CORADMO: A Model to Estimate Schedule Acceleration in Agile Projects

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Introduction

❖ Speedy development is increasingly important [1]
  ❖ Reduced time-to-market
  ❖ Response to competitive or adversarial threats

❖ Research develops CORADMO
  ❖ Constructive Rapid Application Development Model
  ❖ Updated concept of “rapid” [3], factors not phase-specific
  ❖ Uses rapid-response concepts discovered in [10]

❖ Agile adoption/perception has increased dramatically
  ❖ Developers have embraced agile approach [4]
  ❖ Early and continuous delivery of software [5]
Agile development methods have become very popular: In our recent Forrester/Dr. Dobbs Global Developer Technographics® Survey, Q3 2009, 35% of respondents stated that Agile most closely reflects their development process, with the number increasing to 45% if you expand what you include in Agile’s definition (see Figure 1). Both waterfall and iterative approaches are giving ground to much lighter, delivery-focused methods based on the principles the Agile Manifesto describes.

The older methods are not disappearing, however: 34% of the survey respondents stated that they continue to use either an iterative or waterfall development process as their primary method of software delivery.

Figure 1

Agile Adoption Has Reached Mainstream Proportions

Source: Forrester Research, Inc.
Motivation

- Agile chosen when time-certain delivery required [1, 6]
- Schedule planning done at team level [6, 7]
  - Detailed planning by iteration
  - High-level planning by release, at low-resolution
  - Cost/features may vary from plan for given schedule
- Very little literature on agile planning, in terms of achievable effort for given schedule
- Agile schedules reported to be much lower than traditional
  - Traditional schedule proportional to $\sim 3 \times \text{cube-root}(\text{effort})$ [8, 9]
  - Agile schedule appears proportional to square-root(\text{effort})
Research Questions

❖ **RQ1:** Do the durations of larger-scale agile projects remain proportional to the square-root of development effort?

❖ **RQ2:** What factors are predictive of schedule reduction or extension in agile development projects?

❖ **RQ3:** What is the quantitative effect of the application of these factors on project schedule?
Intended Research Contribution

- Clarify the relationship between development effort and schedule duration in agile projects
- Identify key factors affecting agile software project development schedule duration
- Quantify effect of each factor on schedule acceleration/deceleration
- Create a model to allow predictive modeling of schedule acceleration factors
Background
Cost/schedule Tradeoff
Cost/schedule Tradeoff

- COCOMO and other models postulate “optimal” schedule [13]
  - Many models assume convex relationship of schedule and cost

- Deviation from optimal schedule increases costs
  - Given effort in shorter schedule needs more staff or hours
  - More staff or hours decreases productivity [14]
  - Extended schedule may increase “social loafing” [15][16]

- Schedule-sensitive projects may accept increased costs
Agile Claims Improved Schedule

- Agile claims to offer better productivity, possibly lower cost [6][52]

- Specific agile practices shown to increase productivity
  - Agile tends to use more level staffing profile than phased projects
  - Higher degree of collaboration, reduced communication costs
  - Pair programming [1][17], refactoring [18]

- No research on schedule effect of larger-scale influences

- This research identifies product, process, project, people, and risk-tolerance influences on project schedule
Traditional Schedule Estimation

❖ Schedule derived as Duration = C * (Effort)^F [2][19][20]
  ❖ C is a constant in the range 2.0–4.0
  ❖ F is approximately 0.33
  ❖ Relationship is extremely well documented, 1000’s of projects [20]

❖ CORADMO/COPSEMO postulates square-root relation [2]
  ❖ Nobody would use 2 persons for 7.5 months on 16 PM effort
  ❖ More reasonable to expect 4 persons for 4 months
  ❖ Claims square-root relation breaks down between 16-64 PM

❖ Sample ISBSG data supports cube-root relationship [21]
  ❖ Curve fitting using Eureqa GA data analysis package
  ❖ Solves to approximately 4 * (Effort)^0.35
ISBSG Sample Effort vs Duration
Agile Schedule Estimation

- Literature has not reported agile duration vs effort
  - Agile proponents seem not to consider project-level schedule
  - Almost everyone suggests using cube-root relationship
  - Only (Jalote 2002) suggests square-root as “sanity check”

- This research hypothesizes square-root relation for agile

- Supported by 12-project sample data from AgileTek
  - AgileTek was small Midwest company using Architected Agile
  - Data supplied to CSSE around 2004
  - Company president died shortly thereafter, company disbanded
AgileTek Sample Effort vs Duration

AgileTek Data 2004

Effort (in person-months)

Duration (in months)

- Duration
- SQRT
- CUBRT
Reduced Schedule in Agile

- Agile claims schedule reduction as key benefit [6]
- Simple comparison of cube- and square-root curves
  - Shows 50% (low-end, 25 PM) to 10% (high-end, 360 PM)
  - Interestingly, agrees with agile claims and reports of 10-60% [12]
Cube Root vs Square Root Schedule

