although the RT method and the mean-squared deviation method are simple methods for classification, the MT method provides the best results. The MSR, a means of prediction, is an improved version of the T method (1) proposed by Mr. Maeda in later years [3].

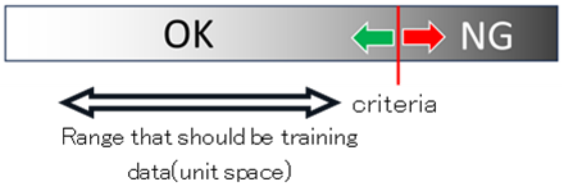


Means of Classification: Themes of this Chapter

Means of Prediction and Estimation

5. Sorting out OK and NG items (MT method)

When using the MT method, the set of healthy individuals in the example of medical checkups is learned. In other words, only the normal state is learned, but there are certain points that must be kept in mind in this sorting. Even among those who are judged to be healthy, there must be shades of gray. It is desirable not to include people who are close to the boundary between healthy and unhealthy in the training data. If it is a product, then among those judged as OK, those judged as OK should be selected with more confidence. This is also true for data requiring characterization, such as waveforms and images. If data is used as training data simply because an inspector judged it as OK, the accuracy of judgment is often degraded.



(As a side note)

Unfamiliar terms are often used in MT systems. Up to this point, we have referred to normal data as "training data. In fields such as deep learning, it is sometimes called "teacher data. In the MT system, however, the set of normal states is called the "unit space." When the MT system was first proposed, it was sometimes called the reference space or normal space, but eventually it became the unit space. The term "unit" came to be used because of the idea of creating a scale (measure) to determine whether the target data is close to the normal state. In English, it is called Unit Space, but in the U.S. it is often called Normal Space. In addition, terms used in Robust Quality Engineering, such as signal-to-noise ratio, also appear in the analysis process.

References:

(1)田口玄一(1994)：「診断と SN 比」,『品質工学』, vol.2,No.4,pp2-7, 品質工学会

(1) Genichi Taguchi (1994): "Diagnosis and SN ratio", "Robust Quality Engineering", vol.2, No.4, pp2-7, Robust Quality Engineering Society.

(2)田口玄一(1995)：「パターン認識のための品質工学(1)」,『品質工学』, vol.3,No.2,pp2-5, 品質工学会

(2) Genichi Taguchi (1995): "Robust Quality Engineering for Pattern Recognition (1)", Robust Quality Engineering, vol.3, No.2, pp2-5, Robust Quality Engineering Society

(3)前田 誠（2017）：T 法(1)の考え方を利用した新しい回帰手法の提案, 『品質』,vol.47,No.2,pp.71-80,日本品質管理学会

(3)Makoto Maeda (2017): Proposal of a new regression method using the idea of T method (1), "Quality", vol. 47, No. 2, pp. 71-80, Japanese Society For Quality Control

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The truth of Robust Parameter Design (1)

-SN ratio is an evaluation of stability in noise as assumed by the evaluator-

Katsuyuki Ota, Kansai QERG

1.1 Noise Factor

One of the characteristics of robust parameter design (hereafter RPD) is the creation of the concept of noise factor and its use in evaluation. Since experiments that increase reliability by increasing repetitions for downstream reproducibility are inefficient, actively incorporating noise that may occur downstream into the experiment can increase downstream reproducibility and also drastically reduce the number of experiments.

Noise incorporated here includes environment-dependent factors such as temperature and humidity, as well as factors that take into account degradation such as mud and corrosion, which can change the response due to noise.

This is because noise changes the level of control factors (including control factors not addressed in the experiment). Environmental changes, such as temperature, cause changes in the design dimensions and material properties, which are control factors. Degradation also changes the response by causing changes in material properties, dimensional changes due to wear, etc., and changes in the coefficient of friction. The less these changes, the more robust the design is against noise.

1.2 Setting up a noise factor in the simulation

In RPD by simulation, it is recommended that the level of the control factor be made noisy by the evaluator by varying the level of the control factor back and forth by an arbitrary width. The method of giving the level width is left to the experimenter, but the following two methods are often used.

(1) A fixed percentage of the level value is given. Set the value at ±1%, ±0.5%, etc.

