PMGlobal Project Governance & Controls Symposium
6-7 May 2014
Canberra
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IF TIME IS MONEY, ACCURACY PAYS DIVIDENDS!

AN OVERVIEW OF PAST AND FUTURE PROJECT MANAGEMENT RESEARCH

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Manager Airport Systems, CofelyFabricom
Director, EVM Europe Association

AGENDA

1. Intro

- Introduction

2. Past / Recent Work

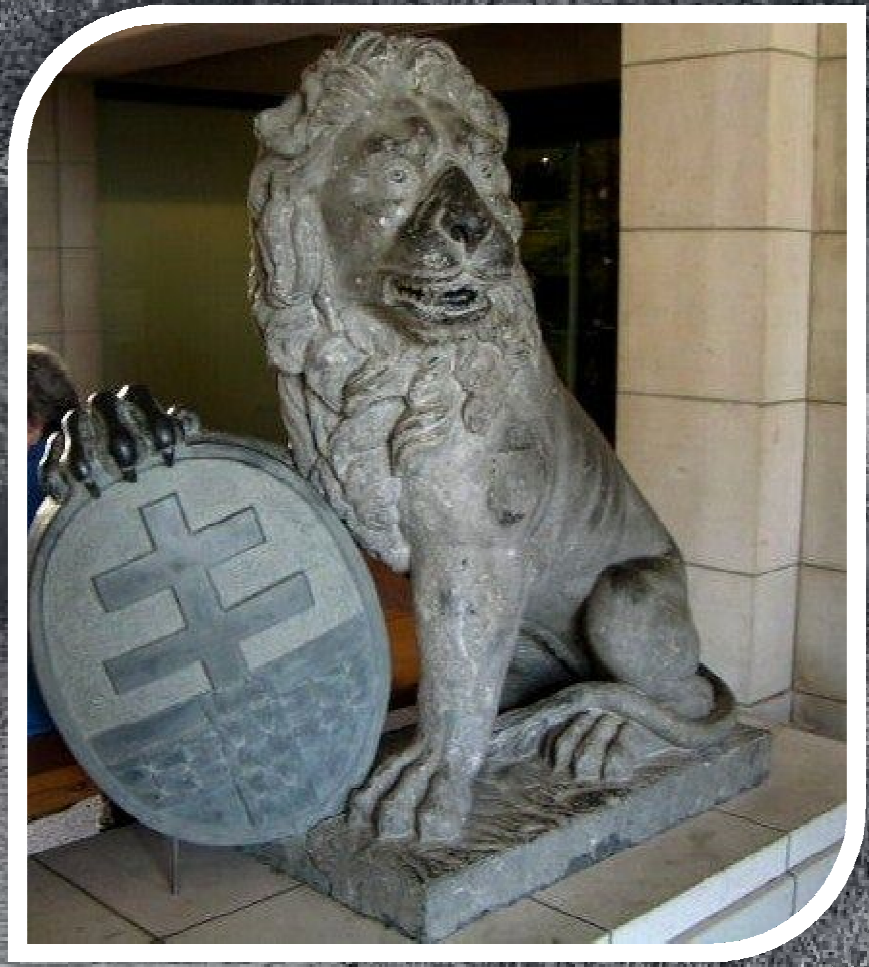
- Study 1: Summarising EV-based duration forecasting methods
- Study 2: Measuring Time – A simulation study
- Study 3: Project control efficiency
- Study 4: P-Factor
- Spin off: Projects database

3. Future Work

- Proposed topics

Belgian – Australian connections

Belgian – Australian connections



PGCS, Canberra 2014

PGCS, Canberra 2014

PGCS, Canberra 2014

Australian - Belgian connections

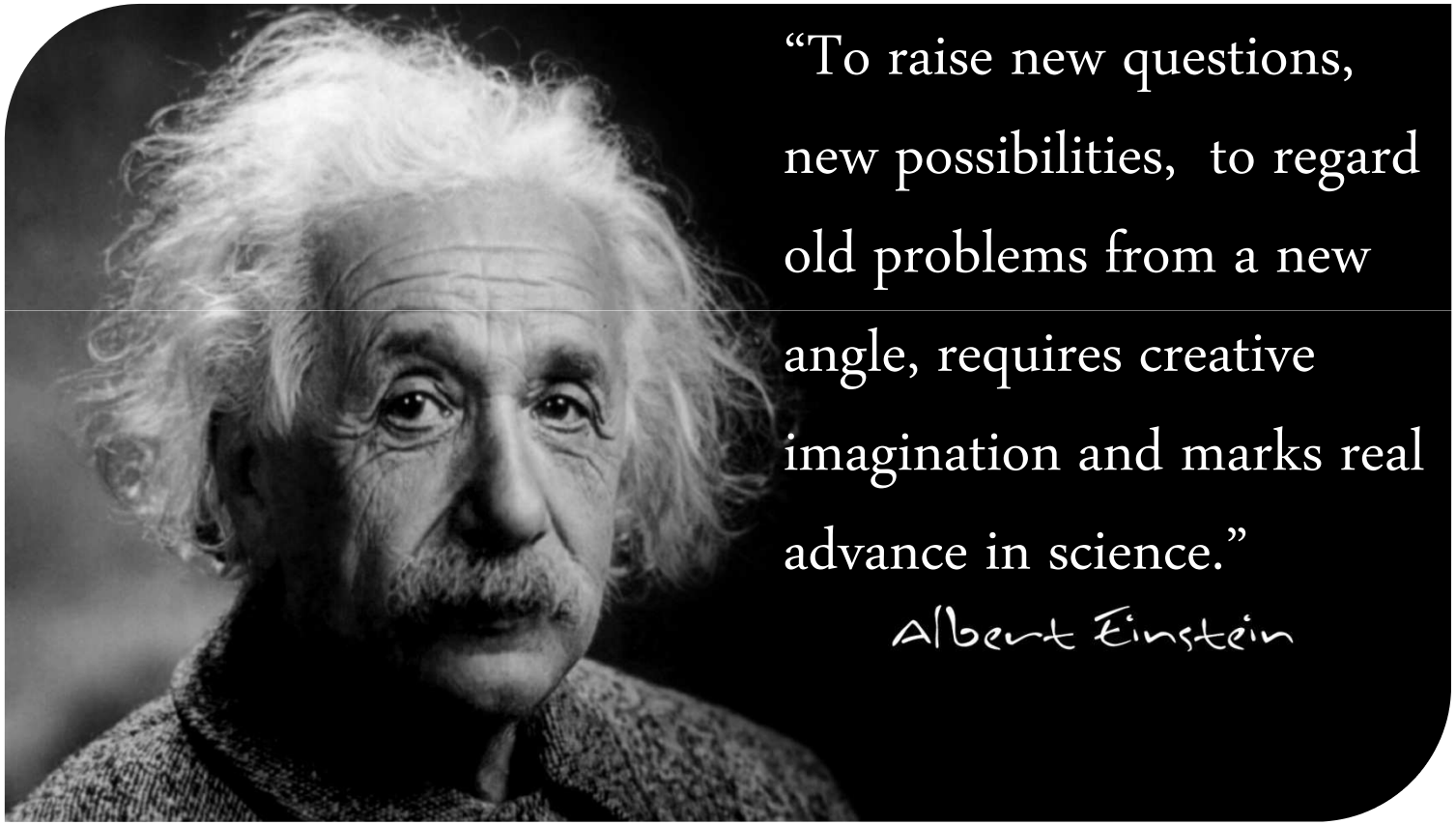
Australian - Belgian connections

EVM Europe Association

www.evm-europe.eu

RESEARCH meets PRACTICE

Why do we need research?



This presentation

- Old problems:
  - CPM forecasting is optimistic (and difficult)
  - Upper management informed too late about delays
- New angle:
  - The use of EV-based methods to predict final duration
  - Investigate these methods by using academic state-of-the-art methodologies
- Advance in project controls:
  - Does it lead to best practices?

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3. Future Work

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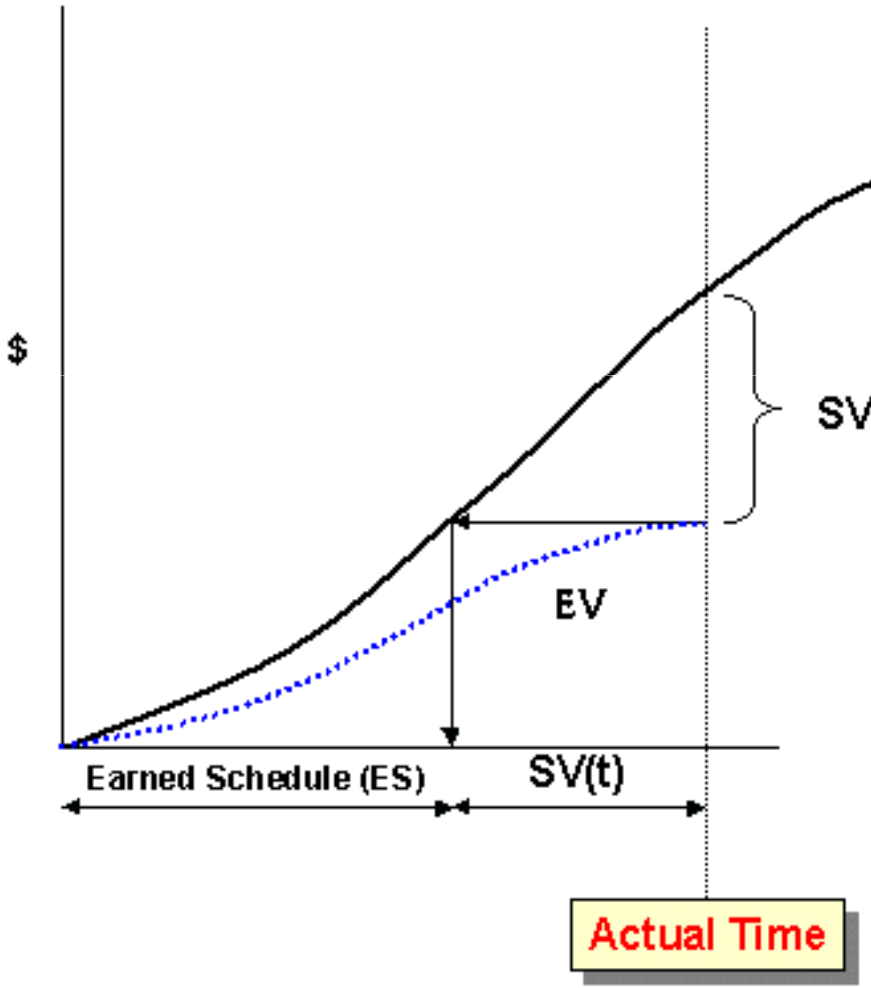
Study 1: Summarising methods

Vandevoorde, S. and Vanhoucke, M., 2006, "A comparison of different project duration forecasting methods using earned value metrics", International Journal of Project Management, 24, 289-302.

EV-based methods

		Planned Value	Earned Duration	Earned Schedule
	Reference	Anbari (2003)	Jacob (2003)	Lipke (2003)
	Indicator	SV / SPI	SV / SPI	SV(t) / SPI(t)
	Generic time forecast formula: EAC(t) = AD + PDWR / P.F.			
Future expected performance	P.F. = 1	PV1	ED1	ES1
	P.F. = SPI P.F. = SPI(t)	PV2 --	ED2 --	-- ES2
	P.F. = CSI P.F. = CSI(t)	PV3 --	ED3 --	-- ES3

Schedule Performance Indicators



	SV	SV(t)
Formula	EV - PV	ES - AT
Units	euros	time
Project end	always 0	real performance

	SPI	SPI(t)
Formula	EV / PV	ES / AT
Units	none	none
Project end	always 1	real performance

IJPM Paper

- Application on 3 real life projects

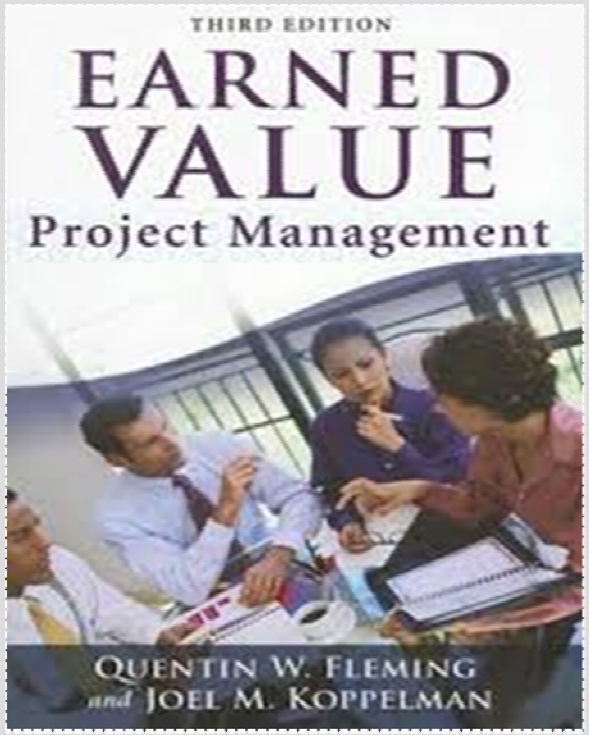
- Conclusion:

  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.

