New Grounds: Time Dimension in Earned Value Management

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Earned Value Management

Scope	EV = Earned Value	How much has been done?
Cost	AC = Actual Cost	How much did the work done cost?
Time	PV = Planned Value	How much was supposed to be done?

Cost Metrics

CV - CPI

Schedule Metrics

SV - SPI

How much will it cost at completion?

COST RESEARCH

Using CPI - metric has been proven usefull in assessing and evaluating final project cost, backed up with lots of research

How long will it take to finish?

SCHEDULE RESEARCH

No back up research & studies available, to the best of our knowledge

Schedule Variance SV

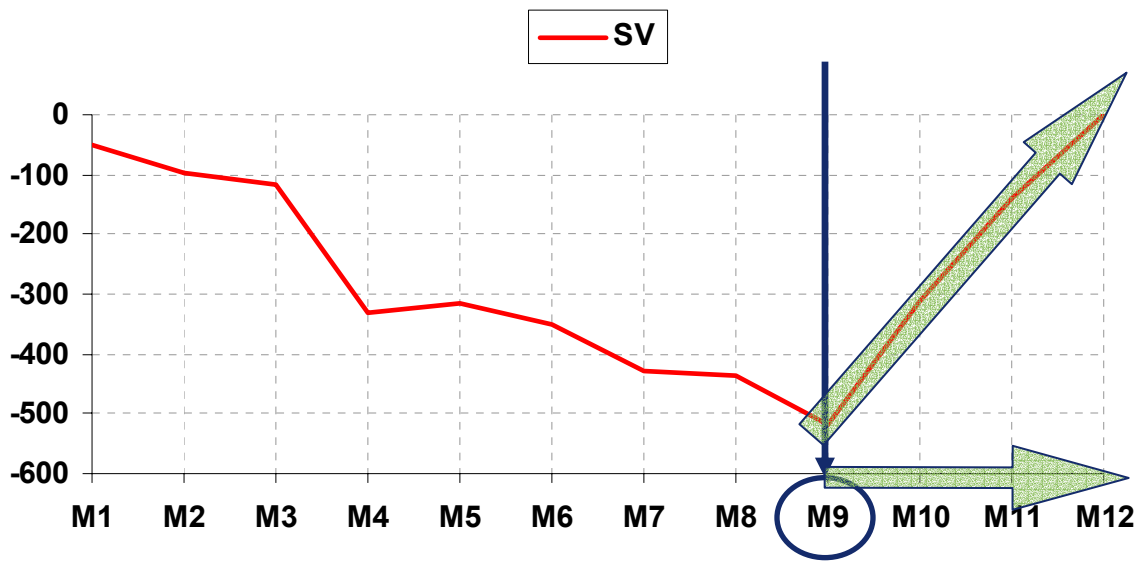
SV = EV - PV < 0: behind schedule > 0: ahead of schedule

SV measures a volume of work performed (€)

- difficult to understand

At the end of the project:

- EV = PV --> SV = EV - EV = 0
- showing perfect performance!



SV shows improving trend

Whilst we are slipping further

At a certain point in time, the SV is no more reliable

Schedule Performance Index

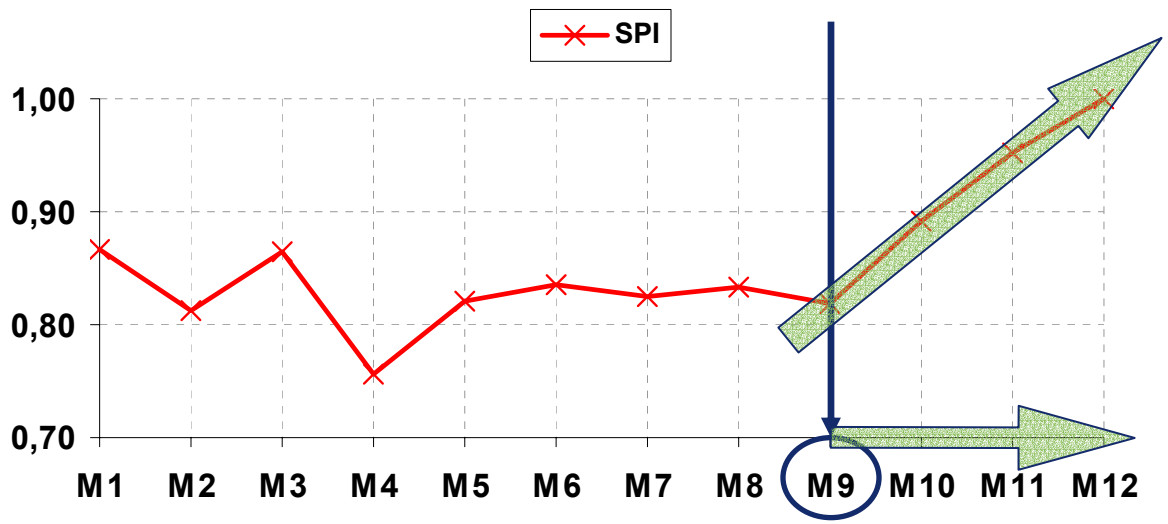
SPI = EV / PV < 1: behind schedule > 1: ahead of schedule

SPI has no dimension

- using an index is easier to understand

At the end of the project:

- EV = PV --> SPI = EV / EV = 1
- showing perfect performance!