Square-root vs. Cube-root

Duration (in months)

Effort (in person-months)

SQR(Eff)

CUB(Eff)

50% Reduction

20% Reduction

10% Reduction
Schedule Acceleration

- Common concept of many models is “impossible zone” of schedule acceleration [19]
- Below 75% of nominal schedule effectively unachievable [13][19]
- Limited by ability to execute tasks in parallel, communications overhead [14]
The “Impossible Zone”
CORADMO Schedule Acceleration

- Research stems from RT-34 identification of key schedule acceleration factors in rapid-response contractors, agencies [10][25][26]

- Factors include:
  - Product
  - Process
  - Project [27]
  - People
  - Risk

- Well supported by NPD literature
Product Factors

- Describe the nature of the system to be developed:
  - Simplicity [26],
  - Ability to reuse existing elements [14], [26], [28],
  - Ability to defer lower-priority requirements [6],
  - Degree that models can be substituted for written documentation [6]
  - Maturity of the component technologies [29]
Process Factors

❖ Characterize the development methodology
  ❖ Concurrency of artifact development [6] [26] [31] [32] [33] [34] [35]
  ❖ Degree of process streamlining [2] [36] [37] [38] [39]
  ❖ Coverage, integration, and maturity (CIM) of tools used to support the development process [30].

❖ Concurrent processes observed to accelerate schedule
  ❖ Spiral model [31],
  ❖ Rational Unified Process [32],
  ❖ Agile methods [6]

❖ Process-streamlining
  ❖ Development Process Reengineering and Streamlining factor in the original CORADMO [2],
  ❖ Removal of bureaucratic and procedural delays; presence of enabling vs. coercive bureaucracy [36].
  ❖ Kaizen performer-identified streamlining [37], [38],
  ❖ Lean approaches such as Kanban [39].

❖ COCOMO database analysis found CIM effect 50% for coverage and 25% each for toolset integration and maturity [40]
Project Factors

- Describe execution of the development effort:
  - Project staff size [41]
  - Degree and nature of team collaboration [41][42]
  - CIM of the single-domain models, methods, processes, and tools (MMPTs) employed [30]
  - CIM of the multi-domain MMPTs used, where required [30]
People Factors

- Describe the project staff
  - General knowledge, skills, and **agility** (or, ability to thrive with the more concurrent nature of the agile/lean process) [1], [41], [43]
  - KSAs specific to the primary problem domain
  - KSAs spanning multiple problem domains, where needed;
  - Team compatibility [26], [42], [44].
Risk Acceptance Factor

- Characterizes the project stakeholders' willingness to accept rapid solutions that may require them to compromise on some expectations [1], [25]
- Stakeholders may range from highly risk-averse, to strongly risk-accepting
## CORADMO Model Factors

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<td>1 TRL 4 or &gt; 2 TRL 5</td>
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<td>Over 300</td>
<td>Over 100</td>
<td>Over 30</td>
<td>Over 10</td>
<td>Over 3</td>
<td>≤ 3</td>
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<td>Regionally distributed; moderate sharing</td>
<td>Metro-area distributed; good sharing</td>
<td>Simple campus; strong sharing</td>
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<td>Moderate CIM</td>
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<tr>
<td>Multi-domain MMPTs</td>
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<td>Minimal CIM</td>
<td>Some CIM or not needed</td>
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Not Traditional “Agile” Factors

- CORADMO factors not principles of Agile Manifesto [51]
- Not practices of agile SDMs [6][7][52]
- Factors derived from behavioral analysis of projects exhibiting schedule acceleration [10], and from theory
ISD Agility Criteria

• Analysis of agility from “first-principles” identifies set of high-level principles distinct from specific agile SDMs [53]

• Method must contribute to at least one of the following:
  • Creation of change
  • Proaction in advance of change
  • Reaction to change
  • Learning from change

• Method component must contribute to at least one, and not detract from any:
  • Perceived economy
  • Perceived quality
  • Perceived simplicity

• Method must be continually ready—minimal time/cost to prepare for use
# ISD Agility

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<tr>
<th>Model Factor</th>
<th>Creation</th>
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Methodology
Initial Evaluation Process

- Decomposed five factors into sub-factors, using a six-value Likert rating scale from *very low* to *extra high*

\[ D = \prod F_i \sqrt{PM} \]

- Based on earlier research into
  - Project macro-risk factors [55]
  - Performance- and personnel competency-risk factors [44]
  - Agile factors as summarized by [56]

- Performed Wide-band Delphi to assign initial multiplier values [13][57]
## Commercial Project Factor Analysis