Critics



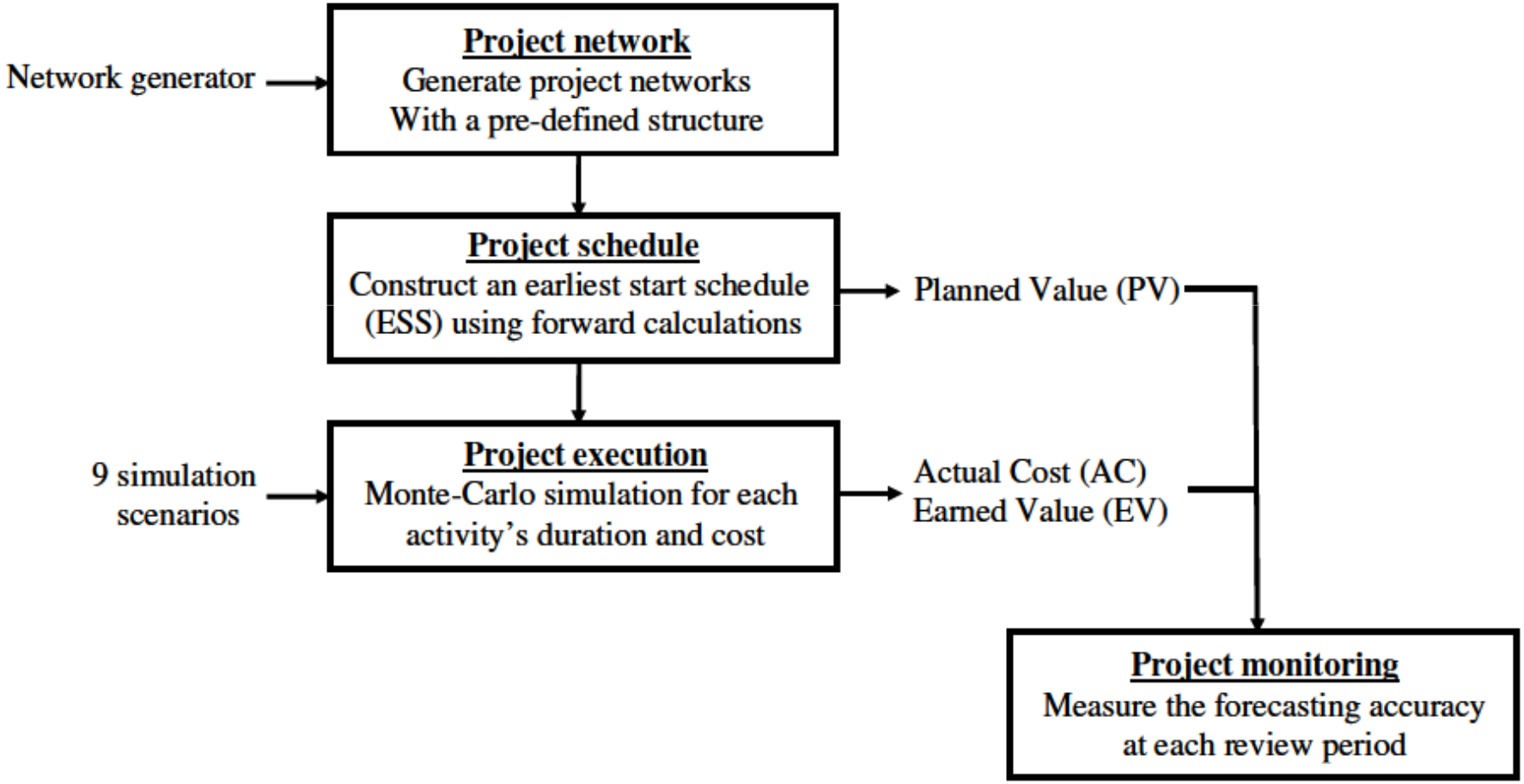
"There are some professionals in the field who feel that the earned value schedule position can be used to predict the final completion date for the project. The authors do not endorse this theory. Nor have they ever read any scientific studies that support this position

Earned Value Project Management,
3th Edition, 2006

Study 2: Measuring Time

Vanhoucke, M. and Vandevoorde, S., 2007, "A simulation and evaluation of earned value metrics to forecast the project duration", Journal of the Operational Research Society, 58, 1361–1374.

Test methodology



Create database : network generator

- 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 occurr in practice
- To control the design of the networks topological indicators are used.
- Based on: Vanhoucke, M., Coelho, J.S., Debels, D., Maenhout, B. and Tavares, L.V., 2008, "An evaluation of the adequacy of project network generators with systematically sampled networks", European Journal of Operational Research, 187, 511–524

Serial / Parallel - Indicator

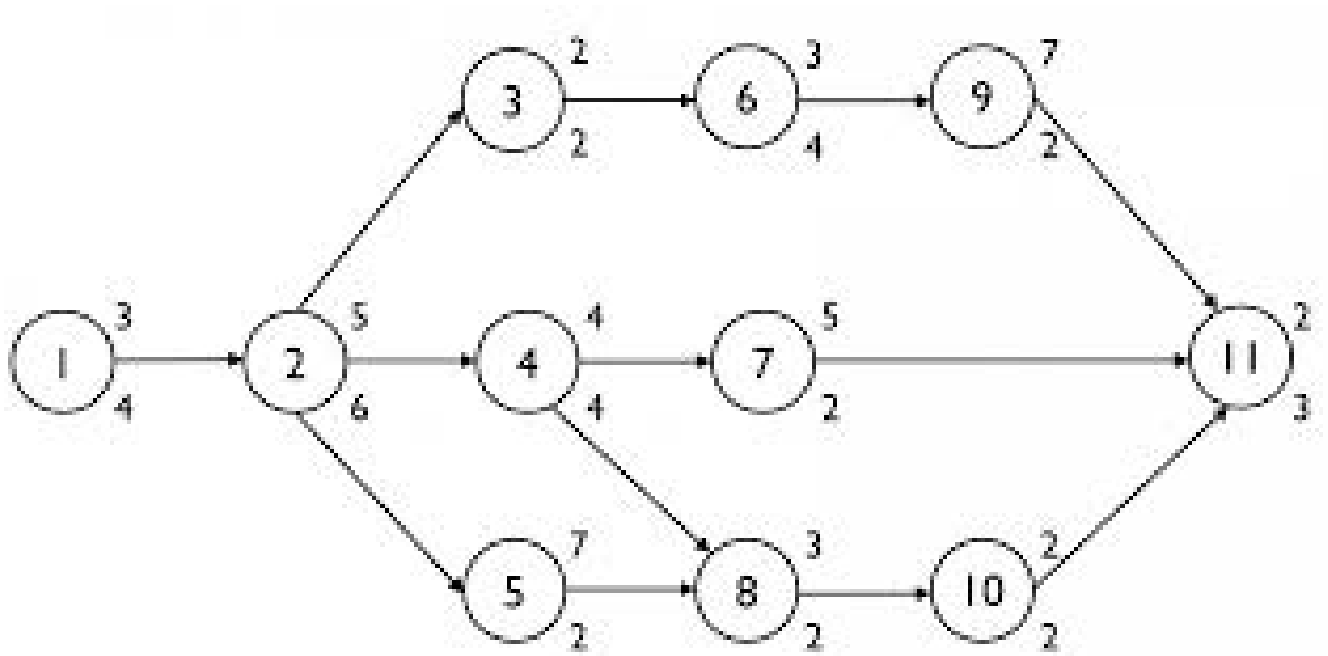
- $SP = 1 \quad if\ n = 1$
- $SP = \frac{m-1}{n-1} \quad if\ n > 1$

  - m = number of activities along the longest path
  - n = number of activities in network

- $SP \in [0, 1]$

  - SP = 0 all activities are in parallel
  - SP = 1 all activities are in serial

Serial / Parallel - Indicator



$$SP = \frac{m-1}{n-1} = \frac{6-1}{11-1} = 0{,}50$$

Serial / Parallel - Indicator

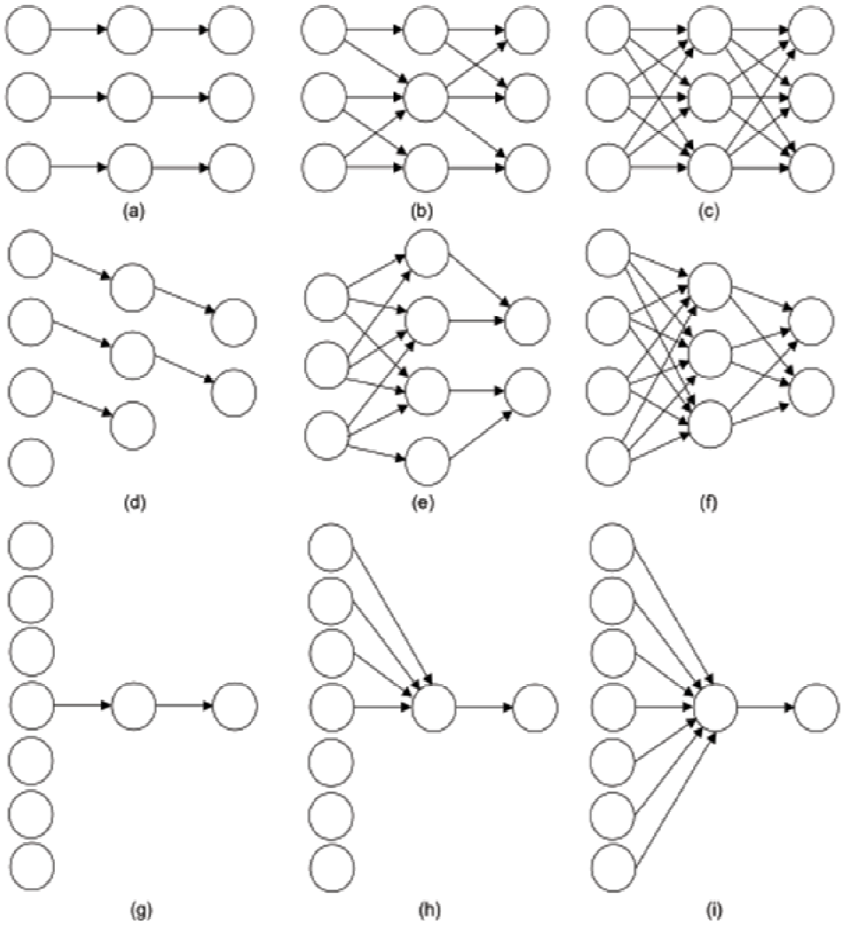
Project Network

Serial/Parallel (SP)

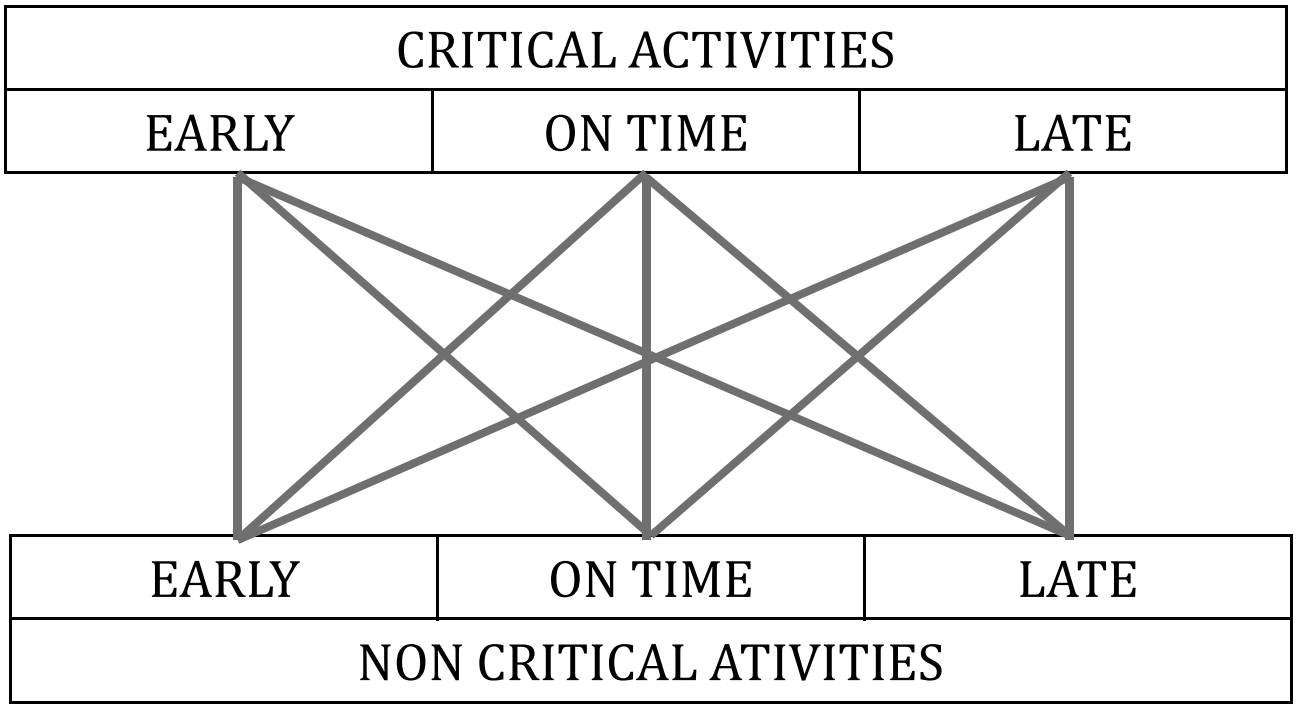
Activity Distribution (AD)

