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(CDR) CLAIMS AND DISPUTE RESOLUTION

(CDR-3790) Delay Claim Entitlement Under FIDIC Contracts

Author(s)/Presenter(s): Shannon Foster, PSP; Dr. Tong Zhao, PE CCP CFCC PSP

Abstract: FIDIC (The International Federation of Consulting Engineers) issued standard form contracts for international projects, which have been extensively used worldwide. Some of the common FIDIC contracts have been issued or updated recently, including the construction only, design/build, and EPC/turnkey contracts in 2017, and the contract for underground work in 2019. Since it is challenging to resolve delay issues in construction projects, it is beneficial for project participants to understand the entitlement and risks associated with those issues, especially in the context of international construction under FIDIC contracts. This paper discusses the rights, obligations, and risks of contractors in various FIDIC contracts with different risk exposures through a comparative analysis on a qualitative basis. This paper would contribute to the body of knowledge by helping construction professionals better understand the basic principles related to delay issues towards a reasonable resolution under FIDIC contracts.

(CDR-3828) Complex Project Forensic Delay Analysis: Applying Multiple, Overlapping TIAs to Schedule Updates Through the Project Duration

Author(s)/Presenter(s): Becky Smith

Abstract: A delay analysis using a modeled additive method, AACE Recommended Practice (RP) 29R 03 method implementation protocol (MIP) 3.6 or 3.7—often referred to as a time impact analysis, or TIA—can be a straight-forward technique to estimate delay occurring in the future of an in-progress project. Using a TIA as a forensic analysis technique requires more effort and analysis. Applying multiple TIAs to schedules through the life of the Project to analyze the impact of multiple delays on a long-duration, complex project is difficult and time-consuming. This paper explains how using overlapping TIAs on such a project can produce a credible delay analysis that assigns responsibility for critical delays.

The methodology detailed in this paper covers identification of delay events, TIA development for individual events, and evaluation of the TIAs chronologically and collectively in contemporaneous schedule updates to determine which events caused critical delay, the amount of critical delay, and which events were concurrent. Application of the AACE RP 29R 03 protocols for this project are discussed.



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Quantifying the impact of multiple delay events on a project and evaluating concurrency through contemporaneous updates is neither easy nor quick. However, TIAs can be used retrospectively to model multiple, complex, overlapping delays that span long periods and produce a reliable and trustworthy analysis.

(CDR-3829) Analyzing Delay When Owner-Provided Work Quantities Are Wrong

Author(s)/Presenter(s): Tara L. Hannebaum; William C. Schwartzkopf

Abstract: When the baseline schedule for a project does not include or reflect all of the work actually required, use of that schedule and subsequent updates for delay analysis will not provide accurate answers. An example would be the situation where an engineering, procurement and construction (EPC) contractor is assigned procurement contracts which provide inaccurate quantities of work to be installed. As a result, the baseline project schedule would not properly reflect the full work to be performed and may not correctly forecast the critical path or duration, both of which could be substantially affected by the significant undisclosed quantity changes in the work. Had the correct scope/quantities been known and disclosed from the beginning, the project would have been scheduled and planned in a significantly different manner. This paper discusses a method that allows a proper analysis of both delay and the actual critical path in such a situation. The method includes correcting the baseline schedule using a time impact analysis and then progressing the contemporaneous updates as modified for the additional quantities of work. It is a hybrid approach using a combination of Method Implementation Protocol (MIP) 3.3 and MIP 3.7 from AACE International Recommended Practice (RP) 29R-03, Forensic Schedule Analysis.

(CDR-3852) Validating Schedules to Conduct Reliable Forensic Schedule Analysis

Author(s)/Presenter(s): Jessica Lunte; Katherine Hull; Bassel Safa

Abstract: Schedule delays are a common and costly issue on construction projects. Analyzing these delays forensically relies upon the accuracy of project source data, thus ensuring the validity of the schedules is one of the most important steps in the process. Schedule validation for forensic analysis is focused on assuring the usefulness of the as-planned schedules and reasonableness of the as-built data for purposes of delay calculations. As-planned schedule validation generally consists of reviewing the technical adequacy and constructability of the schedule based on key aspects such as logic, constraints, milestones, critical path activities, scope



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of work, phasing, sequencing, crew flows, and logistics. As-built validation on the other hand typically consists of comparing the recorded as-built schedule data to contemporaneous documents, such as daily reports, timesheets, and cost records.

The purpose of this paper is to discuss best practices and industry metrics commonly used to determine if the schedule is reliable for forensic schedule analysis. This paper will also include a case study that shows how to implement schedule validation.

**(CDR-3857) A Combined Approach Using a Measured Mile Productivity Analysis
and a Collapsed As-Built Delay Analysis to Quantify Delay on a Linear Project**

Author(s)/Presenter(s): Michelle McMillan, P.Eng.; Nawfal Merzouk, P.Eng.; Daniel Ishmael

Abstract: A measured mile analysis to evaluate disruption is an established and accepted method to determine lost productivity. Using one of the forensic delay methodologies detailed in the AACE International Recommended Practice 29R-03 to determine delays to the project is similarly accepted. Traditionally, lost productivity and delay are evaluated independently. Based on a case study of a pipeline construction project in Northern Alberta, Canada, this paper proposes a combined method where the lost productivity calculated from a measured mile analysis is used in a collapsed as-built delay analysis to quantify the delays to the project.

**(CDR-3868) Recommendations in Dealing with Disruptions and Loss of
Productivity During Global Events (e.g. COVID-19 Pandemic)**

Author(s)/Presenter(s): Khaled M. Aziza, EVP PSP; Ahmed El Kharbotly; Dr. Hatem Ibrahim, PE

Abstract: Many construction projects have suffered various cost and/or time impacts to completion due to the COVID-19 pandemic restrictions (i.e., lockdowns, curfews, travel bans, and social distancing). To address the resulting impacts, the contractor and owner must examine the cost and time impact on engineering deliverables, procurement, manufacturing, and construction performance, and separate the resulting delays from other owner or contractor-caused delays. This paper presents recommendations to project stakeholders to manage the disruptions and loss of productivity, and the claim preparation process, through two case studies and highlights cost and delay analysis considerations in construction claims.

(CDR-3870) Progress is Best Measured One “Half-Step” at a Time



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Author(s)/Presenter(s): Christopher J. Brasco; Dakus Gunn; Glen B. Grant, CCP PSP; Matthew D. Baker

Abstract: Significant debate surrounds the appropriate means of evaluating concepts such as criticality and concurrency both of which play a central role in many if not most delay or impact claims. Project schedule updates are intended to serve as valuable analytical tools to identify and evaluate criticality and concurrency. However, in certain circumstances, the utility of schedule updates can be compromised by schedule revisions unrelated to the progress of the work including but not limited to resequencing or other means of recovering lost time. Such revisions, although often appropriate and necessary, can conceal the very real effects of project impacts and delay events and further complicate the evaluation of concepts such as criticality, concurrency, and perhaps most importantly the allocation of costs associated with resequencing and acceleration. To overcome this difficulty, stakeholders have increasingly turned to forensic methodologies such as half-step analysis. This paper will overview the half-step methodology, common circumstances where its use should be considered, how owners and contractors can benefit from its use, and legal issues related to its application.

(CDR-3873) Identification of Concurrency Through Literal Theory or Functional Theory, Freedom in Selection, or Dictated by Project Considerations?

