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THE **MEASURABLE NEWS**

The Quarterly Magazine of the **College of Performance Management**

2015.04

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INSIDE THIS ISSUE

THE MEASURABLE NEWS

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2015 ISSUE 04

CONTENTS

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Publisher: College of Performance Management
Story Editor: Peter Schwarz
Design: id365 Design + Communications
Communications VP: Mark Phillips

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College of Performance Management
12100 Sunset Hills Road, Suite 130
Reston, VA 20190
Ph 703.370.7885 • Fx 703.370.1757
www.mycpm.org

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IN THIS ISSUE...

Matthew T. Gonzales

In this issue of The Measurable News we have three articles that cover a wide range of topics.

'Classroom Experiments on Project Management Communication' takes a look at learning tools for Project Management that can be employed in a traditional academic environment. Putting a positive spin on the earned value analysis process, we explore the F.A.I.R. model used by CAMs to ensure consistent and thorough monthly analysis of earned value data. And we get a detailed synopsis of Agile content and the 'Top 10 Agile and EVM Concepts' from EVM World 2015.

In his article 'Classroom Experiments on Project Management Communication', Mario Vanhoucke provides a brief overview of three sets of experiments in the classroom with students following a Project Management (PM) course module using a blended learning approach. The paper consists of the following sections. Section 2 gives a brief summary of the learning objectives of the Project Management course module used for the communication experiments. In section 3, the three types of experiments are explained and results are given. Section 4 draws overall conclusions and highlights the need for future research on this interesting topic.

'So you want to know how bad I'm doing' has been a common sentiment among Control Account Managers (CAMs) using the earned value management system. Matthew Gonzales, a project business manager at the Jet Propulsion Laboratory and 30 year earned value practitioner, explores the concept of a standard earned value analysis approach for the CAM in his OP/ED piece that describes his F.A.I.R. model. The F.A.I.R model is a simple step-by-step approach for the CAM to analyze data and report variances, by reviewing Fidelity of data, Assessing historical trends, Identifying emerging issues, and Realism of the estimate at complete. Mr. Gonzales shares the model and a monthly EV Analysis workbook for the CAM to use when doing monthly EV analysis.

Top 10 Agile and EVM Concepts from EVM World 2015, as reported by Andrea Nibert, EVP, is a recount of the EVM World discussion on Agile and EVM.
What does the Agile and EVM implementation look like in 2015? How is Agile and EVM evolving? Agile and EVM content was a theme during EVM World 2015 keynote presentations, work shop sessions and practice symposia sessions. The Agile Track at EVM World 2015 was comprised of six sessions, focused on discussing the current state of Agile and EVMS implementation. The first session was an introductory session designed to educate those new to Agile. The content of the remaining five sessions were panels, strategically aligned with considerations for establishing and then executing a program plan. Whether the program has an Agile component, an EVM component, both or neither, the best program management business practice is to establish a plan prior to executing. Measuring progress as a contract is executed is a program management requirement, Agile methodology, EVM or not.

Also included in this issue is a summary of the CPM WDC July 15, 2015 meeting, and be sure to check out the CPM election results.

SAVE THE DATE – CPM TENNESSEE VALLEY MEETING

TUESDAY, DECEMBER 1, 2015 | 3:00 TO 5:00 PM CENTRAL TIME
DEFENSE ACQUISITION UNIVERSITY, HUNTSVILLE, AL

MEET THE 2016 CPM GOVERNING BOARD

As a result of the recent CPM Governing Board Election the Governing Board wishes to congratulate:

CPM President: Wayne Abba
Wayne has been elected for a three year term as President

VP Administration: Lauren Bone
Lauren was re-elected unopposed for a further three year term

VP Communications: Lisa Wolf
Lisa has been elected unopposed to the board, for a three year term

As announced as part of the 2015 Governing Board election notice:

VP Education & Certification: Bill Mathis
Bill completed 2 years of a term of office vacated due to illness. The Board has extended his term for 1 year to enable continuity on development of the valuable CPM certification activity

VP Conferences & Events: Susan Wood
Susan undertook the duties of this vacant office whilst also serving as Immediate Past President. The Board has asked her to remain for the balancing one year term now that her former role is complete

Immediate Past President: Gary Troop
With the election of a new President Gary becomes Immediate Past President for a term of three years

Continuing in post for the remaining year of their term of office:

VP Global Outreach: Kym Henderson

VP Research & Standards: Dale Gillam

Executive VP Finance: Buddy Everage

Executive VP: Vacant
Due to the recent election of Wayne to CPM President this position has been declared vacant. The board will resolve arrangements for the balance of term.

Please visit http://www.mycpm.org/about-us/council/ for further information about each of the board members and details about how to contact them.

EVM WORLD 2015 AGILE AND EVM CONTENT

By Andrea Nibert, EVP

CPM's EVM Library first documents Earned Value in an Agile Environment during the Fall IPM Conference in 2007[1]. What does the Agile and EVM implementation look like in 2015? How is Agile and EVM evolving?

Agile and EVM content was a theme during EVM World 2015 keynote presentations, work shop sessions and practice symposia sessions. Are you executing a contract requiring both an Agile methodology and an Earned Value Management System (EVMS)? Have either been tailored to work together? Are either transparent? Have you experienced pushback from Agile projects who say that because they are Agile that they do not need to measure anything?

AGILE TRACK EVM WORLD 2015

The Agile Track at EVM World 2015 was comprised of six sessions, focused on discussing the current state of Agile and EVMS implementation. The first session was an introductory session designed to educate those new to Agile. The remaining five sessions were panel discussions, focused on the current state of Agile and EVMS implementation, and strategically aligned with considerations for establishing and then executing a program plan. Whether the program has an Agile component, an EVM component, or both, the best program management business practice is to establish a plan prior to executing. Measuring progress as a contract is executed is a program management requirement, Agile methodology, EVM or not.

PANEL DISCUSSIONS

The five panel sessions were: WBS and Product Backlog; Planning, Scheduling and Baselining; Change Control; Measuring, Collecting and Reporting Progress; and, Forecasting ETCs and the Schedule. The panelists represented multiple companies and a wide range of experiences within the industry – Paul Gorans (IBM), Neil Albert (MCR), Tim Boatwright (Ten Six Consulting), Robin Yeman (LM), Pam Walter (Leidos), Barbara Phillips (Eagle One Solutions, Inc.), Ron Terbush (LM), Glen Alleman (Niwot Ridge Consulting), Ray Stratton (Management Technologies), Julianne Miller (Leidos), and Matthew Strain (GD). The panelists shared their experiences and lessons learned on adapting their corporate procedures and processes to optimize merging the Agile and EVM systems, and to measure progress. Contributing to process improvement are the joint government and industry working groups, which continue to meet and share ideas leading to the identification of best practices which lay the foundation for a common solution set. The panelists were also interviewed for this article and willingly communicated their ideas.

AGILE AND EVM AT OTHER VENUES

Agile and EVM topics were not only addressed in the Practice Symposia sessions – Agile content was also part of a keynote presentation and work shop presentations. Gary Bliss's keynote remarks are captured and reported by one of the panelists, Mr. Ray W. Stratton, PMP, EVP, as follows:

"Mr. Gary R. Bliss, Director, PARCA gave the kickoff keynote at EVM World, titled "Maintaining IPM Discipline in an Agile Environment". "He said that the key problem is how to incorporate Agile in EVM systems. Two important items separate EVM from cost accounting, (a) effort is measured against a baseline and, (b) the mechanics for measuring performance are divorced from resources used. The key is "what progress has been made?"

"He added that in the commercial world organizations seek to thrive and make a profit. It drives them. In government the goal is to prevail. But to prevail the government must iterate at the rate of technology and change. Right now we (the US) are behind and need to be more agile – and EVM is a part of this."

[1] http://www.evmlibrary.org/library/PS35.pdf

Bliss said that Agile is not new. He gave the Berlin Airlift operations as an example. Every three minutes a plane took off with supplies for the citizens of West Berlin. Process was key. Something was delivered every three minutes. What was delivered depended on how the loading went. If something did not make the flight, it made the next one. (Think "sprints".)
"He added that if the EVM community can't figure out how to apply EVM to Agile then we don't have a tool to manage Agile."

"According to Bliss, don't track sprints. They will happen anyway. Track the content. Like the aircraft of the Airlift, there was no point in recording when the planes landed, they just did. Every three minutes. Measure the cargo. (Supplies needed by the residents of West Berlin, per day: 646 tons of flour and wheat, 125 tons of cereal, 64 tons of fat, 109 tons of meat and fish, 180 tons of dehydrated potatoes, 180 tons of sugar, 11 tons of coffee, 19 tons of powdered milk, 5 tons of whole milk for children, 3 tons of fresh yeast for baking, 144 tons of dehydrated vegetables, 38 tons of salt and 10 tons of cheese, 3,475 tons of coal and gasoline.")

