Plain English

TAGUCHI *for Marketers*

How an Innovative Mathematical Formula Produces Explosive Results for Direct Marketing Campaigns

Explanation of the Taguchi & Design Of Experiments

Ranjit K. Roy, Ph.D., P.E. (M.E)
David S. Bullock

Taguchi for Marketers:
Plain-English Explanation of the Taguchi and Design Of Experiments Methodologies

How an Innovative Mathematical Formula Produces Explosive Results for Direct Marketing Campaigns

This report provides a clear and concise explanation of the Taguchi Based Dynamic Advertising Component Optimization Methodology.

- Discusses the benefits and differences in the Taguchi methodology in comparison to one-factor-at-a-time standard split testing.
- Provides brief glossary of common terms for Taguchi Ad Optimization
- Discusses common uses of design of experiments in the domain of marketing.
- Discusses criteria for sample size and results evaluation.
- Provides an explanation of confidence level and error using the Taguchi methodology.

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September 2004

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In response to frequently asked questions that are raised in regard to statistical confidence and validity, the following article by **Ranjit K. Roy, Ph.D., P.E. (M.E)** is submitted to address most common concerns when applying the Taguchi Optimization Method to marketing.

Results² uses proprietary technology that has been designed specifically for marketing and media applications. **Results²** utilizes, and continues to refine, the standard algorithms discussed below, which have been modified to handle the dynamics of media placement and market response variation. Standard Taguchi Optimization Methodology and Algorithm Application may not achieve similar results.

Explanation Of The Taguchi Methodology As It Applies To Marketing

by Ranjit K. Roy, Ph.D., P.E. (M.E)

DOE Test Samples for Marketing Applications – How many is too many?

As an engineering consultant and trainer for the manufacturing industries, I have been involved in the use of the Taguchi version of the design of experiment (DOE) technique for last 20 years.

Based on the industry demands, like many others in my profession, I have developed software to help with number crunching, and have written books with examples of applications mainly in engineering products and process development. The recent surge of interest from the marketing community in the use of the DOE to layout experiments (known as split tests) is surprising, but an expected development. Many of my clients and associates involved in marketing applications have asked me to comment and clarify a few issues related to determining the sample size for the experiments (tests) and how DOE relates to statistical confidence. I will try to address these topics in this brief report.

Before I proceed with describing how DOE is being used in marketing and how to decide on a satisfactory sample size and how you can assign a statistically valid confidence level to your conclusions, I owe you some simple definitions of terms we are going to use in testing based on the planned experiments.

Mastering the Lingo

- **DOE** – It is an acronym for the statistical technique known as design of experiment. The purpose of the DOE technique is to be able to study the effect of many variables at a time and was originally devised to study the effects of rain sunshine, water, fertilizer, etc. on the agricultural production.
- **Taguchi DOE** – Upon further research with DOE, Dr. Genechi Taguchi of Japan standardized many aspects of the use of the DOE for industrial applications. For its ease of use and improvement derived in product and process design, DOE using the Taguchi version is found attractive by the practitioners with minimal statistical background. For discussions in this report we need not make a difference between DOE and Taguchi DOE. I will use these two terms synonymously.
- **Experiment** – Of course, experiment is a formal word for test. Being formal, it would imply that such experiments are designed with a plan and purpose.
- **One-factor-at-a-time Experiments** – This is what we always have done for thousands of years. Here you take one factor (or *variable*) and run at least two tests to see the effects of change. If you are not doing a DOE, you probably have done this.
- **Orthogonal Array** – These are a special set of tables of numbers that Taguchi designed to facilitate the process of laying out experiments. A number of arrays are commonly used for 2-level, 3-level, and 4-level factors. The smallest array is a table of numbers with 4 rows and 3 columns and is used to layout experiments with three 2-level factors.
- **Trial Condition** – When you layout (also called *design*) an experiment with DOE, it comprises of a number of unique combinations of the factors under study. These individual experimental conditions are called trial condition and are equivalent to the term *split tests* used in marketing applications. In Taguchi DOE, the smallest experiment will have 4 trial conditions.
- **Sample Size** – It is the number of individual sample (test) results collected for each trial condition and used for analysis. For example, if the sample size is 5, then there will be 5

separate results for each of the trial condition. Unless, the experiment is designed to include uncontrollable (*noise*) factor influence by means of an orthogonal array (called the *outer array*), the sample size is recommended between 1and 9. When it comes to number of samples, the general rule is the more the better. However, the return diminishes as the number becomes larger. So going over 9 sample results is overkill.

- **Sample Result** – This is the representative performance (measured result in numeric form) of a test sample, a group of specimen. Often it is a single sample result, but in other situation it is based on prolonged observation. Our discussion in this report will deal with this item at length.
- **Confidence Level** – Expressed in percentage, it means how often the stated fact is likely to be true. Thus, if DOE helps you predict that the expected performance is a conversion rate is 12% +/-1% at 90% confidence level, it means that 9 out of 10 times you are expecting the average performance to fall within 11 and 13.

Common Use of DOE in Marketing Research

The DOE technique can be used to study effects of change of many factors at a time. Because the behavior of all kinds of things may usually be dependent on more than one factor, the areas of use of the technique are unlimited. In the early introductory period, it has been mostly used in the agricultural and chemical industry. During last couple of decades, the renewed focus on quality improvement by the auto industry, suppliers including metal, electronics, rubber, plastics, pharmaceutical, and many other industry realized greater benefits from use of the technique. In more recent times, marketing research scientists have found numerous ways to use DOE in optimizing web site landing page design, improving pay-per-click advertising, increasing response from mass mailings on solicitation of bank loans and credit cards.

