Optimizing Software Testing with Cryptic Six Sigma Analyses

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Abstract- Software testing is skill of investigating the purpose and rightness in software behavior caused by variations in component values or the environment. Quality improvement and customer satisfaction becomes an increasingly difficult challenge when there are fewer resources available. This paper proposes an innovative technique of DMAIC methodology using six sigma software testing. The paper supports that Six Sigma is not going to supersede other initiatives, but instead offer a tactics to determine the best approach for the process of testing software. In this paper a discussion has been made to use DMAIC methodology and principals while carrying out six sigma projects.

Index Terms- DMAIC, Software Testing, Six Sigma

I. INTRODUCTION

The term "Six Sigma" alludes to the power of extremely adequate to processes to produce output within specification .Particularly Six Sigma quality controls processes; produce at defects levels below 3.4 defects per one million opportunities called DPMO. Six Sigma caliber as simply an exhaustive diligence of basic and advanced statistical tools throughout an organization and with this view number of consultants and organizations repackaged statistical components of their TQM programs and assign a new name Six Sigma."

One of the unquestioning goals of Six Sigma is to improve all processes to that level of quality or better. Lately others have used the 'TRIZ' methodology for problem solving and product design as part of the six sigma approach. Six Sigma considers as a strategically business concern weapon initiatory rather than a quality program; considered as a philosophy, performance measurement, improvement framework, set of improvement tools and structured approach for business improvement.

Although it is perceived as an advanced form of Total Quality Management but there are some drawbacks that is to be highlight, those are like for the analysis, a sophisticated measurement program is needed; for accuracy purpose it demands a sound mathematical statistics. In spite of lot of care and attention impact of early stages glimpse can never remove. It requires Elicitation and should be attentive towards Customer Voice and for fulfilling process needs functional Size must be measured.

The approach proposed in this paper focuses o the drawbacks and try to solve the complexities of typical six sigma methodology. The paper concentrates on prioritizing specific improvements projects that would be more intended in communication with customers and market place. The suggested approach in this paper by and large a process or product such type of system that convinces the inputs to outputs; it can figure out as IFO i.e. Input, $_{\text{Transfer}}$ function and Output.

Typically proposed approach has chosen an engineering problem 'Black Box' which transfer functions, calculates the problem by observing the behavior of system. Orthogonal experiment, data collection, variance analysis, and other linear regression methods enable functions. Proposed approach draws a mode i.e. utilized for black box transfer function. Black box is chosen as it is quite easy to estimate the tolerance design in white box; but in black box variance analyses is required.

a. DMAIC methodology

Six Sigma is an obligating way to discover improvements for deporting world class processes with a defect rate of less than 3.4 ppm (parts per million). Usually Six Sigma is known as five step methodology-DMAIC. i.e. *Define, Measure, Analyze, Improve and Control.*

Define phase defines the actual problem. It focuses business cases, problems and scope and for understanding the real problem empathizes on customer requisites to identify ill in processes. It maps the process for easily recognizing the links between each step. Further fix the problem too, gather data , pick problems and fix them.

Measure phase measures the problem in quantifiable terms i.e. capabilities of a given process-means what is possible, which endeavors to estimate the process capability that a customer needs can meet.

It measures how many opportunities for defects a certain process or procedure acquaints. throughout measure process defines" critical to quality' or CTQ.

Analyze phase works in quantifiable manner too. It identifies dissimilar engenders for the failure of delivering the customer needs. It finds out that how well or poor the process functions on the basis that what the current competition and what is possible presently. Analyzing means popping out the errors are being committed and how to fix.

Improve phase works in very creative way where the problem and cause are already awarded. It identifies numerically the problematic factors and implements the necessary changes for improvement.

It approaches the problem, make specific changes and make them better by thinking creatively on the development of solution.

Control phase works on avoiding fall back of improvement actions as within their new operating limits, or locked securely and monitor to remain that same order.