"He closed by telling the audience that Agile is the new norm. If we don't adopt Agile we will fall further behind our adversaries."

Some members within the community believe that EVM should not be required if an Agile methodology is part of the contract. Some believe that Agile metrics are enough to execute and track progress on a contract. Agile alone is not enough, as the cost impact of the program management triangle is represented through EVM. Agile represents a fixed cost. Since the first CPM library documentation in 2007, Agile and EVM have been gaining synergy. They do work together and details are continually evolving. Most programs have started by tracking sprints and / or releases as some type of a work package. Most programs have since realized that tracking the progress of the feature(s) or technical function(s) being developed is a better representation of the progress of the contract. Simply tracking the status of the time box is not a recommended approach. Is there such a thing as an "Agile WBS"? There does not have to be, when you plan the product based work. Most programs believe there is merit in tracking story points. The current question is how to use the story points relative to tracking progress? As percent complete? As a weighted milestone? As an earning rule?

Further, acknowledging that some of the traditional waterfall approaches of literally interpreting each requirement as precise scope may not fully represent the delivery of the feature or system functionality to meet the customer or end user expectations. There is merit in the commercial approach of delivering to market the product that end users want, without a predefined prescriptive fixed set of requirements. EVM as a best practice integrated program management approach can control scope. For government application, scope should not be considered either completely flexible or fully defined. It is controlled. The feature has a distinct set of acceptance criteria and the corresponding work package has exit criteria as defined to deliver the contractual scope. Whereas requirements are details or inch stones within the overall system functionality, a requirement can be deleted or added without impacting the overall feature or system functionality acceptance and exit criteria. Use your corporate contracting approach, program management procedures, Agile methodologies and EVMS to your advantage to control scope. There is a natural hierarchy (vertical traceability) from the EVM hierarchy (CBB, PMB, UB, SLPP, Control Account, Planning Package, Work Package, Milestone) through the Agile hierarchy (System, Capability, Epic, Release, Feature, Sprint, User Story, Task). At this time, it is believed that every Agile component should not be represented one for one in the Performance Measurement Baseline (PMB). Find the correct intersection point of the two hierarchies to manage and execute each contract.

Please refer to the "Top 10 Agile and EVM Concepts from EVM World 2015" article in this publication of the Measurable News for more detailed concepts discussed at EVM World. What are the next steps? What are the upcoming initiatives?

NDIA IPMD (http://www.ndia.org/Divisions/Divisions/IPMD/Pages/WorkingGroups.aspx) has an Agile and EVM working group led by Kathy Dailey. A panel session at the August IPMD Event (http://www.ndia.org/Divisions/Divisions/IPMD/Pages/Events.aspx) discusses the initial guidance produced by working sub-groups on Agile and EVM. Content includes: Terms and Definitions; WBS and IMS; and Managing Change. Once the guidance is approved, it will be posted on the IPMD website. NDIA requires published guidance to be reviewed and updated accordingly at a minimum of every three years. Please coordinate with your NDIA Corporate EV Focal Point if you do not have access to the NDIA web site and look for updated guidance to evolve with the various community initiatives.

PARCA (http://www.acq.osd.mil/evm/resources/Initiatives.shtml) has been very active in the Agile and EVM initiatives. They have a significant presence at the fall and spring EVM conferences, as evident by the presentations led by Gordon Kranz, PARCA Deputy Director for Earned Value Management. Although Gordon will be leaving the Government to pursue other opportunities, Agile and EVM will remain a PARCA priority under the leadership of Mr. John McGregor, who will continue the Government Industry communications on how EVM and Agile can work together.

GAO (http://www.gao.gov/products/GAO-12-120G) has been updating the Best Practices Scheduling Guide, planned to be published by the end of GFY'15. GAO is also developing a separate guide for Agile Methodologies, Cost Estimating and EVM. Karen Richey and her team have been socializing their audit findings and the scheduling guide updates through NDIA events and fall and spring EVM conferences. (http://www.ndia.org/Divisions/Divisions/IPMD/Documents/Events/2015-04-QuarterlyMeeting/Presentation%20April%2015/J_Collymore_GAOPRESENTATION_TO_NDIA.pdf) The content of the above presentation will give Agile insight to the new Agile, Cost Estimating and EVM Guide, however, it will no longer be published as an Agile appendix to the Best Practices Scheduling Guide, which is planned to be released by the end of GFY'15.

CPM WDC (http://mycpm.org/cpmwdc) held three consecutive meetings in 2015 in the Washington, DC area focused on the Agile and EVM topic. Panelists that served both CPM WDC and the spring conference were: Matt Strain, Andrea Nibert, Ron Terbush and Paul Gorans. Barbara Phillips served as a moderator for CPM WDC and then as a panelist for the conference. There is opportunity to learn at the local area and leverage for the national audience served by the fall and spring EVM conferences. CPM WDC meetings take caution to ensure attendees are active in the discussion and typically have to limit questions to ensure all get an opportunity to get their questions answered. See the MN article on CPM WDC's next meeting in October 2015 where Gordon Kranz has been invited to speak.

Agile is not scary, it is a reasonable approach to provide incremental value. Everyone is all in – are you? Get value to the customer faster! Is your performance measurement system flexible enough to do so? Agile adds value, period. Embrace and adapt to the change. Experience more Agile and EVM content at IPMW 2015 (http://ipmconference.org/) November 16-18 in Bethesda, MD. The Agile Track will be comprised of both panels and presentations, structured to various levels of exposure to Agile and EVM.

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TOP 10 AGILE AND EVM CONCEPTS FROM EVM WORLD 2015

By Andrea Nibert, EVP

The "top 10" concepts discussed at EVM World 2015, based on industry experience as of May 2015 are highlighted in this article. If you were in attendance, you may recall that most responses from the panelists during the Agile and EVM panel discussions started with "well, it depends." As the concepts below are applied to the program being executed, remember, everything "depends" on the contractual requirements, the contractor's EVM Systems and defined agile practices, and the customer's experiences and expectations.

THE "TOP 10" CONCEPTS ARE:

1. Agile and EVM do work together. Embrace and adapt to report value to the customer faster. Manage the changing baseline.

2. Establish the Agile approach for the program early. What is the hierarchy? (System, Capability, Epic, Feature, Release, Story, Task). Determine (and keep) a set team with diverse, complementary skills and establish a common sizing approach. Story points are a way to weight the complexity of the product. Will all Control Accounts utilize an agile methodology? There should be vertical traceability between the Agile and EVM hierarchy. Complete the right amount of system engineering first.

3. Engage the customer product owner (who has business value responsibility) early and often during the planning/discovery sessions. Do not commit to deliver more than required on the contract. If required to do Agile on software development CLINs, don't plan everything in the Agile tool. Determine if customer will have full access to the Agile tool for transparency of the agile data, which could allow for a higher level schedule with vertical traceability in the Agile tool.

4. The agile process is disciplined. Teams tend to estimate or size the user stories optimistically in the beginning. Their velocity will normalize over time, as they continue working together. Teams do not arbitrarily move user stories across sprints or releases. It is a disciplined coordination between the team and the product owner to move user stories. Be cognizant of the "bow wave" and the burn down of the team completing user stories to monitor agile progress.

5. The Work Breakdown Structure (WBS) MIL-STD-881 standard is a template and a guideline, it is not prescriptive, it is adaptable. Do what is best for the contract. Is Software the mission product? A product oriented WBS is important, but, adapt and tailor it accordingly to facilitate and report measuring product completion. There does not necessarily need to be a difference between a waterfall and Agile WBS. Gain consensus with the customer on the structure.

6. Plan and schedule the feature and / or the functionality to be delivered. It seems natural to start by planning and scheduling the time box (the sprint or the release). Plan the work or the product to be delivered and let the agile process manage the time box.

7. Use the Agile process and EVM together as an approach to control scope. For government application, scope should not be considered either completely flexible or fully defined. It is controlled. The feature has a distinct set of both acceptance and exit criteria as defined to deliver the contractual scope. Whereas requirements are details or inch stones within the overall system functionality, a requirement can been deleted or added without impacting the overall feature or system functionality acceptance and exit

criteria. Use your corporate contracting approach, program management procedures, Agile methodologies and EVMS to your advantage to control scope.