Length of Arcs (LA)

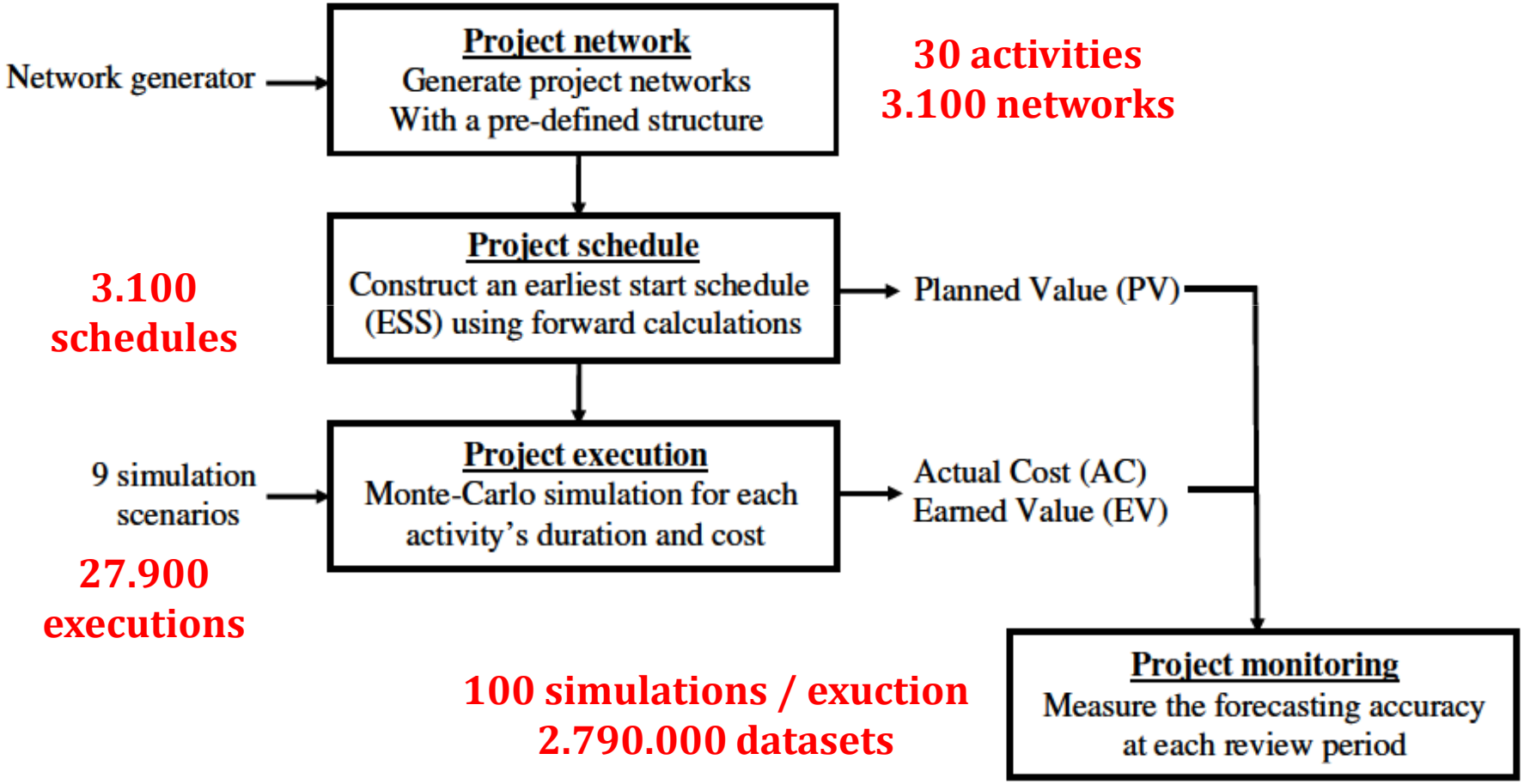
Topological Float (TF)