The DMAIC methodology is consists of what, where, when, whom and why technology.Today's market catch world is to produce high quality products at lower costs with greater responsiveness. To contend in a world market a company needs to move toward a six sigma level of execution.

b. Fundamental dependencies

1. Six-Sigma accepts a leadership capability and team structure as patrons, champions, process owners, green belts, black belts.
2. Six-Sigma accepts an agreed and well- understood top level down business process model.
3. Six-Sigma accepts that the business includes IT, understand the purpose and mandate of the method and how it will integrate to other methods such as development life cycle, organization design methods change management methods.
4. Six-Sigma accepts a sealed knowledge and culture within the business including an awareness of the business strategy, intellect the process and confidence with changes to process and systems.

II. RELATED WORK

Relatively several articles are available that defines the distinctive views and proposals to improve software testing. Reference [4] gives an overview of six sigma, its historical perspective, definition, and its changed phases with changing environment and period and finally its procedure. In [9] the involvement of six sigma has been explained and introduced the power of six sigma by showing DMAIC methodology; it gives a deep motivation towards the direction of business strategies in improvement. Reference [7] describes the present challenges in adopting six sigma in business projects; while in [1] some significant practical solution has been suggested to overcome the problem when it is used in a pharmaceutical sales and marketing field. Reference [2] shows how monte carlo simulation can be applied to predict and improve the quality of a system before even one prototype has been built.It helps to develop the new products rapidly. The analytical methods and optimization process has been applied efficiently. In reference [6] a comparison has been made with other quality initiatives.

III. PROPOSED APPROACH FOR OPTIMIZATION PROCESS

Based on the work [14],[2],[9],[15] an innovative process has been carried out that convinces the inputs to outputs.The unique feature of the model contains several functions in which test process changes its behavior like input,transfer and output.

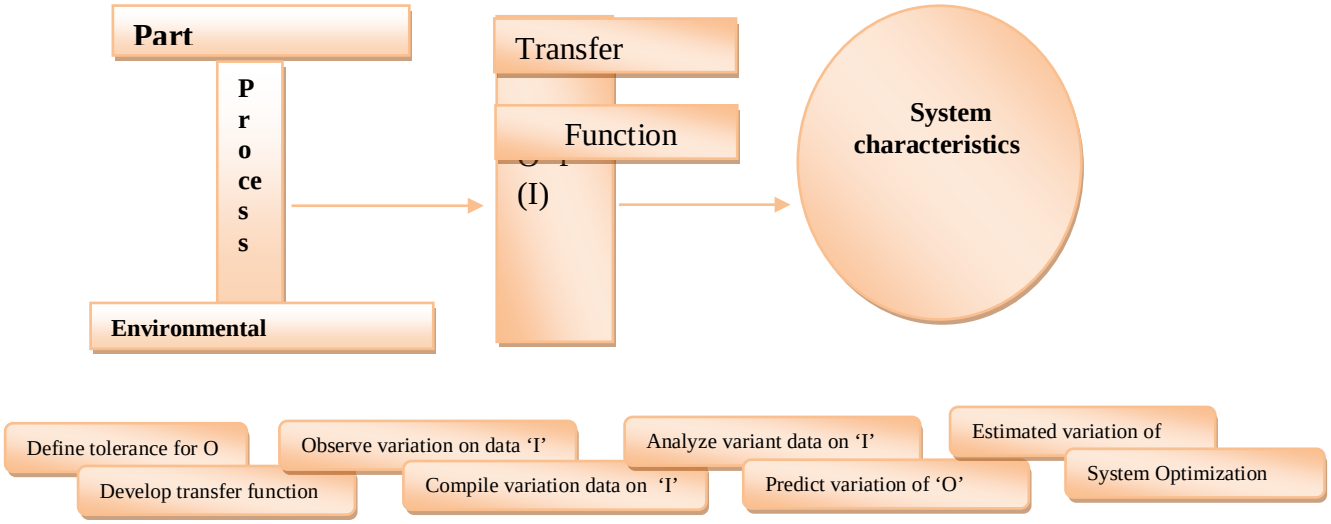


Figure1: Proposed Architecture of optimization process

Steps that has been followed in proposed methodology are as follows

Step1: Creating input phase

1.1 Observing variation on data
1.2 Compiling variation on data
1.3 Analyze variant data

Step2: Building Transfer phase

2.1 Defining tolerance for outputs
2.2 Developing transfer functions
2.3 Predict variation of outputs
2.4 Estimating variation of outputs

