Risk as zero'th order change in software project estimation

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Introduction

The aim of this presentation is to discuss a framework for risk estimation that is theoretically sound but at the same time sufficiently pragmatic for industrial use.

That is, it fits into the philosophy of COCOMO.

Definition of Project Risk

In system development, Risk is the potential impact of any uncontrolled departure from the agreed project parameters of functional & non-functional specifications, time and cost.

Such departures will be due to undesirable events (individual risks) which may combine and interact in complex ways.

Integration of teaching Risk and Project estimation

- Since 1989 and the publication of the first comprehensive coverage of software project risk concepts [1], there have been significant efforts to integrate them into Information Technology courses [2, 3].
- Despite this, the problems for software managers, in applying risk management ideas to their project scheduling, remain considerable

Catalogue of Significant problems with project risk - summary

1 Gap between theory and practical use

2 Understanding the independence of risk factors

3 Serial risks - temporal relationships

4 Probability and impact of event as functions of a third variable

5 The dynamic nature of risk

6 Our inability to validate a risk plan

The gap between theory and practical use

The theory states that

Risk Exposure = Probability x Impact

In practice, management assesses risk of missing project criteria, such as schedule, as {zero, low, medium, high}

or determines a number through the use of weighted check lists.

Understanding the dependencies of risk factors

Events A and B are independent when

Pr(A & B) = Pr(A) x Pr(B)

- In practice there is a lack of testing for the independence of risk factors. This will result in significant inaccuracies when risks are aggregated.
- For example, management is responsible for 85% of source problems – therefore poor management increases many risks.

Special case 1 – serial risks

- The assessment of serial risks - where one bad event increases the likelihood or triggers the next bad event - is extremely difficult to evaluate.
- One problem leads to a chain of incidents and the difficulties accumulate.
- The best example is the loss of a key staff-member, which then triggers more departures.

Special case 2 – probability & impact as functions of a 3rd variable

- There are risks where both the probability and impact depend upon a poorly defined or understood, underlying variable.
- Calculation of risk by multiplying average probability by average impact can be inaccurate.

$$\text{Risk} = \int \text{Prob}(x)\ \text{Impact}(x)\ dx$$

Risk of asteroid of size x hitting the Earth [4]

Asteroid diameter (metres)	Years between impacts	Area of land impacted
< 40	frequent	nil
75	1,000	Los Angeles
160	4,000	New York
350	16,000	Delaware
700	63,000	Virginia
1700	250,000	California
3000	1,000,000	Mexico
7000	10,000,000	USA
16000	100,000,000	North America

The dynamic nature of risk

- The dynamic nature of risk exposure over the length of a project causes difficulties.
- Its changes require multiple strategies and continuous revision of the risk plan.
- Both probability and impact should decrease over the duration of a project.

$$\text{Risk} = \int\int \text{Prob}(x,t)\ \text{Impact}(x,t)\ dx\ dt$$

Inability to validate a risk plan

If your project was a success, was it because of your superb risk management skills or were you just lucky?

If it was a failure, was that despite a superb set of contingency plans?

The link between estimation error and risk

- Given these difficulties, there is a need for a practical framework by which managers may integrate risk into project estimation and planning.
- Both risk and estimation error are large at project initiation and decline to zero at delivery.
- Both represent project uncertainty over effort, cost and schedule.

The link between estimation error and risk - continued

Clearly project risk and estimation error are correlated.

Questions: Can we determine:

- a theoretical function?
- a practical mapping from risk to contingency margins from project data?

Any solution framework must be based on the management of change.

Framework for a solution

- Although it is possible to offer partial solutions to the problems and assumptions discussed above, the average software project manager still has to somehow allow for these issues when preparing project schedules and budgets.
- One practical solution is to give him or her a wider viewpoint (a framework for thinking) on the issues.

Framework for a solution

This may be based on an empirical analysis of the distribution of actual completion times for a given estimate of system size at the start and at other well defined points in the project.

Repositories of project data from COCOMO and ASMA should be of assistance.

First order change

A Personal Project Estimation Tool (PPET) is used to produce a plan containing milestone dates.