9 Execution scenarios

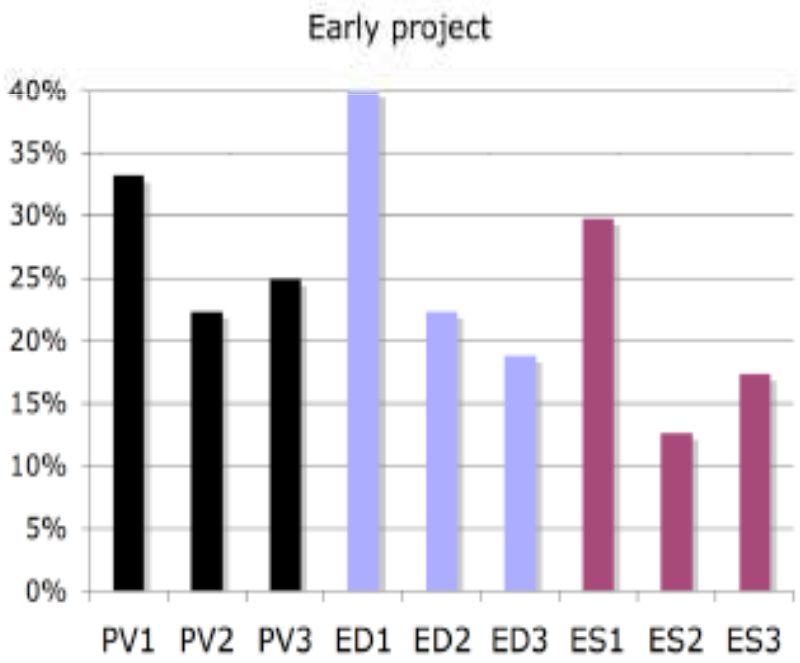


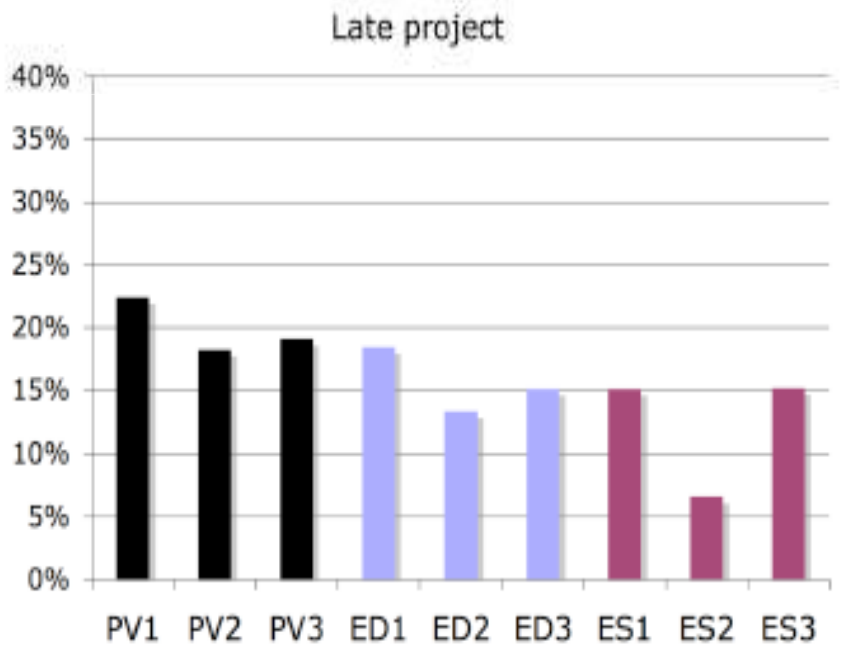
Test methodology



Research Finding 1

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

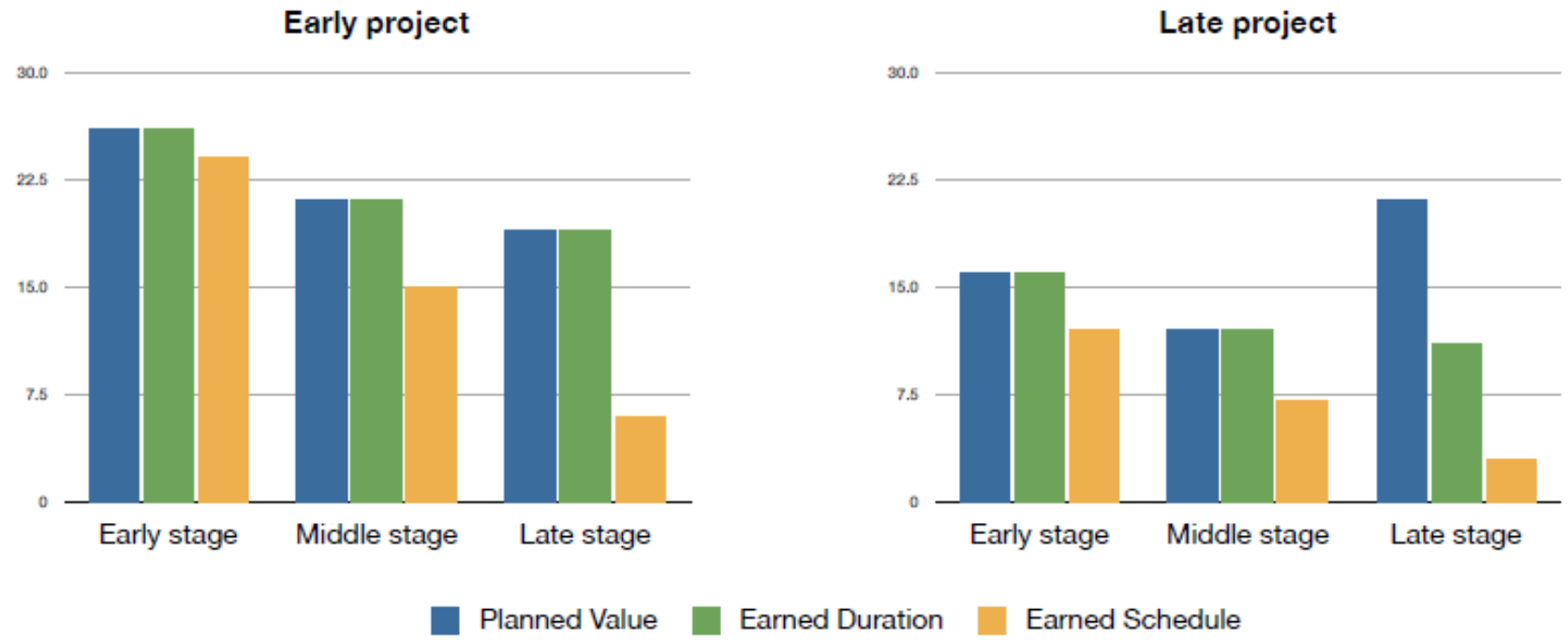




Research Finding 2

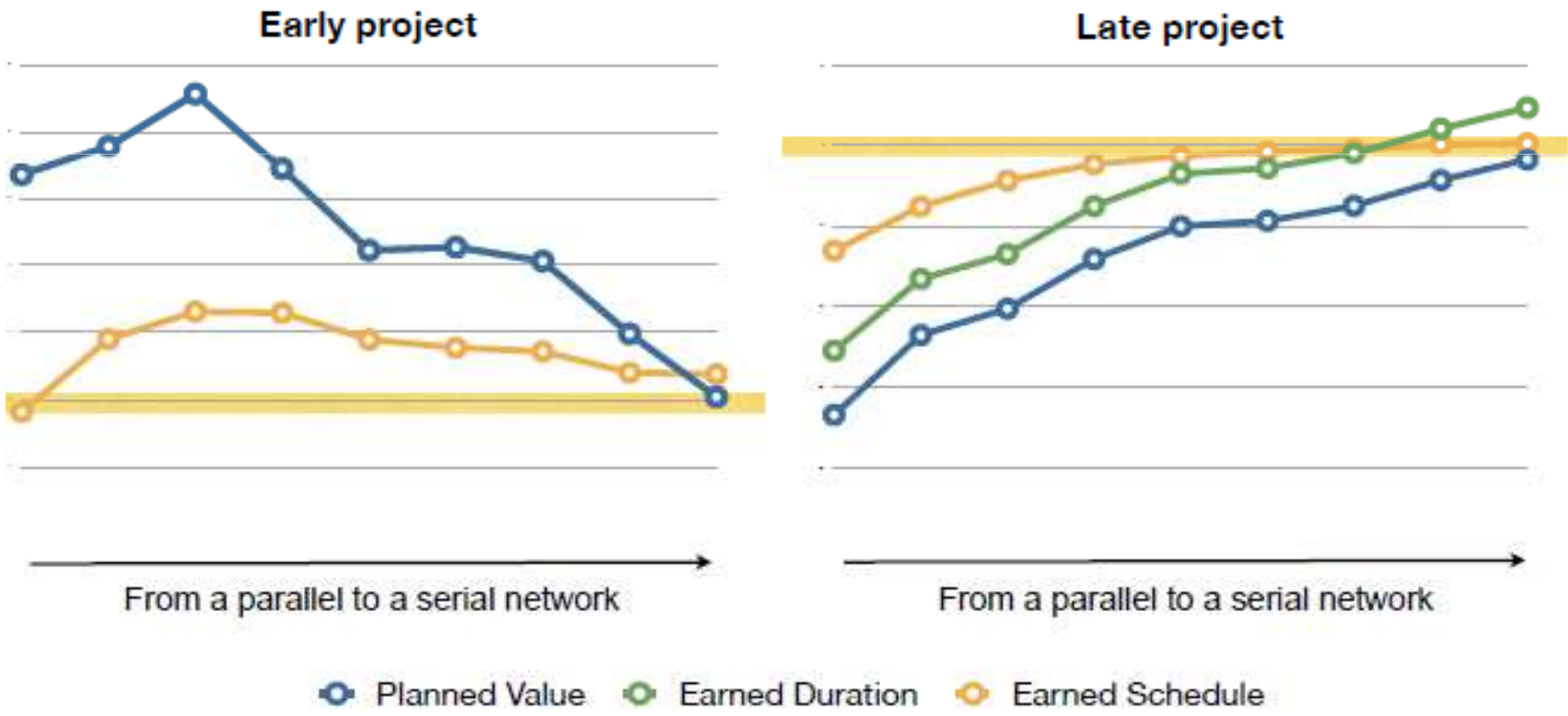
The earned schedule method outperforms the other methods at all stages during the project cycle,

SPI methods make the quirky mistake from ca. 60% completion



Research Finding 3

The network structure as measured by the SP-indicator has a clear influence on the forecast accuracy.

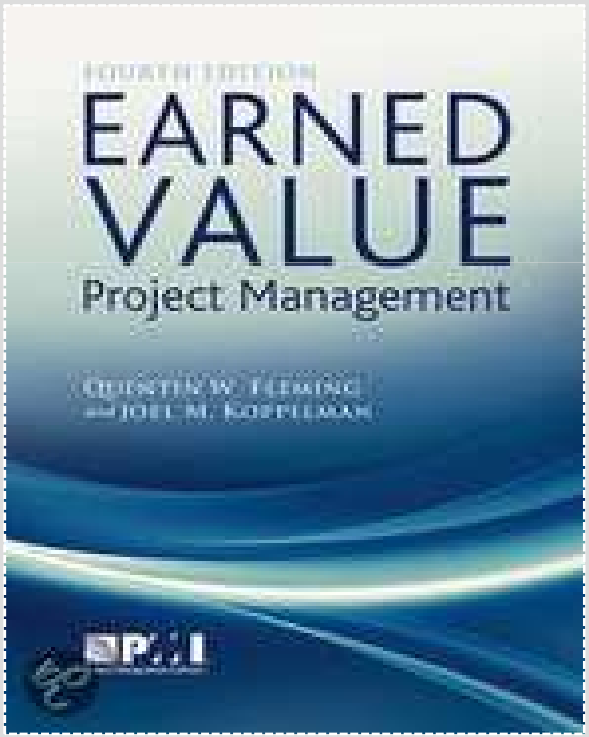


Award winning research

PMI Belgium Chapter Event 12/06/2007
Research Collaboration Fund 5.000 €

IPMA Research Award
2008

Critics



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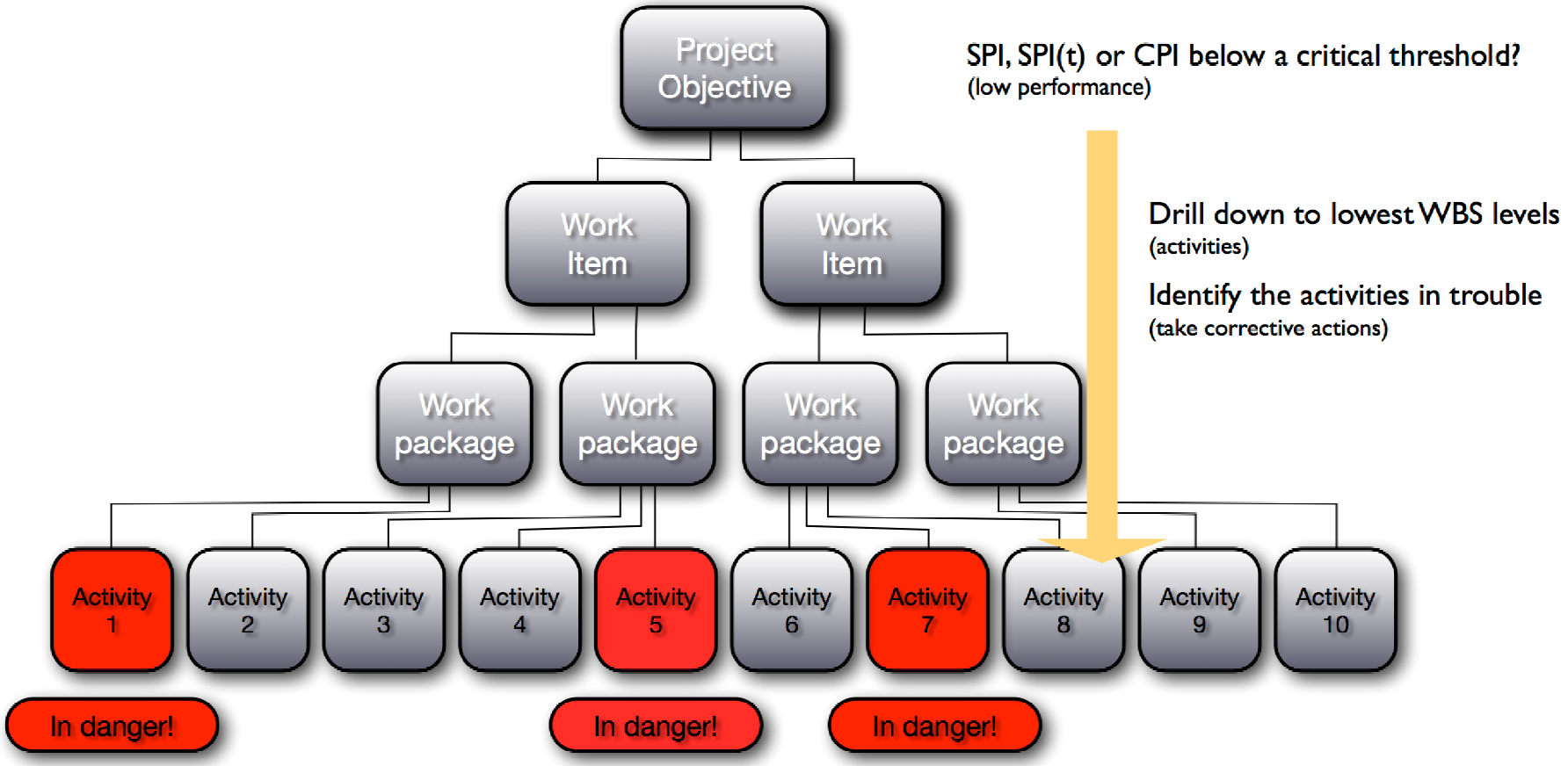
Earned Value Project Management,
4th Edition, 2010

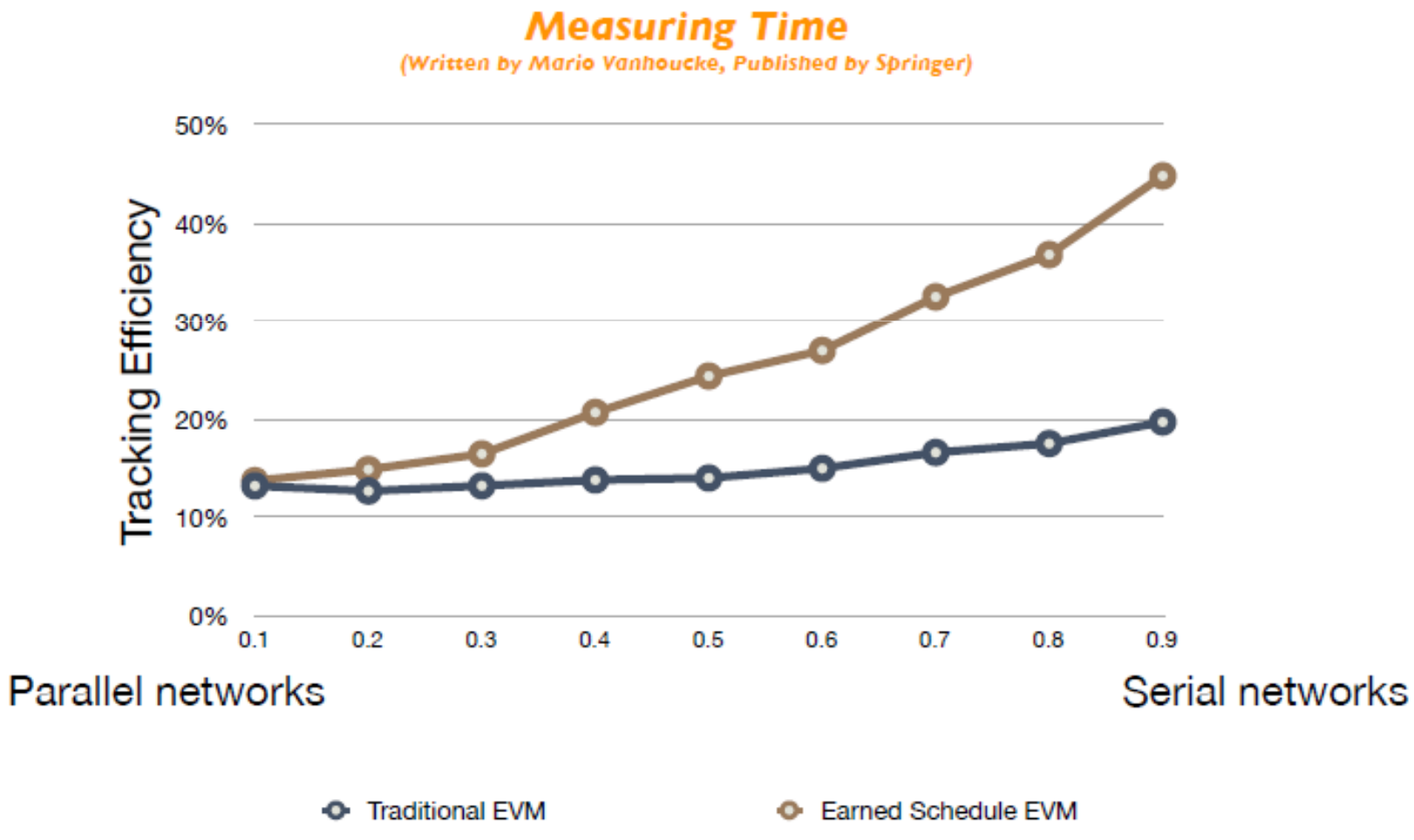
Study 3: Project control efficiency

Vanhoucke, M., 2012, "Measuring the efficiency of project control using fictitious and empirical project data", International Journal of Project Management, 30, 252-263.