SV shows improving trend

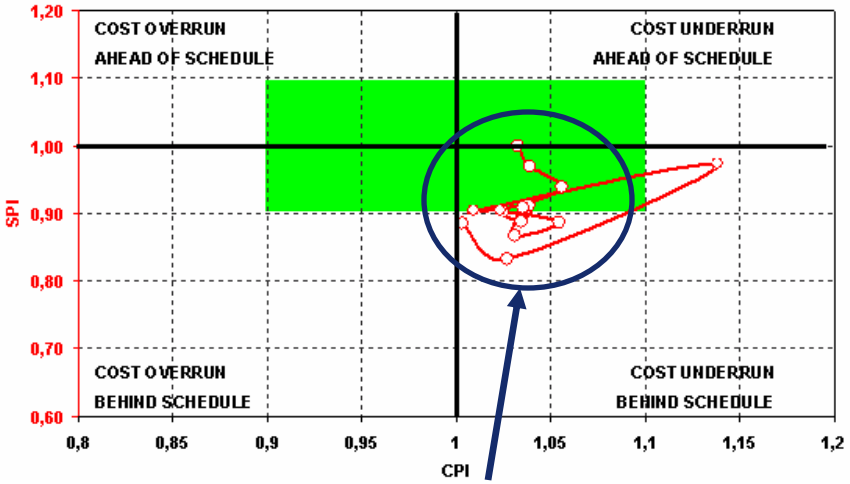
Whilst we are slipping further

At a certain point in time, the SPI is no more reliable

Watch Out

- Be carefull by using data derived from software tools

	DESCRIPTION	LVL	LL	SV	CV	VAC	VAR
1	PCC	3	√	↓	↑	↔	
2	COMMUNICATIONS	3	√	↑	↓	↔	
3	GEN & ADMIN	2	√	↓	↓	↔	
4	SYS ENGINEERING	3	√	↔	↓	↔	
5	I & A	3	√	↓	↓	↔	
6	PROJ MANAGEMENT	3	√	↑	↔	↔	
7	FUNC INTEGRA	3	√	↓	↓	↔	
8	MANAGEMENT DATA	3	√	↑	↓	↑	



Do we really have an improving schedule trend?

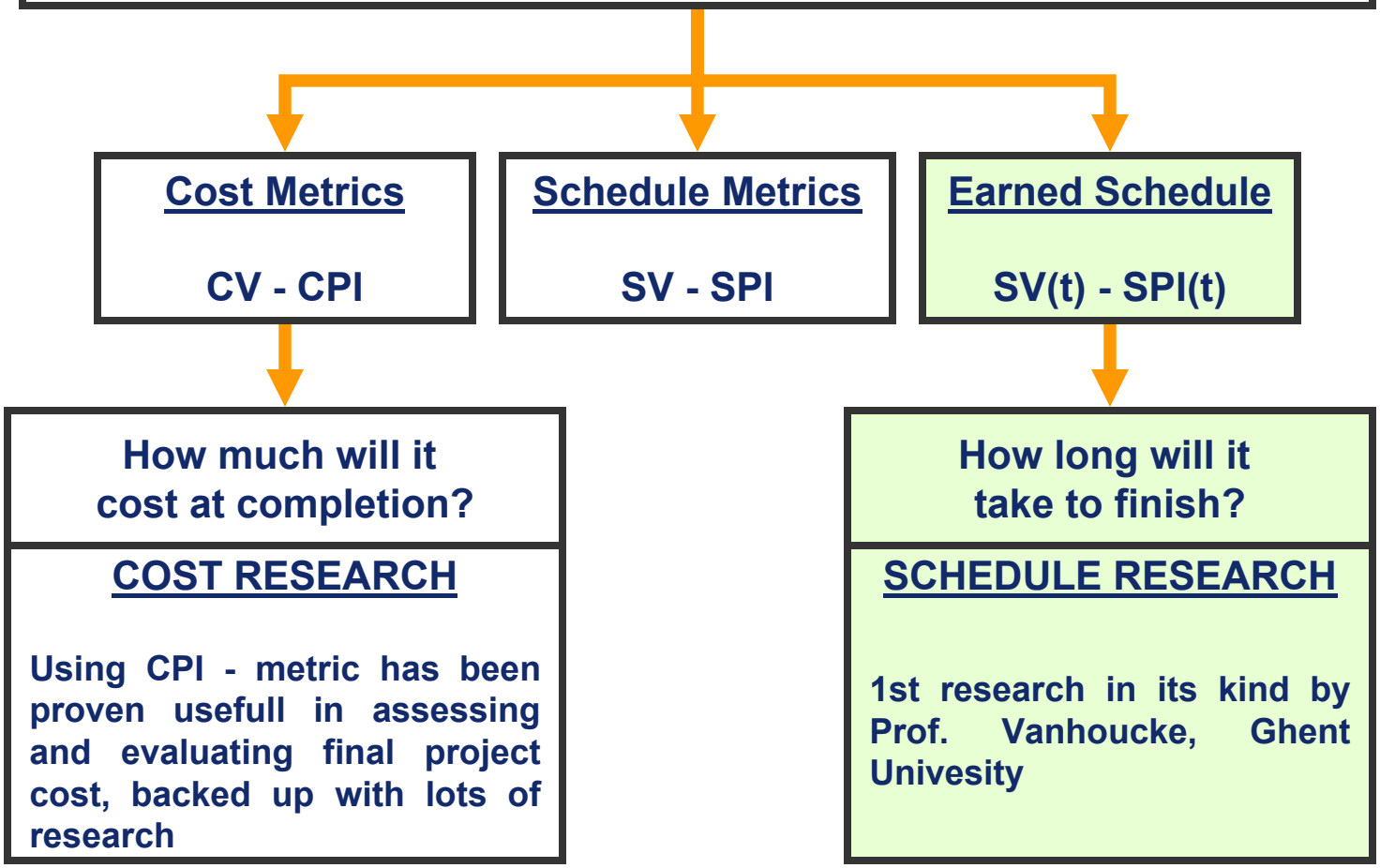
Are we really moving close to the green area?