Author(s)/Presenter(s): Saeid Khademagha, P.Eng. PSP

Abstract: Resolution of delay disputes is a challenging and contentious subject on many projects, for which, both project parties try their best to employ a logically consistent approach in complying with industry-accepted resources and references to reach a mutual agreement or provide sufficient proof for possible legal proceedings related to the delay claims.

One of the most controversial challenges in the resolution of disputes is the identification and quantification of concurrent delays. Since most contracts are silent or ambiguous on this issue, there are plenty of references and resources providing methods and theories that can be used by contracting parties to support their claims.

Literal & functional concurrency theories are two different theories that have been explained by AACE International Recommended Practice No. 29R-03 published for forensic schedule analysis (hereinafter RP 29R-03) to facilitate the process of identification and quantification of the concurrent delays.



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Establishment of whether both theories can be selected under any circumstances, or otherwise the applicable theory is dictated by way of contract language and/or legal and technical considerations, is a necessity for a delay analyst.

Requirements, challenges, and practical experience in the process of selection of the preferred theory will be discussed in detail in this article using an infrastructure project as a case study.

(CDR-3874) Termination for Convenience – What is it and How Does it Work?

Author(s)/Presenter(s): James G. Zack, Jr. CFCC FAACE Hon. Life

Abstract: A new administration took office on January 20, 2021. During the first afternoon in office the President issued a "Proclamation On The Termination Of Emergency With Respect To The Southern Border Of The United States And Redirection Of Funds Diverted To Border Wall Construction". In this proclamation the President directed all "... appropriate officials within their respective departments to pause work on each construction project on the southern border wall ... as soon as possible but in no case later than seven days from the date of this proclamation..." The proclamation also directed all departments to produce plans to terminate or repurpose contracts then under construction. The government determined to terminate some, or all the border wall contracts under the termination for convenience clause included in each contract. This paper discusses terminations for convenience – what are they and what should owners and contractors do when a decision is made to terminate a construction project for convenience.

(CDR-3877) Overtime and Loss of Productivity Claims

Author(s)/Presenter(s): Dr. Hatem Ibrahim, PE; Dr. Tong Zhao, PE CCP PSP

Abstract: Extended overtime can lead to increased fatigue which may cause issues such as reduced safety and increased absenteeism. It can be a factor that could negatively impact labor productivity. Various studies were performed previously to investigate the impact of overtime to labor productivity in certain contexts or under certain conditions. This paper first reviews these studies and discusses relevant contexts and conditions related to them. Despite that overtime can cause loss of productivity, the existence of overtime does not automatically warrant a recovery of lost productivity. This paper discusses loss of productivity claims involving overtime from the aspects of entitlement, causation and damage quantification.



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This paper provides useful tips and suggestions in the context of overtime for various parties in construction from the perspectives of both claim avoidance and mitigation and claim resolution.

**(CDR-3895) Making Acceptable Changes to the Schedule When Performing MIPs
3.3 and 3.4**

Author(s)/Presenter(s): Mark F. Nagata, PSP; Michael P. Ryan, PE PSP

Abstract: An important characteristic of an MIP 3.3 (Observational / Contemporaneous / As-Is) and MIP 3.4 (Observational / Contemporaneous / Split) analysis is their reliance on the contemporaneous schedules as they were submitted during the project to identify and quantify the project delay. This reliance is based on the belief that the contemporaneous schedules embody the real-time perspective of the project participants and were used to track progress and manage resources. However, schedulers are human, and their plans are not perfect. In certain cases, the analyst may decide it is appropriate to make corrections to the contemporaneous schedule in order to ensure a fair and unbiased forensic schedule analysis. This paper identifies acceptable changes that can be made to the contemporaneous schedules during the execution of an MIP 3.3 or 3.4 analysis.

**(CDR-3910) Does the Concept of Practical Completion in Building and Engineering
Contracts Defy Definition?**

Author(s)/Presenter(s): Bolarinwa Dejonwo

Abstract: This paper illustrates critical evaluation of the definition and implication of practical completion in building and engineering contracts. The paper seeks to answer the questions and typical ambiguities related to determination and definition of practical completion in the construction sector especially under circumstances that have resulted in disputes amongst contracting parties and major project stakeholders. The evaluation involves analysis of practical completion definitions and descriptions in globally accepted standard forms of building and engineering contracts and its implications on the underlying project/contract. The paper also includes review of legal precedence that could assist in the contractual determination of the effects of practical completion in the construction sector. The analysis is concluded with deductions from standard forms of contract and case laws regarding definition and implication of practical completion in the construction sector, recommendations for improvements in



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standard forms of contract and identified opportunities for further research in allied fields and sectors regarding the subject.

(CDR-3921) Schedule Analysis without Schedules?! – Applying Earned Value Analysis in the Absence of Progress Updates

Author(s)/Presenter(s): Rachel Domingo, PSP; Dr. Aaron Fackler, PSP

Abstract: At the onset of a forensic delay analysis, it has become almost a ritual for delay experts to initially focus on the substantial completion milestone. Experts track the milestone's slippage and/or recovery from update to update, and ultimately measure the actual date that substantial completion was achieved against the contractually required date to determine the overall as-built project delay. However, this approach may not be applicable in all cases. For instance: if the contractor is terminated and substantial completion is never met, and/or the schedules were not regularly maintained throughout the course of construction. In these instances, it begs the question: How does a delay expert calculate delay damages?

The purpose of this paper is to present a case study where substantial completion was never achieved due to contractor termination. A window analysis was performed, and the case study presents three review periods that demonstrate alternative approaches to conducting a forensic delay analysis in the absence of monthly schedule updates. Specifically, Review Period #1 will highlight the implementation of a window analysis method as detailed in AACE International Recommended Practice 29R-03: Forensic Schedule Analysis. This method quantified delay durations by analyzing activity-level variance in a retrospective actual (hindsight) mode and using progress data from contemporaneous project schedule updates. Then, Review Periods #2 and #3 will illustrate how progress reported in the contractor's payment applications can be used to perform an earned value analysis for the purpose of quantifying progress delays.

(CDR-3924) Project Documentation: Supporting Your Position

Author(s)/Presenter(s): Christopher P. Caddell, PE CCP DRMP; Sydney G. Overman, CST

Abstract: The resolution of a dispute on a project can be dependent upon the available documentation that each party has to either support its request for compensation and time or to refute that request. Yet frequently, the parties lack the proper documentation to clearly establish entitlement, causation of impacts, and cost and time quantification. Contractors, subcontractors, and owners typically fail to collect and retain the necessary data and



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documentation that would help the parties reach an agreement on the disputes. On many projects, the parties have very different perspectives and fail to understand the other side's position and opinion. The right documentation can help both parties agree on facts, the actual impacts, and the cause(s) of those impacts, hopefully helping the parties resolve the dispute before it becomes a formal claim. Collecting proper documentation starts during contract negotiations and continues throughout the life of the project. This paper provides recommendations on what types of data and documentation owners and contractors should collect and how it can be used in addressing these disputes.