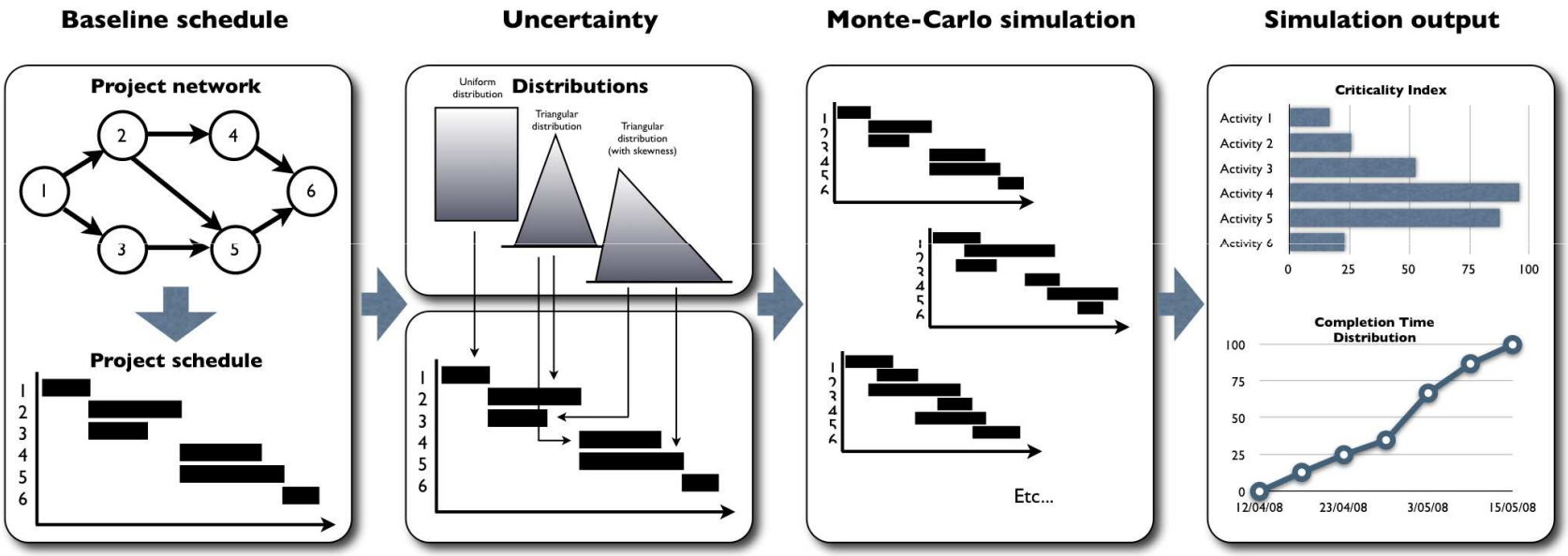
EV/ES: Top down control



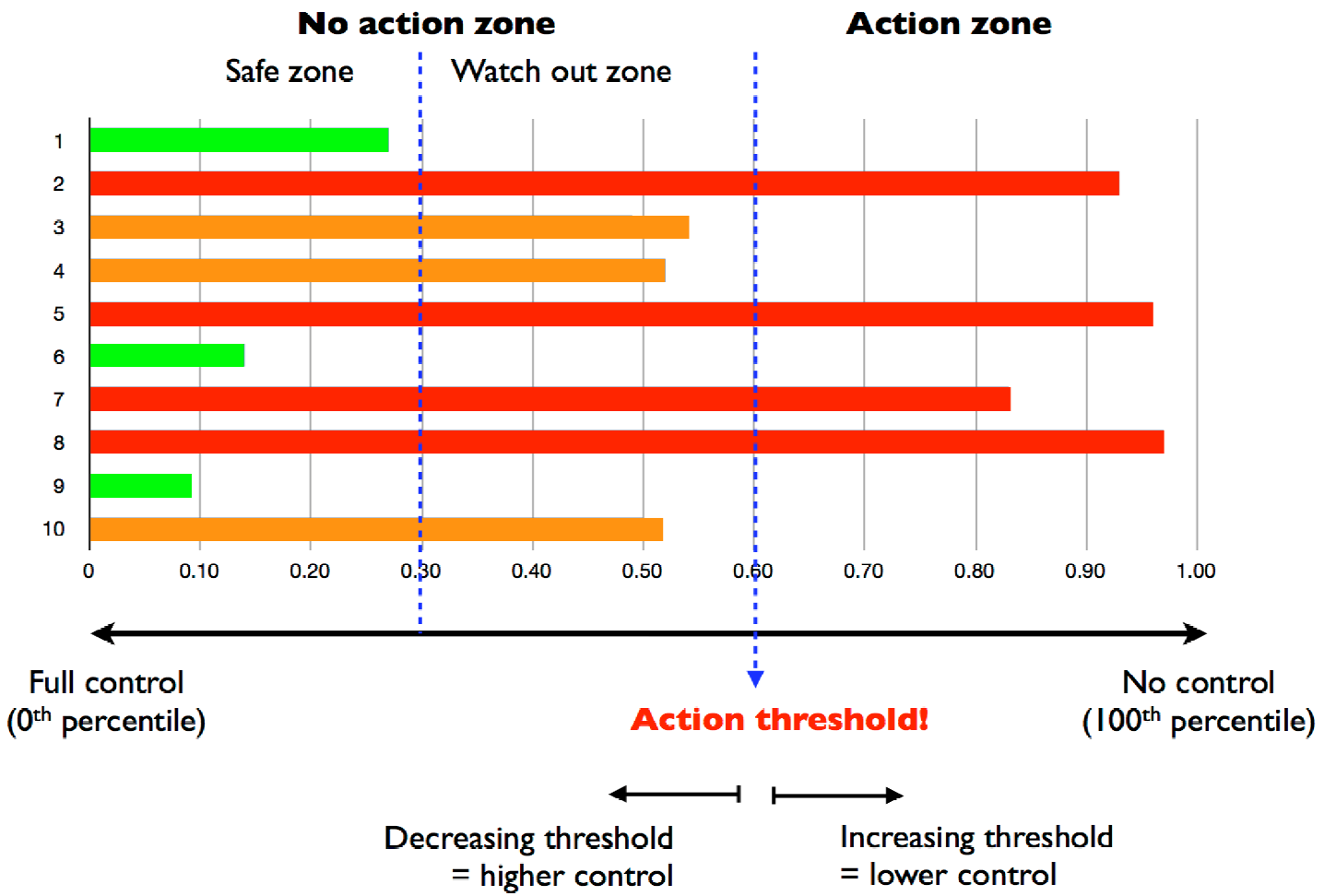
EV/ES: Top down control



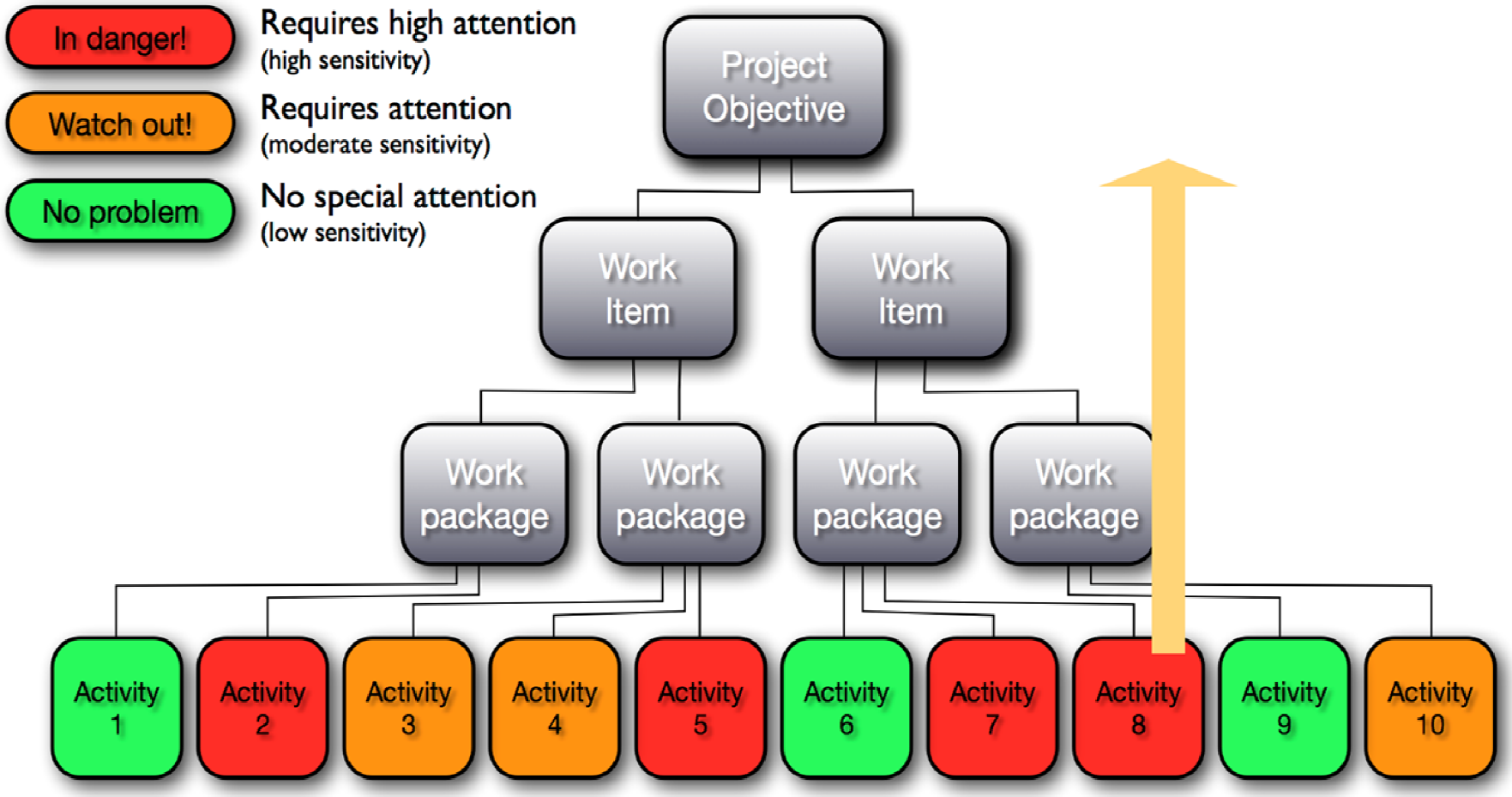
SRA Bottom up control



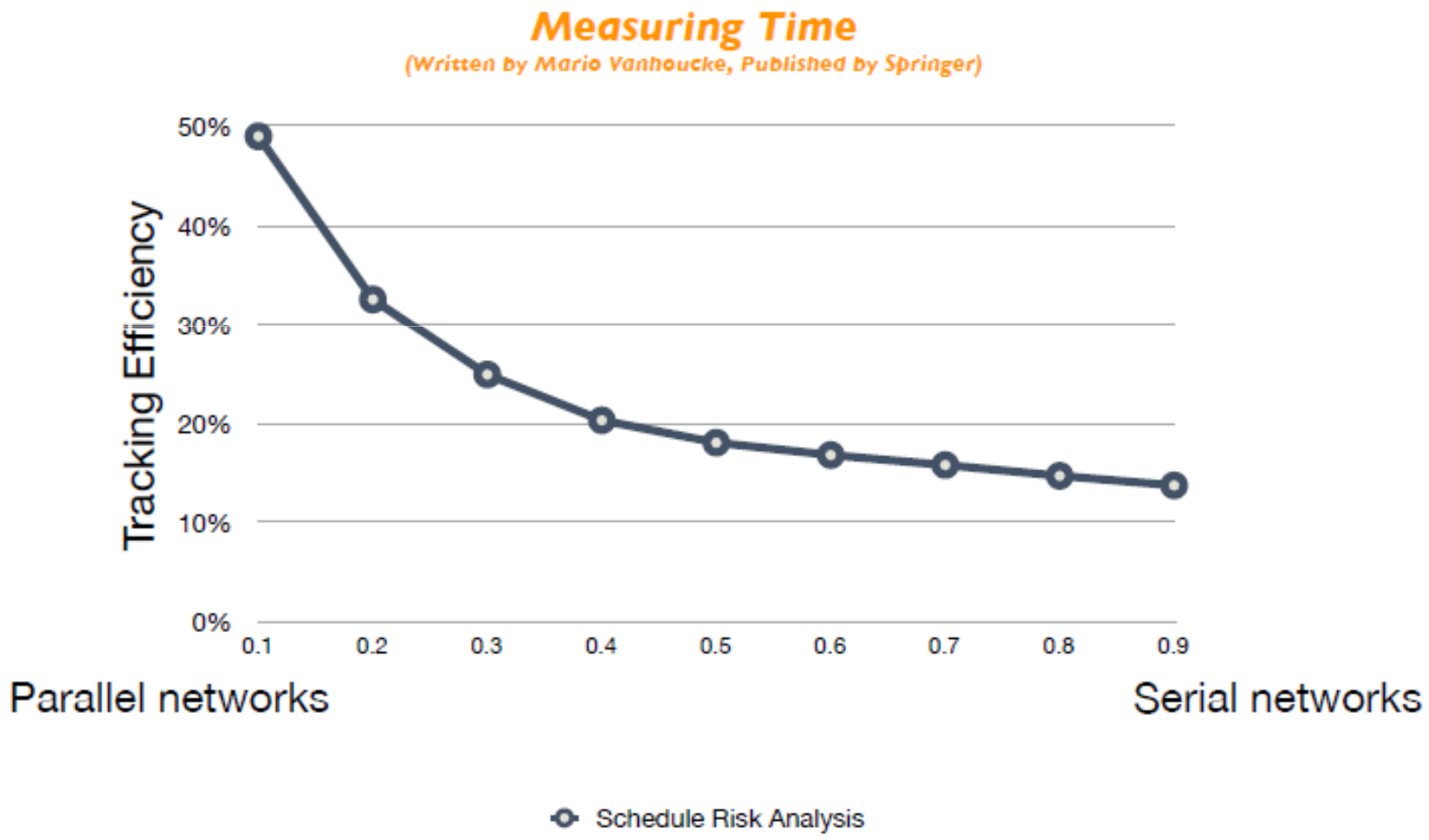
SRA Bottom up control