(2) A constant numerical value change is given to the standard value. Set by ±1mm, ±10℃, etc.

This method does not need to be consistent within the RPD, and the range is left to the evaluator. In actual experiments, the noise factor is the environment, etc., which causes changes in each level of the control factor, but even the degree of influence is unknown, so the experiment is conducted without knowing whether it will be added to each level at a certain ratio or over a certain range.

1.3Verification of the difference by setting the noise factor

To confirm the difference in setting up noise factors (1) and (2), we show the results of simulation calculations with L18. Eight factors (A-H) are assigned to L18, and an additive model with only main effects with no hypothetical interactions is set up. The model set up assumes that the level indicates gain, and the response Y is the sum of the effects of each factor.
Response Y = Effect of factor A (EA) + Effect of factor B (EB) + ... + Effect of factor H (EH)

For the SN ratio, we used the energy ratio type η=10log (Sm/Se), but the conclusion remains the same for the conventional SN ratio. Here we see the difference by assigning noise to the settings (1) and (2).

①	Control Factors			
	Factor name	1	2	3
1	A	1	2	
2	B	1	2	3
3	C	1	2	3
4	D	1	2	3
5	E	1	2	3
6	F	1	2	3
7	G	1	2	3
8	H	1	2	3

<Fig.1.1>Control Factors and their levels

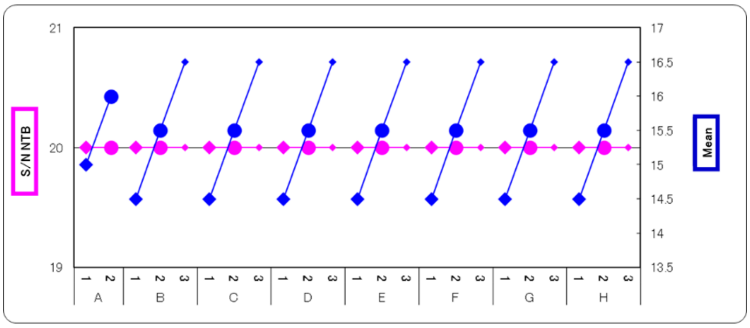
	A	B	C	D	E	F	G	H		Y
1	1	1	1	1	1	1	1	1	1	8
2	1	1	2	2	2	2	2	2	2	14
3	1	1	3	3	3	3	3	3	3	20
4	1	2	1	1	2	2	3	3	4	15
5	1	2	2	2	3	3	1	1	5	15
6	1	2	3	3	1	1	2	2	6	15
7	1	3	1	2	1	3	2	3	7	16
8	1	3	2	3	2	1	3	1	8	16
9	1	3	3	1	3	2	1	2	9	16
10	2	1	1	3	3	2	2	1	10	15
11	2	1	2	1	1	3	3	2	11	15
12	2	1	3	2	2	1	1	3	12	15
13	2	2	1	2	3	1	3	2	13	16
14	2	2	2	3	1	2	1	3	14	16
15	2	2	3	1	2	3	2	1	15	16
16	2	3	1	3	2	3	1	2	16	17
17	2	3	2	1	3	1	2	3	17	17
18	2	3	3	2	1	2	3	1	18	17

<Fig.1.2>L18 orthogonal array and response Y

Verification 1: Ratio noise for setting (1)

	A	B	C	D	E	F	G	H		N1	N2
1	1	1	1	1	1	1	1	1	1	7.2	8.8
2	1	1	2	2	2	2	2	2	2	12.6	15.4
3	1	1	3	3	3	3	3	3	3	18	22
4	1	2	1	1	2	2	3	3	4	13.5	16.5
5	1	2	2	2	3	3	1	1	5	13.5	16.5
6	1	2	3	3	1	1	2	2	6	13.5	16.5
7	1	3	1	2	1	3	2	3	7	14.4	17.6
8	1	3	2	3	2	1	3	1	8	14.4	17.6
9	1	3	3	1	3	2	1	2	9	14.4	17.6
10	2	1	1	3	3	2	2	1	10	13.5	16.5
11	2	1	2	1	1	3	3	2	11	13.5	16.5
12	2	1	3	2	2	1	1	3	12	13.5	16.5
13	2	2	1	2	3	1	3	2	13	14.4	17.6
14	2	2	2	3	1	2	1	3	14	14.4	17.6
15	2	2	3	1	2	3	2	1	15	14.4	17.6
16	2	3	1	3	2	3	1	2	16	15.3	18.7
17	2	3	2	1	3	1	2	3	17	15.3	18.7
18	2	3	3	2	1	2	3	1	18	15.3	18.7

<Fig. 1.3>(1)Result of adding ±10% noise of the level to each factor



<Fig. 1.4>Response graph of (1) with ±10% of level noise for each factor

The result was that the signal-to-noise ratio could not be improved.

