Can Taguchi Method be applied to Improve Software Quality ? A Case Study

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Abstract— *Taguchi method was formulated by Dr. Genichi Taguchi for the purpose of improving quality and hence the productivity of industrial products, ref. Burgam (1965), Moen et al. (1992), Peace (1992), Roy (2010). Since then several US corporations have commenced utilising the method for the above purpose. Basic approach of the Taguchi method is to use a think tank of persons employed in the production to identify the components to be called factors and the levels of each of its use. Different combination of factors and uses are called trials. The resulting production level for each trial is measured and the combination that provides the optimal value is statistically determined. Since software has parallels with industrial or service production, Bagehi et al. (1992), Ravella (2008), Kanchana et al. (1999), had reported on some attempts that have been made to apply Taguchi method to quality improvement of software systems. Instead of using L^f trials; (L - no. levels, f – no. factors for each), Taguchi method uses a lesser number of trials using a concept of orthogonal arrays. A statistical technique close to principal component analysis is then used to determine the trial pattern that is expected to yield the highest quality ranking Taguchi method relies heavily on the use of a think tank of around 10 – 15 members. The main task assigned to its members is to give a possible score, for instance from 0 (very bad) to 10 (excellent) for each trial and the average is taken as the score. An interesting feature of the method is that the optimal trial pattern may sometimes not be one of the orthogonal arrays mentioned. Objective of this research is to investigate the possibility of using the Taguchi method to determine how best the resources, viz., factors and the level of each that should be used to obtain maximum possible quality level of the finished product.*

Keywords*: Software quality, principal component analysis, orthogonal arrays*

I. INTRODUCTION

When Japan was getting rebuilt after the end of War 2, the allied command found that the quality of her telephone system to be extremely poor. The command recommended the Japanese government to set up a R & D facility similar to the Bell Laboratories of USA. Accordingly the Japanese government set up the Electrical Communication Laboratories (ECL).

Dr. Geninichi Taguchi was placed in charge of R & D work of the ECL. He based his work on the following two philosophies.

1. Quality should be designed into the product and not inspected into it.
2. Quality is best achieved by minimizing the deviation from a target.

He also recommended the use of brainstorming as an effective method.

The success of Taguchi Method made these techniques to be transplanted in USA. The US Ford Motor Company decreed that its Engineers be trained in this method,

A) Taguchi Approach

Taguchi recommends the following

(a) Brainstorming should be much used

(b) Instead of doing all the combinations of L^f trials and getting output value for each trial, the method uses a less number n of what are called orthogonal arrays, for each of which the resulting product value x_i, i =1, 2, ..., n; has to be found.

(c) S/N ratio can be determined as follows:

There can be one of three criteria

In items $x_1, x_2, \ldots, x_N$

(i) Larger the better, then take Mean Square Deviation (MSD) as

MSD = $\sum \frac{1}{x_i^2}$

(ii) Nominal near x_0 is better

MSD = $\sum_i^N (x_i - x_0)^2 / N$

(iii) Smaller the better

MSD = $\sum x_i^2$

Signal to Noise Ratio is defined as S/N ratio = $-10*\log_{10}(\text{MSD})$

Using a statistical technique the trial pattern which gives the optimum value is determined.

II. OBJECTIVE & THE METHODOLOGY TO BE USED FOR THIS RESEARCH

Objective of this research is to investigate the feasibility of applying Taguchi method to software design in the local context.

The methodology to be used will be described using a test case where 5 factors have been identified with each having 2 levels; (L =2, f= 5). Instead of taking 2^5 = 32 trials, the output value for each combination of 8, (n = 8) Orthogonal Arrays have to determined. The arrays are obtained from a website given by Roy, (ref link.)

A prototype Matlab programme had been designed to obtain the optimal combination based on the 'larger the better' principle.

III. TEST CASE

A test case considered is the production of a school time table system within a prescribed time period. Here the head teachers assign a Teacher for a Subject in a Class, so that a teacher is assigned only to one class at a particular time period. There will be constraints like some classes being parallel, some subjects of different classes being held together, etc.