8. Story points completed divided by the total story points planned for a feature can be calculated as a percent complete with quantifiable backup data to measure progress. However, this approach could potentially result in negative earned value to be reported as the agile process naturally executes. The trending model is to use story points relative to weighing the interim milestones. The product is the feature with the stories as a means to weight the milestones while monitoring the completion of the stories to measure the progress of the product being delivered.

9. Forecast assessments should be conducted based upon the individual agile team in question and generalizations should be avoided, where possible. Specifically, each agile team within an agile train will have its own profile for velocity and overall work complexity. Because of this they should not be measured or forecast with a blanket velocity assumption as each team will produce on a different curve. Velocity can be used as a means to validate the estimate to complete (ETC) for a team supporting a specific feature. Continue to forecast the ETC according to the EVM process. Both Agile and EV metrics should be somewhat consistent.

10. Consider the corporate culture with regard to both the agile process maturity and the Corporate EVMS Description (EVMSD). Do not underestimate the impact of the corporate culture and maturity level of embracing agile and EVM processes. Agile philosophies will play into how the program is structured. That structure may drive how scope is documented. With a very prescriptive EVMSD, a lower level of tracking may be required than a company with a less prescriptive EVMSD. Likewise, the corporate infrastructure to support EVM may impact the ability to execute the EVMSD with an agile program.

Commitment from all levels of the organization is required for successful and efficient execution of both the Agile and the EVM processes. The Agile community has a fable that can periodically be referenced to check itself if that level of commitment could be an impediment for an individual or a team. Are you a pig or a chicken?

What is next with Agile and EVM? Since EVM World 2015, these thought leaders along with other members of both industry and government have been working together to continue the discussion and put pen to paper to document a shared set of commonly accepted best practices to support the integration of Agile and EVM. By the time you read this article in the Measurable News, many of those documents will be published. The latest information will be shared at the Integrated Program Management (IPM) Workshop 2015.

EARNED VALUE ANALYSIS, THE FAIR MODEL

by Matthew Gonzales

> "What is practicable must often control what is pure theory."
> - Thomas Jefferson

It is circa 1985 and I am a young buck working as a business analyst for TRW, an aerospace company, attending my first ever meeting on Earned Value Management (EVM). We are a new manufacturing division for avionics hardware and are bringing on line a VAX/VMS mainframe system as part of infrastructure development. The division manager wants to track progress of the IT project using earned value metrics, which was the impetus for the EVM kick off meeting. Upon informing the IT project lead that we would be using earned value to track his progress, the first words out of the project lead's mouth were, "Oh. So you want to know how bad I'm doing?"

Thirty years hence, I have found this to be a common attitude by the Control Account Manager (CAM) community. With the perception that the system tracks 'how bad I'm doing', the CAM is not particularly motivated to participate in the system. Having implemented earned value management systems, techniques and tools on dozens of government projects, I have experienced CAM responses ranging from apathy to outright hostility, which seems to be born of this negative perception.

The earned value management approach has gained wide acceptance with government oversight agencies, contracting communities and independent analysts. The basic building blocks, upon which all analysis is predicated, are the CAM inputs into the system. The CAM needs to establish robust, stable and accurate baseline plans, provide accurate assessments of work accomplished, and conduct variance analyses that result in a realistic projection of an at-complete position for both cost and schedule. If the quality of the input by the CAM is not uniformly implemented on the project, the resulting analysis is less accurate due to the variability of quality (accuracy) of the foundational data. Also, as a project business manager who is analyzing at level 1 and 2 of the project, normalizing the quality of the inputs is extremely important as I don't want to have to drill down every time to find outliers at the account level due to poor quality inputs by a CAM.

The responsibility of implementing a robust and accurate earned value management system often falls upon the business management function on the project. Size and complexity of the project determines the business management presence. Large complex projects can have dozens of project control professionals deployed, along with a business management reporting hierarchy. A few professionals in a flat organization structure, reporting directly to a project manager, might support small projects.

Regardless of project size, the business management team should develop a series of processes to circumvent the 'how bad I'm doing' dynamic that could afflict the CAMs.

Established techniques and tools have been employed to ensure a robust, accurate, and stable baseline plan is put in place. Basis of Estimates (BOEs) and documented key assumptions are reviewed and discussed by the CAM and project manager prior to setting a baseline.

The 'how bad I'm doing' dynamic becomes very prevalent during the recurring monthly management cycle, when assessment of progress is made, variances analyzed and reported. Normalized quality (accurate) inputs for the subsequent variance analysis step, done monthly by the CAM, are achieved by implementing a standardized analytic model.

The remainder of this discussion is focused on definition and utilization of a standard analytic model, FAIR.

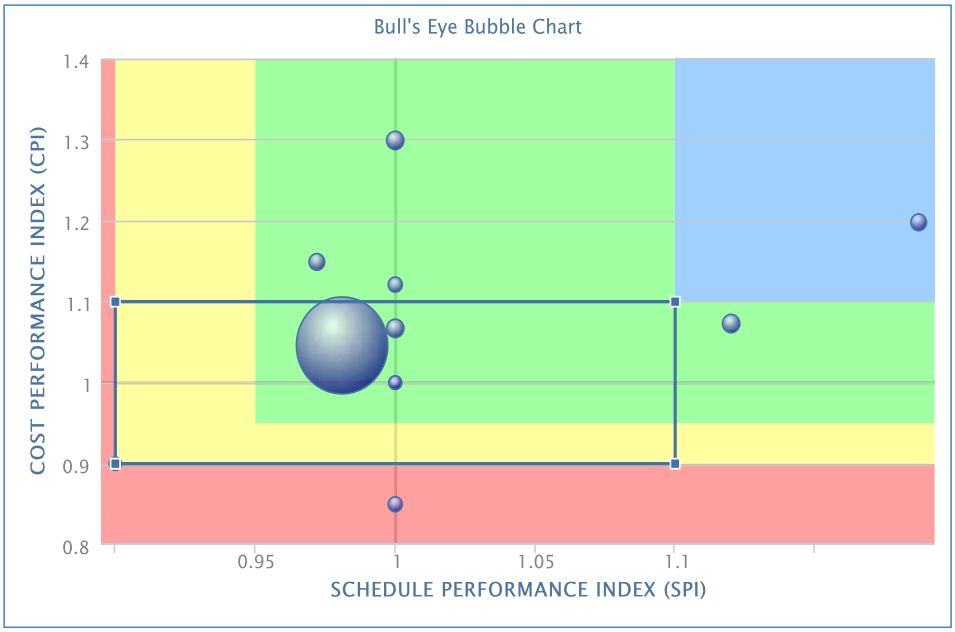
F - Fidelity of your data, validate,
A - Analyze Performance Trends,
I - Identify emerging issues:
R - Realism of Estimate at Complete (EAC)

The FAIR analytic model uses standard earned value analysis approaches, laid out in a step-by-step fashion enabled by state of the art analytic software. This provides the CAMs with a methodology, to follow every month, for reviewing and analyzing their performance data. The web based software tools enable the process by quickly and easily disseminating performance data to CAMs as well as being the data repository for variance analysis reporting and tracking.

A key attribute of the FAIR model employs the practicable use of a monthly workbook, which walks the CAMs through the monthly analysis process. With predefined charts, data tables, and analysis questions, the CAMs approach to analysis is common across the project. Utilization of the web based tool, allows multiple stakeholder review of information that is quicker and easier.

By employing a FAIR way to analyze the CAM information, we hope to dispel the notion that the earned value management system is just for tracking of "how bad I'm doing." After several month end cycles, the analysis steps should become a normal activity imbedded within the CAM workflow. Focus now moves toward data based decision making and away from management system bureaucracies.

EARNED VALUE ANALYSIS, THE *FAIR* MODEL



EARNED VALUE PRIMER

By assessing the value of the work accomplished, comparisons can be made to the original baseline cost plan and to the actual costs incurred to complete the work. With these comparisons, analyses of trends assist in projecting the outcome, which is represented as the Estimate at Complete (EAC). Cost and schedule variances are derived and provide the Control Account Manager a quantified view of performance. From this data, the future can be extrapolated and decisions can be made by the CAM to make adjustments to future plans (estimate to complete) to recover variances or to establish a new EAC. The value of the early warning metrics is to allow management time to react to changes in the project and to be proactive.