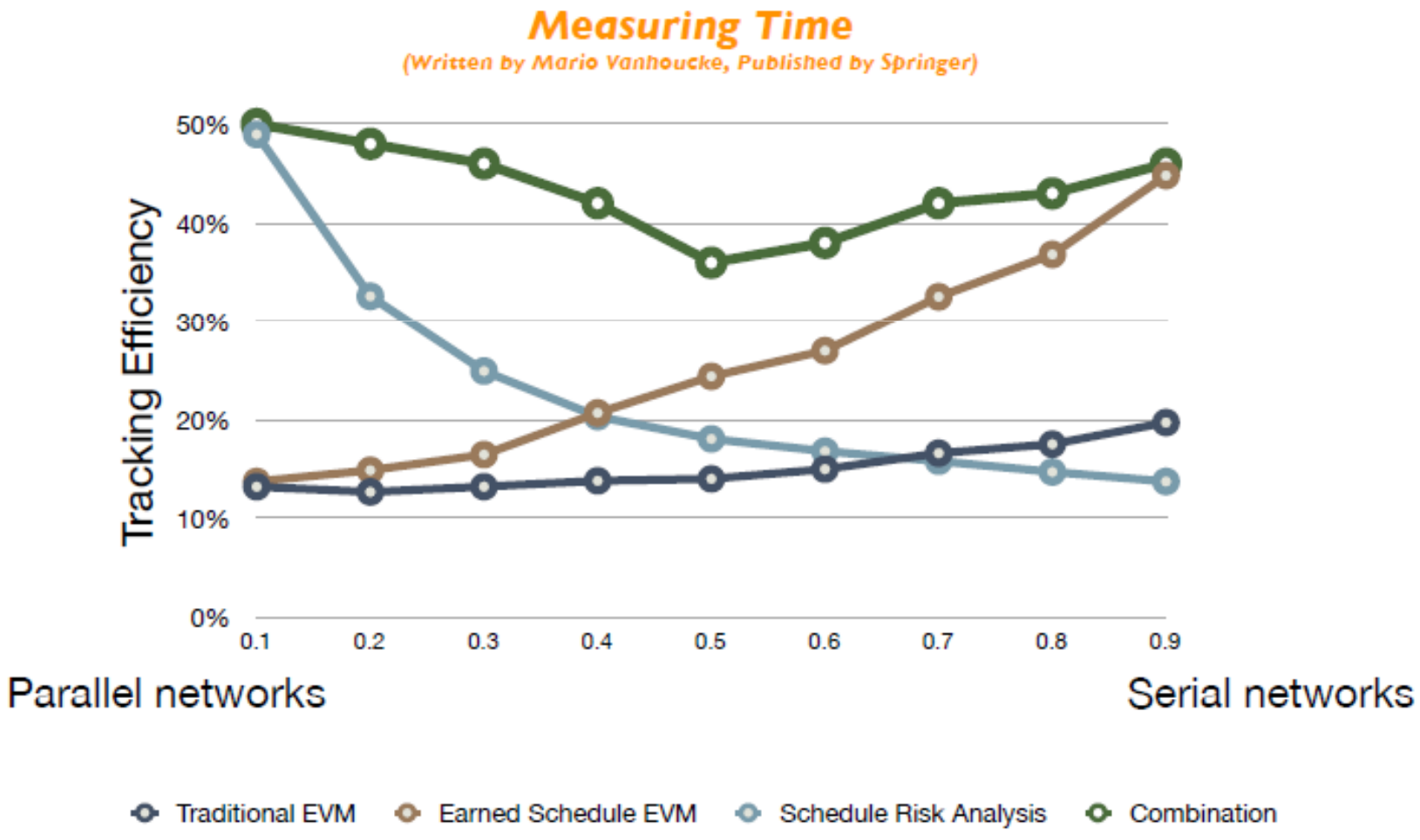
SRA Bottom up control



SRA Bottom up control

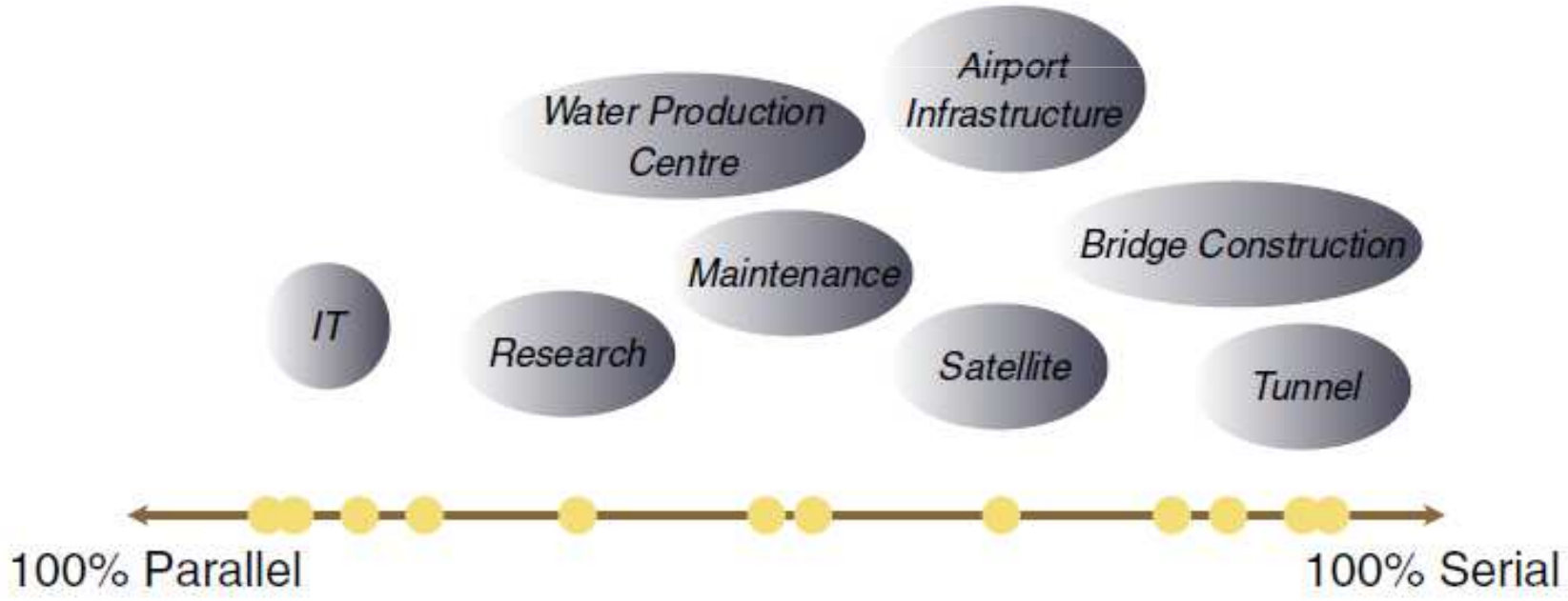


If time is money, accuracy pays dividends!

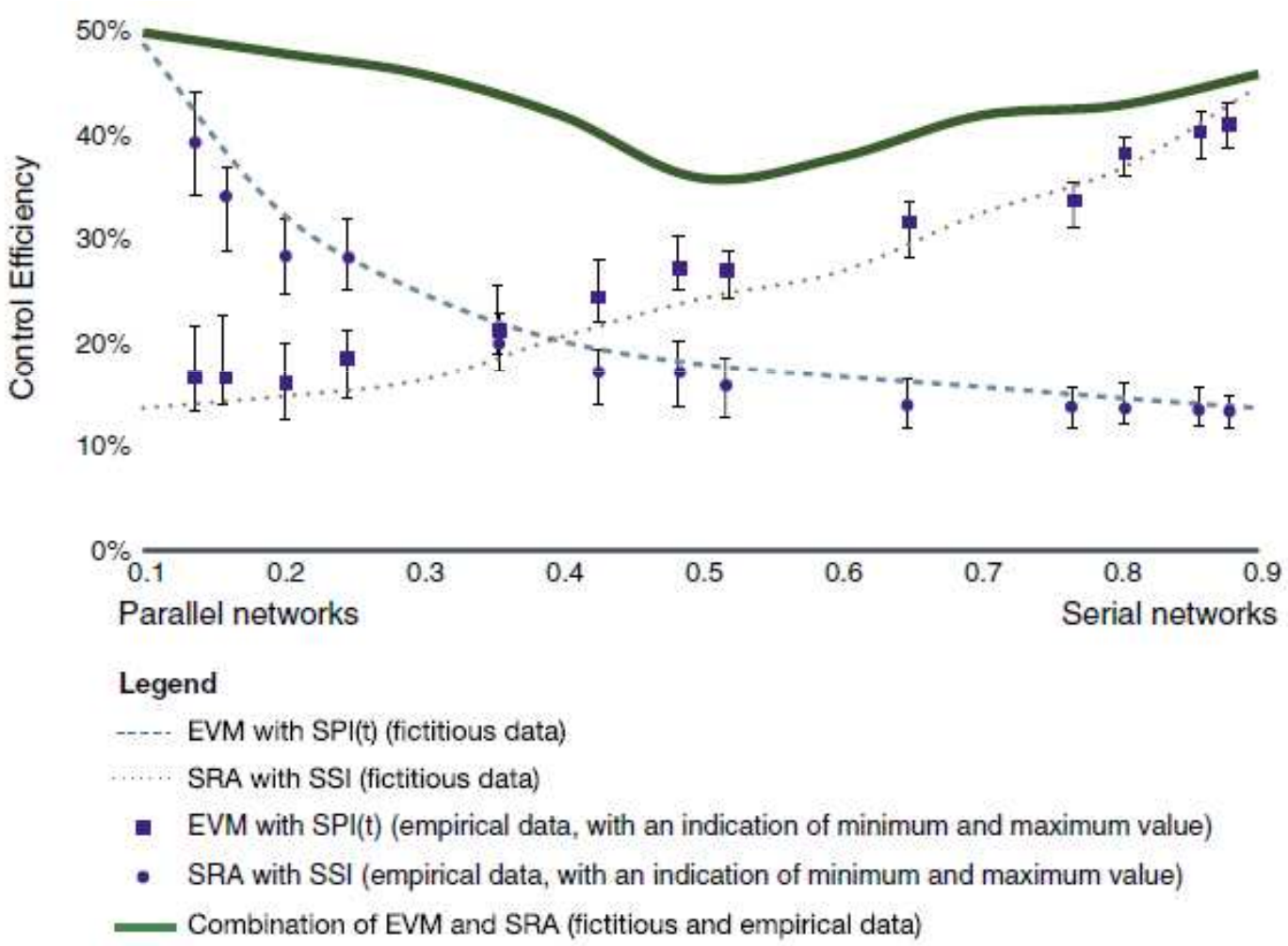


How does this relate to the real world?