(COM) TECHNICAL SUBCOMMITTEE MEETINGS

(COM-3912) Value Engineering and Constructibility Subcommittee Meeting

Author(s)/Presenter(s): Douglas W. Leo, CCP CEP FAACE Hon. Life

(COM-3928) Planning and Scheduling Subcommittee Meeting

Author(s)/Presenter(s): Jessica Colbert, PRMP PSP; Daniel P. Gilmour, PSP

(COM-3929) Claims and Dispute Resolution Subcommittee Meeting

Author(s)/Presenter(s): Anthony J. Gonzales; Mark F. Nagata, PSP

(COM-3930) Cost Estimating Subcommittee Meeting

Author(s)/Presenter(s): Dave Kyle, CCP CEP

(COM-3931) Decision and Risk Management Subcommittee Meeting

Author(s)/Presenter(s): Sagar B. Khadka, CCP DRMP PSP FAACE; Dr. David T. Hulett, FAACE

(CSC) COST AND SCHEDULE CONTROL

(CSC-3786) Improving Owner's Cost Controls & Cost Optimization Processes and Practices - NOC Perspectives Covid-19 Dimensions

Author(s)/Presenter(s): Johnson O. Awoyomi, CCP CEP



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Abstract: Covid-19 dealt a serious blow on the global economy including National Oil Companies' (NOC) bottom lines. The revenues of several National Oil companies nose-dived to near zero while costs of operations and maintenance persisted. This particular NOC deployed some cost controls and cost optimization techniques that enabled it to not only weather the storms but turn the curves. Today, those techniques are continued to be deployed and are helping the NOC gain wider stakeholder acceptance than ever before. The paper underscores the checklists and significant cost reduction cum cost optimizations initiatives deployed by the NOC. Finally, the paper identifies a number of issues and offer best practices for the benefit of the AACE International community, other NOCs, and industries in general.

(CSC-3787) Schedule Delays: Why They Happen & How to Avoid Them

Author(s)/Presenter(s): Vijaykumar A. Damle

Abstract: The paper will present the need to develop a credible baseline schedule, the tools to maintain a hierarchy-driven schedule program where development of the schedule proceeds from top- or summary-level to bottom- or detailed-level schedules. It will further discuss the causes of schedule delays and the necessary mechanisms to avoid such delays. Schedule development normally ranges from the management-level summary schedules to the working-hands-level detailed schedules. Additionally, the validation and maintenance of the schedule program must be driven bottom to top, maintaining schedule integrity at each level. This paper will present illustrations of standard logic networks that will help project personnel develop logic-, duration-, and resource-driven schedules. It will then discuss project internal, and project external causes of schedule delays and which tools must be in place to avoid logic- and duration-driven critical-path schedule delays and resource-driven cumulative schedule delays. The paper will conclude by addressing key issues like schedule integrity, timely critical-path analysis, and the expeditious resolution of the resulting action items. The paper will further touch upon pertinent advances in the scheduling field, including 4D planning, emerging data analysis techniques, the use of drones and satellites in site and plot-plan development, and the use of onsite cameras to record project progress.

(CSC-3791) Extra! Extra! Read All About It! The Schedule Narrative Tool

Author(s)/Presenter(s): Joseph V. Caldarera, PSP

Abstract: The project schedule, particularly on large, complex, and extended construction projects is a tool used to convey anticipated milestone dates and the project completion date.



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Oftentimes, the logic and necessary detail needed to include project activities, changes, architectural supplemental instructions, unforeseen events, differing site conditions, and overall project delays complicate the owner's review of these schedules. When delays are incorporated into schedules that seek compensable damages from a project owner, it becomes critical to explicitly convey substantiated, timely reasons that the delay is excusable and compensable. In order to simplify the review of project schedules, the schedule narrative is a tool that can be added to the contractor's periodic schedule submissions. A schedule narrative can be tailored to include clear explanations of events, identify weather delays, the origin of a delay activity and established notice, the contractor's measure of compensable time, responsible party action to mitigate delays/advance the project, and can provide a forecast of any changes in the completion date. The clarity provided by an all-inclusive schedule narrative will unquestionably convey project circumstances in clear written form. The preparation of the schedule narrative as a beneficial tool for the owner, contractor, and designer will be discussed in this paper.

(CSC-3831) Advancing Project Management with Multi-Dimensional Project Controls and Digital Twin

Author(s)/Presenter(s): Dr. Bahadir V. Barbarosoglu, CCP EVP PSP; Ben Milner

Abstract: Robust project controls are a must-have mechanism for successful project management. Timely and reliable project controls data is crucial to diagnose the project's current status, predict the project's future performance, and manage risks. However, traditional project controls practices, tools, and techniques are not standardized, sophisticated, consistent, objective, synthesized, or connected enough to support project management in its entirety. The project team's lack of commitment and trust in project controls are not uncommon due to past experiences with impractical and unreliable project controls mechanisms. With increasing complexity and resource constraints, projects need to have comprehensive and reliable project controls. The negative impact of project complexity and risks on schedule, cost, quality, and safety can be effectively and efficiently managed only by implementing multi-dimensional, design-centric, and data-driven project controls approaches such as digital twin (DT). DT is a promising project controls approach where a real-time virtual replica of physical structure functions as a single-source-of-truth. It helps establish a plan, monitor and control progress, measure the project's current state, forecast its trend, manage risks, and communicate project status with stakeholders. However, incorporating DT into existing project controls practices does not guarantee successful implementation unless the practices meet critical success criteria. This



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paper reviews current practices, barriers, enablers, opportunities, and future trends for project controls with digital twin and advanced technologies.

(CSC-3837) Advanced Work Packaging (AWP): An Introduction and Project Controls Guide for Implementation

Author(s)/Presenter(s): Ferdinand R. Karbowski, Jr. PSP

Abstract: Beginning with the “end-in-mind” is a fundamental principle of advanced work packaging (AWP). It is an evolution of the standard principles familiar to most project management professionals responsible for executing EPC capital projects. The Construction Industry Institute (CII) defines AWP as a construction-driven planning and collaboration system for building capital projects primarily focused on removing obstacles necessary for productive and effective field execution. Perhaps the most important role project controls has in the overall implementation of AWP is when the field installation work package (IWP) is developed. That is where WBS codes, schedule dates, resources (such as workhours, installation quantities, material take-off quantities, etc.), and cost codes are applied. This paper will introduce the advanced work packaging concept but will focus on the integration of project controls elements required for successful implementation throughout the project lifecycle using the AACE Total Cost Management™ (TCM) project control process map as a basis. These elements include scope, project system requirements, data requirements, budget and cost requirements, schedule requirements, contract requirements, etc. In the end, understanding AWP, its components and how project controls elements are applied can lead to significant improvements in the safety, quality, cost, and schedule of any EPC capital project.

(CSC-3867) Leverage Innovative Technologies and Standardized Coding System for Real-Time Project Cost Control

Author(s)/Presenter(s): Jing Xu

Abstract: While the world is going through the pandemic, it is noticeable that the uncertainty of the economic environment is increasing. Controlling the costs of mega construction projects within budgets becomes even more challenging. To quickly respond to changes, the ultimate solution would be to leverage innovative new technologies to create a multiple dimension control system that can monitor project progress and cost flow in an integrated manner. This article discussed existing technologies and how they could empower data collection, increasing accuracy and effective reporting to facilitate cost control and forecasting trends. Real-time cost



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control allows fast decision-making by understanding actual cost in real-time while the project progresses and enhances predictive analysis for future expenditures.

(DEV) PROFESSIONAL DEVELOPMENT

(DEV-3782) The Competitive Edge: "Competence Modeling for Today's Industry"

Author(s)/Presenter(s): Dr. Edward Shelton

Abstract: Human Resource organizations recognize that their workers competencies are an important source of competitive advantage but struggle or encounter difficulties when they attempt to identify, transfer, and assess those competencies. Specific competencies are often ambiguous to managers, and individual perceptions of a firm's competencies may vary significantly.