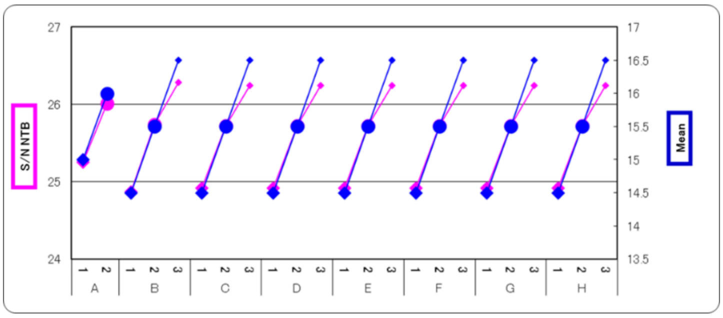
This is because the model has no nonlinear effects such as main effects or interactions, and these "nonlinear effects" will be discussed in another chapter.

Verification 2: Setting (2) Equal noise

Add a noise factor of ±0.1 of the level to each factor.

	A	B	C	D	E	F	G	H		N1	N2
1	1	1	1	1	1	1	1	1	1	7.2	8.8
2	1	1	2	2	2	2	2	2	2	13.2	14.8
3	1	1	3	3	3	3	3	3	3	19.2	20.8
4	1	2	1	1	2	2	3	3	4	14.2	15.8
5	1	2	2	2	3	3	1	1	5	14.2	15.8
6	1	2	3	3	1	1	2	2	6	14.2	15.8
7	1	3	1	2	1	3	2	3	7	15.2	16.8
8	1	3	2	3	2	1	3	1	8	15.2	16.8
9	1	3	3	1	3	2	1	2	9	15.2	16.8
10	2	1	1	3	3	2	2	1	10	14.2	15.8
11	2	1	2	1	1	3	3	2	11	14.2	15.8
12	2	1	3	2	2	1	1	3	12	14.2	15.8
13	2	2	1	2	3	1	3	2	13	15.2	16.8
14	2	2	2	3	1	2	1	3	14	15.2	16.8
15	2	2	3	1	2	3	2	1	15	15.2	16.8
16	2	3	1	3	2	3	1	2	16	16.2	17.8
17	2	3	2	1	3	1	2	3	17	16.2	17.8
18	2	3	3	2	1	2	3	1	18	16.2	17.8

<Fig.1.5>(2)Result of adding noise of a ± 0.1 magnitude to the level of each factor.



<Fig. 1.6> Response graph of (2)

For all factors, a higher mean value results in a higher signal-to-noise ratio, which differs significantly from the result in (1). **The signal-to-noise ratio of the nominal-the-best response is the ratio of the mean to the variability, so if the variability cannot be improved, the higher the mean, the higher the SN ratio.** Since the model in (2) has the same variability regardless of the mean, tuning is not expected to improve the variability.

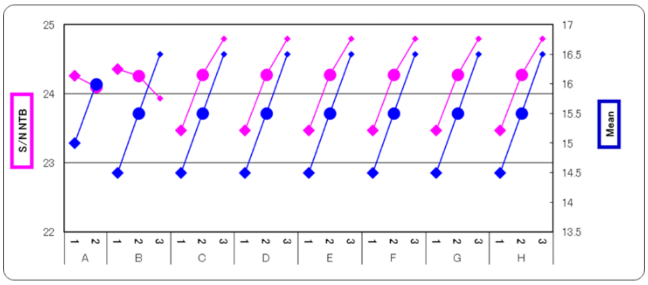
The way the noise is given is left to the evaluator, and the choice of the noise setting (1) or (2) will change the response graph, which means that the factorial effect graph will change. The main effect of each factor is also unknown, which is why the experiment is conducted, but the noise in the market is unknown both in its magnitude and whether the noise setting is (1) or (2), so it makes no sense to unify the noise setting to one or the other. **The response graph of the signal-to-noise ratio depends on the evaluator's noise settings, so it only shows the superiority at the noise assumed by the evaluator.**

Even if both patterns (1) and (2) are mixed in actual noise, since there is no difference in (1) and the higher average value is better in (2), choosing **the one with the higher average value is more likely to improve the variability in the nominal-the-best response.** An example of verification when settings (1) and (2) are mixed is also shown.

