# "The Cost Model A short Review of Literature "

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*ABSTRACT*

With the intrusion of computers in every walk of our lives-improper functioning/failure of Mathematics can cause serious problems. As Mathematics systems have become more and more complex, the importance of effective, well planned testing has increased many folds. Testing is an important stage of Mathematics development life cycle as it provides the measure of Mathematics reliability and assists to judge the performance, safety, fault-tolerance or security of the Mathematics. A Mathematics development life cycle consists of four phases: Specifications, Development, Testing and Implementation. Nearly half of the resources of SDLC are used up in the testing phase. Before newly developed Mathematics is released to the user, it is extensively tested for errors that may have been introduced during development. During the testing phase one of the major concerns for the management is to determine when to stop testing and release the Mathematics to the user. Although detected errors are removed immediately, new errors may be introduced during debugging. Mathematics that contains errors and is released to the market incurs high failure costs. Debugging and testing, on the other hand, reduces the error content but increases development costs. Thus, there is a need to determine the optimal time to stop Mathematics testing. An optimal release time of the Mathematics is a necessary event as it ranges from market considerations to increase in cost. An undue delay in the release results in term of penalties and revenue loss, while a premature release may cost heavily in terms of fixing to be done in operational phase and may even harm manufacturer's reputation. No Mathematics can be tested indefinitely in order to make it bug free since users of the Mathematics want faster deliveries and constraint on development cost. During system testing, reliability measure is an important criterion in deciding when to release the Mathematics. Several other criteria, such as the number of remaining errors, failure rate, reliability requirements, or total system cost, may be used to determine optimal testing time. As discussed above an important objective of developing SRGM is to predict Mathematics performance using the measure of Mathematics reliability and use thei nformation for decision-making. An important decision problem of practical concern is to determine when to stop testing and release the Mathematics system to the user known as "Release Time Problem". This decision depends on the models used for describing the failure phenomenon and the criterion used for determining system readiness. In a perfect debugging environment when an attempt is made to remove a fault, it is removed with certainty and no new faults are introduced. Mostof the Mathematics reliability models assume the fault removal process (fault debugging) to be perfect. Generally we will formulate release time problems under perfect debugging environment depending on different criteria's. The optimal testing termination time T can vary from minimizing total Mathematics development cost to maximizing reliability .Since the cost function plays an important role in determining the release time of Mathematics we will first discuss the cost model, it determines the optimal release policies so that the total Mathematics development cost incurred during testing and operational phase of SDLC is minimized.

***Keywords*** – Mathematics reliability, models, variants, exponential, warranty.

## *INTRODUCTION-*

The Cost Model

In this study, we use Goel - Okumoto NHPP model as explained as model as a Mathematics reliability function in our cost model.

The reasons why we prefer G - O model are as follows:

1) The Goel - Okumoto reliability model possesses a simple form and is easy to apply.

2) It works well for plenty ofapplications [Wood,1996].

In this section, we present aMathematics cost model and the optimal time to release aMathematics product under different circumstances is discussed.

Let Y be the time to remove an error during testing period.

From assumption (6), the probability density function of Yi is given by:

$$s(y) = \begin{cases} \dfrac{\lambda_y e^{-\lambda_y y}}{\int_0^{T_0} \lambda_y \, e^{-\lambda_y x} dx} & for\ 0 \le y \le T_0 \\ . & . \\ 0 & for\ y > T_0 \end{cases}$$

where

$\lambda_y$ aconstant parameter associated with truncated exponential density function Y.

$T_0$ maximum time to remove any error during testing period.

The expected time to remove each error is given by:

$$\mu_y = E(Y) = \int_0^{T_0} y\, s(y) dy = \int_0^{T_0} y \frac{\lambda_y \, e^{-\lambda_y y}}{\int_0^{T_0} \lambda_y \, e^{-\lambda_y x} dx} dy$$

After simplification, we obtain:

$$\mu_y = \frac{1 - \left[\lambda_y T_0 + 1\right] e^{-\lambda_y T_0}}{\lambda_y \left[1 - e^{-\lambda_y T_0}\right]}$$

Similarly, we assume that the time to remove an error during warranty period also follows a truncated exponential distribution with probability density function:

$$q(w) = \begin{cases} \dfrac{\lambda_w e^{-\lambda_{\cdot w} w}}{\int_0^{T_0} \lambda_w \, e^{-\lambda} x_{dx}} & for\ 0 \le w \le T_0 \\ . & . \\ 0 & for\ w > T_0 \end{cases}$$

where

$\lambda_w$: a constant parameter associated with truncated exponential density function W.