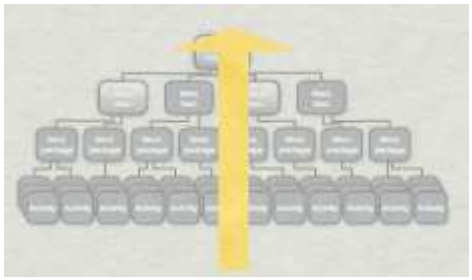
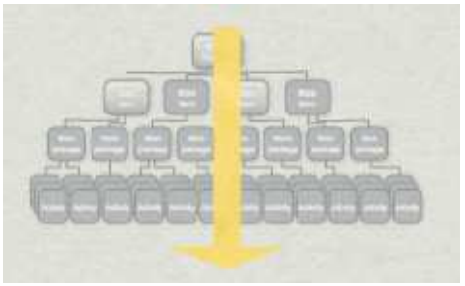
- Period 2007 – 2010:
  - students of Ghent University collected real life data
  - 8 Belgian companies, 48 projects



Research meets practice



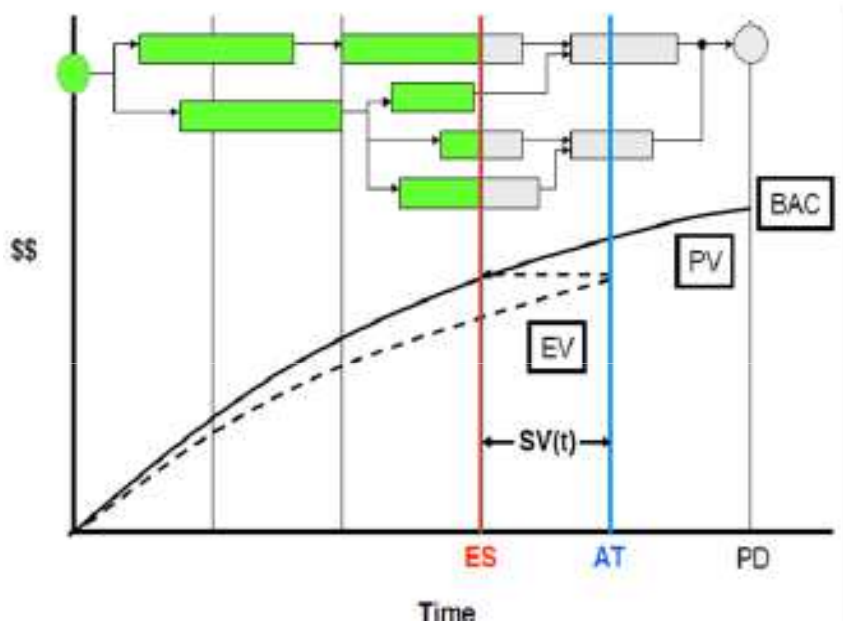
Time forecasting best practices

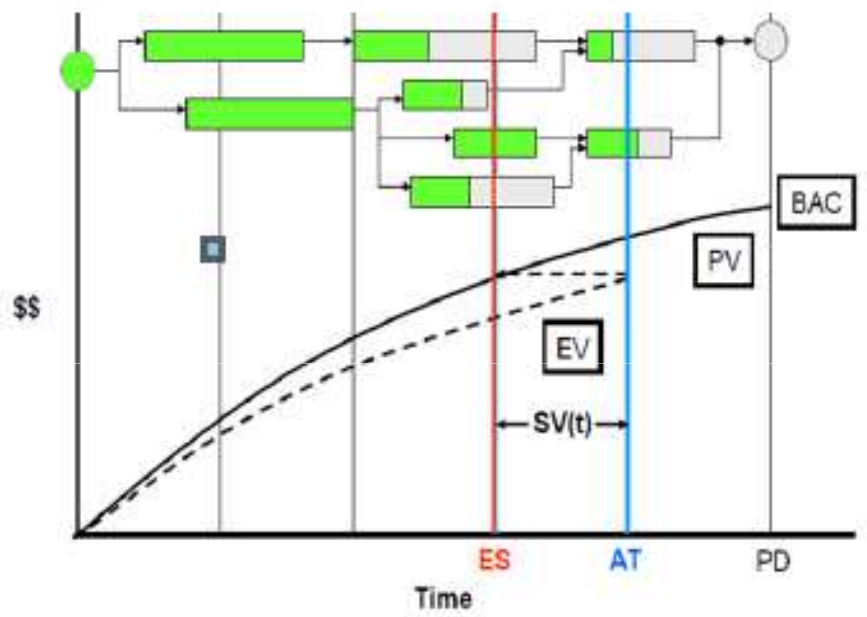
	 Activity based tracking Bottom up Schedule risk analysis	 Project based tracking Top down Earned schedule
Parallel networks	**Yes!** **Focus on sensitive activities**	No! Inaccurate time forecasts
Serial networks	No! Focus not possible	**Yes!** **Accurate time forecasts using earned schedule**

Study 4: P-Factor

Vanhoucke, M., 2013, "The impact of project schedule adherence and rework on the duration forecast accuracy of earned value metrics", In E.C. Hoffmann (Ed.), Project Management: practices, challenges and developments, Nova Publishers

Schedule Adherence





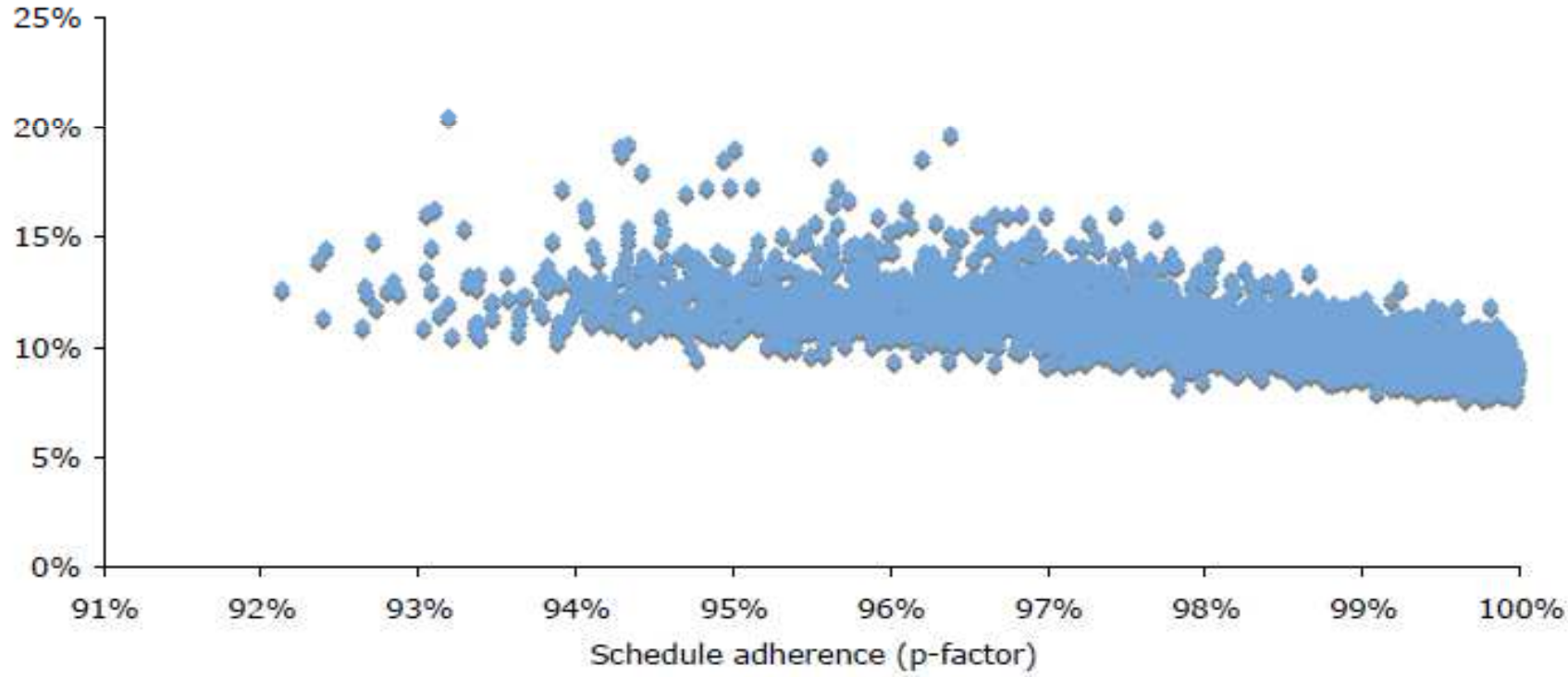
$$p = \frac{\sum_{i \in N} min(\mathrm{PV}_{i,\mathrm{ES}}, \mathrm{EV}_{i,\mathrm{AT}})}{\sum_{i \in N} \mathrm{PV}_{i,\mathrm{ES}}}$$

with

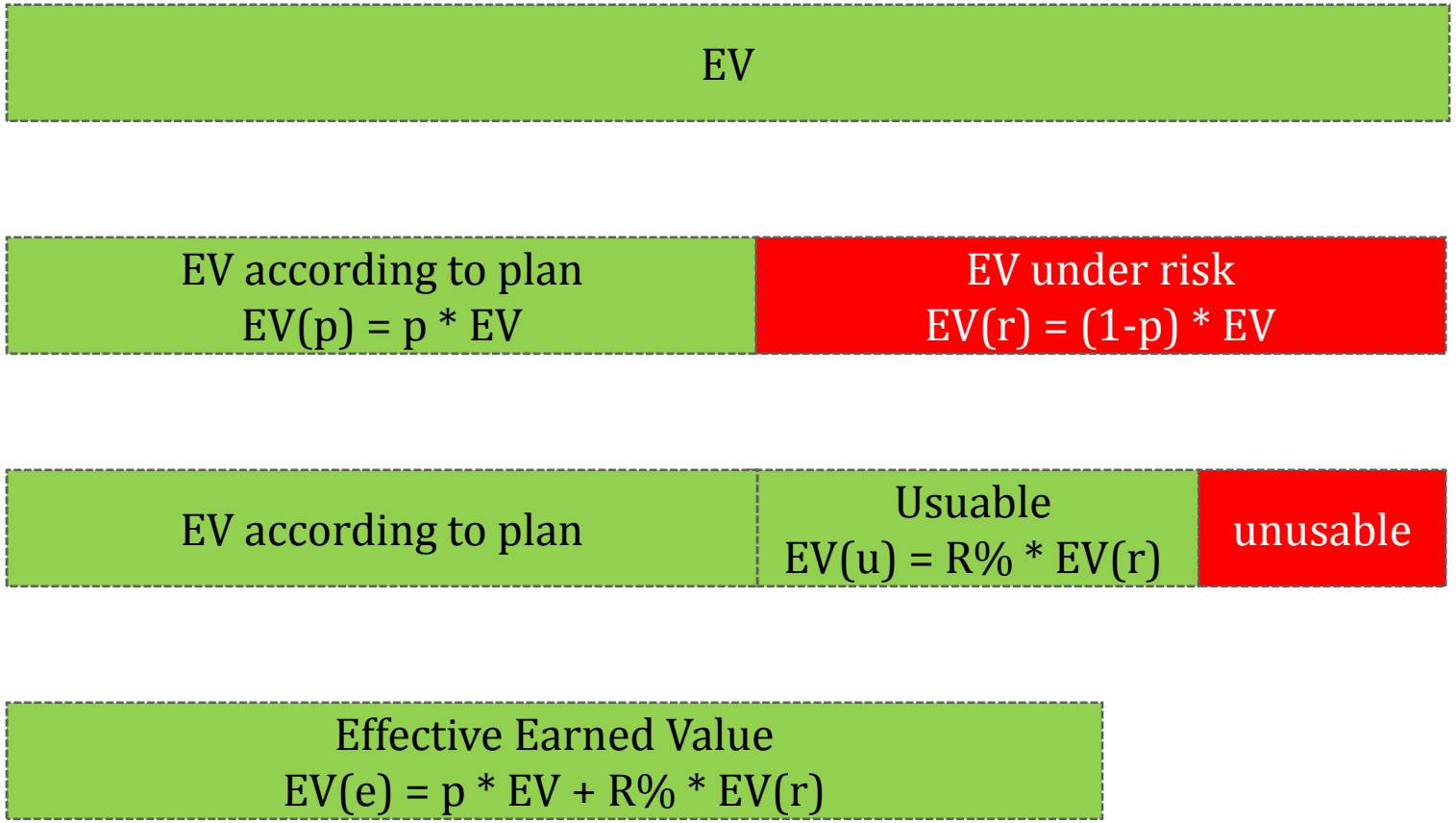
p	Schedule adherence = 1: perfect schedule adherence < 1: lack of perfect schedule adherence
N	Set of activities in the project
$PV_{I,ES}$	Planned value of activity i at time instance ES
$EV_{I,AT}$	Earned value of activity i at the actual time AT