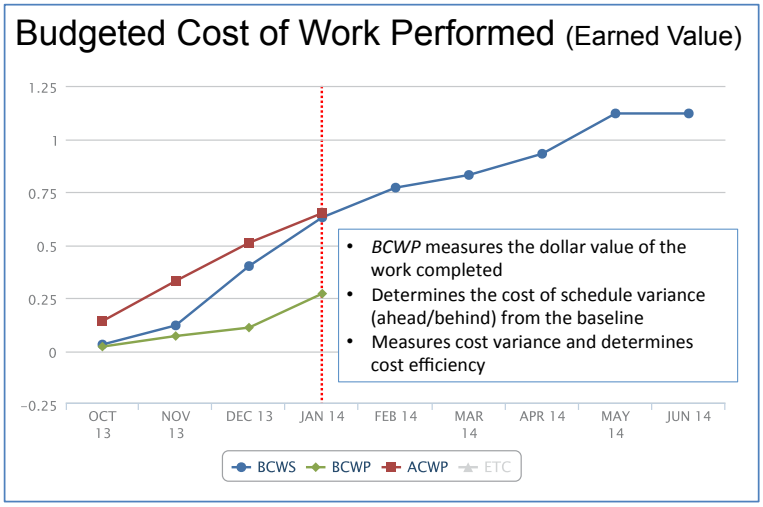


Figure 1. Cumulative Element Performance Chart

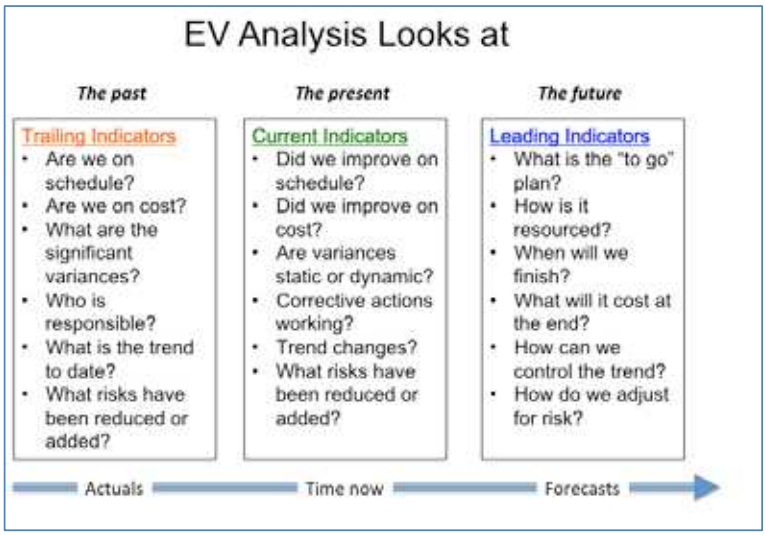


Figure 2. Questions to ask in earned value analysis

THE FAIR MODEL

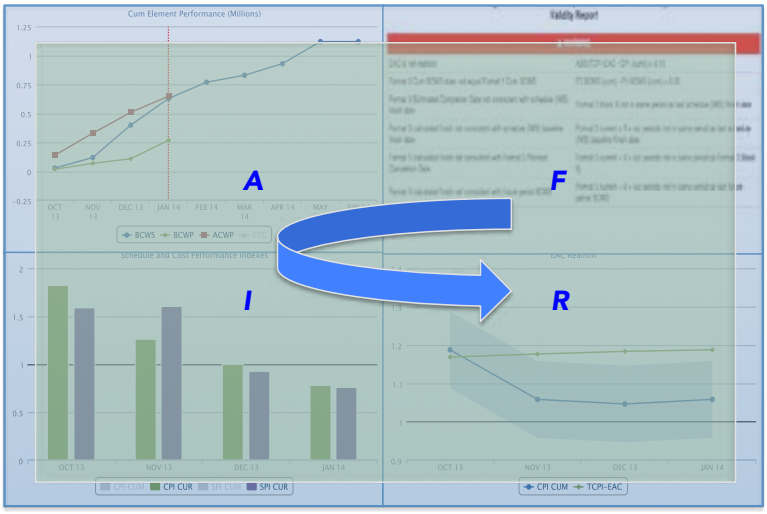


Figure 3: The Fair analysis model

F Fidelity of your data, validate: Review for data anomalies. Fix or understand.

A Analyze Performance Trends: Review all trends and address those that are out of tolerance and document via a Variance Analysis Report (cause/impact/corrective action).

I Identify emerging issues: Review current period variances for emerging cost and schedule issues. Analyze for potential trends.

R Realism of EAC? Using performance trends and metrics, is the go forward plan achievable? Are there sufficient reserves to support performance impacts?

THE MONTH END ANALYSIS PROCESS

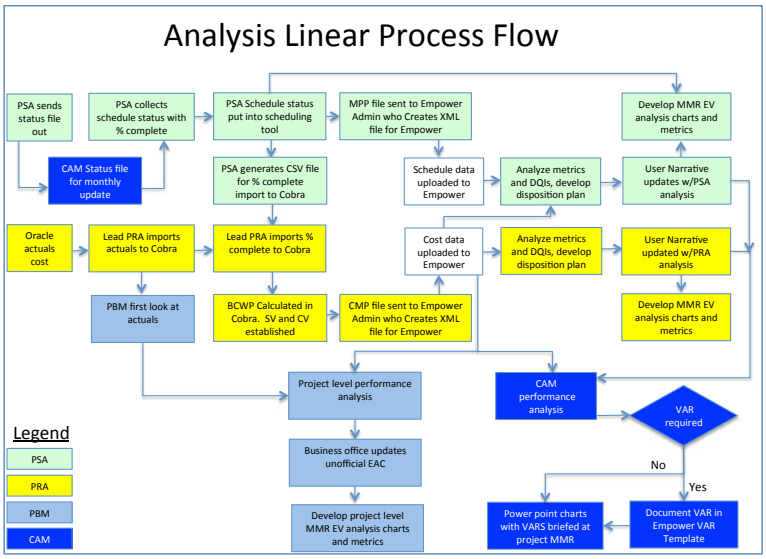


Figure 4: Standard month end process flow

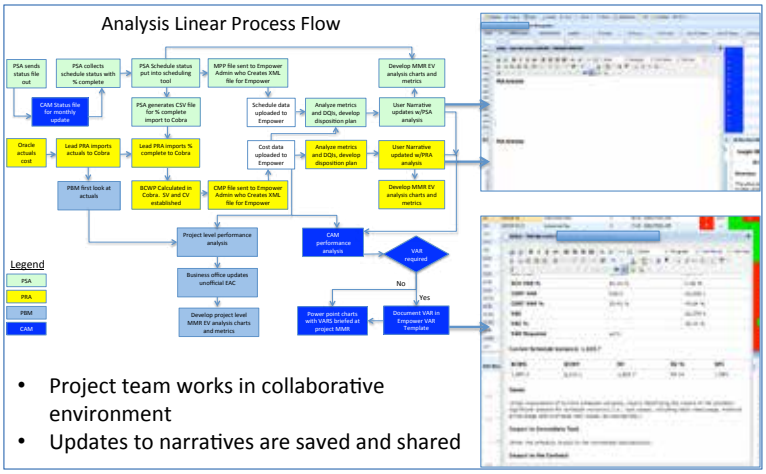


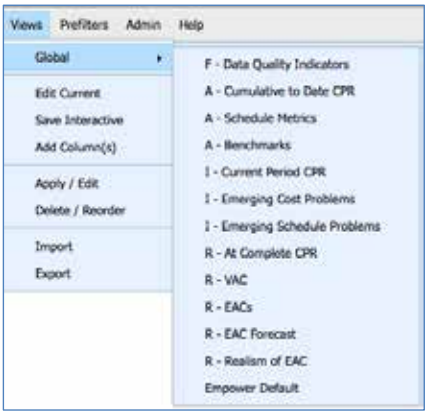
Figure 5: CAMs and Analysts' enter results of analysis in User Narrative and VAR templates

USING THE TOOL TO GET TO INFORMATION

The Views > Menus in software lists the information to analyze using the FAIR structure.

Use the structured approach to walk through the data views and conduct analysis. The Charts and Reports menus provide the variety of charts used to analyze the performance data.

If S, C, V is in the VAR column of the view, CAM uses the Input/ VAR template to enter narratives. Cost and schedule analyst will enter analysis in the Input/User Narrative section.



Key Reports:
- Artificial Intelligence Report
- Six month DQI Trend
- Six month performance trend

Key Views
- Cum to date CPR
- Benchmarks
- Realism of EAC

Key Charts:
- Cumulative Element Performance
- Bulls Eye Chart
- Cumulative Cost Schedule Variance
- Cumulative Variance by EOC
- EAC Realism
- Schedule Performance Indexes
- Schedule Gantt Chart
- Constraints Pie Chart
- Current Cost Schedule Variances
- Current Variance by EOC
- BCWR vs ETC
- Variance vs Index

Step 1) Fidelity of the Data – Review Data Quality Indicators

There are a variety of 'Views' that display the DQI column in the table section of the tri-pane display. Following are a listing of the DQI codes and a brief description the code, magnitude of the code, the management issue and what the action plan should be to resolve the indicator, if required. The code descriptions are displayed in one of several DQI Reports and DQI exports to Excel. The DQI column in the View will only show the category of the DQI (E, F, S, I).

