Quantitative Software Management

Using Metrics to Develop a Software Project Strategy

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Outline

- Overview
- Measurement, Expense or Investment
- State of the Industry: Project Estimation
- Staffing and Schedule
- Understanding Trade-offs
- Conclusion
- Questions?
Overview

Does this sound familiar?
Measurement: Expense or Investment

Software measurement (and process improvement) are viewed as expenses: Overhead

- Lean, agile organizations want to reduce overhead
- But, how do organizations become “lean & agile”?

Part of cost of doing business

- 3 – 5% on average
- Project management averages 14%
Measurement: Expense or Investment

What does software measurement provide?

1. Knowledge of an organization’s capabilities
2. Identifies patterns and trends (Strengths to leverage and weaknesses to correct)
3. Insight into projects in time to make effective mid-stream corrections
4. Ability to benchmark against competition or “the industry” in quality, productivity, and time to market
5. Quantitative basis for evaluating project and organizational performance

Improves ability to meet commitments, avoid pitfalls, and evaluate trade-offs
State of the Industry: Project Estimation

- Software estimates are **not** project plans

- Estimates contain uncertainty about two key components:
  - Scope of the requirements (project size)
  - Team productivity
The Cone of Uncertainty

• Not enough information is available early in the development lifecycle to make accurate estimates

• Precision is not accuracy
Actual vs. Estimated Effort

Effort Growth

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<th>Percent</th>
<th>Smaller</th>
<th>At Size</th>
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Actual vs. Estimated Effort
Actual vs. Estimated Schedule

Schedule Growth

- Smaller
- At Size
- Larger

Percent

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Actual vs. Estimated Size

Size Growth

Percent

0 10 20 30 40 50 60 70 80 90 100

Smaller  At Size  Larger

Actual vs. Estimated Size

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In Summary

- Average schedule growth is 8%
- Average cost/effort growth is 16%
- Average size growth is 15%

So how can we use this information to create more accurate estimates?
Modeling Increased Size

- Create best project estimate based on proposed size
  - Use historically based productivity
  - Account for project constraints (staff, effort, schedule)

- Create estimate based on 15% size growth
  - Does this account for projected schedule & effort growth?
500 FP Project

Staffing & Probability Analysis

Avg Staff Life Cycle (people)

<500 FP project>

Miles to nes
0 - CSR
1 - SRR
2 - HDR
3 - LLDR
4 - CUT
5 - IC
6 - STC
7 - SAT
8 - FCR
9 - 99R
10 - 99.9R

Solution Panel - <500 FP project>

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9.4 months duration
37 person months effort
50% probability
500 FP Project

Evaluate Probability of Current Estimate

Likely outcomes 10.2 months schedule, 43 effort months

Life Duration (Months) Risk Profile
Life Effort (PM) Risk Profile

Assurance Level (%)  Life Duration (Months)
1  7.26
5  7.90
10  8.25
15  8.48
20  8.66
25  8.82
30  8.96
35  9.09
40  9.21
45  9.33
50  9.45
55  9.57
60  9.69
65  9.81
70  9.94
75  10.08
80  10.24
85  10.44

Assurance Level (%)  Life Effort (PM)
1  0.00
5  5.11
10  12.20
15  16.99
20  20.79
25  24.05
30  26.98
35  29.69
40  32.27
45  34.75
50  37.20
55  39.65
60  42.13
65  44.61
70  47.42
75  50.35
80  53.61
85  57.41

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15% Growth (575 FP)

10.2 months duration
46 person months effort
15% Growth (575 FP)

Averages close to numbers predicted for effort and schedule growth (10.2 duration and 43 staff months of effort)
Schedule varies by a factor of 3.5 from -1σ to +1σ.

Effort varies by a factor of 8 from -1σ to +1σ.

What is “normal” variability?
How Should Project Effort Be Expended
A Case Study

- 838 projects that had data reported for Analysis/Design as well as Construction and Test phases
- Average Effort applied to Analysis/Design = 20%
- 474 projects in the sample used <= 20% design effort
  - Average Analysis/Design Effort = 11%
- 364 projects in the sample used > 20% design effort
  - Average Analysis/Design Effort = 33%
- Size profiles of samples very similar
Observations

Projects with <20% effort in Requirements and Design

- Took 12% longer to complete
- Averaged 5.6% more effort (median 24.4% greater)
- Had an average staff 14.6% higher

But these projects did excel at one thing:

- Found 63.7% more defects in systems test
- Had 127% more defects in the first 12 months after delivery
Understanding Trade-offs

Size = Effort$^a$ \times Time$^b$ \times Productivity

where $a = \frac{1}{3}$ and $b = \frac{4}{3}$

Additional schedule has a much larger impact on a software project than increased effort
Estimating Conundrum
Schedule / Effort Tradeoff

Uncertainty about Size and Productivity creates uncertainty about the Duration-Effort curve.
The Estimating Conundrum

Sometimes no Solution Works

Duration

Effort

Impossible Zone

Feasible Solutions

Impractical Zone
The Estimating Conundrum

Relax the Schedule

Effort

Duration

Impossible Zone

Feasible Solutions

Impractical Zone
The Estimating Conundrum

Increase Effort

Impossible Zone

Effort

Feasible Solutions

Impractical Zone

Duration
The Estimating Conundrum

Reduce Size (Functionality)

Effort

Duration

Impossible Zone

Feasible Solutions

Impractical Zone

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The Estimating Conundrum
Assume Higher Productivity

Duration

Effort

Impossible Zone

Feasible Solutions

Impractical Zone

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Conclusions

- Measurement is an integral part of management
- Information required to make precise estimates is unavailable at project start-up
  - Estimate uncertainty decreases rapidly with more information
- Project estimates understate effort, schedule, & size
  - Estimating based on a larger size or at a higher assurance level can account for this
- The trade-off between schedule & cost/effort is non-linear
Conclusions

Effort spent in Analysis & Design pays big dividends

- Reduces overall project effort (cost$$$$)
- Reduces overall project schedule
- Improves project quality
Questions
?

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