<table>
<thead>
<tr>
<th>Application Type</th>
<th>Technology</th>
<th>Person Months</th>
<th>Duration (Months)</th>
<th>Duration / √PM</th>
<th>Product</th>
<th>Process</th>
<th>Project</th>
<th>People</th>
<th>Risk</th>
<th>Multiplier</th>
<th>Error %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insurance agency system</td>
<td>HTML/VB</td>
<td>34.94</td>
<td>3.82</td>
<td>0.65</td>
<td>VH</td>
<td>VH</td>
<td>XH</td>
<td>VH</td>
<td>N</td>
<td>0.68</td>
<td>5%</td>
</tr>
<tr>
<td>Scientific/engineering</td>
<td>C++</td>
<td>18.66</td>
<td>3.72</td>
<td>0.86</td>
<td>L</td>
<td>VH</td>
<td>VH</td>
<td>VH</td>
<td>N</td>
<td>0.80</td>
<td>−7%</td>
</tr>
<tr>
<td>Compliance - expert</td>
<td>HTML/VB</td>
<td>17.89</td>
<td>3.36</td>
<td>0.79</td>
<td>VH</td>
<td>VH</td>
<td>XH</td>
<td>VH</td>
<td>N</td>
<td>0.68</td>
<td>−15%</td>
</tr>
<tr>
<td>Barter exchange</td>
<td>SQL/VB/HTML</td>
<td>112.58</td>
<td>9.54</td>
<td>0.90</td>
<td>VH</td>
<td>H</td>
<td>H</td>
<td>VH</td>
<td>N</td>
<td>0.75</td>
<td>−16%</td>
</tr>
<tr>
<td>Options exchange site</td>
<td>HTML/SQL</td>
<td>13.94</td>
<td>2.67</td>
<td>0.72</td>
<td>VH</td>
<td>VH</td>
<td>XH</td>
<td>VH</td>
<td>N</td>
<td>0.68</td>
<td>−5%</td>
</tr>
<tr>
<td>Commercial HMI</td>
<td>C++</td>
<td>205.27</td>
<td>13.81</td>
<td>0.96</td>
<td>L</td>
<td>N</td>
<td>N</td>
<td>VH</td>
<td>N</td>
<td>0.93</td>
<td>−3%</td>
</tr>
<tr>
<td>Options exchange site</td>
<td>HTML</td>
<td>42.41</td>
<td>4.48</td>
<td>0.69</td>
<td>VH</td>
<td>VH</td>
<td>XH</td>
<td>VH</td>
<td>N</td>
<td>0.68</td>
<td>−1%</td>
</tr>
<tr>
<td>Time and billing</td>
<td>C++/VB</td>
<td>26.87</td>
<td>4.80</td>
<td>0.93</td>
<td>L</td>
<td>VH</td>
<td>VH</td>
<td>VH</td>
<td>N</td>
<td>0.80</td>
<td>−14%</td>
</tr>
<tr>
<td>Hybrid Web/client-server</td>
<td>VB/HTML</td>
<td>70.93</td>
<td>8.62</td>
<td>1.02</td>
<td>L</td>
<td>N</td>
<td>VH</td>
<td>VH</td>
<td>N</td>
<td>0.87</td>
<td>−15%</td>
</tr>
<tr>
<td>ASP</td>
<td>HTML/VB/SQL</td>
<td>9.79</td>
<td>1.39</td>
<td>0.44</td>
<td>VH</td>
<td>VH</td>
<td>XH</td>
<td>VH</td>
<td>N</td>
<td>0.68</td>
<td>53%</td>
</tr>
<tr>
<td>On-line billing/tracking</td>
<td>VB/HTML</td>
<td>17.20</td>
<td>2.70</td>
<td>0.65</td>
<td>VH</td>
<td>VH</td>
<td>XH</td>
<td>VH</td>
<td>N</td>
<td>0.68</td>
<td>4%</td>
</tr>
<tr>
<td>Palm email client</td>
<td>C/HTML</td>
<td>4.53</td>
<td>1.45</td>
<td>0.68</td>
<td>N</td>
<td>VH</td>
<td>VH</td>
<td>VH</td>
<td>N</td>
<td>0.76</td>
<td>12%</td>
</tr>
</tbody>
</table>
Survey Instrument

- Online survey instruments of about 22 questions
- Gone through 10+ refinement iterations
- Divided into six sections
  - Introductory and general project data
  - Product factors
  - Process factors
  - Project factors
  - People factors
  - Risk acceptance factor
- Piloted by several individuals, ready to roll out
Survey Data Sources

Here’s where you can help...
Questions
Bibliography


Bibliography


<table>
<thead>
<tr>
<th>No.</th>
<th>Reference</th>
</tr>
</thead>
</table>

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Bibliography