This lack of specificity may mask significant misunderstanding and confusion about competencies. When this misunderstanding or confusion occurs among middle managers who are responsible for the day-to-day management of these competencies, the implications for an organization can be serious. This paper outlines challenges that most organizations will face post pandemic and over the next 10 years, as a large part of the knowledgeable workforce will be retiring or leaving. These separations from the skilled workforce need to be identified, collected, organized, and transferred into the main body of workers to maintain operational efficiency.

Developing a program that can identify, assess, and transfer competencies is the challenge for all international organizations and managers. As part of the strategy, professionals must develop a model that identify key skill competencies for their supply chain middle managers' that not only improve performance but is proven to be an effective knowledge transfer vehicle. A proposed model is presented as a preferred methodology that identifies skills and developmental activities that result in knowledge transfer and skill gap reduction. In addition, we describe a method that any international organization can use to assess its competencies, and we show how management can use the assessment to enhance the firm's competitive advantage through knowledge transfer and skill development.

(DEV-3901) (Panel Discussion) Career Stories in Claims & Dispute Resolution

Author(s)/Presenter(s): Avi Sharma



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Abstract: This panel discussion will be a wide-ranging conversation led by the Rising Professionals Committee with a panel of seasoned claims and dispute resolution professionals about their careers in the industry. The expert panel carries varied experience in the engineering, oil, and gas, and construction industries and represents the perspectives of owners, consultants, and contractors. Discussion topics for the panel will include their own professional journey and career path, advice for young professionals, lessons learned along the way, and how the industry has changed over time. Finally, the panel will field questions from the audience.

(DSAA) DATA SCIENCE AND ADVANCED ANALYTICS

(DSAA-3798) Implementation of a Project Data Warehouse

Author(s)/Presenter(s): Eric Vyskocil

Abstract: The importance of an integrated database for project historical data to measure project performance is recognized by the recent AACE International Recommended Practice 114R-20. A historical database allows project teams to create standardized reports on key performance indicators, trend metrics over time, and analyze the data to observe common trends in project performance. There are many challenges to overcome in the development of an integrated database; establishing data input standards, maintaining the data quality, establishing and maintaining the necessary data security, resolving database errors in a timely manner and developing effective metrics.

This paper will focus on the key challenges whilst implementing an integrated project data warehouse at Ontario Power Generation (OPG), and some of the benefits that have been observed. The development of this data warehouse began in 2015 as part of a mega-project and was extended to all OPG projects in 2019.

**(DSAA-3814) Data Collection and Visualization for an Improved Analysis of
Historical Project Data**

Author(s)/Presenter(s): Helge Schlott; Luis A. Garcia Loera, CEP

Abstract: Projects produce data around the clock and provide broad opportunities to generate organizational knowledge. Digital initiatives, especially in the field of cost engineering, establish a competitive advantage to owner organizations by improving cost and productivity, consistency of approach, and risk management processes. This paper shares practical experiences from the



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implementation of a digitalization process, which evolved from a stumbling block into a steppingstone. It addresses the design of a framework for the implementation, data collection, storage, analysis and sharing of relevant project data, whilst also demonstrating a methodology to adapt the AACE recommended practice 114R-20 on the development of project historical databases.

The paper starts with the introduction of the technical development by outlining the data collection process, the design of the database architecture, and the data analysis approach. A common business intelligence application (e.g., Microsoft Power BI, Tableau, Sisense) helps to perform data visualizations and sharing of results. The second part addresses the implementation process and how to create buy-in. It closes with a discussion of identified success factors like building a simple system, collecting structured data, sharing results via interactive dashboards, implementing in phases, and planning the communication precisely.

(DSAA-3816) Data Model for Advanced Data Analytics

Author(s)/Presenter(s): Subhash Tuladhar

Abstract: Many owners have access to an abundance of project data. That includes schedules, risk logs, and cost reports to name a few. Owners may also have data on other project attributes. Historical project data always existed and have an important reference in managing projects on hand. However, the popularity of information management systems in the recent years has led to an unprecedented growth in the quality and scale of available historical data. Such a trend has made historical data increasingly more valuable in managing projects.

Data analytics is the extraction of meaningful business insights from data. Recent advancements in artificial intelligence and computing power have accelerated the adoption of data analytics. This adoption promotes a data driven culture in managing projects and managing them proactively and more effectively. Owners can now leverage empirical data in developing more robust schedules and cost forecast. A robust plan is one that is not just reliable at the onset but can adapt well to a changed environment. A data driven approach to planning complements the knowledge and experience of experienced professionals in managing projects and gets its own seat on the table.

To implement a data analytics framework, planning is necessary. A good plan covers the approach to data acquisition, data enhancement, data predictions and delivery of insights. Explained with



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a real-world example, the paper describes a practical approach to the first two steps and how it results in a best-in-class historical database and data model.

(DSAA-3862) Machine Learning: Classification and Clustering Strategies for Work Breakdown Structures

Author(s)/Presenter(s): Maura Lapoff

Abstract: The National Nuclear Security Administration (NNSA) collects work breakdown structure (WBS) data for capital asset projects. A WBS allows cost estimators and program managers to track and compare capital acquisition costs across the entire Nuclear Security Enterprise (NSE). The difficulty is that implementing the structure across projects grows exponentially in complexity due to varying project scope, contextual changes, and vendor requirements. This paper will demonstrate the capability of natural language processing to identify and classify the WBS elements used for NNSA capital asset projects.

The results indicate that both unsupervised and supervised machine learning algorithms can obtain a pre-defined classification scheme developed by capital acquisition experts. Multiple machine learning techniques were employed and are compared based on ease of deployment, computational time to completion, and accuracy with respect to the desired results. These technologies can dramatically alter the cost analyst's workflow by automating significant and often time-consuming components of their work.

(DSAA-3890) Raising the Bar on Data Collection Strategies as it Relates to Claims

Author(s)/Presenter(s): Michael A. French, PE CCP CEP PSP; Ajay Raman, PSP

Abstract: Collecting accurate data is necessary for continued success in the construction industry, and when it comes to claims and dispute resolution, the bar is raised. Supporting data is now open to critique by opposing attorneys, other experts, and possibly a jury. If data issues are exposed, credibility is quickly lost, and the results of inaccurate information could be damaging to the dispute.

Obtaining reliable information can be challenging, especially as it relates to labor and equipment. Difficulties exist when allocating workers and equipment to multiple tasks. Also, determining whether the equipment was operating, idle, or on standby can be difficult to justify.



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Data collection efforts can be very time-consuming and costly and may still yield inconsistencies. This is one area in which improved technical capabilities can help. More reliable and enhanced data may be possible by combining high-tech solutions such as equipment telematics, drones, geo-fencing, and online software platforms into a well-integrated system capable of producing consistent and reliable data.

Since construction disputes can be very costly, finding solutions to better remedy issues can be extremely helpful to contractors. In addition, improved data collection methods and information may also result in lessons learned, improved estimates and schedules, and possible future claims avoidance.

(EST) ESTIMATING

(EST-3792) Changing Estimate Process

Author(s)/Presenter(s): Waymon Lofton

Abstract: When an estimating process is not working, what can be done? Is it patched with updated procedures, or does one start over? At Black and Veatch (B&V), the estimating team chose to start over. The new process had many challenges and key activities to consider. This paper will walk through each step with explanations and results.

The process started from the end. The team asked themselves “what is needed” from the estimating process. Key answers included consistency, accuracy, collaboration, integration, digitization, reduced time and history collection and usefulness. That’s a big list with each of the times listed posing unique challenges.