Verification 3: Example of mixing settings (1) and (2).

Add noise factors A and B in setting (1)and factors C-H in setting (2).
Condition for N1: Y=EA*0.9+EB*0.9+EC-0.1+ED-0.1+...+EH-0.1
Condition for N2: Y=EA*1.1+EB*1.1+EC+0.1+ED+0.1+...+EH+0.1

	A	B	C	D	E	F	G	H		N1	N2
1	1	1	1	1	1	1	1	1	1	7.2	8.8
2	1	1	2	2	2	2	2	2	2	13.2	14.8
3	1	1	3	3	3	3	3	3	3	19.2	20.8
4	1	2	1	1	2	2	3	3	4	14.1	15.9
5	1	2	2	2	3	3	1	1	5	14.1	15.9
6	1	2	3	3	1	1	2	2	6	14.1	15.9
7	1	3	1	2	1	3	2	3	7	15	17
8	1	3	2	3	2	1	3	1	8	15	17
9	1	3	3	1	3	2	1	2	9	15	17
10	2	1	1	3	3	2	2	1	10	14.1	15.9
11	2	1	2	1	1	3	3	2	11	14.1	15.9
12	2	1	3	2	2	1	1	3	12	14.1	15.9
13	2	2	1	2	3	1	3	2	13	15	17
14	2	2	2	3	1	2	1	3	14	15	17
15	2	2	3	1	2	3	2	1	15	15	17
16	2	3	1	3	2	3	1	2	16	15.9	18.1
17	2	3	2	1	3	1	2	3	17	15.9	18.1
18	2	3	3	2	1	2	3	1	18	15.9	18.1



<Fig.1.8> response graph of (3)

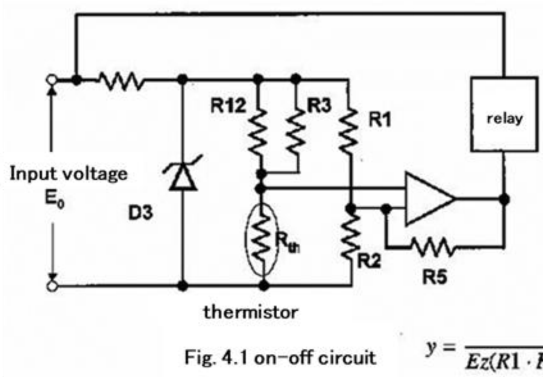
When settings (1) and (2) are mixed, as shown here, this response graph of the signal-to-noise ratio can occur up to the inversion of the optimum level. It can easily occur not only in this example, but also with changes in the mixing pattern and noise magnitude.

Again, in an actual experiment, it is still unclear whether the effect of the noise given is proportional to the level of each control factor, or whether it is a ratio or a difference, or a combination of the two. **Therefore, it is meaningless to argue which is the correct way to apply noise.**

The model presented here is not a special case, but a general model with no interactions, and similar changes can occur in models with complex interactions. Naturally, there can be cases where "no change" occurs, but please be aware that "changes can easily occur".

Verification 4: Thermistor circuit example (mixture of settings(1) and(2))

Confirm that the change can occur in a real case involving interaction. Verification will be made using circuit simulations in Akira Tomishima's case study of a water heater temperature controller (thermistor circuit) (1978, QCRG).



$$y = \frac{\frac{R12 \cdot R3}{R12 + R3} R2(Ez \cdot R5 + E_0 \cdot R1)}{Ez(R1 \cdot R2 + R1 \cdot R5 + R2 \cdot R5) - R2(Ez \cdot R5 + E_0 \cdot R1)}$$

<Fig. 1.9> Thermistor circuit and theoretical equation

The control factors are five resistance values. Noise is compounding of noise factors by a change in the ratio of the five resistance values and the two power supply voltages E0 and Ez outside the control factor in response to a larger or smaller value.