- May be due to the “strange” behavior of the SV & SPI, no research has been done so far.

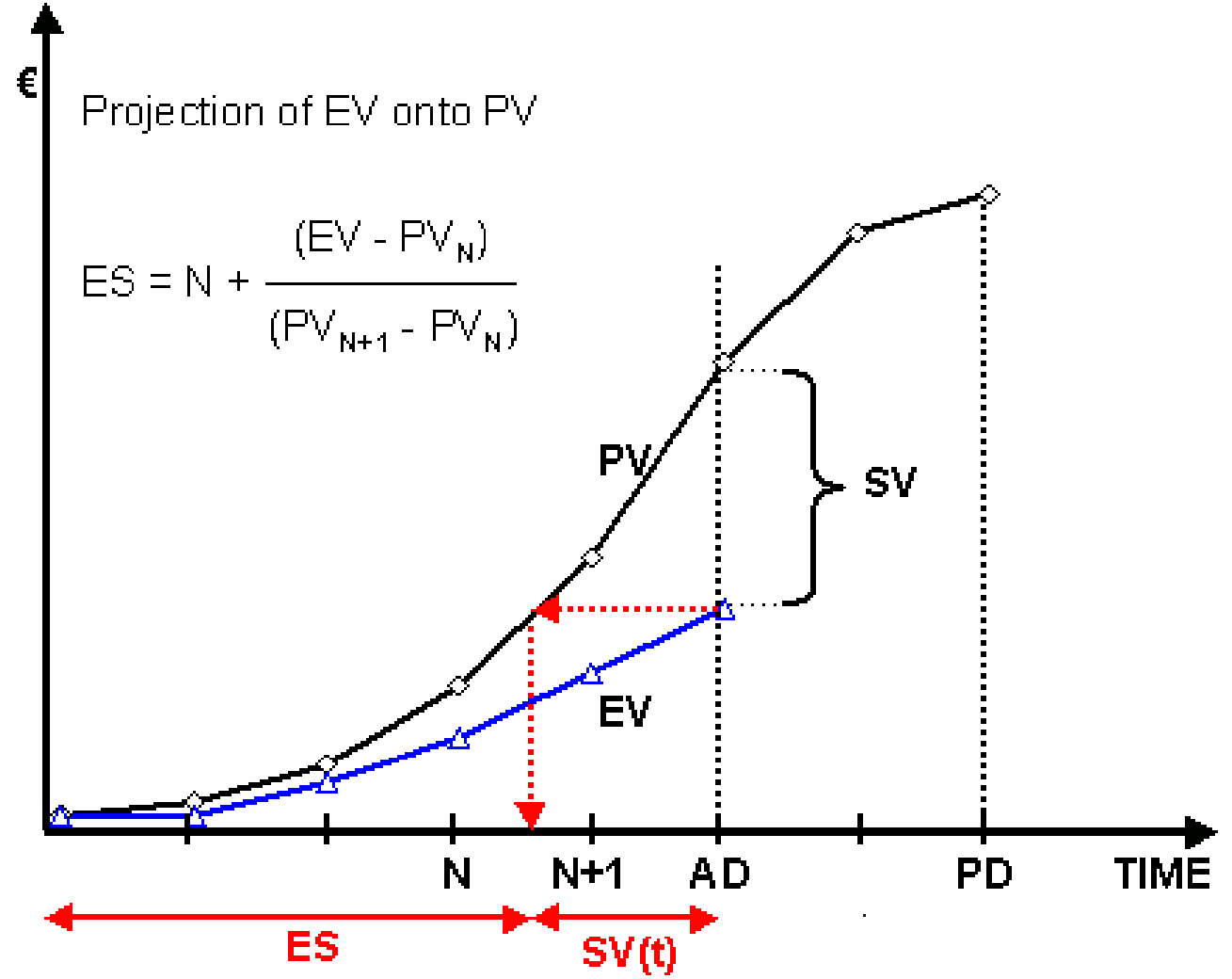
- However there is a need to have a schedule metric which behaves correctly during the whole project life, to sanity check schedule expectations

Extending Earned Value

Scope	EV = Earned Value	How much has been done?
Cost	AC = Actual Cost	How much did the work done cost?
Time	PV = Planned Value	How much was supposed to be done?