Processes and procedures have been incorporated for each of these challenges in the new estimating process. Each of these will be discussed with a description of what has been put into place and what the results have been. This discussion will include the resistance to the changes and how that resistance has been dealt with.

(EST-3795) (Presentation Only) RP 115R-21, Cost Estimate Classification System - As Applied in Engineering, Procurement, and Construction for the Nuclear Power Industries

Author(s)/Presenter(s): Shoshanna Fraizinger, CCP



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Abstract: This presentation will provide an overview of the recently published recommended practice (115R-21) on cost estimate classification for the nuclear power industries. The recommended practice provides guidelines to both owners and service providers for applying the principles of estimate classification specifically to project estimates for engineering, procurement, and construction (EPC) or other contractual arrangements and execution venues, and their related work in ongoing or developing nuclear power related projects. This recommended practice provides the nuclear power industries with a project definition deliverable maturity matrix. It also provides an approximate representation of the relationship of planning, preparation, design input data and project scope deliverable maturity with the estimate accuracy and methodology used to produce the cost estimate.

(EST-3818) Equipment-Factored and Engineering-Model Estimates

Author(s)/Presenter(s): Larry R. Dysert, CCP CEP DRMP FAACE Hon. Life

Abstract: Supporting AACE Class 4 estimates in the process industries, the maturity of technical deliverables should typically have progressed to include a preliminary equipment list, preliminary plot plan, and process flow diagrams. These primary scoping documents support the preparation of estimates using equipment factored and engineering-model methodologies.

This paper provides an overview of these AACE Class 4 estimating methodologies. There is a variety of equipment factored estimating techniques that can be applied to estimating process facilities, and several examples will be presented and discussed. Engineering-modeled estimates typically use specific commercial software applications. Examples for upstream and downstream oil and gas facilities will be presented.

(EST-3819) Alignment of Cost Estimating and the Project Development Process

Author(s)/Presenter(s): Larry R. Dysert, CCP CEP DRMP FAACE Hon. Life

Abstract: Cost estimating supports critical decision-making during the project planning and development processes for capital projects. In early project planning phases, cost estimating supports value-based decisions regarding project capacity, location, technology selection, execution and contracting strategies, and other important project characteristics. Eventually, the cost estimate is a key element to the final approval and funding authorization that commits a project to proceed to construction and eventual start-up.



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This paper will discuss the important role of cost estimating during the various stages of project development, and the alignment of cost estimating methodologies with project development phases. The provision of the appropriate maturity of required design and engineering deliverables to support cost estimating is essential during each phase of the project development process to ensure that effective decisions are made to meet all project goals and objectives.

(EST-3823) Cost and Throughput Analysis for the NASA Ames Arc Jet Modernization Program

Author(s)/Presenter(s): Jennifer Scheel; Dr. Christian B. Smart

Abstract: NASA Ames Center is currently evaluating alternatives to modernize the Arc Jet Complex, a critical part of testing for NASA's planetary missions. NASA's Arc Jet Complex facilities "are used to simulate the aerothermodynamic heating that a spacecraft endures throughout hypersonic atmospheric entry, and to test candidate thermal protection system (TPS) materials and systems." Because planetary mission schedules often have tight windows due to planetary alignment constraints, a small increase in schedule could result in a two-year delay. Such a delay could increase the cost of a \$1 billion mission by hundreds of millions of dollars due to project personnel pay and clean room storage. To avoid these costs, the authors support NASA Ames in evaluating return on investment (ROI) and effectiveness of alternatives for modernizing the complex. The first input into the ROI is the deconstruction and construction cost estimates, which are developed using independent research on highly specialized subsystems, vendor quotes, and Unified Facilities Criteria (UFC), depending on the facility and work package. One of the measures of effectiveness is throughput analysis of the test bays, as a main goal of the modernization is to increase the number of possible test runs per year. This analysis is conducted via a probabilistic simulation and accounts for a variety of stochastic factors that influence the sequence of test runs, such as the facility availability; test complexity; the need to pause to assess test results; test failure; and the possibility of a system failure. The methodologies for both these analyses are discussed, along with the challenges presented due to the unique nature of the highly specialized test equipment.

(EST-3845) Application of Parametric Models for Cost and Carbon (CO₂) Footprint Estimating in Infrastructure Projects

Author(s)/Presenter(s): Apostolos Chatzisyseon; Dr. Manolis Georgiudakis; Justice Sechele; Arnaldo M. Angelini; Andrew Langridge



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Abstract: As the environmental impact of infrastructure mega projects becomes increasingly important in early concept decisions, especially due to CO2 emission reduction commitments of developed countries, it is essential that consultants and project owners can assess not only budgetary costs but also the overall embodied CO2 of their project designs. Having timely feedback of the cost and CO2 footprint of the asset types they assess for their projects, before their final design, can help reduce both costs and CO2 and therefore optimize the overall design. This paper describes a case study on how infrastructure asset conceptual parametric models (also called smart assemblies) for providing both cost and CO2 estimates can be used in a road project and how they can apply in Class 5 to 3 estimates in conjunction with GIS definitions or more detailed asset scope to deliver cost and carbon optimized projects

(EST-3855) False Estimate Accuracy

Author(s)/Presenter(s): Dave Kyle, CCP CEP

Abstract: Understanding true estimate accuracy is critical in determining if the estimate meets client expectations and is suitable for the intended purpose. This paper examines and discusses the foundations of estimate accuracy, and common misrepresentations and misconceptions of it. A strong understanding of the foundations of estimate accuracy enables the estimate reviewer or recipient to uncover true estimate accuracy.

Some incorrect practices to be examined are: Creation of deliverables to estimating based on conjecture instead of sound engineering design; incorrect use and presentation of historical data; assumptions used in place of a sound execution plan; incorrect use of factors and allowances; improper understanding of uncertainty and contingency; and a lack of benchmarking.

This paper will also examine key contributors to desired estimate accuracy. A proper understanding of the key drivers of estimate accuracy guides the estimate developer to successful practices that will result in the best possible (most accurate) outcomes. For the estimate recipient, the proper understanding of the foundations of good estimate accuracy allows early (and comparatively inexpensive) identification and correction of deviations from best practices that contribute to poor accuracy.

The reader will understand that while a few minor inaccuracies in an estimate may not have a significant impact on the overall accuracy, a wholesale disregard of the need to reduce uncertainty in the estimate by the many parties providing input will lead to grossly inaccurate project cost estimates.



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The author is drawing from real life experiences.

(EST-3860) Cost Growth in Early Stage NNSA Construction Projects: Root Cause Analysis

Author(s)/Presenter(s): Christopher J. Massey; Jeffrey E. Beck; Tyler Hoss; Jennifer Vandervort

Abstract: The Office of Program Analysis and Evaluation (PA&E) within the National Nuclear Security Administration's (NNSA) is charged with leading programmatic cost estimating and associated analytical support throughout the federal budgeting process. In this role, PA&E has conducted a root cause analysis on cost growth in early capital acquisition programs meant to revitalize the NNSA's aging infrastructure. This analysis tracked projects from initial mission need and requirements through conceptual design and initial budget submission, a process that takes approximately 3 to 5 years. The study tracks and catalogues changes in estimates from the initial mission need stage through subsequent analysis of alternatives, conceptual design, and final budget submission.

