An Estimation Improvement Program in a Software Organization

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Summary

- Introduction
- Important concepts
- Methodology
- Diagnostics
- Proposed actions and results
- Conclusion
Introduction

- Good estimates are essential for software development organizations:
  - Competitiveness.
  - Allow better project planning and monitoring.
  - Avoid excessive schedule pressure, proved to be destructive for projects [Nan & Harter, 2009].
Industry survey in 2008 [Yang et al., 2008]:

- 59% to 76% of software projects show effort overrun - estimation errors between 18% and 41%.

- 35% to 80% of software projects show schedule overrun - errors between 22% and 25%.
Although estimation in software has been widely studied for decades, so far it is not well solved.

Main difficulties [McConnell, 2006], [Laird, 2006]:

- Hope-based planning.
- Confusion between goal and estimation.
- Incomplete requirements.
- Organizations don’t know their own capacity.
- Unstable requirements (shooting at a moving target).
Introduction - Objectives

- Performing a software estimation process improvement program (SPI) at Synergia:
  - Managers from Organization have claimed that projects have poor estimation accuracy.
Important concepts

- At Synergia, estimation is performed in three distinct moments:
  - During project activation, to present a proposal for our customers.
  - Macro planning (iterations), when the project starts.
  - Detailed iteration planning, before each iteration begins.
**Important concepts**

- **Accuracy indicators**

\[
MRE_i = \frac{|y_i - \hat{y}_i|}{y_i}
\]

\[
MMRE = \sum_{i=1}^{n} MRE_i
\]

\[
MER_i = \frac{|y_i - \hat{y}_i|}{\hat{y}_i}
\]

\[
MMER = \sum_{i=1}^{n} MER_i
\]

\[
BRE_i = \begin{cases} 
\frac{(\hat{y}_i - y_i)}{y_i} & se(\hat{y}_i - y_i) \geq 0 \\
\frac{(\hat{y}_i - y_i)}{\hat{y}_i} & se(\hat{y}_i - y_i) < 0
\end{cases}
\]

\[
MBRE = \frac{1}{n} \sum_{i=1}^{n} BRE_i
\]

\[
IBRE_i = \begin{cases} 
\frac{(\hat{y}_i - y_i)}{y_i} & se(\hat{y}_i - y_i) < 0 \\
\frac{(\hat{y}_i - y_i)}{\hat{y}_i} & se(\hat{y}_i - y_i) \geq 0
\end{cases}
\]

\[
MIBRE = \frac{1}{n} \sum_{i=1}^{n} IBRE_i
\]

\[
PRED(x) = \% \text{ of errors bellow } x
\]

\[
\hat{y} = \text{estimated value, } y = \text{actual value}
\]
ProMOTe

- Proprietary Improvement Process for Technical Organizations
- Based on SEI’s IDEAL model.
Initiating Phase

- Scope definition
- SPI program team definition
- Kick-off meeting
Diagnostics

Proposed actions after diagnostics:
1. Define a process for proposal estimation
2. Improve the macro planning process
3. Define a method to count Function points directly on UML Models
4. Define a process for detailed iteration planning
5. Create a central repository for project data
Action 1 –
Estimation for proposals

- Adoption of COCOMO II [Boehm et al., 2000]:
  - Development of a Lines of Code (LOC) tool that conforms to SEI recommendations [Park et al., 1992].
  - Development of a parameters interpretation manual.
  - Including risk assessment in COCOMO modelling.
Action 1 –
Estimation for proposals

- Results (accuracy):
  - Effort (without model calibration)
    
    | MMRE   | MMER  | MBRE   | MIBRE  | PRED(0,25) |
    |--------|-------|--------|--------|-----------|
    | 319,50%| 71,97%| 319,50%| 71,97%  | 0,00%     |

  - Effort (with model calibration)
    
    | MMRE   | MMER  | MBRE   | MIBRE  | PRED(0,25) |
    |--------|-------|--------|--------|-----------|
    | 15,63% | 14,44%| -0,31% | -1,51% | 87,50%    |

  - Schedule (with calibration)
    
    | MMRE   | MMER  | MBRE   | MIBRE  | PRED(0,25) |
    |--------|-------|--------|--------|-----------|
    | 43,34% | 44,68%| 0,17%  | 1,51%  | 37,50%    |

- Simulations used *leave-one-out* method.
Action 2 – Estimation for macro planning (iterations)

- It makes no sense to elaborate a complete project WBS for all iterations:
  - Volatile requirements
  - Staff turnover
  - Large variation of effort and schedule in fine grained activities