Earned Schedule Concept



Created by Walt Lipke, Schedule is Different, The Measurable News, Summer 2003

Schedule Variance SV(t)

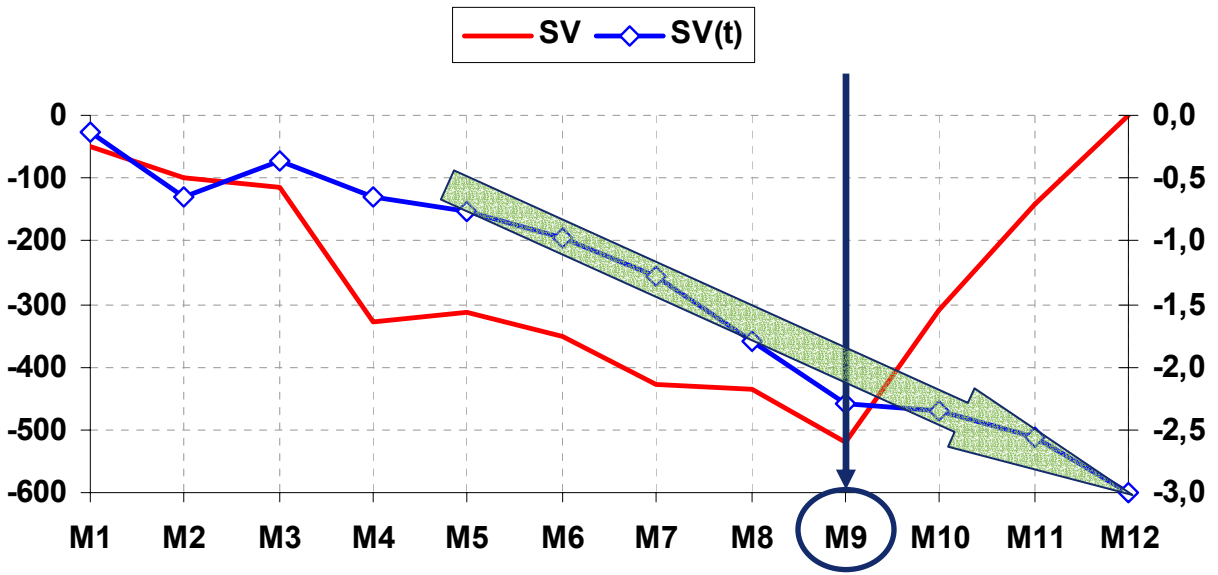
SV(t) = ES - AD **< 0: behind schedule** **> 0: ahead of schedule**

SV(t) measures in time units

- easy to understand

At the end of the project:

- SV(t) shows real deviation from plan



SV(t) shows the real performance

At all time, the SV(t) is reliable

Schedule Performance SPI(t)

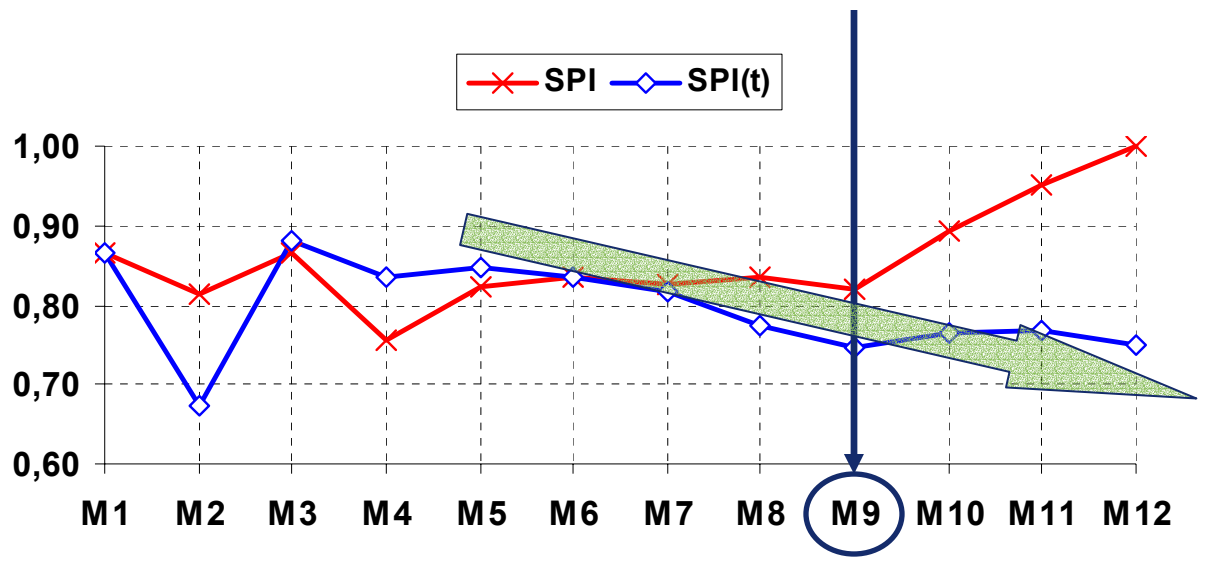
SPI(t) = ES / AD **< 1: behind schedule** **> 1: ahead of schedule**

SPI(t) has no dimension

- easier to understand

At the end of the project:

- SPI(t) shows real schedule performance

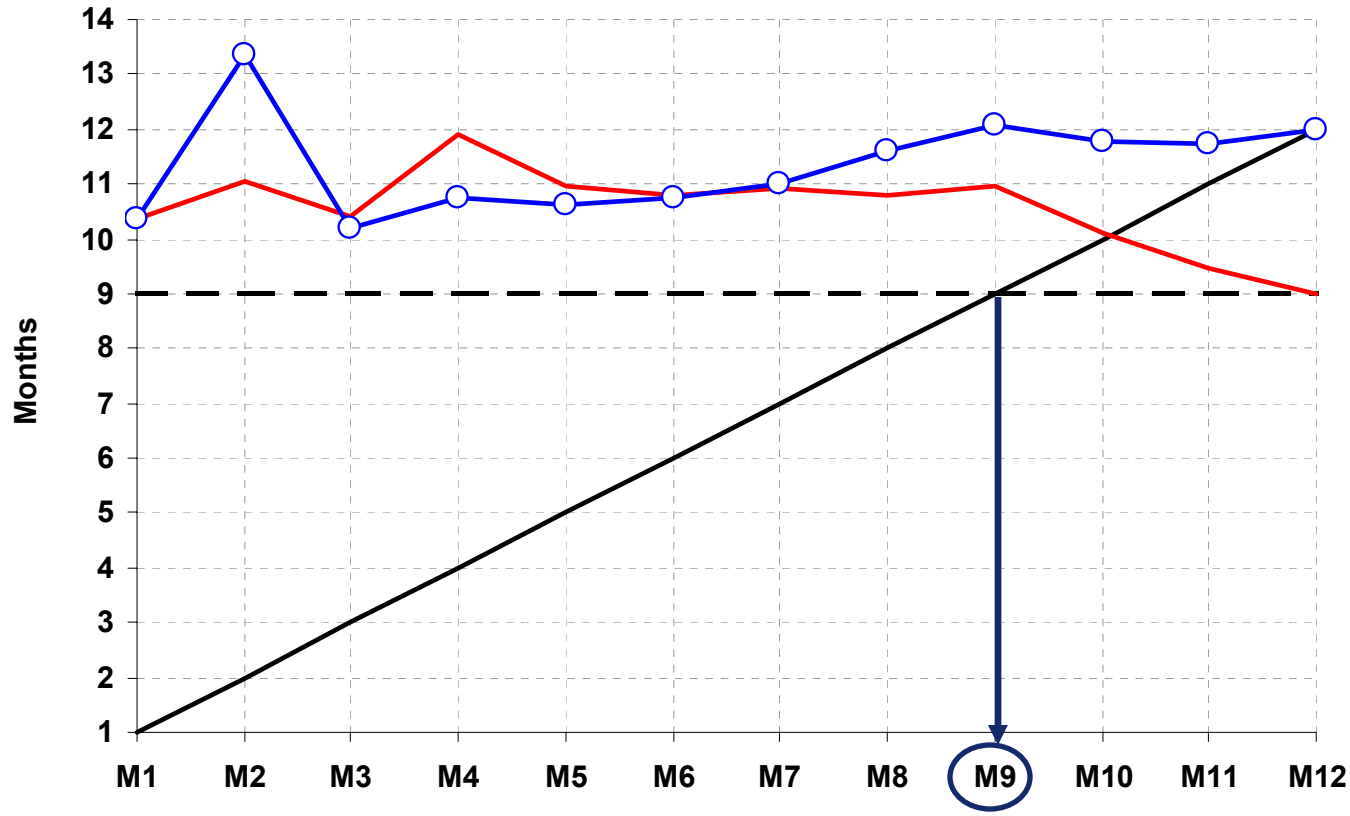


SPI(t) shows the real performance

At all time, the SPI(t) is reliable

Forecasting Duration

EV Method: PD / SPI	ES Method: PD / SPI(t)



