TIME FORECASTING USING EARNED SCHEDULE

THE EUROPEAN EXPERIENCE (WITH THE HELP OF THE US)

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Director, EVM Europe
Agenda

- The Start
  - The beginnings

- Study 1
  - Duration forecasting methods

- Study 2
  - Measuring Time: A Simulation Study

- Study 3
  - P-Factor

- Study 4
  - Project time control

- C.R.A.
  - Concerted Research Actions Program
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- Concerted Research Actions Program
The Start

2001
Scheduling Workshop in Antwerp

An Academic meets a Practitioner
The Topic: Project Time Control

SCHEDULE

• Problems in real life:
  • Schedule tracking is difficult
  • Often the busy PM = scheduler
  • Delays announced too late

• Question: are there other time control methods?
  • Schedule Risk Analysis (for time critical projects)
  • Earned Value Management
2003: Methods using SV / SPI

• The Measurable News, March 2003, “Forecasting Project Schedule Completion With Earned Value Metrics”, D.S. Jacob
  
  • Earned Duration
  • ED = AD x SPI

  
  • Planned Value Method
  • TV = SV / PVRate
2003: Earned Schedule

• The Measurable News, March 2003, “Schedule is Different”, Walt Lipke
  • Description of quirky behaviour SPI
  • Introducing Earned Schedule Concept

  • Initial validation of ES

  • Prediction capability introduced
SV vs. SV(t)
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Study 1: Time Forecasting - Overview

Getting the 1st ES reference in a peer reviewed international journal
• Description of SPI / SV vs. SPI(t) / SV(t)
• Description of duration forecasting methods
• Application of methods on 3 sets of real life project data
IJPMP Paper

• Conclusion:

“Earned Schedule was the only method which showed satisfying and reliable results during the whole project duration”

• Recommendation:

“In order to generalise the results found in this study, we will test the three concepts on projects based on a full factorial simulation experiment, rather than relying on a (small) set of real life projects.”
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Study 2: Measuring Time

A comparison and evaluation of forecasting metrics based on a simulation approach on a large set of project networks

A simulation and evaluation of earned value metrics to forecast the project duration

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1 Ghent University, Ghent, Belgium, 2 Deloitte Center Ghent Management School, Ghent, Belgium

In this paper, we systematically review and evaluate earned value (EVM)-based methods to forecast the total project duration. EVM systems have been set up to deal with the complex task of controlling and adjusting the baseline project schedule during execution, taking into account project scope, project deliverables, and budget. Although EVM systems have been proven to provide reliable estimates for the follow up of cost performance within a project, they often fail to provide total duration of the project. In this paper, we review the literature on the use of EVM for duration estimation and find that the EVM-based estimation of project duration is not widely used. The main reason for this is that EVM-based methods are often seen as too complex and not suitable for project managers. In our experiment, we use a simulation approach to evaluate the performance of different EVM-based duration estimation methods. We find that the most accurate method, which improves the accuracy of EVM metrics and the project duration forecast, is based on the Operational Research Society’s online publication. 15 September 2009: doi:10.1007/s10208-009-9281-9

Keywords: project management, simulation, forecasting
Creating Project Database

• Create a database of networks with a controlled topological structure by the use of a network generator

• So we guarantee we have a very large set of networks that can and might occur in practice

• To control the design of the networks 4 indicators are used:
  
  • Network indicator: Serial or parallel network (SP)
  • Activity indicator: Activity distribution (AD)
  • Precedence relations indicator: Length of arcs (LA)
  • Float indicator: Topological float (TF)

Network Indicators

Project Network

Serial/Parallel (SP)
Activity Distribution (AD)
Length of Arcs (LA)
Topological Float (TF)
Simulation Setting

Generate Network
- 30 activities
- SP, AD, LA, TF
- 3,100 networks

Create Schedule
- 3,100 schedules

Execute Project
- 9 scenarios
- 27,900 possible executions

Monitoring
- 100 simulations / execution
- 2,790,000 datasets
PMI BE June 2007

PMI BE Research Collaboration Fund 5,000 €

Awarded to
Prof. Dr. Mario Vanhoucke

To support further EV/ES research
(for buying additional computer power)
Research Finding 1


The results reveal that the ES method outperforms, on the average, all other forecasting methods.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>PV1</th>
<th>PV2</th>
<th>PV3</th>
<th>ED1</th>
<th>ED2</th>
<th>ED3</th>
<th>ES1</th>
<th>ES2</th>
<th>ES3</th>
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<tbody>
<tr>
<td>Scenario 1</td>
<td>0.106</td>
<td>0.128</td>
<td>0.481</td>
<td>0.112</td>
<td>0.128</td>
<td>0.249</td>
<td>0.076</td>
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<td>0.095</td>
<td>0.101</td>
<td>0.121</td>
<td>0.095</td>
<td>0.087</td>
<td>0.094</td>
<td>0.036</td>
<td>0.054</td>
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<td>0.080</td>
<td>0.254</td>
<td>0.066</td>
<td>0.080</td>
<td>0.175</td>
<td>0.055</td>
<td>0.064</td>
<td>0.164</td>
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<td>Scenario 4</td>
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<td>0.071</td>
<td>0.426</td>
<td>0.023</td>
<td>0.071</td>
<td>0.229</td>
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<td>0.237</td>
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<td>0.000</td>
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<td>Scenario 6</td>
<td>0.024</td>
<td>0.051</td>
<td>0.416</td>
<td>0.021</td>
<td>0.051</td>
<td>0.242</td>
<td>0.019</td>
<td>0.063</td>
<td>0.273</td>
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<td>Scenario 7</td>
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<td>0.077</td>
<td>0.409</td>
<td>0.032</td>
<td>0.077</td>
<td>0.222</td>
<td>0.034</td>
<td>0.093</td>
<td>0.227</td>
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<tr>
<td>Scenario 8</td>
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<td>0.119</td>
<td>0.102</td>
<td>0.090</td>
<td>0.102</td>
<td>0.076</td>
<td>0.031</td>
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<td>Scenario 9</td>
<td>0.061</td>
<td>0.064</td>
<td>0.232</td>
<td>0.064</td>
<td>0.064</td>
<td>0.132</td>
<td>0.046</td>
<td>0.032</td>
<td>0.142</td>
</tr>
</tbody>
</table>
The earned schedule method outperforms the other methods at all stages during the project cycle,
All other methods make the quirky mistake from the 50% à 60% percentage complete,
Research Finding 3