Step3: Generating Output

3.1 Generating the output for system optimization

The overall optimization process of proposed method is mentioned in figure [1] and explained in the following figure [1] contains the following steps.

Step1: Input Phase

Input process is consists of different type of characteristics; Part characteristics and environmental characteristics. Input is denoted as 'I' that determines which input is conducted well nigh to variation of output? And what type of input can provide right periodical variations towards output?

Part characteristics are the included features in the input process whereas *environmental characteristics* concerned with external conditions or surroundings.

Concerned features are

Observing variations on data observes the instances of change; the rate or magnitude of change or an activity that varies from a norm or standard either from changes in part characteristics or in environmental characteristics.

Compiling variations on data this phase also compiles the variations found on data after variation due to changes in characteristics.

Analyses the variant data *:* It considers in detail and subject to an analysis in order to discover essential features or meaning before transfer to the F basis.

Step2.Transformation phase

This phase is denoted as 'F'. The basic function of F basis is to transfer the functions performed on I basis.After variation, adoption is very necessary, whether the function is platform independent and can be develop newly if business process is re-styling.

Defining tolerance for outputs

'F' basis determines and defines the tolerance level for output. It fixes the range of tolerance that has been varied on 'I ' basis.

Developing transfer functions

It develops the transfer function; and while developing Predict variation of outputs and Estimating variation of outputs.

Step3. Output Phase

The final and most important phase is output denoted as 'O' that generates the outputs with the verification and validation process that whether the estimated result matches the customer requirements? And whether the reflections of input are accurate for the tolerance of output?

Although the result of the magnitude of difference between sigma levels can obtained and accepted simply.these differences helps to encourage efforts. These differences can be of various types can be depicted graphically are as follows.

Magnitude of difference between sigma levels

Sigma Level	Area	Spelling	Time	Distance
1	Floor space of the covered stadium	170 misspelled words per page in a book	31 ¾ years per century	From here up to 500 feets
2	Floor space of a large workshop	25 misspelled words per page in a book	4 ½ years per century	1 ½ times around the world
3	Floor space of a small head-quarter of armed forces	1.5 misspelled words per page in a book	3 ½ months per century	Coast-to-coast trip
4	Floor space of a distinctive Bank	1 misspelled words per 30 pages	2 ½ days per century	45 minutes of freeway depositing and withdrawing
5	Volume of a book on table	2 misspelled words in a set of guide	5 pages per hour	1 trip to the local station
6	Size of a stone	1 misspelled words in encyclopedias	6 seconds per century	5 steps in direction of garden
7	Size of a statue	2 misspelled words in all books	10 seconds per century	1 km towards the direction of market
8	Size of the holes in cooking stove	1 misspelled word in most of the books and magazines	2-3 eye blink per century	inches

Table 1: Sigma Level differences

Advantages to go through with Six- Sigma in testing environment

1. Management stock (buy in)
2. Consecrate team both drivers and as well as adopters.
3. Training and cultivating.
4. Acculturation edifice: preprocess culture is very efficient to make the life better.
5. Continuous and affirm determination and effort for improvement over adoption as transforming,people,thoughts and actions.
6. An apparent difference between hardware and software, because software is not hardware,software defects are designed in, not the result of manufacturing variation.
7. Merging six sigma with strategic planning
8. Re-Style the business process framework.