PD/SPI: forecasting capability only at early & middle project stage

PD/SPI(t): forecasting capability during the whole project life

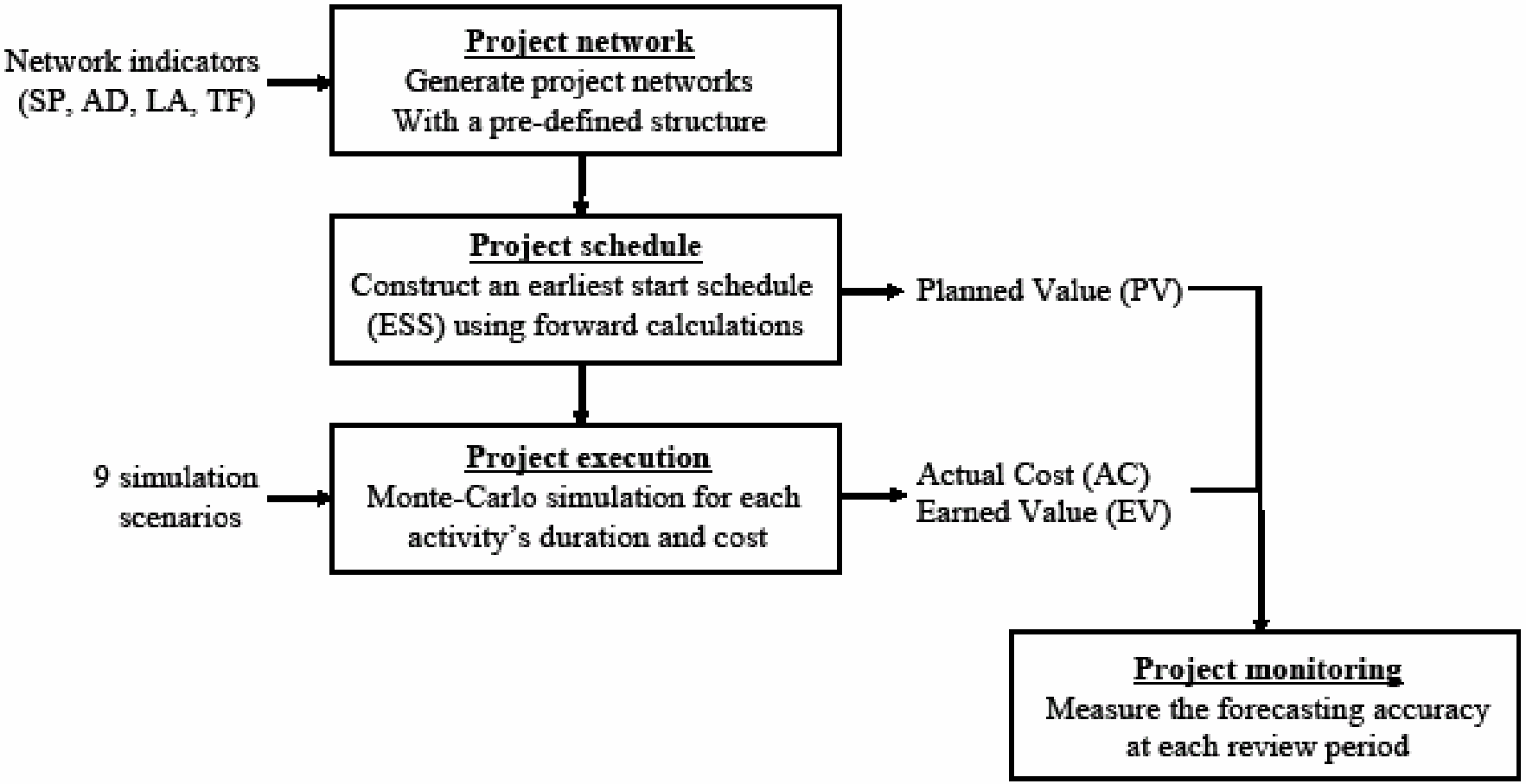
What Next

- Emperical evidence:
  - Vandevoorde St., Vanhoucke M., A Comparison of different project duration forecasting methods using earned value metrics, Ghent University, working paper 2005/312, June 2005
  - to appear in International Journal of Project Management
  - State of the Art Report on Forecasting Duration Methods

  - **Earned Schedule provide schedule metrics which behave correctly during the whole project life,**
  - **Earned Schedule forecasting is more reliable, and usefull to sanity check schedule expectations**

- But can these findings be generalised? So we started a research project.
  - Vanhoucke M., Vandevoorde St., A simulation and evaluation of earned value metrics to forecast the project duration, Ghent University, working paper 2005/317, July 2005
  - paper under submission for publishing in international journal