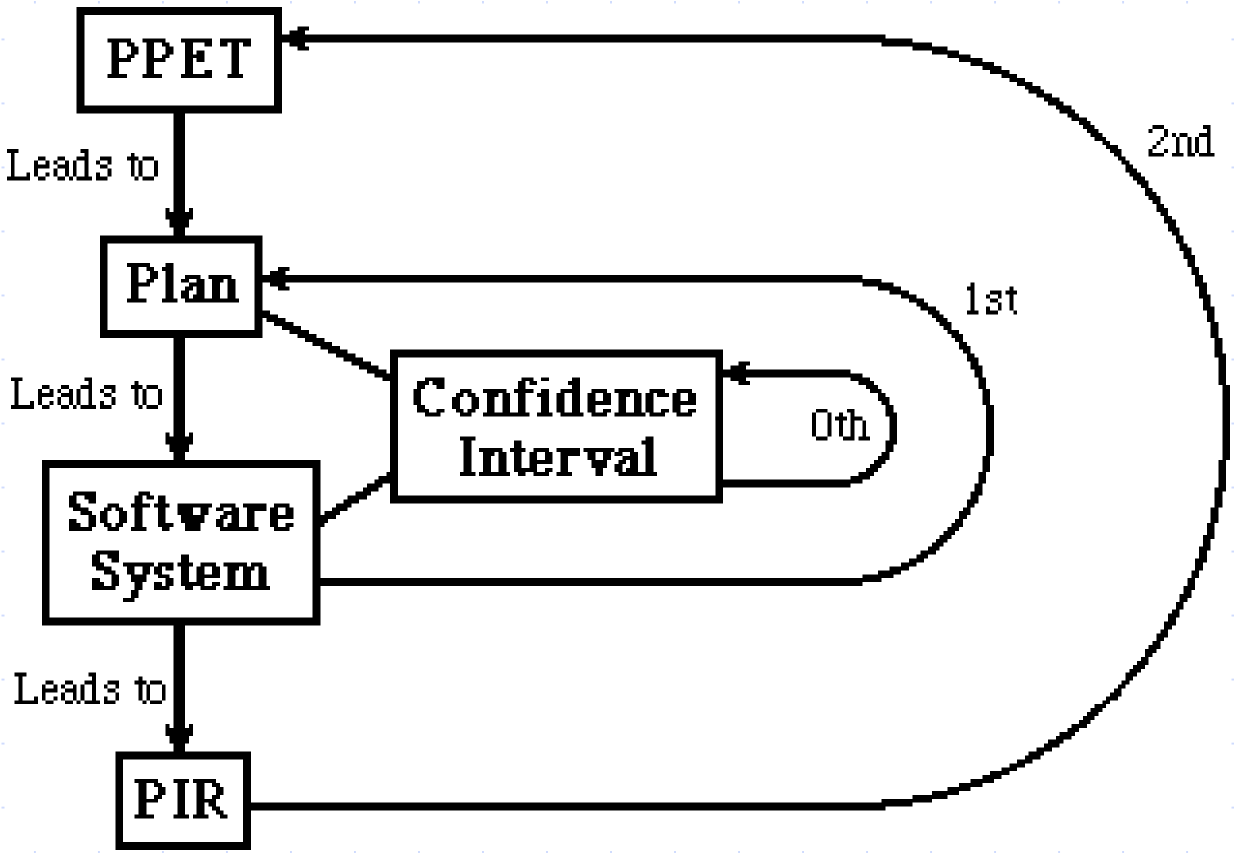
No assumptions are made regarding development paradigms or methodologies, other than the ability to define intermediate checkpoints.

As the production of the system progresses and milestones are reached, the newly available information permits the revision of the plan and adjustment to milestone dates.

This is known as *first order change*.

Three Orders of Change

within project estimation



Second order change

- Upon completion of the project, it is usual to carry out [5] a Post Implementation Review (PIR).
- In comparing the various estimates (effort, budget, duration) in the plan with the actual performance, it is possible to identify those elements of ***the estimation process***, most in need of improvement. This is known as a ***meta-*** or ***2nd order change*** as it does not modify the plan but rather the instrument which produces the plan.

Second order change

The changes to the Personal Project Estimation Tool (PPET) may include:

- inclusion or exclusion of particular estimation techniques;
- inclusion or exclusion of particular factors within a model;
- revision of the weights used to combine the estimates from various models;
- re-calibration of the parameters.

Zero'th order change

There is a difference between the plan which states the project will be completed in 24 months, plus or minus 5 days, and the one which gives an end date of 24 months, plus or minus 20 months. Although both predict two years duration, the second is quite uncertain.

Thus, within this framework of changes, the confidence interval represents the propensity (or vulnerability) for variation of the estimate. At a lower level than the other two, it may be thought of as *zero'th order change*. It tells the reader that there is a risk or likelihood of modification to the plan.

Linking risk and Delphi planning (1)

- COCOMO uses a similar idea to zero'th order change to provide project stakeholders with a framework for rescoping the system if cost and time estimates are unacceptable.
- In planning practices, the desired result is an unbiased estimate of the effort or cost. It is the role of the confidence interval to display the variance associated with that estimate.
- Delphi iterations provide the standard practice for the reduction of the estimate variance.

Linking risk and Delphi planning (2)

- Delphi iterations would be expected to move the estimate towards consensus and, most importantly, reduce the confidence interval. The zero'th order of change reflects the number and size of risks.
- As risk amelioration strategies are put into place, the uncertainty in the project parameters is decreased – that is, the likelihood of having to make significant adjustments to the schedule during the project is reduced.

Linking risk and Delphi planning (3)

- The gaining of information during the Delphi process and as the project progresses results in lower risks and less uncertainty.
- Clearly the expression of the uncertainty is a useful software metric.
- The rate of decrease of the confidence interval (error of the estimate) is a meta-metric, a measure of the efficiency of the Delphi process.

Having 95% confidence in your estimate

The recognition of likelihood of change to a schedule is a promising approach to assisting managers to assess risks. They understand the concept of being 95% certain of delivering before a date given as the estimate plus two standard deviations.

This approach depicts a high risk project in a numerical form. When presented as a large confidence interval on the estimate, risk is in a form that is understandable to the client.

The Metrel Rule [7]

The Metrel rule is used to link software metrics through levels of influence.

"For any valid product metric, its derivative with respect to time is a valid process metric."

Use of the Metrel Rule

- The inter-relationship and changes of process metrics (2nd order) and product metrics (1st order) and their linkage to risk is an example of the Metrel rule.
- A change in risk implies the need for a new estimate.
- A change in an estimate implies the need to improve the estimation process.

In Conclusion

- There is a significant gap between risk theory and its application in software projects.
- There are a number of over-simplifications with current project risk assessment methods.
- There are advantages to providing managers and students with a pragmatic linkage of risk to an estimation confidence interval.
- There are advantages to providing managers with a framework for evaluating change at a number of levels - emphasising risk evaluation as a dynamic process.

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