	Factor name	1	2	3
A	e	1	2	
B	e	1	2	3
C	R1	1	3	6
D	R2	4	7.5	9
E	R3	0.5	1	2
F	R5	130	360	720
G	R12	1	3	5
H	e	1	2	3

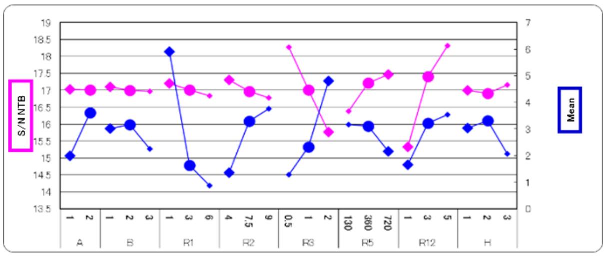
<Fig.1.10>Control factors and levels of thermistor circuits

Compounded Noise		R1	R2	R3	R5	R12	E0	Ez
N1	Swing to the small side	+10%	-10%	-10%	+10%	-10%	9.6	5.6
N0	Standard conditions	Specified	Specified	Specified	Specified	Specified	10.1	5.3
N2	Swing to the big side	-10%	-10%	+10%	-10%	+10%	10.6	5

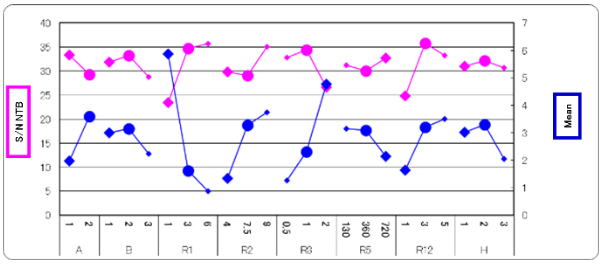
<Fig. 1.11>Tuning error (R1 and R2 give noise in ratio)

Compounded Noise		R1	R2	R3	R5	R12	E0	Ez
N1	Swing to the small side	+0.1	-0.1	-10%	+10%	-10%	9.6	5.6
N0	Standard conditions	Specified	Specified	Specified	Specified	Specified	10.1	5.3
N2	Swing to the big side	-0.1	+0.1	+10%	-10%	+10%	10.6	5

<Fig. 1.12>Tuning error (R1 and R2 give noise in terms of difference)



<Fig.1.13> R1 and R2 are response graphs in ratio noise



<Fig.1.14> R1 and R2 are response graphs with difference noise

In this example, the factorial effect of the signal-to-noise ratio changed significantly in addition to R1 and R2, which were changed. **In other words, the SN ratio is an evaluation of stability in the noise assumed by the evaluator, and the response graph will change if the assumption changes, so care must be taken when using it as technical information.**

The noise condition in the SN ratio evaluation **should be set considering the worst possible condition. The purpose of this series of articles is to help you understand the "true meaning of RPD," which is how to achieve a robust design against unexpected noise, based on the knowledge of the nature of the signal-to-noise ratio.**

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What is a Honmamon (real/genuine) engineer (3)

Kazuhiko Hara, Advisor of Kansai QERG

Continuing from the previous issue, I would like to talk about my own idea of a "real engineer".
This time, I mentioned the following two points.

6) Be a prototype-less and test-less engineer

Even in the case of technology development type development, it is impossible to shorten the development period if prototypes are made based on function's robustness design. The first step in any theme is to consider whether computer simulation is possible. Recently, robust design by simulation has been widely used not only in product development but also in manufacturing technology. Even in the case of simulation, a two-step optimization can be considered. In function's robustness design, the objective is to stabilize the function, so it is not necessary to consider all control factors and the pursuit of accuracy is not so much of a problem. However, in functional design, tuning to a target value is required, so it is necessary to be close to the actual product, and accuracy must also be increased. For this purpose, it is often easier to make a prototype under optimum conditions on robustness and match the prototype with standard conditions (Robust Quality Engineering for the 21st Century). Conventional evaluations in reliability tests and life tests are based on pass/fail judgments against standards, not on the quality level of good products.