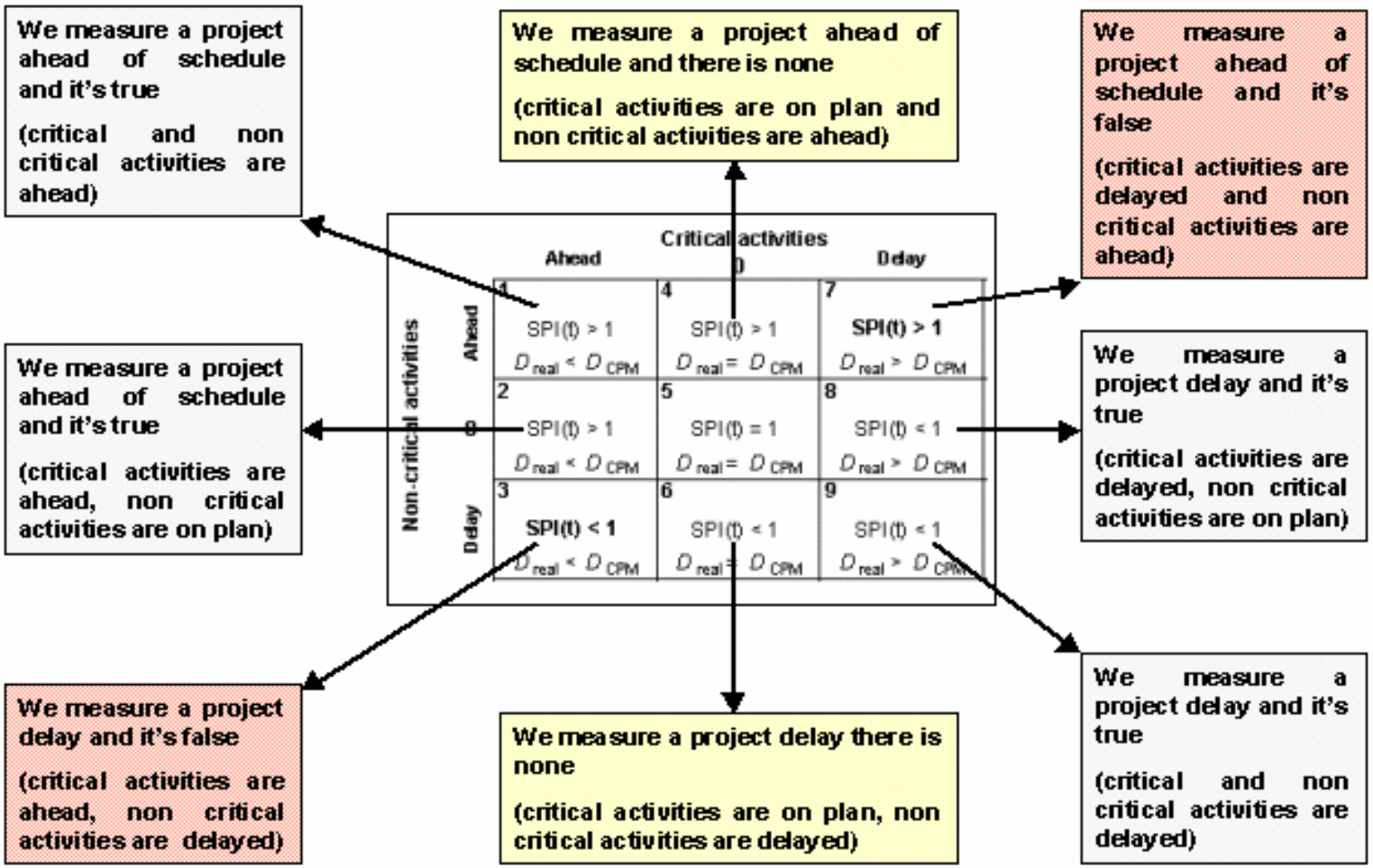
Research Methodology



Network Generation

- So far: ES adopted to a small set of real life project data
- But: we need a very large dataset, which is not available
- Create a database of networks with a controlled topological structure by the using a network generator
- So we guarantee we have a very large set of networks than can and might occur in practice
- To control the design of the generated 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)
  - Based on: Vanhoucke, M., Coelho, J.S., Tavares, L.V. and Debels, D., 2004, “On the topological structure of a network”

Execution scenarios



Research Analysis

1. Forecast Accuracy for each Scenario
   - We measure the overall forecast accuracy of all methods for each scenario by using the MAPE
   - Comparison between scenarios is of little value, as simulations have been forced to reflect the respective scenario

2. Influence of the network structure
   - We measure the influence of the network structure as defined by the network indicators of the forecast accuracy of all methods for each scenario by using the MPE

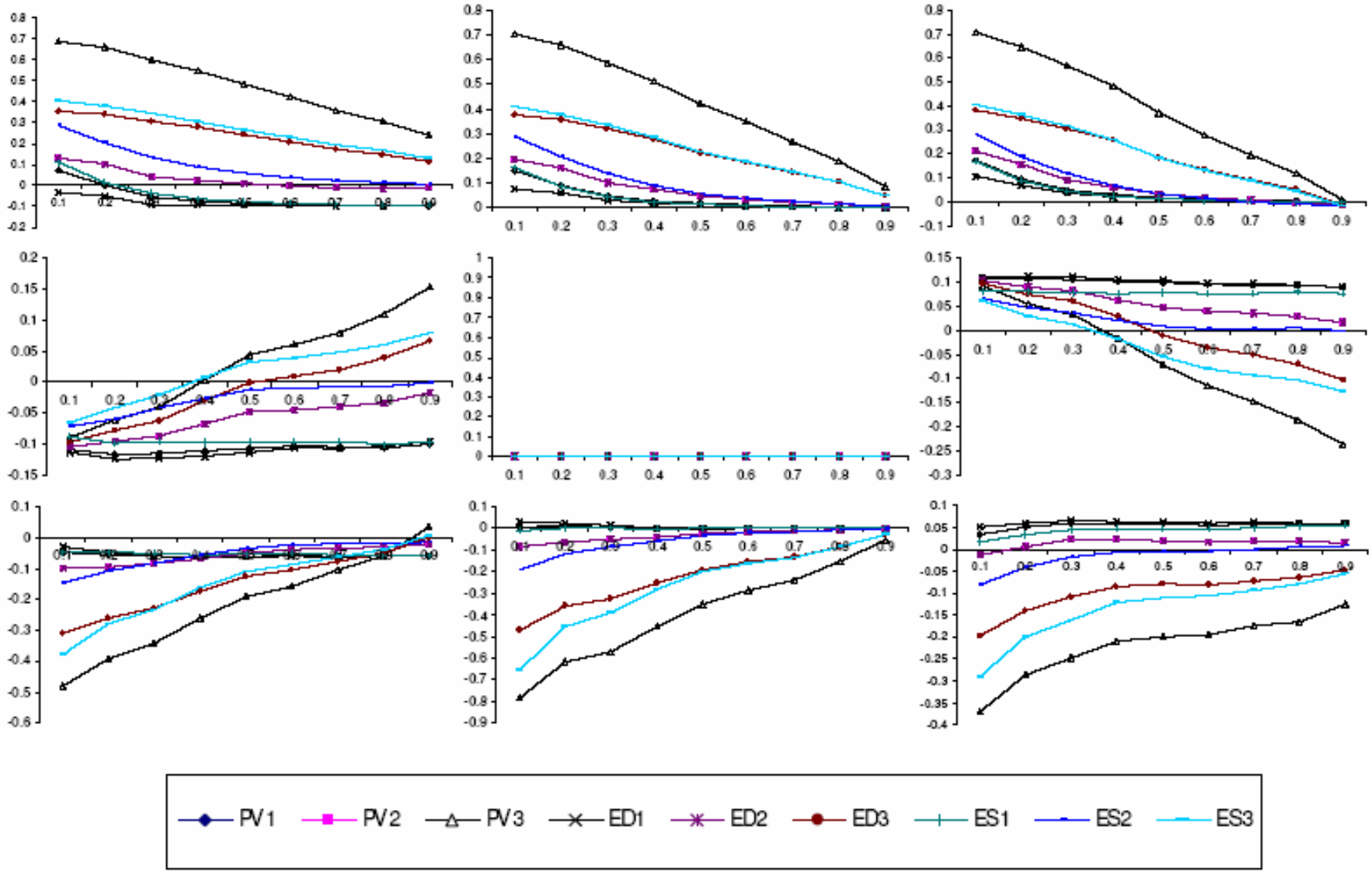
3. Forecast Accuracy along project stage
   - We measure the overall forecast accuracy of all methods along the project stage (early, middle, late) by using the MPE for early and late finish projects

