**Quality Management Seminar**

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Essay: An analysis of the critical review of Eduardo, Pedro, and Carlos of the signal to noise methodology used by Taguchi.

In this critical review of the signal to noise methodology used by Taguchi, Eduardo, Pedro, and Carlos seek to critical review the design of experiments used by Taguchi, especially his noise to signal ratios methodology, which, according to the study, make the experimental design difficult, and an inefficient practice. In other words, they hunt to point out the drawbacks and disadvantages of Taguchi’s design of experiments with respect to Taguchi's statistical procedures. In this essay, a brief curriculum vitae of Taguchi will be conducted. Then, we will state the arguments of the critics, make a final assessment of their positions, and conclude with our own opinions of their critical review.

Born in 1924 in [Japan](https://www.google.com/search?q=Japan&stick=H4sIAAAAAAAAAOPgE-LUz9U3MLIoTqpQ4gAxjeONU7TEspOt9AtS8wtyUoFUUXF-nlVSflHeIlZWr8SCxDwABMa-mjcAAAA&sa=X&ved=2ahUKEwiOv7ubk8XjAhVFDq0KHXbIC1wQmxMoATAZegQIDxAH), Genichi Taguchi got his Ph.D. at the age of 18 (Kiran 2016). He was an engineer and statistician. From the 1950s onwards, he created the *Taguchi* methods which are statistical methods to improve the quality of manufactured goods. He d[ied](https://www.google.com/search?q=genichi+taguchi+died&stick=H4sIAAAAAAAAAOPgE-LUz9U3MLIoTqrQks9OttIvSM0vyEnVT0lNTk0sTk2JL0gtKs7Ps0rJTE1ZxCqSnpqXmZyRqVCSmF4KokHCACFUQgVFAAAA&sa=X&ved=2ahUKEwiOv7ubk8XjAhVFDq0KHXbIC1wQ6BMoADAaegQIDxAK) on June 2, 2012, [Tokyo, Japan](https://www.google.com/search?q=Tokyo&stick=H4sIAAAAAAAAAOPgE-LUz9U3MLIoTqpQ4gAxzVPSsrXks5Ot9AtS8wtyUvVTUpNTE4tTU-ILUouK8_OsUjJTUxaxsobkZ1fmAwDKzL0ZQAAAAA&sa=X&ved=2ahUKEwiOv7ubk8XjAhVFDq0KHXbIC1wQmxMoATAaegQIDxAL).

Taguchi is known for his quality Loss function model which describes the economic value of reducing variation.

For Taguchi,

“It is better to be precise and inaccurate than being accurate and imprecise.”

“Quality should be designed into the product and not inspected.”

“Quality is achieved by minimizing the deviation from the target.”

“The cost of quality should be measured as function of the deviation from the target” (Kiran, p. 437).

These are the philosophies emphasized by Genichi Taguchi and which form the primary concept behind the quality loss function put forward by him.

Taguchi accentuated the need for integrating quality and reliability at the design stage, prior to production. According to Maghsoodloo et al (2004), Taguchi introduced robust designs in engineering that is parameter and tolerance. Additionally, he defined a set of measures called signal-to-noise (S/N) ratios that syndicate the mean and standard deviation into one measure in analyzing data from a robust design. His methodology is highly adapted by industrial organizations in the United States under the name of Taguchi Methods. However, there have been some criticisms of his methods, especially with some well-known Western statisticians.

Although the detractors of Taguchi recognize his contribution to the methods of quality improvement, which they called exceptional, they also have a problem with his statistical procedures, which, they say, are often unnecessarily complicated and ineffective. To understand the positions of the critics, let us first see what Taguchi encourages and recommends.

Taguchi encouraged product designers not to focus on nominal performance or cost, but also to consider robustness and sensitivity to sources of variability (noise) as early as possible, during the design phase precisely. Variations due to 'noises' are the cause of 'losses' in terms of quality or reliability that the end user will suffer in the longer term (Kackar, 1989).

The signal-to-noise ratio (S / N) developed by G. Taguchi is directly related to the measurement of these variations. G. Taguchi emphasizes the use of statistical tools to reduce the influence of noise and help with experimental plans (Kackar, 1989).

He recommends using cross plan; a plan for controllable factors that is crossed with another plan for noise factors. During the experiment, the noise factors vary in a systematic way for each combination of controllable factors. At each line of the cross plan, a standard deviation is estimated which represents the underlying effect of the noise factor. The Signal to Noise (S / N) ratio is calculated from this standard deviation.

Besides, Taguchi affirms that in each case, the selection of the levels of the control factors that maximize the S / N ratio guarantees a minimum variability and therefore a greater robustness against the non-controllable variables. The Taguchi’s method was well received in the USA, but numerous criticisms have also been raised.

In the O’connor’s (1989) statistical methods for quality improvement, Ryan delivers a detailed discussion and review of the limitations of the Taguchi methods including the selection of the S / N ratios, the choice of orthogonal arrays, optimization, etc. He recommends that a discriminant design of some type is applied with the purpose of eliminating factors that they are not important. It states that in selecting factors, it is better to use fractional factories (instead of fixes orthogonal suggested by Taguchi). For the optimization of all performance measures such as S / N ratios, Ryan recommends the use of mathematical optimization procedures such as non-linear programming. In this case, it was deduced that in many occasions it is safer to work with the variance or its logarithm directly than with the signal-to-noise ratio suggested by Taguchi. The use of (S / N) S as a response variable, they say, confuses localization and dispersion effects, making it inconvenient to make adequate inferences. Consequently, the critics in this review conclude that the use of signal-noise ratios proposed by Taguchi, although it cannot always be rejected, should be used with extreme caution in the analysis of experimental data.