The analysis identified the following as primary cost growth drivers: differences in escalation assumptions, scope "growth" additions, missed scope, and contingency growth. Cumulatively these resulted in as much as 100% growth over the studied timeframe. Identifying these underlying root causes as drivers enable program managers and organization leadership to better prevent, track, and manage project and portfolio risk.

(EVM) EARNED VALUE MANAGEMENT

(EVM-3780) Comparison Between Earned Schedule and CPM in Estimating the Project Duration

Author(s)/Presenter(s): Omar Al Rawashdeh, P.Eng. CCP PSP

Abstract: Earned schedule (ES) is a new technique to measure the performance of the project using the same variables and assumptions that are used in earned value management (EVM). The new addition that earned schedule did is that it measures the performance in term of time instead of cost or unit as it is usually done in the EVM. This allows ES to be used to estimate the project completion time.



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The most common practice in the construction industry to assess the status of the project schedule and estimate the project completion time is critical path method (CPM). The assumptions used to estimate the project completion time in CPM are different than those used in ES. These two methods (ES & CPM) can be used to estimate the project completion time which raise the question that which one can be more accurate than the other in estimating the actual completion time. This study compares between these two methods (ES & CPM) and shows the effectiveness of each one in estimating the actual project duration for a construction project of a gas station in UAE.

(EVM-3797) Earned Value Management Use in Claims

Author(s)/Presenter(s): Dan Melamed, CCP EVP FAACE; Charles E. Bolyard, Jr. CFCC PSP FAACE Hon. Life; Robert M. Freas; Dave Ingalls, EVP; Michael F. Marcell, EVP PSP

Abstract: Earned Value Management (EVM) integrates scope, schedule and costs to provide a factual basis from which methods can be applied to evaluate actual progress and performance, including resources, against the planned schedule and budgets. The analyst can then determine whether schedule and costs are meeting planned targets and budgets. This panel will explore what characteristics make an EVM system the source of robust data with integrity for use in claims analysis, both prospectively and retrospectively. The panel will also examine the challenges EVM Practitioners may encounter while seeking to ensure that their EVM data can be readily used by forensic experts in the preparation and analysis of schedule delay and lost productivity claims.

(EVM-3806) Taming Your Organization for Earned Value Management System (EVMS)

Author(s)/Presenter(s): Abbas Saifi, EVP PSP

Abstract: The gradual shift in implementing an earned value management (EVM) system (EVMS) on public infrastructure projects has raised many questions. There is a lack of clarity regarding why and how to implement EVMS, and many contractors often shy away from adopting and implementing the earned value management system (EVMS). This paper focuses on providing answers and recommendations for the implementation of EVM at the program/project level. It demonstrates a simple technique for the input of data to the project schedule to get reliable outputs and metrics for the stakeholders. This paper also highlights a detailed systematic guide



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to implement EVMS for the contractor and provides recommendations to consultants for a flexible and realistic approach, to be best suitable to the nature of the project relative to the construction industry.

(EVM-3926) Earned Value Management Model for Data Center Retrofit Program

Author(s)/Presenter(s): Haegon Kim, CCP PSP

Abstract: Earned value management (EVM) allows discovery of problem areas to prompt corrective action. Most EVM tools require intensive work; however, it is difficult to achieve these efforts in the case of a small data center retrofit project because of resource limitations. This paper covers a simple EVM Excel model with a Primavera P6 layout, which provides weekly and cumulative performance and percentage completion by areas and trade partners. This model was validated by multiple data center retrofit projects of varying sizes. This model is currently being used by four major general contractors in the retrofit program, and it can be easily used by even entry-level project controls engineers. Thus, this model can be used to achieve effective, error-minimized, and uniform EVM for an entire retrofit program.

(INT) GLOBAL PROJECTS

(INT-3898) Construction Management Fee Model for Theme Park Project in China

Author(s)/Presenter(s): Lan Zhang; Jie Xu; Jianfan Chen

Abstract: A well-developed theme park project requires the full integration of the ride, show, theme, and facility to achieve an immersive experience for the guest. Theme park developers, therefore, would usually employ a construction management (CM) company to coordinate the integration during the execution phase of the project. Specifying the expectation and budgeting the service is critical when selecting a competent CM company at a competitive price, while in the current market, the cost model is not available. This study starts with a typical theme park attraction project description, the scope of the work needed to be performed by a CM company with an organization chart with headcount and level of the position. Then, a manpower plan is drawn from the baseline schedule and the organization chart. Furthermore, an analysis of the selling rate is combined with the CM resources needed to form the CM fee model. The model is presented and validated at a theme park project, followed by a discussion on the relationship between CM fees and overall direct construction costs. A well-defined CM fee model can assist



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the client in budgeting and selecting the CM company for theme park projects in China to avoid shortcomings on the side of the CM company.

(INT-3899) Procurement Strategy for a Theme Park Project under China's Public Tendering Law

Author(s)/Presenter(s): Lan Zhang; Zhitao Fan; James QS Zhang

Abstract: The theme park industry is growing rapidly in China; however, some of the theme parks have a low visitor turnover because of their non-immersive design elements. Some of the parks had to shut down and were a poor investment. Non-immersive experiences are created by a combination of functions and the overall quality of the theme park, which are in turn produced by a full spectrum of stakeholders, from creative designers to specialist contractors. Quality suppliers and vendors must be selected in order to build the quality of theme parks. However, due to the limitations of China's public tendering law, the public tendering process might select players that tender at a low price but complete the contract with big claims, which is not rare in China. How can a theme park developer select vendors with previous experience and, at the same time, comply with China's public tendering laws? This study first analyzes all the public tendering laws in China and then divides the procurement structure into "Public Tendering" and "Invited Tendering." Based on the nature of the service provided and the FIDIC (Federation International Des Ingenieurs-Conseil) contract's template, each category is further divided into consultants, specialist contractors, facility equipment, ride and show equipment, and performance packages, with the managing plan, recommend, negotiate, and select processes as the procurement framework. This model is utilized and validated at case study section. The model can assist developers in executing projects successfully. Engaging a knowledgeable tendering agent, having clear objectives, and controlling the procurement process are key to procuring the right vendors in China in compliance with public tendering laws.

(OWN) OWNER ISSUES

(OWN-3820) The Importance of Owner/Contractor Transparency Across All Contract Types

Author(s)/Presenter(s): Stephen L. Cabano



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Abstract: Many owner organizations use lump sum contracting to deemphasize the need for diligent transparency of project cost, schedule, risk, resources, etc. They reduce oversight and superficially transfer responsibility for successful project execution - with the attitude that 'it's the contractor's job' to control the project. This approach eliminates attention to detail with the historically accepted premise that the owner may be limited in access to performance data that can be expected from a fixed-price contractor.

History has proven that the above approach is often unsuccessful and that owners can only partially transfer project risk to the contractor. At the end of the day, owners may end up with surprise cost/schedule impacts, contractors who are suddenly struggling financially, and the realization that it's too late for effective corrective or mitigation actions. Project control transparency is critically important for any selected contracting strategy, and the extent to which contractors are willing to share trends is often mischaracterized.

While reporting on internal rates, overhead buildups and full-cost impacts may be seen as somewhat restrictive, many contractors are willing to share manhour unit rates to provide adequate visibility for productivity measurement, as well as overall project staffing. It has also been observed recently that many contractors are willing to provide added/improved transparency in an overall trend toward contracting partnerships versus the previously experienced adversarial relationships. The detailed information required will vary, but the owner's primary goal should be to maintain visibility and an understanding of reliable, accurate project status that will facilitate an effective owner/contractor relationship. This paper will include an outline of a reasonable data request which, when correctly communicated, will encourage a win-win situation.