$T_0^{'}$ : maximum time to remove any error during warranty period.

The expected time to remove an error during warranty period, $11_w$, is, therefore:

$$\mu_w = \frac{1 - \left[\lambda_w T_0^{'} + 1\right] e^{-\lambda_w T_0'}}{\lambda_w \left[1 - e^{-\lambda_w T_0'}\right]}$$

The expected Mathematics system cost consists of the following parts:

1) a set - up cost means the cost of set up the Mathematics development process, and we assume it is a constant $C_0$;

2) cost to do testing $\left(E_1(T)\right)$ ,

3) error removal cost during testing period $\left(E_2(T)\right)$ ,

4) error removal cost during warranty period $\left(E_3(T)\right)$ , and

5) risk cost due to Mathematics failure $\left(E_4(T)\right)$ .

These cost components can be determined as follows:

1) Cost to do testing $E_1(T)$ is apower function oftime T:

$$E_1(T) = C_1 T^{\alpha}$$

Here, we use the power function to model the testing cost, which captures the feature that the increasing gradient is different in the beginning and at the end. This reflects the learning process of the testing process.

2) The expected total time to remove all number of N(T) errors is given by:

$E\left[\sum_{i=1}^{N(T)} Y_i\right] = E[N(T)].E[Y_i] = m(T)1J_y$ , where N(T)i is the number of failures experienced up to time T. Hence, the expected cost to remove all errors detected by time T, $E_2(T)$ , can be expressed as:

$$E_2(T) = C_2.E\left[\sum_{i=1}^{N(T)} Y_i\right] = C_2 m(T)\mu_y.$$

3) The expected total time to remove all errors detected during warranty period $[T, T + T_w]$ is given by:

$$E\left[\sum_{i=N(T)}^{N(T_W)} W_i\right] = E[N(T)].E[W_i] = [RejectT + T_w) - RejectT)].\mu_w.$$

Hence, the expected cost to remove all errors detected by time T, $E_3(T)$ is:

$$E_3(= C_3.E\left[\sum_{j=1}^{N(T)} W_i\right] = C_3\mu_w[lq\tau + T_w) - n4\,]$$

4) The risk cost due to Mathematics failure after releasing the Mathematics, $E_4(T)$ , is given by:

$E_4(T) = C_4\big(1 - R(xT)\big)$ .

Therefore, the expected total Mathematics cost $E(T)$ can be expressed as following:

$E(T) = C_0 + C_1T^{\alpha} + C_2 RejectT)\mu_y + C_3\mu_w[nXT + T_w) - n\langle T)] + C_4[1 - R(T)]$, (2.29)

where $m(T)$, $R(xT)$ , $t^{J_y}$, and $\mu_w$ are given in (2.1), (2.4), (2.25), and (2.28), respectively, and $0 \le \alpha \le 1$. Many existing models [Hou, Kuo and Chang,1997], [Leung,1992], [Okumoto and Goel,1980] have been studied;however, to best ofour knowledge, our model proposed here is the first one which considers both the risk factor and warranty issue in the Mathematics cost model.

Optimal Mathematics Release Policies

In this section, we study the behavior of the expected cost model, $E(T)$ and determine the optimal Mathematics release time, $T^*$, which minimizes the expected total system cost. Taking the first derivative of E(T) , as given in (2.29), we obtain

## *Conclusion*

In general we investigates optimal Mathematics release policies which minimize the total expected Mathematics costs while the Mathematics reliability requirements are satisfied, for several SRGMs based on NHPP. We discuss release policies based on different criteria for an exponential SRGM and an S-shaped SRGM. Further if the manufacture fails to release the Mathematics at the scheduled delivery time, he has to pay a price termed as penalty cost. We discuss release policies for an exponential SRGM with inclusion of concept of penalty cost. Furthermore, warranty and risk cost issues, which have not been investigated in literature, are included in the cost model. We provide the optimal release policies in which the total Mathematics system cost is minimized. The benefits of using our cost model are that they provide

1) assurance that the Mathematics has achieved safety goals, and
2) a means of rationalizing when to stop testing the Mathematics.
In addition, with this type of information, a Mathematics manager can determine whether more testing is warranted or whether the Mathematics is sufficiently tested to allow its release or unrestricted use. Such predictions provide a quantitative basis for achieving reliability, risk and cost goals. Also we discuss an SRGM based on NHPP under the assumption that the number of errors detected may cause the detection of some of the remaining errors without these errors causing failure. It may be further noted that whereas the error-detection phenomenon is S-shaped, the resulting failure phenomenon is exponential. We feel that our model depicts the real-life situation more realistically.

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