Robust Assessment is the evaluation of function's robustness, which is the deviation from the ideal function. Testing" is to examine past results, and "Estimation" is to predict the future. I have had the experience of shipping a product after 100 million cycles of life testing, only to have it fail after less than 200 cycles on the market. If I had thought about the noise better, I could have Robust Assessment of function's robustness within 24 hours. Also, university admissions test scores are not a correct assessment of a university student's ability. They are only used as a pass/fail decision for the purpose of capacity limitation. True evaluation is multifaceted information, and it is important to use the MTS method to assess future ability and potential.

7) Be a cost-conscious engineer

Professor Taguchi often says, "Cost is not mentioned in the education of engineers at universities," and it is rare that engineers in companies also consider cost in development and design. In system design, many systems are devised to satisfy functions, but the best system is selected of design concept without considering the approximate cost. In robust parameter design, we use inexpensive components and design systems that do not require a 2nd look VE. It may sound contradictory, but it goes without saying that a minimum complex system is necessary to improve function's robustness. In tolerance design, waste should be eliminated in a balanced design between quality and cost in order to return the results of quality improvement to cost. Direct costs such as parts are important, but indirect costs, such as losses due to development and delivery time, are a major problem for companies and are rarely considered. Furthermore, the current situation is that companies do not consider the cost of customer losses in the market at all.

I would like engineers to keep in mind that in order to maximize the profit of a company, the loss of society must be minimized. Robust Quality Engineering therefore proposes to evaluate the loss of society's quality loss using a quality loss function. The loss of society includes the problem of protecting the global environment. In addition, "safety design" to minimize damage in the event of a disaster is also an important issue, and we want engineers to be able to think about this at the system design stage using quality loss functions.

I have described what I consider to be a "Honmamon (real, genuine) engineer" from seven different perspectives. How did the readers feel about it? I would be grateful if you could give me your opinions.

That's all.

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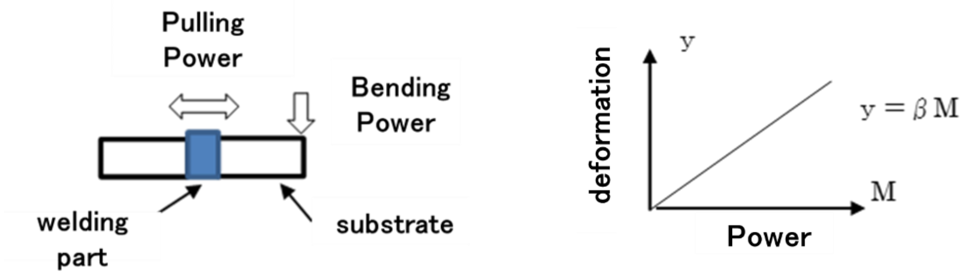
An Old Tale from Quality Engineering Research Group (No.3)

-It's not a fight - Serious discussion is what Research Groups are all about-

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

Currently, the venue for the Kansai RQEG is a rented meeting room of the Nikkan Kogyo Shimbun, but in the past, we were able to use the meeting room of the Kansai Branch of the Japanese Standards Association (JSA) free of charge. We would like to express our sincere gratitude to the Kansai Branch of the Japanese Standards Association for their generous support. This old story is an episode from those days, when a Japanese Standards Association staff member, hearing for the first time the discussions in the Research Group coming from the meeting room, was concerned that they might be fighting in the meeting room. I would like to introduce to you what kind of discussions we had there. However, even though this was over 20 years ago, the content of the discussions at the Research Group is, in principle, closed, so I will omit the details of the subject products and technologies, and focus on the Robust Quality Engineering aspects of the discussions, so please understand that.

Now, the case study we were discussing at the time was related to welding. Two metal parts were to be joined into one product using welding techniques, and the person in charge (the person introducing the case study), who was trying to optimize the welding combination, was struggling with how to evaluate the welding quality. In Robust Quality Engineering, it is considered better to evaluate joining techniques such as welding not by destructive tests such as joint strength, but by examining the amount of deformation under applied weight, or the stress on the amount of deformation, the so-called retention function, as shown in the figure below.