In a study to optimizing click-through rate in a pay-per-click advertisement (say with Google Adwords), typically there are four lines of information. Considering these as individual factors such as Title line, Text line 1, Text line 2, and Link to a site with two descriptions (also described as value or level), there could be 16 possible combinations. If all such conditions could be tried to see which one offers the most number of visitors or click-through-rate, then there would be no need for any special technique to do the same. The only problem is that when you are dealing with larger number of factors, your budget and time will not allow you to try all possible combinations. In this situation, you would definitely need to know some way to do a few tests that can produce the most information. The Taguchi version of DOE often will greatly reduce the number tests you need to when dealing with many factors.

Why do DOE and not do one-factor-at-a-time test? Before DOE was introduced, people have always done one-factor-at-a-time test. Unfortunately, associated this short-cut approach is the unwanted risk that the knowledge gathered from such tests may not always be reproducible. As a result, the conclusions drawn from the test may not hold true in real life application. DOE tend to increase the likelihood of deriving conclusions that come out right most of the time.

The discussions of how the experiment is designed using the Taguchi DOE, or how the results are analyzed, are beyond the scope of this report. We would instead deal with the immediate concern of how to decide what makes an acceptable representative sample result and how to speak about it with some level of confidence.

Deciding on Sample Size and Result

From the definition of sample size above, you should have a pretty good idea about what a sample size is. Having multiple samples (results) in each trial condition is highly desirable, particularly when performance is suspected to be influence by uncontrollable variable and the goal is to determine condition which is most insensitive to the uncontrollable factors. However, running more than one sample in trial condition may be expensive and time consuming for many market research applications like pay-per-click ad, or web site conversion rate. Also bare in mind that, in situations where the results from sample to sample are not expected vary, there is no need to repeat tests. The general guideline here is that consider repeating test samples only when the results are not expected to repeat. For example, if you experience or suspect that the response from visitors will be different depending on the time of the day, day of the week, or season in the year, you may want to create multiple samples in each trail condition. If you could afford the time and cost, more than one sample in

each trial condition are expected to produce more dependable conclusions. *When repeating samples, keep the number under 10 and prefer to analyze results using the signal-to-noise ratios of the trial results.*

What constitutes a sample result?

No matter what the number of samples you decide to use, each sample result is the representative of performance expressed in terms of a numeric value. But what is a valid result for the test condition (trial)? How long or how many visitors/customer data should suffice? When would you know that you have enough observations? What do you need to do **to** associate some statistically valid confidence level (%)?

A valid result is the one that you can trust to find most of the time. You can only trust a result that is stable, meaning you are getting the same value within a range over a desired period of time. Suppose that in a banner advertising to drive traffic to your site, you find that the conversion rate from 500 impression (arbitrary number, will depend on the product you are advertising) is 2.5%. Based on your experience, you will need to establish a band (tolerance) around this number. Again this is an arbitrary number. A recommended practice will be to select a value less than 5% (1/ 20) of the performance. Suppose that you decide on 0.1, then for the result to be stable you will be looking for it to be within 2.4 and 2.6 (= 2.5 +/- 0.1).

For the result that has reached a steady value is considered stable and you may find it within a few subsequent observations to conclude that it is so. On the other hand, if the result is unstable, that is it is going up and down with magnitude greater than your tolerance band or increasing/decreasing in value, you will need several observations before you can obtain a stable value. Exactly how many exposure of the advertisement or how long you should wait between two observations is something you will need to determine from experience with products of the same kind. There is no theoretical recommendation that seems to apply for marketing.

If speaking with confidence that is statistically valid is your desire, then there is a simple rule you can follow to determine how stable your data is. In other words, say, how many times do you need to see the result as 2.5 (or within the band established) before you can tell that it is expected to be so in future times? You can get this probability of error (not being true) by multiplying ½ as many times as your observation. Thus, if you saw 2.5 two times in a row, you can be only 75% sure (25% unsure) that you will have 2.5 for the next one. Like wise, to say with over 99% (1 - 1/128) confidence level that your result will be 2.5, you will need to see it as 2.5 seven times in a row. As you can see, to gain confidence will cost you time and money. But, if you need to develop the confidence level, use the following simple rules. To look for more statistical validation will be to unnecessarily complicate you life.

Observations # (Same result)	Confidence Level
1	50%
2	75%
3	87.5
4	93.75%
5	96.875%
6	98.437%
7	99.219%

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Implications of this Technology

This technology has the potential to revolutionize advertising, especially online. The reason for this is the ease at which testing can be done. **Copywriting** decisions are reduced to a simple matrix of assumptions which can be tested in a matter of days or weeks, resulting in dramatically improved response and more intelligence about customers and their preferences. More than 2000 combinations of variables can be tested with just 12 versions of an advertisement.

Pay Per Click Advertising brings new implications to the table. The only way to shut out competitors is if the cost of clicks is too high – you need to be able to outbid them. The only way to do this is to have a higher sales conversion rate than your competitors.

If you improve your sales conversion rates by 100%, 300% or more, you are now able to outspend your competitors by a factor of 2:1, 3:1 and even 5:1. This allows you to get more traffic volume and still more test results and more response improvement. Eventually it becomes impossible for a competitor to enter your market for any reasonable amount of money.

For offline media such as **newspaper and magazine,** the cost savings are even more staggering. Instead of placing ads and "hoping" that it will work. Smaller test ads can be designed, placed, optimized and validated before major roll out.

Finally, for **direct mail,** which has its foundation in testing – everything including copy, layout and list can be optimized and validated completely, easily and quickly to ensure profitable results.

For all media channels, the winners will be those who optimize their campaigns with **Results^2** – before launching their campaigns!

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