HIER			LL	LVL		DQI	BCWS	BCWP	ACWP	% CMP
1111	1	F	x	4	M	FSI	387,410	387,410	349,050	9.00
1121	1	E	x	4	S	SI	415,120	415,120	394,400	9.54

Figure 4: Sample view with DQI Column

Run the DQI Six Period Trend report to assess overall DQI status for each account or WBS leg.

Six Period DQI Trends

Data Quality Indicator	JAN 14	FEB 14	MAR 14	APR 14	MAY 14	JUN 14
CPI-TCPI > 0.1	1	1	1	1	1	1
FF relationship						1
Missed target finish date						31
BEI Incomplete						1
Forecast start after first ACWP/ETC						1
Forecast finish after last ACWP/ETC						1
Baseline start after first BCWS						1
Baseline finish before last BCWS						1

Figure 5: Six period DQI Trends Report

In the following tables each of the DQI tests is listed with a DQI code and the description of the DQI code. This portion of the workbook is a reference for the analyst to better understand the code, in English, and determine if action needs to be taken.

DQI Code E: Earned Value DQI

E1	BCWS CUM > BAC
E2	BCWP CUM > BAC
E3	ACWP CUM with no BAC
E4	ACWP CUR with no BAC
E5	Zero budget work package
E6	LOE with CUM SV
E7	LOE with CUR SV
E8	BCWP with no ACWP
E9	Negative BCWS CUM
E10	Negative BCWS CUR
E11	Negative BCWP CUM
E12	Negative BCWP CUR

E1: Cumulative to Date Budget is in excess of Budget at Complete.
Magnitude: Correction Action Required
Issue: No budget controls. Negative future budgets.
Action: Fix immediately

E2: Cumulative to Date Earned Value is in excess of Budget at Complete.
Magnitude: Correction Action Required
Issue: No EV controls. Negative future budgets.
Action: Fix immediately

E3/4: Cumulative/current actual cost incurred against a control account with no budget.
Magnitude: Observation
Issue: Allowable costs? Charging an account with no budget. Analyze.
Action: Execute appropriate action: monitor, journal voucher, budget.

E5: Work package with no budget.
Magnitude: Observation
Issue: Work planned in schedule but no budgets planned? Analyze.
Action: Execute appropriate action: monitor, establish budget.

E6/7: Level of Effort Work package has a schedule variance.
Magnitude: Correction Action Required
Issue: LOE SV always equals zero. Review earned value derivation methods and work package content for work type.
Action: Fix immediately. No later than next month end closure.

E8: Earned value on work but no actual costs incurred.
Magnitude: Observation
Issue: Charging cost correctly? Assessing work correctly? Getting work done with out paying for it. Analyze.
Action: Execute appropriate action: monitor, journal voucher

E9/10: Negative budget entered to balance BAC.
Magnitude: Correction Action Required
Issue: The PMB is not a balance sheet, it is a costed resource plan
Action: Fix immediately. MR transaction, EAC adjustment.

E11/12: Negative performance (regression) recorded.
Magnitude: Observation
Issue: Is completed work being reworked? Is it in the EAC?
Action: Execute appropriate action: monitor, EAC adjustment.

DQI Code F: Reasonableness of Forecast

F1	CPI-TCPI > 0.1
F2	CPI-TCPI < -0.1
F3	Negative BAC
F4	Completed work with ETC
F5	Incomplete work without ETC
F6	ACWP on completed work
F7	ACWP CUM > EAC

F1/2: Difference between Cumulative Cost Performance Index and To Complete Performance Index is greater than 1 percentage point.
Magnitude: Observation
Issue: The EAC is either overstated or understated based on performance history.
Action: Execute appropriate action: monitor, EAC adjustment.

F3: Negative value entered in Budget at Complete
Magnitude: Correction Action Required
Issue: The PMB is not a balance sheet, it is a costed resource plan
Action: Fix immediately. MR transaction, Budget Change Request.

F4: Work is complete (cum BCWP = BAC), but there are forecasted costs
Magnitude: Observation
Issue: EAC overstated; is work really complete?
Action: Execute appropriate action: Review EV plan, ETC adjustment.

F5: Work is not complete (cum BCWP < BAC), with no forecasted costs
Magnitude: Observation
Issue: EAC understated
Action: Execute appropriate action: ETC adjustment. Get BCWR and ETC into alignment.

F6: Actual costs incurred on completed work (cum BCWP = BAC)
Magnitude: Observation
Issue: Actual costs should not be incurred on completed work.
Action: Execute appropriate action: monitor (lagging actuals), journal voucher, review EV plan

F7: Cumulative actual costs greater than EAC
Magnitude: Observation
Issue: Understated EAC, incorrect charging.
Action: Execute appropriate action: update ETC, journal voucher

DQI Code I: Cost and schedule integration

I1	Forecast start before first ACWP/ETC
I2	Forecast start after first ACWP/ETC
I3	Forecast finish before last ACWP/ETC
I4	Forecast finish after last ACWP/ETC
I5	Baseline start before first BCWS
I6	Baseline start after first BCWS
I7	Baseline finish before last BCWS
I8	Baseline finish after last BCWS

I1-4: Current schedule dates not in alignment with actual costs and/or ETC
Magnitude: Observation
Issue: Disconnect between the timing phasing of forecasted scheduled work and actual costs and future costs (ETC).
Action: Execute appropriate action: update schedule, update ETC, journal voucher

I5-8: Baseline schedule dates not in alignment with time-phasing of baseline costs
Magnitude: Correction Action Required
Issue: Loss of cost schedule integration and integrity of performance data.
Action: Fix immediately. Develop integrated cost schedule plans

DQI Code S: Schedule

S1	No predecessor
S2	No successor
S3	Leads
S4	Lags
S5	SF relationship
S6	SS relationship
S7	FF relationship
S8	Hard constraint
S9	High float
S10	Negative float
S11	High duration
S12	Start date prior to status date
S13	Finish date prior to status date
S14	Actual start date after status date
S15	Actual finish date after status date
S16	Missed target finish date
S17	BEI Incomplete
S18	CEI Incomplete
S19	No actual finish but percent complete = 100
S20	Actual finish with percent complete < 100
S21	Out of sequence status
S22	Missing logic

S1/2: No predecessor/successor
Magnitude: Observation.
Issue: Tasks in schedule missing relationships. Critical path could be affected, as well as why is the task there. Excess of 5% should be considered a flag.
Action: Execute appropriate action: monitor, add appropriate logic.

S3/4: Leads and lags on tasks
Magnitude: Observation
Issue: Critical path could be affected as float values are adjusted. Leads are negative Lags (negative time is not demonstrable), the goal metric is 0. Tasks with Lags should not exceed 5%.
Action: Execute appropriate action: monitor, remove.

S5-7: SF/FF/SS relationships

Magnitude: Observation
Issue: Critical path could be affected by non FS relationships. Goal is that 90% of the tasks are defined with FS relationship
Action: Execute appropriate action: monitor, adjust logic as appropriate.

S8: Hard constraint

Magnitude: Observation
Issue: Critical path could be affected by constraining dates. Number of tasks with hard constraints should not exceed 5%
Action: Execute appropriate action: monitor, remove all constraints for end to end critical path analysis

S9: High Float

Magnitude: Observation
Issue: High float value is 44 working days or greater. Tasks missing relationships? Analyze.
Action: Execute appropriate action: monitor, add relationships to reduce float value.

S10: Negative Float

Magnitude: Observation
Issue: Project is delivery not achievable.
Action: Execute appropriate action: adjust future schedule to get the project end date in line with contractual requirements.

S11: High Duration

Magnitude: Observation: Baseline start date within detail planning period.
Issue: Task duration is too long, 44 working days or greater. Total count of high duration tasks should not exceed 5% .
Action: Execute appropriate action: monitor, create more detail

S12/13: Start/finish date prior to the status date

Magnitude: Correction Action Required
Issue: Schedule not accurately updated. Metrics impacted.
Action: Fix immediately. Update all activities accordingly.

S14/15: Actual Start/finish date after to the status date

Magnitude: Correction Action Required
Issue: Schedule not accurately updated. Metrics impacted.
Action: Fix immediately. Update all activities accordingly.