The network structure as measured by the SP-indicator has a clear influence on the forecast accuracy.
IPMA 22nd World Congress, Rome

IPMA Research Award 2008
Mario Vanhoucke

Measuring time – A project performance simulation study
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Study 3: Schedule Adherence

Examining the P-Factor (schedule adherence)
Schedule Adherence

\[ p = \frac{\sum_{i \in N} \min(PV_{i,ES}, EV_{i,AT})}{\sum_{i \in N} PV_{i,ES}} \]

with

- \( p \): Schedule adherence
- \( = 1 \): perfect schedule adherence
- \( < 1 \): lack of perfect schedule adherence
- \( N \): Set of activities in the project
- \( PV_{i,ES} \): Planned value of activity \( i \) at time instance \( ES \)
- \( EV_{i,AT} \): Earned value of activity \( i \) at the actual time \( AT \)
Research Finding P-Factor

High P-Factors lead to more accurate forecasts, and thus acts as a warning signal.
Effective Earned Value

EV

EV according to plan  EV under risk

EV according to plan  usable  unusable

Effective Earned Value EV(e)
Preliminary Research Finding EV(e)

The use of effective earned value to improve the forecast accuracy of time prediction is limited.
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Study 4: Project Time Control

Is there an alternative for improving time forecasting accuracy for projects with parallel networks?
ES: TOP DOWN CONTROL

[Diagram showing a hierarchical structure with project objectives, work packages, and activities. The diagram highlights activities 5, 7, and 10 as being in danger.]
SRA: BOTTOM UP CONTROL
SRA: BOTTOM UP CONTROL

No action zone
Safe zone | Watch out zone

1 2 3 4 5 6 7 8 9 10
0 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00

Full control (0th percentile) | Action threshold! | No control (100th percentile)

Decreasing threshold = higher control
Increasing threshold = lower control
SRA: BOTTOM UP CONTROL
ES vs. SRA

![Graph showing comparison between ES and SRA in parallel and serial networks.](image-url)
Research meets Practice

- Period 2007 – 2010: students of Ghent University collected real life data
  - 8 Belgian companies
  - 48 projects
Research meets Practice


Legend
- EVM with SPI(t) (fictitious data)
- SRA with SSI (fictitious data)
- EVM with SPI(t) (empirical data, with an indication of minimum and maximum value)
- SRA with SSI (empirical data, with an indication of minimum and maximum value)
- Combination of EVM and SRA (fictitious and empirical data)
Peer Reviewed Publications

Other Publications

• Vanhoucke, M., 2008, “Project tracking and control: can we measure the time?”, Projects and Profits, August, 35-40.
Other Publications

National publications


Book chapters

• Vanhoucke, M., 2009, “Static and dynamic determinants of earned value based time forecast accuracy”, in: Handbook of Research on Technology Management’s Planning and Operations, 361-374
Books Published

2012 (ISBN 978-3-642-25174-0)
PMI Practice Standard for Earned Value Management; Second Edition Update Project

J. Greg Smith
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EVM Europe, Ghent, 03 / 04-12-13
CRA Award Flemish Government

Awarded in 2011

Budget: > 1.200.000 €

Timespan: 2012 – 2018

8 Researchers
CRA: The Team in 2013
CRA: The Toys

- High Performance Computing system (HPC)
- Biggest supercomputer in Belgium
- Rank 118 (Top500 list of June 2012)

- Data size typical simulation run: > 1 TB (ca. 1,450 CD’s)
Focus 1: Continue “Measuring Time”

- Extending / improving forecasting methods
- Studying schedule adherence (P-Factor)
- Studying forecast quality

- Stability: how to define thresholds for measuring stability??
Defining Stability - Thresholds

- The “American” way:
  - Finding generalised to “all projects” (without proof)

\[ |\text{CPI}_{\text{final}} - \text{CPI}_{20\%}| \leq 0.10 \]

UCL = \text{CPI}_{20\%} + 0.10

CPI_{20\%}

LCL = \text{CPI}_{20\%} - 0.10
Defining Stability - Thresholds

- The “Japanese” way:
  - Use of statistical process control charts
  - But:
    - Use of historical performance data (from other projects)
    - Normalised performance data needed
    - Considered factor has no correlation with other factors
    - Based on continuously processes
Focus 2: Statistical Project Control

• The proposed “Belgian” way: Statistical Project Control
  • Use of SRA process during planning phase to set thresholds
  • Define allowed common cause variation (natural variation)
The Proposed Model
The Proposed Model

- Setting thresholds based on risk profiles
- Update thresholds during review by new simulation run
- Method which truly integrates EVM & Risk
Focus 3: Research Meets Practice

- Publish research in top academic journals

- Translate & publish & present research into practical applications
  - Ex. The Measurable News
  - EVM Europe, EVM World, ...

- We need your help:
  - “Real life data” needed
  - Any new ideas? Research suggestions?

- Ghent University Master Thesis Project Control
  - May 2014: 10 works
  - May 2015: 16 works
Stay Tuned for updates

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Mario Vanhoucke

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