In addition, the authors of this review admit the widespread recognition of Taguchi's main contributions, there are also quite widespread criticisms, the most common being attributed to the disproportionate number of experimental conditions, not considering the interactions between controllable factors, the use of unproductive signal ratios to excessive zeal in the optimization process and sometimes inaccurate analyzes. Despite of the fact I am not an expert on the subject, I will proceed with a brief assessment of the review based on some external reading in the field.

Generally, G. Taguchi's S / N ratios, which are synthetic indicators, combine several types of data: the mean, the residual standard deviation and the variations due to noise. It seems and appears that this can lead to loss of information, especially for Noise Signal reports of the type "the greater the better" or the type "the smaller the better" (Logothetis, 1990).

Moreover, the experimenter cannot do more to distinguish which improvement is associated with an optimization of the average and which gain is obtained thanks to a reduction of the variability. Data of very different nature (average and standard deviation) are thus confused which does not allow to have a detailed and differentiated view of the characteristics of the system (Steinberg & Bursztyn,1994).

In addition, Taguchi's cross-plots can be considered as split plots in which noise factors are considered difficult to change and control factors are considered easy to change. In this type of plan, every effort is made to reduce the number of changes in levels of factors that are difficult to change. Therefore, many authors, such as Rosenbaum (1996), Borkowski & Lucas (1997), suggest using conventional schemes in which noise and control factors are combined into a single plan. These combined plans are used to directly study the effects of interactions between control factors and noise factors that improve robustness. The main advantage of this approach is that it eliminates the signal-to-noise ratio and its limits. Given the very high number of tests required in these combined plans to improve robustness, they are almost always fractional (very fractional) plans.

All in all, one ought to always remember that quality will ne be quality until we see the embodiment of quality: Jesus Himself. Taguchi, undeniably, has great contributed in the domain of quality, as we perceive in this world. His work has greatly contributed to the significant advances in quality improvement methodologies, such as quality control, TQM, and zero defects in the latter half of the 20th century. Taguchi loss function, for example, is largely credited for the increased focus on continuous improvement throughout the business world. It has also been instrumental to the Six Sigma movement and the concept of variation management (Kiran, 358). Are there defects in Taguchi’s methodology? I think so. Are there criticisms of his methodology? Hundreds of them! But I concur to the final statement of the review, which underlines the fact that tthese criticisms have led to interesting and valuable contributions, from new experimental plans to methods of identifying factors. Some of these contributions adapt existing statistical methods, such as split-plot designs, the surface response methodology and the optimal experimental plans. Others are contributions that have expanded the statistical methodology, such as measures of performance that are independent of adjustment and studies of effects on dispersion. And if we were to make a suggestion, we would suggest keeping Taguchi's cross-plans but directly studying the influence of controlling factors on the effects of noise factors (rather than going through the S / N ratio).

**References**

Borkowski, J. J., & Lucas, J. M. (1997). Designs of Mixed Resolution for Process Robustness Studies. *Technometrics*, *39*(1), 63–70. https://doi.org/10.1080/00401706.1997.10485440

Kackar, R. N. (1989). Off-Line Quality Control, Parameter Design, and the Taguchi Method. In K. Dehnad (Ed.), *Quality Control, Robust Design, and the Taguchi Method* (pp. 51–76). https://doi.org/10.1007/978-1-4684-1472-1\_4

Kiran, D. R. Total Quality Management (p. 28). Elsevier Science. Kindle Edition.

Kiran, D. R. Total Quality Management (pp. 28-29). Elsevier Science. Kindle Edition.

Kiran, D. R. Total Quality Management (p. 437). Elsevier Science. Kindle Edition.

Logothetis, N. (1990). Box-Cox Transformations and the Taguchi Method. *Applied Statistics*, *39*(1), 31. https://doi.org/10.2307/2347809

Maghsoodloo, Saeed & Ozdemir, Gultekin & Jordan, Victoria & Huang, Chen-Hsiu. (2004). Strengths and limitations of Taguchi's contributions to quality, manufacturing, and process engineering. Journal of Manufacturing Systems - J MANUF SYST. 23. 10.1016/S0278-6125(05)00004-X.

O’connor, P. D. T. (1989). Statistical methods for quality improvement, T. P. Ryan, Wiley interscience, 1989. number of pages: 446. price: £39.30. *Quality and Reliability Engineering International*, *5*(4), 339–339. https://doi.org/10.1002/qre.4680050416

Rosenbaum, P. R. (1996). Some Useful Compound Dispersion Experiments in Quality Design. *Technometrics*, *38*(4), 354–364. https://doi.org/10.1080/00401706.1996.10484547

Steinberg, D. M., & Bursztyn, D. (1994). Dispersion Effects in Robust-Design Experiments with Noise Factors. *Journal of Quality Technology*, *26*(1), 12–20. https://doi.org/10.1080/00224065.1994.11979494