Research Finding P-Factor

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

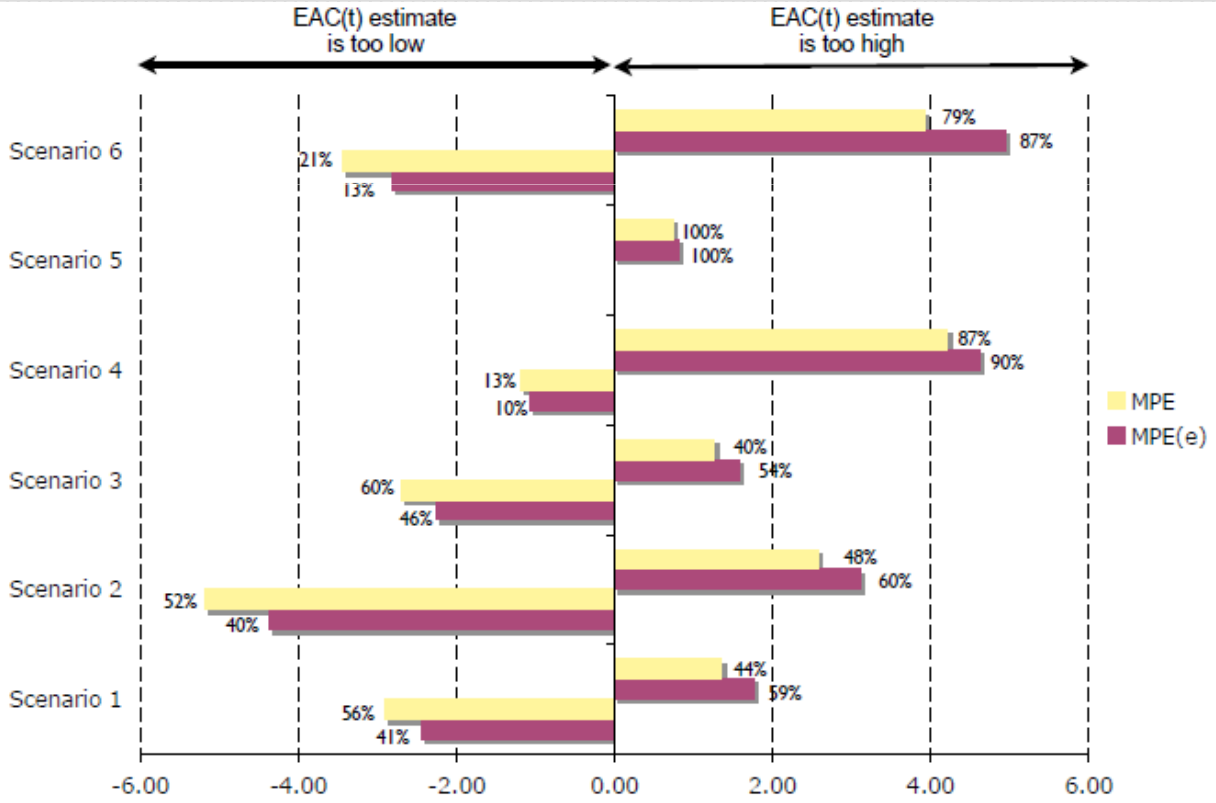


Effective Earned Value



Prelimanary Research Finding EV(e)

The use of effective earned value to improve the forecast accuracy of time prediction is limited.



Spin – off: Project database

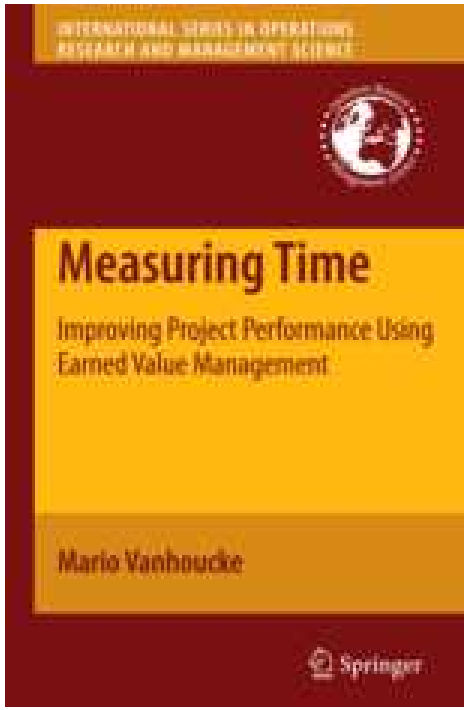
www.or-as.be

→ *research* → *project data*

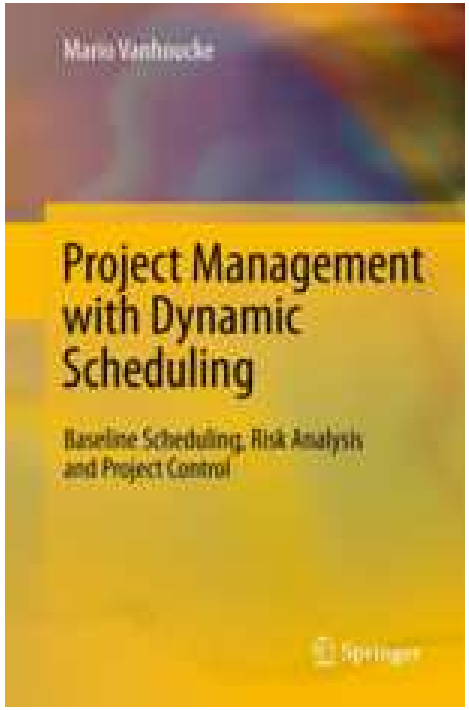
Project database

- The 1st commercial project database ever (to be best of our knowledge)
- Project data contains:
  - Baseline schedule (network, resources ,...)
  - Project control data (EV & ES metrics, ...)
  - Project risk analysis data
- Confidentiality: cost & time data re-scaled, removal of company & project name.
- Guidelines for project input, input .xls files are available for download
- Currently: 52 project cards

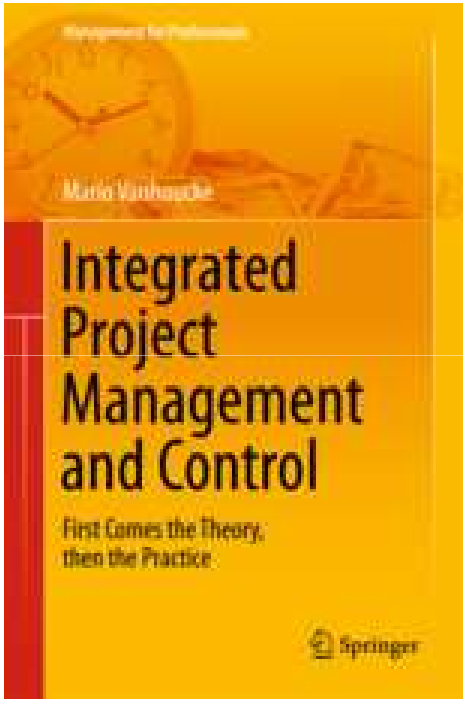
Published books



2010, 1st Edition



2012, 1st Edition
2014, 2nd Edition



2014, 1st Edition

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Ongoing topics

Searching more accurate forecast methods

- Use of composite forecast methods
- Probabilistic methods: Bayesian inference, Kalman filter,...
- Artificial intelligence (machine learning)

Research on forecast quality

- Accuracy: forecast error measured by MPE / MAPE
- Stability: variation of forecast error
- Research on integrating accuracy & stability is void
- Conjecture: p-factor approach and its extensions may be the link between accuracy & stability

Concerted Research Action Plan

Searching for static and dynamic project drivers to predict and control the impact of management / contingency reserve on a project's success

Awarded in 2011

Budget: > 1.200.000 €

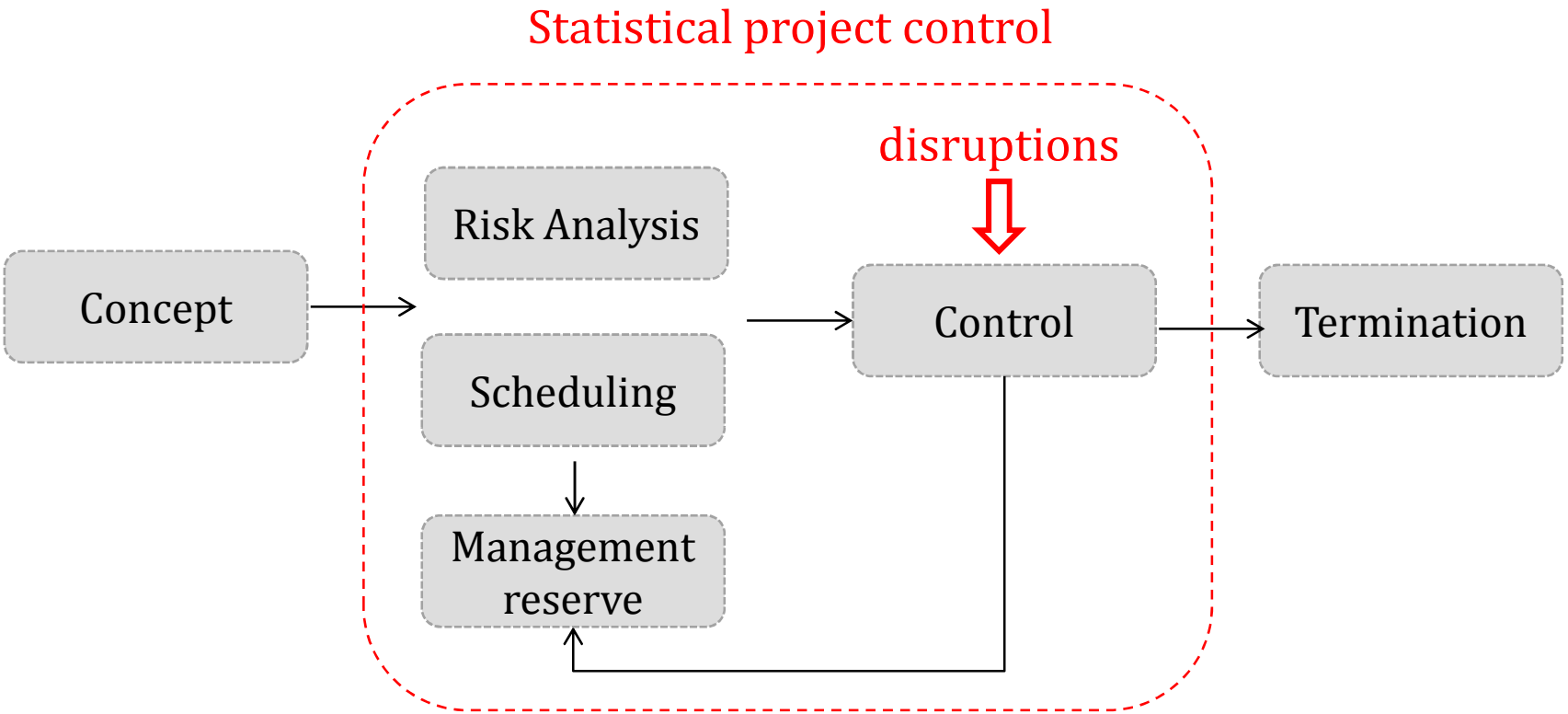
Timespan: 2012 – 2018

CRA: the toys

High Performance Computing system (HPC)
Biggest supercomputer in Belgium
Rank 118 (Top500 list of June2012)

Data size typical similation run: > 1 TB (ca. 1.450 CD's)

CRA: preparing the next generation



Development of the next generation project control decision tool

CRA: keep up to date

- Publishing of research
  - top academic journals ex. JORS, OMEGA, …
  - professional journals ex. PMJ, IPMJ, …
  - popular journals ex. The Measurable News
  - books
- Translate & present research into practical applications
  - PGCS Symposium, EVM Europe, EVM World, ...
- Ghent University Master Thesis – Project Control
  - May 2014: 10 works
  - May 2015: 16 works

We need your help:

"Real life data" needed

Any new ideas? Research suggestions?

Research suggestion – Mr. Pat Weaver

Mosaicproject's Blog

Earned schedule comes of age

posted on 22 april 2013

What is not proved is does ES provide a more reliable end date than CPM? My assessment outlined in ***Why Critical Path Scheduling (CPM) is Wildly Optimistic*** is that ES should be more accurate. Given the mass of data collected by Capt Crumrine it would be a pity if this last step is not applied by a future researcher.

The key role of CPM is (or should be) making the best use of the currently available resources on a project – this is the antitheses of predicting outcomes based on current trends in the way ES does. All that's needed is another Masters candidate!!

EV/ES vs. CPM

Earned Schedule provides a more reliable end date than the CPM method

Table 1. Computational results for the four methods along the completion stage and network structure
Vanhoucke, 2008, IPMA

	Early stage			Middle stage			Late stage		
	P	S/P	S	P	S/P	S	P	S/P	S
PVM	12.30%	13.69%	14.07%	9.91%	9.88%	8.50%	12.08%	9.48%	7.32%
EDM	12.30%	13.69%	14.07%	9.91%	9.90%	8.51%	7.73%	5.52%	3.96%
ESM	10.40%	8.59%	8.22%	7.84%	4.96%	3.76%	4.05%	1.94%	1.31%
CPM	21.10%	14.86%	13.10%	10.81%	8.60%	7.40%	2.55%	2.40%	1.85%

Note 1. The completion stage is measured as the percentage completed EV/BAC with EV the Earned Value and BAC the Budget At Completion. Early, middle and late stages are defined as [0%,30%[, [30%,70%[, and [70%,100%] percentage completed, respectively.

Note 2. The Serial/Parallel degree of a project is measured by the I2 indicator presented by Vanhoucke et al. (2008).

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Education

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PMKC PM Knowledge Center

www.projectmanagement.ugent.be

Operations Research & Scheduling Research Group

www.evm-europe.eu

evm EUROPE ASSOCIATION

Thanks