- Solution: estimate only total effort, schedule and staff required for each iteration, based on its scope
Action 2 – Estimation for macro planning (iterations)

- Given required effort for each iteration and effort distribution from historical data, estimate:
  - Staff needed to achieve required schedule, or;
  - Likely schedule for available staff.
Action 3 – Count FP directly on UML Models

- Keep IFPUG counting practices as method.
- Development of a plug-in to modeling tool (Rational Software Modeler) to support counting using UML model:
  - Use of stereotypes to record FP counting data
  - User friendly interface to document FP count decisions (with error prevention)
  - Automatic model and counting validation using OCL constraints applied to stereotypes
  - Automatic reports extracted from models to present FP size evolution to managers and board of directors
There are some previous works that tried to automate FP count from UML Models [Caldiera et al., 1998] [Cantone et al., 2004] [Harput et al., 2005] [Uemura et al., 1999], but:

- Don’t guarantee accurate counts.
- Require a detailed and very formal UML modeling, which is not possible in earlier project stages.
Action 3 – Count FP directly on UML Models
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Action 3 – Count FP directly on UML Models

- Merchandise
  - sku
  - date created
  - description
  - current stock
  - minimal stock
  - manufacturer
  - model
  - purchase price
  - sales price
  - unit

- Merchandise Item
  - quantity
  - total amount
  - unit price

- Purchase Order
  - number
  - purchase date
  - total amount
  - status

- Purchase Order Item
Action 3 – Count FP directly on UML Models
Action 3 – Count FP directly on UML Models

● Benefits:
  ● Functional size can be tracked during product specification.
  ● Consistency between UML Model and FP count (previously, FP were recorded in spreadsheets).
  ● Defect prevention in counting procedure
  ● Major counting productivity improvement:
    ● 18.1 counted FP/h in past projects
    ● 37.6 counted FP/h in new projects
Action 4 – Detailed iteration planning

- Evaluation of two techniques proposed by McConnell [McConnell, 2006]:
  
  - Divide big tasks into small ones. Take advantage of the “large numbers law”
  
  - Individual tasks are estimated by its performer
## Action 4 – Detailed iteration planning

<table>
<thead>
<tr>
<th>Task</th>
<th>Estimated</th>
<th>Actual</th>
<th>MRE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study the proposed solution design</td>
<td>16</td>
<td>4,92</td>
<td>225,2%</td>
</tr>
<tr>
<td>Code entity layer and business rules</td>
<td>30</td>
<td>7,98</td>
<td>275,9%</td>
</tr>
<tr>
<td>Code controllers</td>
<td>20</td>
<td>23</td>
<td>13,0%</td>
</tr>
<tr>
<td>Code data objects for test</td>
<td>30</td>
<td>20,29</td>
<td>47,9%</td>
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<tr>
<td>Code boundaries (screens and reports)</td>
<td>28</td>
<td>83,98</td>
<td>66,7%</td>
</tr>
<tr>
<td>Integrate use case to product</td>
<td>8</td>
<td>8,69</td>
<td>7,9%</td>
</tr>
<tr>
<td>Perform manual tests from specification</td>
<td>8</td>
<td>12,11</td>
<td>33,9%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>140</strong></td>
<td><strong>160,97</strong></td>
<td><strong>13,0%</strong></td>
</tr>
</tbody>
</table>

**MMRE** 95,8%
Action 4 – Detailed iteration planning

MMRE = 21,8%.

PRED(0,25) = 69,6% .

Previous: 52,8%.
Previous: 36,8%
Challenges:

- Integrate several tools and databases into a central repository:
  - Redundant data without standardization
- There is no tool in the market which adapts to organization’s tools and databases without large integration effort [Auer et al., 2003].
- Flexible database models for software project data [Olsina et al., 2002] [Harrison, 2004] that support any process are very hard to understand and to extract data.
Action 5 – Central project data repository

- Solution: Development of a Data Warehouse (DW).


- Information need was detailed with Synergia staff using PSM [McGarry *et al.*, 2001].
  - Several measures and indicators are already collected at Synergia.
Action 5 – Central project data repository

<table>
<thead>
<tr>
<th>Disciplina</th>
<th>Geral</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
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<tr>
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<td>0,000%</td>
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<td>75,893%</td>
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</table>
Conclusions

- Performing an SPI program using a defined process (ProMOTe) eases the hard work of changing organizational process and culture

- During SPI, several issues related to estimation are handled
Conclusions

- Some results achieved in SPI are already tested and incorporated into Synergia’s processes:
  - COCOMO
  - FP count over UML models
  - Detailed iteration planning using performer estimative
  - Data warehouse (has been continuously improved)
Questions

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References

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