The software managers have identified five factors each at two levels as shown in Table 1 below:-

Table 1 – Available Resources

Factor	Designing	Coding	Testing	Quality Control	Reporting
Level 1	1 senior	1 senior + 2 programmers	1 senior + 2 testers	1 senior + 1 QA	1 junior
Level 2	2 senior	2 senior + 4 programmers	2 senior + 4 testers	2 senior + 2 QA	1 senior

Instead of using 2^5 = 32 trials, Taguchi method uses only 8 trials based on orthogonal arrays shown in Table 2. Due to shortage of time instead of using a think tank of around 10, scores of only 3 stake holders were asked to give scores rating from 0 of worse to 10, and technique used in PERT, Armstrong-Wright A.T (1969), Taha (2002), was applied and results are shown in Table 2.

Table 2 – Results of 8 Trials

Trial Number	Level of Factors					Average Score
	1	2	3	4	5	
1	1	1	1	1	1	7
2	1	1	1	2	2	5
3	1	2	2	1	1	6
4	1	2	2	2	2	8
5	2	1	2	1	2	7
6	2	1	2	2	1	6
7	2	2	1	1	2	7
8	2	2	1	2	1	6

Averages for each level and the level giving maximum average for the five factors are shown in Table 3.

This table gives the final result showing what level of each factor should be applied to obtain maximum quality grading.

Table 2 – Average Score for each Factor & Final Results

Factor	Description	Average Level 1	Average Level 2	Level giving Maximum	Description
1	Designing	6.51	6.5	1.	1 senior
2	Coding	6.25	6.75	**2.**	2 senior + 4 programmers
3	Testing	6.25	6.75	**3.**	2 senior + 4 testers
4	Quality Control	6.75	6.25	4.	1 senior + 1 QA
5	Reporting	6.25	6.75	**5.**	1 senior

CONCLUSION

This paper demonstrates that Taguchi method can be applied for planning resources in software development to obtain maximum quality grading for the finished product and shows how it can be done.

REFERENCES

Burgam, Patrik M, 1985, Design of experiments – the Taguchi way, Manufacturing Engineering, May 1985, pgs 44-46

Moen, R D; Nolan, T W & Provost, L P (1991) *Improving Quality Through Planned Experimentation*

Peace, Glen Stuart,1992, Taguchi methods, Addison-Wesley

Roy Ranjit, Taguchi Method , 2 nd ed., 2010, Society of Manufacturing Engineers

Bagchi Tapan P and Madhuranjan Kumar (1992) *Multiple Criteria Robust Design of Electronic Devices*, Journal of Electronic Manufacturing, vol 3(1), pp. 31–38

Ravella Sreenivas Rao, C. Ganesh Kumar, R. Shetty Prakasham, Phil J. Hobbs (2008) The Taguchi methodology as a statistical tool for biotechnological applications: A critical appraisal *Biotechnology Journal* Vol 3: pp. 510–523.

Kanchana V,. Sarma, V.S.,Engineering of Computer-Based Systems, 1999. Proceedings. ECBS '99. IEEE Conference and Workshop on; 04/1999

Armstrong-Wright A.T (1969), Critical Path Method. Introduction and Practice, Longman Group Ltd, London

Taha H.A (2012), Operations Research 8th Edition Prentice Hall

Link for Orthogonal Arrays
https://controls.engin.umich.edu/wiki/index.php/Design_of_experiments_via_taguchi_methods:_orthogonal_arrays

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Professor G.T. F de Silva, served University of Moratuwa as Lecturer, Head of the Department of Mathematics and as Vice Chancellor. He served as Chairman of the Committee of Vice Chancellors & Directors (CVCD) in 1996.He was the Director General of S.L.I.A.T.E and Managing Director of Media Defined, the Sri Lankan Branch of a USA Company working in e-Learning. Currently he is attached to the Department of IT & Mathematics at KDU. He holds DIC & M. Phil. in Mathematics & Computing, D. Phil (H.C.) from Moratuwa, MBCS, C. Eng and MBIS.

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