(OWN-3821) Benefits of Outsourcing the Estimating Function

Author(s)/Presenter(s): James K. Cravens

Abstract: It is not surprising that today's owner organizations are looking for more accurate project cost estimates. For the purposes of this paper, the term 'owner' is defined as a heavy industrial owner/operator. In addition to other recurring issues, owners are cash sensitive as they recover from the impacts of the pandemic and are dependent on the fact that, as projects transition from one phase of project development to the next, they will achieve the desired level of estimate accuracy (or better) that their established capital project delivery process defines. With this said, in many cases owners have dramatically reduced their internal capabilities associated with the development of early estimates and instead rely on their front-end



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engineering contractors. This has proven only partially successful due to biases, conflicting objectives, limited owner cost experience, etc.

A growing trend in the industry is the use of outsourced cost estimating support. This technique provides qualified, experienced cost estimating expertise, as needed, while also delivering company and industry benchmarks and data that offer an independent perspective without hindrance from internal company pressures, biases, etc. The outsourced estimators use of various cost estimating tools, proprietary as well as industry available data, risk analysis systems, etc. creates an environment for highly reliable, accurate and timely estimates on an 'as needed' basis. This paper will provide a road map and checklist for successful use of outsourced estimating support and will identify pitfalls of a poorly implemented process.

(OWN-3925) A Case Study in Saudi Arabia: Completion of Major Pipeline Project within Budget and Schedule Utilizing Multiple Contractors

Author(s)/Presenter(s): Hassan A. Mansour; Mohanna A. Herzalla; Arindam Neogi; Tanveer N. Ahmed, PE CCP

Abstract: Typically, large capital projects are complex in nature and events happening during the project life cycle continue to impact the final outcome of the project. Although all company projects follow the stage gate process to determine whether or not the project can continue to the next phase, factors beyond company's control cannot be avoided and they can only be mitigated. External factors which impact the project prove difficult to be fully controlled, however, timely steering efforts by higher management and due diligence from the team may improve the chance for project success. This study will review the circumstances and indicators that entailed the project in distress, and what was done to recover and achieve the required targets. This study will take a deep dive into techniques utilized to mitigate the challenges which resulted in the successful completion of this project.

(PM) PROJECT MANAGEMENT

(PM-3783) Optimization of Effort and Workforces in Project Organizations

Author(s)/Presenter(s): Alex James

Abstract: Workforce management is a key factor in organizational success. Unfortunately, human effort, at the heart of all productivity, is poorly understood because of its many levels of



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abstraction. This paper proposes a new conceptual framework to manage human effort. The new effort management theorem (EMT) defines the relationship between effort and workforce outcomes called ability, efficiency, and intensity. Within this framework, advanced effort management (AEM) analysis leverages EMT to provide: i) predictive forecasts for outcomes and inefficiencies, ii) aggregated forecasts throughout an organization, iii) the effort outcome window (EOW), which provides a unified visualization of all outcomes, iv) prescriptive interventions that optimize an entire workforce, and v) resultant impacts that change delivery, margins, and even wellbeing. Underlying all this is the outcome unity equation (OUE), where 'ability x efficiency x intensity = 1'. This determines how many people an organization will need, have, and use. An example is provided that illustrates a scenario of project engineers in a San Francisco, Dallas and New York office. Their effort, outcomes and results are optimized thru EMT, AEM, EOW, and OUE. This in-depth approach allows managers to comprehend and communicate a workforce's future. Effort management provides actionable insights necessary for making workforce decisions easier and for greatly improving workforce productivity and organizational success.

(PM-3796) An Adaptable and Comprehensive Project Assessment Tool

Author(s)/Presenter(s): Dan Melamed, CCP EVP FAACE; Bryan A. Skokan, PE CCP; Wei Liu; Jake Lefman; Rodney Lehman

Abstract: Most companies, agencies, and other real property owners require capital asset projects to pass some type of scrutiny before budgets and authority to expend funds for the design, construction and eventual operations are approved. This process typically involves management approval of key/critical decision(s) or a project's passage through gates (or critical decisions). Cost, functionality, safety, and risk are just some of the factors typically considered during project assessment processes. This paper describes a tool that was developed and is used by the Department of Energy to facilitate this project assessment process. There are three versions of this tool for construction, decontamination and decommissioning (D&D), and environmental restoration/cleanup project types. The tool's elements and associated criteria are tailored for each project type; although some elements, such as cost estimating and scheduling, are used in common. The tool is easy to use, requiring little or no training. It provides a common assessment tool for project self-appraisals and independent project reviews. It promotes efficiency and reduces disagreements and unnecessary effort. A comprehensive array of elements covers the gamut of cost, schedule, scope/technical, and safety/security ensuring that no important project attributes are overlooked. The tool is adaptable for use by any organization.



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(PM-3817) Governing for Success: Effective Project Governance for Megaprojects

Author(s)/Presenter(s): Dr. Ahmed Ewida, PEng

Abstract: The significant cost overruns and schedule delays experienced by many megaprojects show how important it is to explore and tackle the main influential factors and root causes behind such overruns and delays. A key influential factor that significantly impacts the performance of megaprojects is the project governance landscape adopted for these projects. The development and implementation of an effective project governance framework should pave the way for successful selection and execution of megaprojects.

This paper presents a comprehensive project governance framework for megaprojects that takes today's complex business environment and critical management processes into account. Key processes, actions, and principles associated with an effective project governance are identified and discussed under the following topics: project governance main objectives, leadership roles in project governance, project governance organization structure, decision-making strategy, critical success factors and key performance indicators, project selection and progression, risk management strategy, oversight and assurance strategy, and project monitoring and reporting. Influential factors and challenges that may be associated with publicly funded megaprojects are also presented and discussed.

Recommendations are made throughout this paper for the purpose of developing effective project governance practices that aim at achieving outstanding project performance.

(PM-3827) Megaproject Success Factors

Author(s)/Presenter(s): Noorussaadah Bt Yahya; Ir. Mashitah Jais

Abstract: Industry benchmarking shows that a company's megaproject performance is very close to the industry average and almost in the top quintile as compared to other typical megaproject performance. The megaproject is deemed to be one of only a handful of successful megaprojects that has met four industry criteria for megaproject success of cost underrun, average cost-effectiveness, limited execution schedule slip, and average schedule effectiveness. This paper will showcase the key success factors along with the best practices adopted in successfully undertaking efforts to drive a megaproject towards being delivered at a manageable and competitive cost. It is suggested that the project competitiveness is driven largely by effective project shaping and definition, developing a strong project management team, and maintaining good discipline during execution as well as safety and HSE requirements, all of which are critical



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as the building blocks for a successful megaproject. A study on a company's mega project has been conducted and aims to shed light on factors that have contributed to the success of the megaproject execution and delivery. The goal is to identify primary lessons learned and key take away from the overall study that potentially can be put into practice and become a part of the system to improve future project execution and performance.