<Methods for evaluating retention>

However, under ideal welding conditions where the base metal is completely melted, the weld area (melted area) is stronger than the base metal, and deformation occurs at the base metal. The person in charge thought that this was evaluating the response of the base material and not the welding quality, which is the most important part.

In other words, an incomplete weld where the base material is not fully melted can be evaluated, but once the base material is fully melted, the results are all the same (≒ substrate response), from efficiently melted conditions to just barely melted conditions. This would not only reduce reproducibility in robust parameter design, but also increase the likelihood that the optimum combination selected would have too much energy input.

Therefore, we came up with a method to cut out the weld area from the product after welding and evaluate it (relationship between applied weight and deformation). This way, the influence of the base material is eliminated and the welding quality can be evaluated purely. However, there was a split in support of this proposal. Opposing members believe that the purpose of welding is to achieve the same response as the base material, so there is no need to go to such trouble. The exchange (discussion) between the two sides became heated, and it was at this point that the Japanese Standards Association staff mistook it for a fight. Osaka's language seems to be perceived harshly by people from other prefectures, so it must have been a very heated discussion. I, as an Osaka native, am not so aware of this. However, the staff member told me that the Research Group is that serious. Discussing other people's cases seriously, as if they were your own, is what Research Groups are all about. Are you discussing seriously? Now, to the best of my recollection, there was no conclusion on this subject. What are your thoughts on this issue? For or against? Incidentally, a case study on joining technology with ideal base material response was presented by an automotive company at a research conference later in the day. At that time, Dr. Genichi Taguchi published a method for calculating standardized SN ratios, and the study in question was also tackled using that procedure. Why don't you discuss this

case study together you're your Research Group? I am sure it will be a heated Research Group.

That's about it.

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Nagano QERG Activity Record

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

Date: November 10th 2023
Place: Nagano Prefectural General Industrial Technology Center, Precision, Electronics and Aerospace Technology Division (Okaya, Nagano) and online (Webex)
Number of participants: 9
We discussed about following two issues:

【Case Studies】

1. Optimization by Engineering Measure

(Advisor: Yukihiro Iwashita)

Although robust parameter design evaluates function, it is often stumped by the consideration of function in application. Therefore, we examined a method to evaluate them using Engineering Measure. Since multiple quality characteristics are evaluated, the optimal parameters can be calculated by "(1) creating an estimation formula for each quality characteristic using the T method and the least-squares method, and (2) calculating a loss function from each characteristic to find the parameter with the lowest total. It is important that the response be the nominal-the-best response.

【Common Theme】

2. How to evaluate function in screw tightening

The first step was to take data in a preliminary experiment and discuss the data as we went along.

Date: December 2nd 2023
Place: The 20th Four Prefectures Robust Quality Engineering Joint Research Group (Saitama, Hokuriku, Yamanashi, Nagano) was held at Techno Plaza Okaya (Okaya City, Nagano Prefecture) and online (Webex).
Number of participants: Total of 21(Saitama:1 Hokuriku:3 Yamanashi:4 Nagano:13)
We discussed about following issues:

【Reports on Recent Developments in Each Prefecture】

Activities of Research Groups in each of the participating prefectures were reported.

【Presentation of case studies from each prefecture】

- The use of estimation formulas in robust parameter design
  (Mr. Iwashita, Nagano Robust Quality Engineering Research Group)
- Easy-to-understand Robust Quality Engineering Concept
  (Mr. Hayashi, Hokuriku Research Group on Robust Quality Engineering)
- Technical development of turning process
  (Mr. Sagiya, Robust Quality Engineering Forum Saitama)
- In-house practice of robust parameter design
  (Mr. Furue, Yamanashi Robust Quality Engineering Research Group)

【Discussion: Robust Quality Engineering as a Tool】

Discussions were held on such issues as the following: What can we do to make Robust Quality Engineering usable as a tool? Simply educating employees, putting it into practice, and presenting the results will not spread as widely as we would like. What is the next step?

Date: January 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 discussed about following three issues:

【Case Studies】

1. Is Robust Quality Engineering's ________ Concept Correct? (Are you sure you're not just taking it on faith?)

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

A fundamental idea of Robust Quality Engineering, "If the interaction between control factors is large, the system (technology) is unstable and therefore cannot be used," was discussed. This concept has a major problem in that it is explained only as "Mr. Taguchi says so," and no clear evidence is provided. And this is to the detriment of the popularization of Robust Quality Engineering. We tried to come up with a rationale for this idea, but were unable to derive a basis for it. We came to the conclusion that the lack of distinction between control factors and noise has led to a wrong way of thinking.