3.1. Limitations and Disputes to go through with Six- Sigma in testing environment

As an improvement in testing process, Six-Sigma is adopted by very few organizations and they have their experience either beneficial or speculative. Although, yet organizations are not fully successful to implement Six-Sigma precisely. Organization hesitates to take risk of adoption of Six-Sigma in their conventional process method.

The complexities of Six-Sigma are:

1.Some prominent authorities view that it is very expensive and using it is a mistake.

2.it is just to empower all strength and energy and fizzled.

3.Use of Six-Sigma does not ensure any verified or exact assistance in time of need.

4.Six-Sigma does not carry on with individual consequences.

Conduct the disputes of Six-Sigma:

a. First with the positive approach organization should make up the mind that it is impossible to implement any process improvement method successfully and organization should need to look at the bigger picture rather than assume the method itself is the solution, should appraise critically whether the right framework is in place to make the method work.Problem analyzing and find out the solution with the framework. :

The question arises and must satisfy that

- Whether all individuals are familiar and happy with changes or not.
- Whether the testing process model is comprehensive.
- Whether the people are committed to the team roles and duties.
- Whether the strategy of organization is elaborate and systematic from peoples perspective.
- Whether the testing process or model is really able to implement in broader testing environments and methods.

b. Valid measurement of method should be placed, tests carefully and check is it really adding value and providing approx. accurate result.

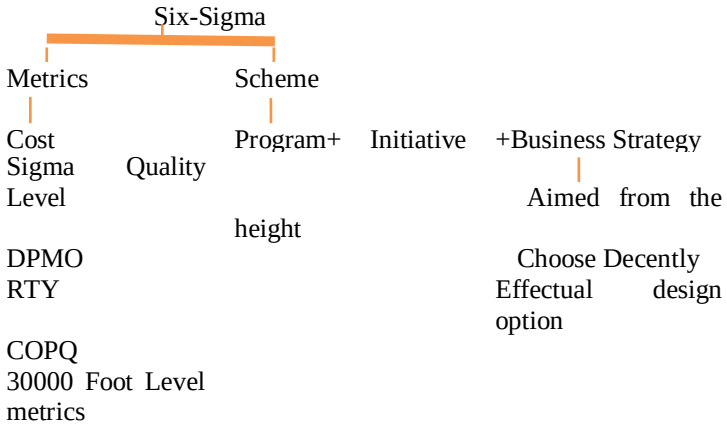


Figure2: Six-Sigma Metrics

IV. TESTING OPTIMIZATION PROCESS CASE STUDY WITH ILLUSTRATION

The decision table shown below is an illustrated part of a Printer Troubleshooter designed to detect when the HP L1023 dangles too jammed. When this falls out, user changes conditions as well as state, resets the printer settings before it starts doing objectionable behavior.

Printer troubleshooter

		Rules							
Conditions	Printer does not print	Y	Y	Y	Y	N	N	N	N
	A red light is flashing	Y	Y	N	N	Y	Y	N	N
	Printer is unrecognised	Y	N	Y	N	Y	N	Y	N
Actions	Check the power cable			X					
	Check the printer-computer cable	X		X					
	Ensure printer software is installed	X		X		X		X	
	Check/replace ink	X	X			X	X		
	Check for paper jam		X		X				

CONDITION ENTRY

		RULE 1	RULE 2	RULE 3	RULE 4
CONDITION STUB	CONDITION 1	YES	YES	NO	NO
	CONDITION 2	YES	I	NO	I
	CONDITION 3	NO	YES	NO	I
	CONDITION 4	NO	YES	NO	YES
ACTION STUB	ACTION 1	YES	YES	NO	NO
	ACTION 2	NO	NO	YES	NO
	ACTION 3	NO	NO	NO	YES

ACTION ENTRY

Figure 3.a Printer troubleshooter Decision Table 3.b

3. c Troublesome Decision Table

	Rule 5	Rule 6	Rule 7	Rule 8
CONDITION 1	I	NO	YES	YES
CONDITION 2	I	YES	I	NO
CONDITION 3	YES	I	NO	NO
CONDITION 4	NO	NO	YES	I
DEFAULT ACTION	YES	YES	YES	YES