Forecast Accuracy / Scenario

Table 5. The forecast accuracy (MAPE) of the three methods for the 9 scenarios

	PV1	PV2	PV3	ED1	ED2	ED3	ES1	ES2	ES3
Scenario 1	0.106	0.128	0.481	0.112	0.128	**0.249**	**0.076**	**0.099**	0.270
Scenario 2	0.114	0.095	0.101	0.121	0.095	0.087	**0.094**	**0.036**	**0.054**
Scenario 3	0.067	0.080	0.254	0.066	0.080	0.175	**0.055**	**0.064**	**0.164**
Scenario 4	0.035	**0.071**	0.426	**0.023**	**0.071**	**0.229**	0.033	0.092	0.237
Scenario 5	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Scenario 6	0.024	**0.051**	0.416	0.021	**0.051**	**0.242**	**0.019**	0.063	0.273
Scenario 7	0.042	**0.077**	0.409	0.032	**0.077**	**0.222**	**0.034**	0.093	0.227
Scenario 8	0.100	0.090	0.119	0.102	0.090	0.102	**0.076**	**0.031**	**0.067**
Scenario 9	0.061	0.064	0.232	0.064	0.064	0.132	**0.046**	**0.032**	**0.142**

Influence of SP - Indicator



Execution scenarios

Table 9. The mean percentage error (MPE) for project with RD > PD (project delay)

	Early			Middle									Late		
	0-20	0-30	0-40	20-60	20-70	20-80	30-60	30-70	30-80	40-60	40-70	40-80	60-100	70-100	80-100
PV1	0.11	0.10	0.09	0.07	0.07	0.07	0.07	0.06	0.06	0.06	0.06	0.06	0.07	0.07	0.08
PV2	-0.03	-0.03	-0.02	-0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.05	0.06	0.07
PV3	-0.26	-0.24	-0.22	-0.16	-0.15	-0.14	-0.14	-0.13	-0.12	-0.14	-0.13	-0.12	-0.07	-0.06	-0.04
ED1	0.11	0.11	0.10	0.08	0.08	0.08	0.08	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.08
ED2	-0.03	-0.03	-0.02	-0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.05	0.06	0.07
ED3	-0.24	-0.22	-0.19	-0.12	-0.10	-0.08	-0.09	-0.08	-0.06	-0.08	-0.07	-0.05	0.03	0.04	0.06
ES1	0.11	0.10	0.10	0.08	0.07	0.07	0.07	0.07	0.06	0.07	0.07	0.06	0.03	0.03	0.02
ES2	-0.04	-0.05	-0.04	-0.03	-0.03	-0.02	-0.02	-0.02	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00
ES3	-0.26	-0.24	-0.22	-0.14	-0.13	-0.11	-0.12	-0.10	-0.09	-0.10	-0.09	-0.08	-0.03	-0.02	-0.02

Table 7. The mean percentage error (MPE) for project with RD < PD (ahead of schedule)

	Early			Middle									Late		
	0-20	0-30	0-40	20-60	20-70	20-80	30-60	30-70	30-80	40-60	40-70	40-80	60-100	70-100	80-100
PV1	-0.89	-0.83	-0.78	-0.64	-0.60	-0.56	-0.60	-0.56	-0.52	-0.56	-0.52	-0.47	-0.29	-0.25	-0.21
PV2	-0.16	-0.15	-0.16	-0.14	-0.15	-0.15	-0.14	-0.15	-0.15	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14
PV3	0.35	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.38	0.38	0.38	0.39	0.39
ED1	-0.94	-0.89	-0.84	-0.72	-0.68	-0.64	-0.68	-0.64	-0.60	-0.64	-0.60	-0.55	-0.35	-0.31	-0.27
ED2	-0.16	-0.15	-0.16	-0.14	-0.15	-0.15	-0.14	-0.15	-0.15	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14
ED3	0.32	0.31	0.29	0.24	0.21	0.19	0.22	0.19	0.17	0.19	0.17	0.15	0.04	0.01	-0.01
ES1	-0.91	-0.86	-0.80	-0.67	-0.62	-0.57	-0.63	-0.58	-0.53	-0.58	-0.53	-0.48	-0.23	-0.18	-0.13
ES2	0.05	0.05	0.04	0.03	0.02	0.02	0.02	0.02	0.01	0.02	0.01	0.01	0.00	0.00	0.00
ES3	0.44	0.42	0.40	0.33	0.30	0.28	0.30	0.28	0.25	0.28	0.26	0.23	0.11	0.09	0.07

Conclusions/Future Research

1. Forecast Accuracy (continued)
   - Accuracy of time and cost metrics
   - Need for new software package?
   - Real-life data available?

2. Project complexity?
   - What if the project is not yet defined?
   - Rework / Uncertainty / Dynamic planning / …

3. Early warning or corrective action?
   - What do we do with more accurate metrics?
   - Corrective actions (re-active) or management reserve (pro-active)?

Questions

Coming Soon:

Management Jaarboek 2006

“Waar zit het tijdsaspect in een “earned value” meetsysteem?