2. Methods of interaction considerations

(Advisor: Yukihiro Iwashita)

We examined the calculation method for considering interactions in the estimating equation of the regression analysis T method. In the case of a binomial interaction, it was found that although the product xi*xj of the explanatory variables xi and xj can be estimated to some extent as the explanatory variable for the interaction, it is better to use the absolute value of the difference between the two explanatory variables as the explanatory variable by standardizing each as (x-Av)/σ.

3. T-method method without calculating η

(Advisor: Yukihiro Iwashita)

In the T method, β and η are calculated for each explanatory variable, and 1/β*ηiΣη is added together as a coefficient to form the estimating equation. In this study, we examined a method in which β is calculated and weighted using the least squares method so that the data and the estimating equation match as closely as possible. This method not only produces an estimating equation with a high correlation to the data, but is also easier to calculate and more practical.

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

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～News from Robust Quality Engineering Research Groups～

◆From Kansai QERG◆

1. start of activities in fiscal year 2024

A general membership meeting was held on January 13 (Sat), and a report on activities in FY2023 and a proposal for activities in FY2024 were proposed by the secretary and approved. Regular monthly meetings, Joint Research Groups, and Robust Quality Engineering Symposium will be held this year as well. After the general meeting, the annual New Year's Lecture and New Year's Party were held to start the new year's activities. At the Research Group on Friday, February 2, Mr. Hatakeyama (YKK) gave a presentation on his passion for Robust Quality Engineering and shared valuable and enjoyable stories gained from his rich experience in the past activities. It was wonderful to see how he has continued to run with his strong conviction to pass on Robust Quality Engineering to the next generation, even though he has run into various problems, and we look forward to his future endeavors.

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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◆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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In order to make this Magazine more useful for our readers, we thought it would be a good idea to include questions and opinions about the articles submitted. We believe that your comments after reading the Magazine, as well as opinions, questions, and advice from readers on the activities and case studies published in the Magazine, will help us to revitalize the activities of the Research Group and improve the level of our researchers. We welcome your comments and questions.

◆Questions for the article, advice, I think◆

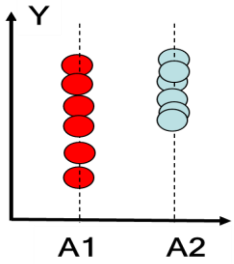
～A place for free discussion and exchange of ideas～

Opinions and advice on the article "Optimum combination of efficiency of air blowing fan
(From the Winter 2023 issue of the Nagano Prefecture Robust Quality Engineering Research Group Activity Record)

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

I think it is reasonable to use the best result from the orthogonal array experiment as the optimum combination when reproducibility cannot be obtained. That is what I did. However, low reproducibility has a high probability of causing problems in later processes (mass production and market), so care must be taken even if good results are obtained in orthogonal table experiments. So, my advice is, find out the level where the value of sensitivity is high from the sensitivity response graph. If it is not significantly different from the optimum combination you have chosen, you can be sure that there is no problem.

The reason why this is so is that in the L18 orthogonal array experiment, the sensitivity response graph is plotted as the average of 9 or 6 experiments. (see figure on the right).



Since each experiment is a combination of complex changes in the level of each control factor, a high average value means that the sensitivity≒airflow efficiency is high even when the control factor is varied significantly. Generally, there is a limit (≒ upper limit) to the airflow efficiency, so a level with a high average value has a high possibility that the airflow efficiency is stable against changes in the control factors. In the right figure, we can say that A2 is good.

It is unclear what kind of error factor this experiment was tested with, but as Dr. Genichi Taguchi stated in Robust Design by Simulation, the Noise Factor can be considered as a change in the Control Factor. In other words, the orthogonal array experiment can be said to be an experiment in which the change in the control factor is considered the Noise Factor in a larger sense. So, in this experiment, if you choose a place where the average value of sensitivity is large, it is inevitably likely that the level is also strong for the Noise Factor. Please check it out.

That's all.

◆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