	RULE 1	RULE 2
CONDITION 1	YES	YES
CONDITION 2	I	NO
CONDITION 3	YES	I
CONDITION 4	NO	NO
ACTION 1	YES	NO
ACTION 2	NO	YES

RULE 1.1	RULE 1.2	RULE 2.1	RULE 2.2
YES	YES	YES	YES
YES	NO	NO	NO
YES	YES	YES	NO
NO	NO	NO	NO
YES	YES	NO	NO
NO	NO	YES	YES

3.d Immaterial transformation Decision table

Step 1: Define margin for output(O)

First off,What is the concept of O?What prominent attributes of this decision table are we concerned in ? here are three:
PRIN_on :-these are the actions based on conditions when the power supply embarks on printer changes state.
PRIN_off :-these are the actions based on conditions when the power supply keeping out and printer changes state.
PRIN_serve :- PRIN_on – PRIN_off

For stability, the printer device acquires a firm amount of hysteresis.

For the sake of easiness, Only PRIN-off has been analyzed and analysis of other two O's (outputs)has been taken as exercise. now focusing on user requirement when PRIN-off? These conditions and actions are immersed deep down and seems far off of his/her awareness. No any naïve user is cognizant of these states, conditions and actions, unless it fails to work properly, like printing paper or not.

These states, conditions and actions are for making the device dependable, proposed to prevent from undesired malfunctions. So the user demand for PRIN_off is to shut down the printer before these conditions become out of control. Therefore three conditions are minimum tolerance limit.
The maximum tolerance limit is set by the variation in the output(O) itself. If PRIN_on conditions are different then actions would be in inherent variations, device will not work correctly.

Step 2: Building the $_{transfer}$ function

As dozens of problems faces, this step can be unmanageable but some guidelines can make this easy.
Inputs (I) which have paltry impact should be avoided.

Intermediate values should be represented smartly as unexampled symbols etc.

Statements and expressions should be clear and short and there should have any substitute for the portions.

For the deserted device, there are many inputs that should be neglected. A wild action is required with engineering judgment. Risk of disregarding an input is really necessitated. Hence, two actions can take in situation of doubt either to leave it or to take other way and to measure carefully the significance of input.

Now, the impression of Toner Cartridge has been neglected with the Diode laser. As its name explicitly, "Diode lasers are compact and low cost alternatives to huge expensive dye…in research laboratories as well as in commercial instruments like laser