S14/15: Missed target finish date

Magnitude: Observation
Issue: Schedule tasks not completed per plan. Measure of schedule ability to meet baseline plan. Number of missed tasks should not exceed 5%.
Action: Execute appropriate action: monitor, review BEI monthly.

Step 2) Analyze Performance Trends – Review cumulative cost performance indices

Upper left: Cumulative cost, schedule and at complete variances.
Menu: Charts > Cumulative Variance

Upper right: Cumulative CPI, SPI trends
Menu: Charts > Bull's Eye

Lower left: Cumulative variances by Element of Cost
Menu: Charts > Element of Cost > Cumulative CV by EOC

Lower right: Cumulative trends of baseline cost, earned value and actual cost
Menu: Charts > Cum Element Performance

Bottom: Active sort window with for cumulative out-of-tolerance variances
Menu: Views > Global > CPR

Review cumulative schedule performance indices

Upper left: Schedule gantt view
Menu: Charts > Schedule Gantt

Upper right: Cumulative BEI, SPI, CEI and CI metrics
Menu: Charts > Schedule Analysis > Execution Indexes

Lower left: Cumulative total float chart
Menu: Charts > Schedule Analysis > Total Float

Lower right: Constraints metric
Menu: Charts > Schedule Analysis > Constraints

Bottom: Schedule performance view
Menu: Views > Apply/Edit Views > Schedule Modified (scroll to bottom)

Analyze Trends: Trailing Indicators (Cumulative to Date)

Cost Performance		
CPI trending:	Positive	Negative
Element of Cost Variances:	Expected	Unexpected
Variances out of tolerance:	Yes	No
Are Variances:	Recoverable	Unrecoverable
Acceptable performance quandrant	Yes	No
Percent Complete _____ Percent Spent _____	Positive	Negative
Recovery plan defined:	Yes	No
Schedule Performance		
SPI trending:	Positive	Negative
BEI trending	Positive	Negative
Variances out of tolerance:	Yes	No
Are REC/DELs impacted:	Yes	No
Is Critical Path impacted:	Yes	No
Corrective action plan defined:	Yes	No

Step 3) Identify Emerging Cost Issues – Review current period cost performance indices
Use Chart Icon and select column for histogram view

Upper left: Current cost and schedule variances.
Menu: Charts > Current Variance

Upper right: Current variances by Element of Cost
Menu: Charts > Element of Cost > Current CV by EOC

Lower left: Current SPI CPI
Menu: Charts > SPI/CPI (in the chart click on CPI Cum and SPI Cum to remove graphic)

Lower right: Current months baseline cost, earned value and actual cost
Menu: Charts > Cur Element Performance

Bottom: Current months cost performance view
Menu: Views > Apply/Edit Views > Identify Emerging Cost

Review current period schedule performance indices

Upper left: Schedule gantt view (focus on current period activities for slips)
Menu: Charts > Schedule Gantt

Upper right: BEI, SPI, CEI and CI metrics (CEI for current performance)
Menu: Charts > Schedule Analysis > Execution Indexes

Lower left: Total float chart (review current period float)
Menu: Charts > Schedule Analysis > Total Float

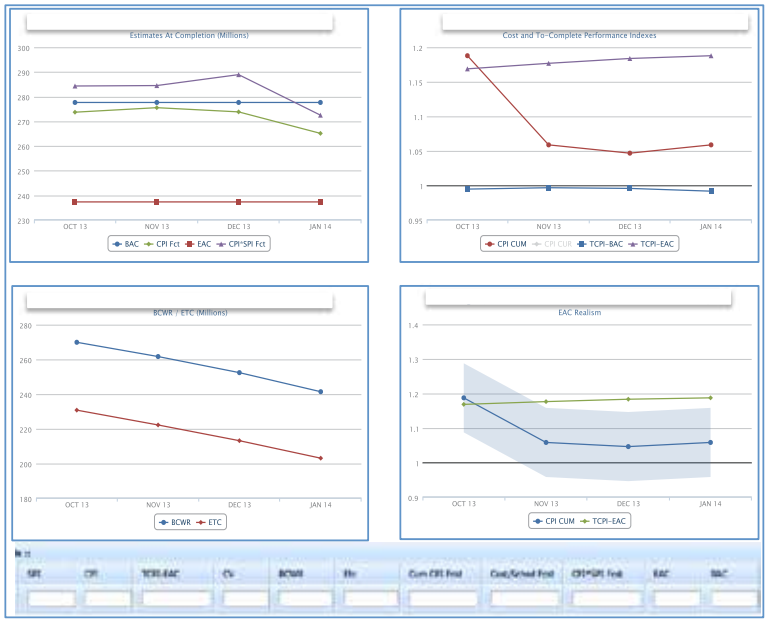
Lower right: Constraints metric
Menu: Charts > Schedule Analysis > Constraints

Bottom: Schedule performance view
Menu: Views > Apply/Edit Views > Schedule Modified (scroll to bottom)

The Present: Current Indicators (Current Period)

Cost Performance		
Current Period CPI:	Positive	Negative
Element of Cost Variances:	Expected	Unexpected
Is this the start of a trend:	Yes	No
Are Variances:	Recoverable	Unrecoverable
Recovery plan defined:	Yes	No
Schedule Performance		
Current Period SPI:	Positive	Negative
Current Execution Index (CEI)	Positive	Negative
Variances out of tolerance:	Yes	No
Are REC/DELs impacted:	Yes	No
Is Critical Path impacted:	Yes	No
Corrective action plan defined:	Yes	No

Step 4) Realism of EAC – Is the EAC achievable?



Upper left: Estimate at Complete comparisons
Menu: Charts > EAC

Upper right: Cost and To-Complete Performance Indexes
Menu: Charts > CPI / TCPI

Lower left: Budgeted Cost of Work Remaining and ETC
Menu: Charts > Custom Charts > Open/Edit Chart > BCWR / ETC

Lower right: EAC Realism
Menu: Charts > EAC Realism

Bottom: EAC Forecast View
Menu: Views > Apply/Edit Views > EAC Forecast

The Future: Leading Indicators (EAC Realism)

EAC Assessment

EAC realism trending:	Positive	Negative
Is there sufficient cost in the estimate to complete:	Yes	No
Are calculated EACs withing acceptable range of Current EAC	Yes	No
Is the Variance At Complete accurate:	Yes	No
Have reserves been adjusted to reflect anticipated VAC:	Yes	No
CPI - TCPI > .1	Yes	No
Are the BCWR and ETC variance acceptable	Yes	No
Is the TCPI to the EAC achievable	Yes	No
Is cumulative to date cost variance reflected in VAC	Yes	No

CPM WASHINGTON, DC CHAPTER NEWS

By Barbara Phillips, EVP, PMP; Chair, CPM WDC

CPM WDC is pleased to announce that PwC is now a corporate sponsor. This sponsorship affords CPM WDC the opportunity to enhance the key benefits of the chapter to our members including more educational events and networking dinner meetings.

PwC US helps organizations and individuals create the value they're looking for. We're a member of the PwC network of firms, which has firms in 157 countries with more than 195,000 people. We're committed to delivering quality in assurance, tax and advisory services. Find out more and tell us what matters to you by visiting us at www.pwc.com.

PwC, together with Strategy&, creates value for clients by building trust and addressing businesses' most important problems, from strategy through execution. Combining depth of industry and business knowledge with technical skill, PwC's capabilities across consulting, deals and forensics can help organizations build the next competitive advantage – whether that involves strategy, structure, people, process or technology. PwC's global network of assurance, tax and advisory professionals brings together the right skills and capabilities to help clients achieve success anywhere around the world.

For more information about sponsorship opportunities contact cpmwdc@mycpm.org or visit our website www.mycpm.org/cpmwdc

JULY 15, 2015 MEETING IN REVIEW

The CPM WDC Chapter hosted panelists from the General Accountability Office (GAO) on July 15, 2015 at the Westin Crystal City for the Meeting: GAO Scheduling Best Practices and the Agile Process: A Round Table. Panelists, Karen Richey, Jennie Leotta and Juana Collymore, answered questions about the forthcoming agile appendix to the GAO Schedule Guide. The 40+ attendees enjoyed the discussion.

The program control field is still abuzz with combining agile methodology practices with EVM reporting requirements. With the success of our January and April meetings on the topic, this was our third meeting to continue the discussion but with the GAO perspective.