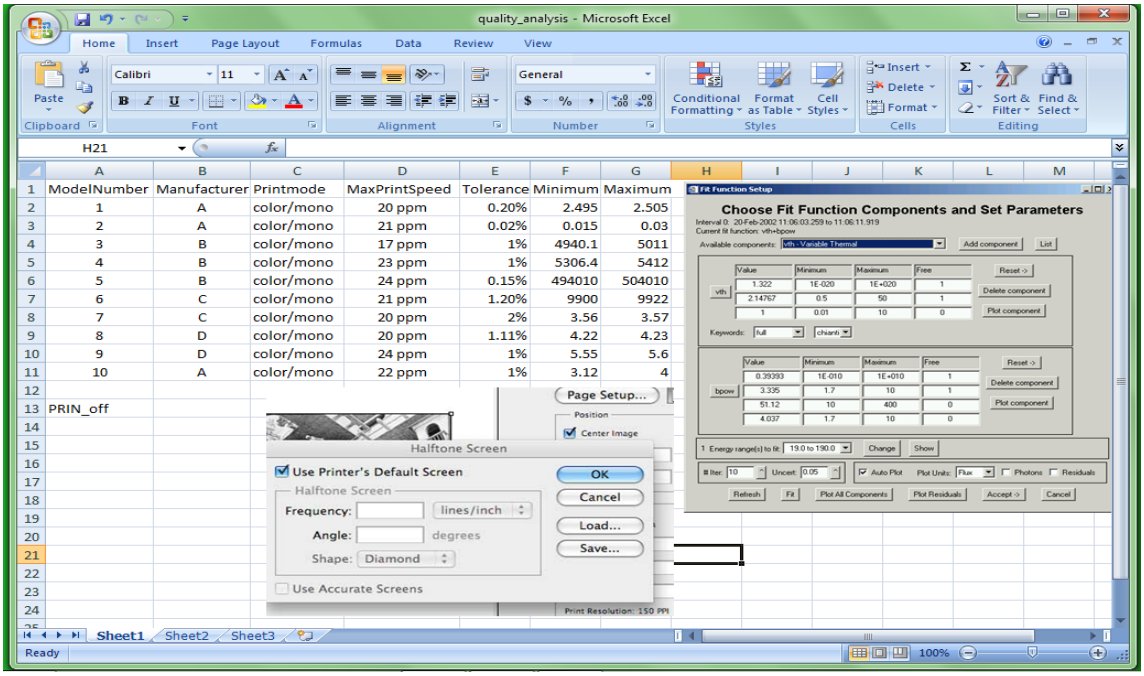
printer….against reference frequency preferably an absolute references in terms of atomic absorption such a laser system whose output frequency corresponds, over a period of time to the desired atomic transition."
The toner cartridge impression allowance can be calculated, but it drenched out by the tolerance of the diode lasers..So it is safe in ignoring this input.

Likewise, the print mode of the toner cartridge and the load impedance of the printer following the printer have effects but these are extremely slight among several models, so it can be ignored.

What follows is one way to derive the transfer function. In this filliation
To deduce the $_{transfer}$_function,in this derivation :
PRIN_on:-is the point where the printer changes state.

Step3: Accumulate Variation Data on Each Input(I)

In the perfect existence, Tester would have accession towards huge databases with real evaluated values from samples of all these parts. From this data, the most appropriate probability distribution has been selected. But in real life most testers have no data.
For the first in data poor real life, it is recommended that each component is consistent distributed between its specification limits. This is a conservative assumption , because it is usually worse than real data will be.



	A	B	C	D	E	F	G
1	ModelNumber	Manufacturer	Printmode	MaxPrintSpeed	Tolerance	Minimum	Maximum
2	1	A	color/mono	20 ppm	0.20%	2.495	2.505
3	2	A	color/mono	21 ppm	0.02%	0.015	0.03
4	3	B	color/mono	17 ppm	1%	4940.1	5011
5	4	B	color/mono	23 ppm	1%	5306.4	5412
6	5	B	color/mono	24 ppm	0.15%	494010	504010
7	6	C	color/mono	21 ppm	1.20%	9900	9922
8	7	C	color/mono	20 ppm	2%	3.56	3.57
9	8	D	color/mono	20 ppm	1.11%	4.22	4.23
10	9	D	color/mono	24 ppm	1%	5.55	5.6
11	10	A	color/mono	22 ppm	1%	3.12	4

Figure4: Print Mode and Maximum Speed of the Laser Printer Models

Step 4: Anticipative variation of Output (I)
Step 5: Optimize System

Distinctly, Improvement is required .tolerance PRIN_off can be revisited but only on the basis of above explicated reasons , no alterations are possible further. why the variations are needed? It is answered by Sensitivity Chart.
Target Forecast: PRIN_of

Through implementing Six Sigma it concludes that Six Sigma effectively predicts defect density

V. CONCLUSION

Certainly, Six-Sigma is a top-drawer measurement program and brings storming results. But any process improvement method undoubtedly can be made to work within organization and improves the skill but it is not fair to expect enchantment because no any band aid method is magical, till it is implemented at right time, right way and on right stage. It is not just to put a value and change the answer. It is an eternal process based on feedback to gain the desired benefits.

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