GAO discovered during many audits for IT systems that they did not have schedules because they were using the Agile method to develop software. The purpose of the appendix is to identify common misconceptions about scheduling for Agile projects and dispel them. The appendix will describe the applicability and benefits of scheduling best practices for Agile projects with various considerations. It will also identify key document differences. Details of the appendix were published in this journal (http://www.mycpm.org/wp-content/uploads/2015/05/Measurable-News-Issue-2-2015.pdf). The Chapter appreciates our July meeting sponsor SNA Software (www.sna-software.com) and Humphreys & Associates (www.humphreys-assoc.com).

Brian Evans (Moderator), Karen Richey (Panelist), Juana Collymore (Panelist), Jennie Leotta (Panelist), Eric Christoph (Sponsor)

Chapter meeting sponsors:

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OCTOBER 15, 2015 MEETING ANNOUNCEMENT

Our meeting was held at the Westin Crystal City from 4:30 to 7:00 on October 15, 2015. Gordon Kranz, former Deputy Director of PARCA, spoke on the Earned Value Management System Interpretation Guide (EVMSIG) and its many transformational attributes. The Chapter appreciates our October meeting sponsor EcoSys (www.ecosys.net).

NOVEMBER 17, 2015 LUNCHEON ANNOUNCEMENT

Please join the CPM WDC committee members at lunch time tables on the second day of the fall conference, Integrated Program Management Workshop (IPMW) in Bethesda, MD.
The Washington metropolitan area is home to the many members of the College of Performance Management. The Washington, DC Chapter (CPM WDC) was founded to provide opportunities for local members to network with in-person meetings; to learn not only from experts but from each other; and to volunteer to give back to the community and have fun.

This lunch time session will provide information CPM WDC accomplishments to date and future planning. Please join us if you are interested in volunteering and being a part of CPM WDC.

Your CPM WDC Committee,
Barbara Phillips
Laura Ayres
Walter Barnes III
Michael Marcello
Melissa Nino
Ryan Smith
Eva Walter

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CLASSROOM EXPERIMENTS ON PROJECT MANAGEMENT COMMUNICATION

By Mario Vanhoucke[1] and Mathieu Wauters[2]

ABSTRACT

This manuscript gives a brief overview of three sets of experiments in the classroom with students following a Project Management (PM) course module using a blended learning approach. The impact of communication on the student performance using business games as well as the advantages of the use of integrative case studies and their impact on the learning experience of these students are tested. The performance of students is measured by their quantitative output on the business game or case exercise, while their learning experience is measured by the student evaluations. The experiments have been carried out on a sample of students with a different background, ranging from university students with or without a strong quantitative background but no practical experience, to MBA students at business schools and PM professionals participating in a PM training. The results have been presented at an international workshop on computer supported education in Lisbon (Portugal) in 2015 and details have been published in Vanhoucke and Wauters (2015).

INTRODUCTION

The Project Management course modules given at Ghent University (Belgium), Vlerick Business School (Belgium, Russia, China) and University College London (UK) for master and MBA students are set up in such a way that the students learn to get acquainted with the necessary project management components through a mix of different techniques as described in Vanhoucke (2014a,c). The teaching process can be best described as a blended learning approach since the delivery of content and instructions happen via a mix of media and tools, ranging from digital and online media to the use of case studies and business games.

Part of the lectures are given by means of a computerized approach using business games, software exercises and online learning tools, which is the topic of this manuscript. A number of experiments with students from the previously mentioned universities have been carried out in order to test the impact of various degrees of communication under controlled settings on both the performance of students as well as on their learning experiences and satisfaction. This paper reports on the results and experience of these communication experiments as presented on the international conference on computer supported education in Lisbon (Portugal) in May 2015.

The paper consists of the following sections. Section 2 gives a brief summary of the learning objectives of the Project Management course module used for the communication experiments. In section 3, the three types of experiments are explained and results are given. Section 4 draws overall conclusions and highlights the need for future research on this interesting topic.

COURSE OVERVIEW

The course module focuses on quantitative themes in project management, with a clear and special attention given to the integration of project baseline scheduling, schedule risk analysis and project control using Earned Value Management methods. This integration is known in literature as “dynamic scheduling” (Vanhoucke, 2012b) or “integrated project management and control” (Vanhoucke, 2014b). The objective of the course is to teach students how to plan, monitor and control projects in progress such that they can be delivered on time and within budget to the client and is shown in Figure 1.

1) Ghent University, Tweekerkenstraat 2, 9000 Gent (Belgium), Vlerick Business School, Reep 1, 9000 Gent (Belgium) and UCL School of Management, University College London, Gower Street, London WC1E 6BT (United Kingdom). 2) Ghent University, Tweekerkenstraat 2, 9000 Gent (Belgium),

The material used consists of a mix of tools and methodologies and the corresponding teaching approach can be described as blended learning. The content of each topic discussed in class is based on results from numerous research studies mixed with practical experience. The student handbook used in class is written by Vanhoucke (2012b), and an overview of this book and course module content is printed in the Measurable News (Vanhoucke, 2013, 2012a). These articles are shared with the students and used as background material for group assignments.

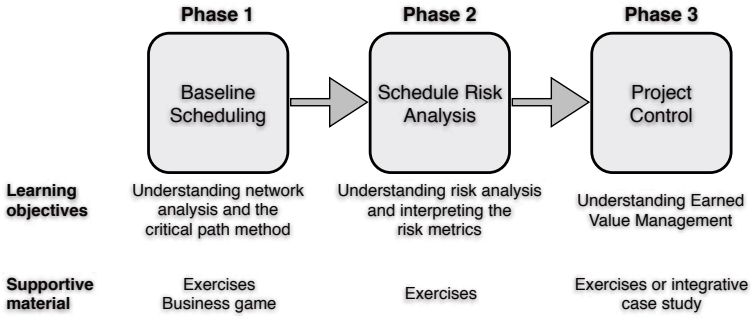

Figure 1: Course module overview (Source: Vanhoucke and Wauters (2015))

Apart from the student book and various articles published in the Measurable News, other support material is used in the classroom to stimulate interaction, to improve the ability of learning and to enhance student satisfaction. This material can be divided in three classes, as follows:

- Exercises are mainly used ex cathedra in class or possibly in small teams and require a certain degree of participation by the students by translating the theoretical concepts into the settings of the exercise.
- Case studies are mainly used in small teams and focus on oral communication between the students and the lecturer. The use of case studies is possibly embedded in a problem based learning mechanism in which the team is responsible for both lecturing and learning, guided by the teacher. Unlike exercises, case studies do not require a single solution approach, but rather aim at solving a management situation open for interpretation.
- Business games: The use of business games is to actively involve the student in the teaching process by making him/her responsible for a simulated project environment. Through the use of an interaction between the student and the computer, data are presented to the student in terms of schedule, risk and control information, which must be used to make decisions about the future project progress. In the course, the game that is used aims at optimizing the timing and costs of activities, while the computer simulates uncertain events that harm the initially constructed baseline schedule. The game is known as the Project Scheduling Game (PSG) Vanhoucke et al. (2005). Complexity and uncertainty experiments using these business games are available in Wauters and Vanhoucke (2015).

The specific use of this teaching material depends on how the themes of the different (weekly) lectures are assembled, and small modifications in the specific approach have been implemented to test the impact of communication on student results and learning experience. The course module consists of three main phases as shown in Figure 1, thereby gradually building up the learning objectives in order to reach an integrative view on dynamic scheduling and to maximize the transfer of knowledge from teacher to student.

- Phase 1: The main goal is to obtain knowledge about the network and critical path analysis techniques, as well as to understand the importance of planning projects for their later progress.
- Phase 2: Understanding the relativity of a deterministic baseline scheduling phase within the presence of uncertainty, as well as understanding the importance of risk analysis prior to the project progress is the main goal of this second phase in the teaching process.
- Phase 3: Learning how to monitor and control projects in progress using the Earned Value Management (EVM) methodology is the primary objective of this phase. This requires that students are able to interpret risk analysis reports (phase 2) and use the baseline schedule information (phase 1) as guiding tools for taking corrective actions.

The three phases on the course module of Figure 1 are further subdivided into 5 lectures as shown in Figure 2. In general, each session focuses on one or multiple educational

components. Instruction (I) either takes the form of the classic ex-cathedra classroom session or as an introduction to a case study or business game. During this instruction, partial or complete information can be given to the student, thereby influencing their expectations and possibly their decisions. Feedback (F) can occur intermediately during an exercise or a game (under different formats) or to conclude a session. During feedback, the experiences of the students are captured and translated into lessons learned and managerial insights. Assessment (A) evaluates the students on a number of criteria and is translated into a grade or a report covering the different aspects of the solution obtained by the students. In an integrated exercise, the assessment is given at the end of a set of teaching sessions. For smaller exercises, intermediate assessments are given for each separate exercise which can be used as valuable information for later exercises.

The way in which the different lectures are constructed can vary along the target group, and has been one of the major design inputs for the communication experiments discussed in this article. More specifically, the specific three-phased approach of the course module and the different ways in how instruction, feedback and assessment are scheduled along the progress of the course module allowed us to test three classes of communication experiments, for which the design and the results are briefly discussed in the following section.

EXPERIMENTS

In this section, the design and results for the three different classes of communication experiments are briefly explained. These experiments have been carried out by varying the use and timing of the various educational components along the three-phased learning approach.

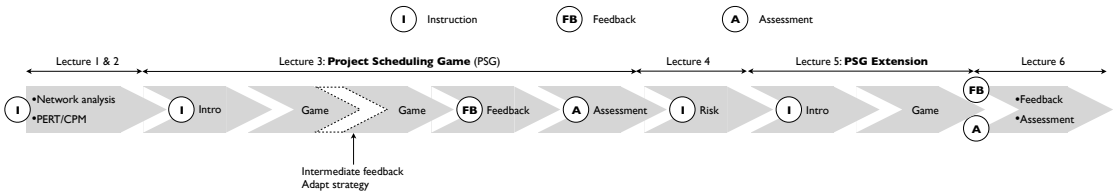

Figure 2: Three phases in the PM curriculum (Source: Vanhoucke and Wauters (2015))

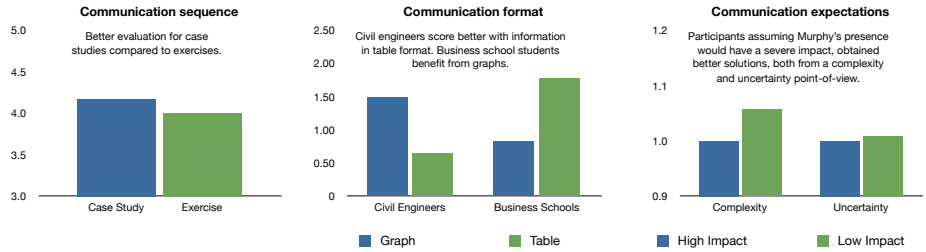

Figure 3: Communication experiments (Source: Vanhoucke and Wauters (2015))

3.1 Sequence

Design: In a first experiment, the timing and the sequence in which the support material is used throughout the weekly teaching lectures are varied, and hence, the way the knowledge is built up is varied between different groups of students. The timing is related to the use of exercises as stand-alone exercises held at the end of each teaching session, or the use of integrative case studies at the end of multiple sessions as an integrated full exercise. The sequence of the support material is varied by playing the business game at the beginning of the course module, at a moment where students have little knowledge of risk management, or at the end of the course module, where the students might be able to make better decisions thanks to their knowledge of risk discussed in the middle of the course.

Results: The results clearly show that integrative case studies that cover multiple topics during different teaching sessions lead to higher satisfaction than exercises during each session that are easy to understand and focus on only one topic at the time. These results are shown on the left graph of Figure 3 and measure the course evaluation and corresponding student satisfaction on a scale between 1 to 5. Moreover, the results also demonstrate that prior knowledge of the concepts of risk management has a beneficial impact on the quality of the decisions made during the game, and proves that the business game can be best used after a theoretical session on risk management, rather than before.

3.2 Format

Design: In order to test the impact of the communication format, the business game has been used under various settings, each time with a different maximum time limit and a different way of presenting results at intermediate decision periods. The time limit is varied from 1 hour to 2.5 hours to test the impact of time pressure on the student performance. In this time window, students are responsible for

a project in progress subject to uncertainty, and six sequential decisions need to be made to bring the endangered project back on track. The communication format is varied from graphical charts to detailed tables with numbers and an overload of KPIs that can be used to evaluate the current performance of the project in progress. The changes in the format are used to test how students react on quantitative data or graphical summary sheets and how it affects the quality of their decisions.

Results: The results have shown that student performance clearly depends on previous education, while surprisingly, the communication format had no impact on learning experience and student satisfaction. The impact of student background is shown in the middle graph of Figure 3 for university students with a strong quantitative background but no working experience and business school students with a mixed quantitative back- ground but much more working experience. The y-axis of the graph shows the final result on the business game, with lower values equal to better performance (the objective is to minimize the total project cost). On average, civil engineers benefit from information presented in a table format with an overload of numbers that can be transformed into performance measures after some (basic) algebraic operations. Business school students achieve better results with graphical information that shows the intermediate performance measures in a more structured and accessible way. Despite the difference in preferences on the communication format and the impact on the results, no relation could be found between the format and the satisfaction of students during learning. Both groups of students liked both ways in which the data was presented, and were not really aware that they performed better or worse for the one or the other format. These results have been briefly described in an initial experiment in the book "Reinventing Communication" (Phillips, 2014) which discusses the importance of communication in a professional project management environment.

3.3 Expectations

Design: Testing the impact of expectations on the quality of decisions is done by revealing partial information to the student prior to the business game session. More precisely, a group of students is warned of the complex and uncertain nature of the project progress that is embedded in the game, while another group starts playing the game with the idea that little to no uncertainty is present. While the second student group only creates a feeling about the complex and dynamic nature of the game along the progress of the game, the first student group starts the game with prior information about complexity and uncertainty, and is therefore much better prepared for uncertain events.

Results: The results show that better expectations of the environment lead to more effort. When students know that they have to deal with highly complex and uncertain projects, they spend much more time on evaluating alternative decisions in the hope to finish the game with a good outcome (i.e. low cost). This higher attention had a positive effect on the solution quality, and Figure 3 shows that more effort indeed leads to better solutions. The right graph shows that the total cost is lower (and therefore the results are better) when the complex and uncertain nature is emphasized prior to the game session. This effect is higher for complexity than for uncertainty, meaning that students can better cope with complexity than with (unknown) uncertainty.

CONCLUSIONS

In this manuscript, results on communication experiments have been given in a blended learning project management course module taught at universities and business schools. The tests have been carried out by varying the way the course material is used along the various sessions of a course, consisting of exercises, integrated case studies and business games. Tests on three classes of communication experiments have been carried out.

The timing and integration of communication is crucial in the learning process of students and positively contributes to the learning experience and sometimes to the student performance. The communication format has a significant impact on the students' performance and differs along their practical experience and background. However, no relation could be found between the format and the satisfaction of students during learning. Expectations are also an integral part of communication. In the final experiment, it was shown how highlighting the complex and uncertain nature of the environment can affect the achieved results. It was found that participants invested more effort and attained better solutions when the importance of reacting to uncertainty was stressed. If the decision on whether a change is desirable was left to the students, considerably less effort was put into the evaluation process and a larger cost deviation was the result.

Obviously, this study is conducted using a limited set of experiments. Many of the experiments have been done with a small sample of students, and without strict control of lurking variables that might impact the results. Nevertheless, the obtained results, measured both by the quality of the business game results and the satisfaction of the students, were often so clear that it can be assumed that they show a certain trend. In future studies, more experiments are needed under a controlled setting, and results should be investigated by statistical techniques in order to better learn how students learn and capture information in a project management environment.

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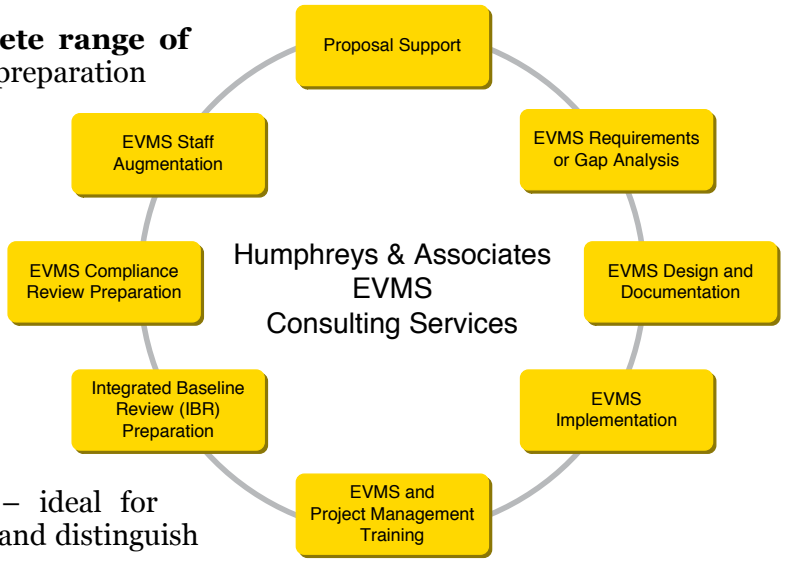

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