(PM-3830) A Standard WBS Proposition for Fixed Platforms Decommissioning in Brazil

Author(s)/Presenter(s): Alberto Carlos Caldeira Costa Coelho; Cocis Alexandre dos Santos Balbino, Sr. P.Eng.; Leonardo Muller, CCP PSP

Abstract: The process of oil and gas exploration and production (E&P) in offshore environments has been carried out for over 70 years in the world, mostly through fixed production platforms. As the end of the life cycle of these structures approaches, the topic of decommissioning has entered the agenda of several companies, leading to the need of more robust planning and generating new business opportunities. It is estimated that between 2021 and 2025, only in Brazil, the total expenditure in decommissioning will reach \$5.2 billion. The formation of this market involves overcoming technical, logistical, environmental, regulatory and project management challenges, among them, the structuring of a work breakdown structure (WBS) that organizes and orders the activities that make up the complete scope of the project, contemplates the specificity of Brazilian legislation, and facilitates the identification of service providers related to each step of the process. This paper proposes, based on international experience, particularities of the Brazilian legislation, and good project practices, a standard WBS specific to the Brazilian case. This WBS covers the decommissioning process from planning to project closure, including a proposal for a standard contract WBS for the contract model of engineering, preparation, removal and disposal (EPRD).

(PM-3843) (Panel Discussion) New Faces of Facilitation: The Nexus Between Project Controls and Facilitation

Author(s)/Presenter(s): Sandra MacGillivray; Eileen Sien, PE; Tom Orr, PE; Justin Jacobsen, PRMP PSP; Mairav Mintz, PE PRMP (Moderator)

Abstract: In design and construction projects, facilitation has traditionally taken one form “partnering” and has unfortunately been limited to only a minor role on the project: improving relationships between the individuals on the project team. However, facilitation offers numerous



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additional opportunities to improve project and team performance and takes more forms than just partnering. Tools such as Project Definition Rating Index (PDRI), value engineering and analysis (VE), project risk management (PRM), and partnering represent the “new faces of facilitation” and, when used in various combinations, create a critical nexus between facilitation and project controls. Through conversations with practitioners in PDRI, VE, PRM, and Partnering in a panel discussion and by highlighting specific project examples and case studies, attendees at this valuable session will explore with us how each form of these facilitated engagements improves collaboration, identifies key performance metrics, and engages the team to focus on not only forming a well-functioning team, but also tracking the quantitative indicators of success.

(PM-3865) Using Linear Programming to Create Optimal Budget Scenarios

Author(s)/Presenter(s): Cadence Doyle

Abstract: Within the National Nuclear Security Administration (NNSA), federal program managers heavily rely on their contractors at Department of Energy (DOE) laboratories to plan their budget. Each site is asked to prioritize investments internally and communicate those priorities back to the program offices. Federal program managers must weigh competing priorities across all laboratories to make funding decisions. In the NNSA, program managers often wish to eliminate the most risk, which raises the question: “how can the enterprise ensure it is using its dollars to buy down the most amount of risk?”

In this study, the author delivers an analytical approach to create optimal budget scenarios. Using linear programming, an operations research technique, the team is able to mathematically derive the “optimal” way to spend dollars on the recapitalization of programmatic equipment. Combining the risk score and the procurement cost for each piece of equipment, it is possible to translate this business question into a system of linear inequalities. Methods explored in this study do not provide a proposed budget for federal program managers. Instead, they facilitate a data-driven discussion between managers and laboratories. This process will enable federal program managers to make portfolio-wide decisions in an informed manner.

(PM-3876) Bridge Over Troubled Waters: Challenges of Mid-Stream Project Management

Author(s)/Presenter(s): Praduman Maraj, PE PSP; Daniel Sokoloski, PE PSP



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Abstract: This paper is focused on the challenges and lessons learned from taking over the project management of a bridge replacement project after two years of construction. It outlines the work progress, the correspondence backlog, the contractor's attitude, the owner's approach and limitations, the process of navigating dispute resolution, and the evaluation of resulting multiple claims. The presentation discusses the situation that contributed to the breakdown of communications, the increased adversarial attitude of the contractor, and the measures taken to gain control of the project management process. Communication and timely responses to contractor requests are key to minimizing conflicts and disputes. Detailed contemporaneous project documents create an accurate record that can be used to evaluate the basis of disputes and claims. Understanding the contract documents is necessary to effectively review and analyze requests for equitable adjustments (REA) and extensions of contract time. Discussions involve illustrating the shortfalls and challenges found on the project, highlighting measures that can help avoid or mitigate escalating disputes, and the need to understand the contract as the framework for project control.

(PM-3915) Construction Project Management Technology: Point Solutions vs. Integrated Platform Solutions

Author(s)/Presenter(s): Natalie Takacs

Abstract: In the recent Global Capital Projects Outlook report, one particular idea surfaced time and time again: smarter insights yield better outcomes. This is largely because technology continues to make actionable construction data more accessible, and the industry recognizes that value. However, the debate persists between traditional point solutions, such as Primavera or PlanGrid, and streamlined integrated platform solutions. This paper seeks to put that debate into fresh perspective while exploring practical solutions to help the industry deliver improved outcomes, predictability, and safety.

(PS) PLANNING AND SCHEDULING

(PS-3794) The Art of Scheduling

Author(s)/Presenter(s): Sylvia M. Donado

Abstract: With every discipline, foundational concepts are instilled and continually used and developed in order to reach advanced levels. These relate to a core set of technical principles and aspects of a particular craft. In mastering the technical aspects and continually refining those



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skills, an individual can learn to use those rules in their own way in order to give the work stronger meaning and effectiveness. This same thought process applies to the arts as well as the sciences.

In today's complex climate, everything has become segmented where technical and creative skills are seen as separate skillsets yet they both have significant value in managing projects. The manner in which technical skills get applied is what leads to effectively developed schedules and management of CPM schedules in order to effectively manage and control projects. Proper CPM techniques have proven to be extremely effective in establishing a communication of a plan, establishing production goals, monitoring and managing progress, and managing change in projects and programs.

(PS-3804) The Top Ten Worst Situations With Proven Project Controls Solutions

Author(s)/Presenter(s): Christopher W. Carson, CEP DRMP PSP FAACE; Glen R. Palmer, CFCC PSP FAACE

Abstract: Many situations occur in project delivery which appear to be unmanageable or impossible to resolve, and the authors have a long history of experience in successfully pulling off resolution of what appear to be impossible or very difficult situations. These situations range from project problems that arise from owner or contractor actions or inactions, or even third-party interference, and risk negative impacts to the project goals. Some of these were projects where the authors were brought in after the CM team recognized that they were in trouble, and some were projects that the authors participated as team members and provided the solutions.

Participants in this session will benefit from being provided ten good war stories about difficult situations and learning about proven practical solutions that should give them insight into resolving similar issues in their own careers. These are not hypothetical solutions but rather actual issues and solutions that were implemented to successfully resolve real problems.

The authors have classified these situations so they can serve as a library of typical types of project issues with solid and workable solutions.

(PS-3805) Scheduling: Do You Have All the Puzzle Pieces?

Author(s)/Presenter(s): Sylvia M. Donado; John M. Holincheck



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Abstract: Projects are becoming more and more complex and costly requiring a greater level of attention to the management of both time and resources. Critical path method and other scheduling concepts, tools, and techniques are applicable to the majority of industries that rely on planning and scheduling professionals to effectively manage work. Ensuring all components are considered thoroughly during the planning and scheduling of the project can be a factor between overall project failure or success.

Current market climate requires a more intricate level of detail however, the segmented nature of managing our work create communication and knowledge gaps that result in things being missed during the planning process. Making sure all components are considered from the beginning of the project can ensure a more successful execution as well as monitoring & controlling of the work throughout the project lifecycle.

**(PS-3835) Critical Path Method (CPM) and Project Production Planning (PP):
Complimentary or Exclusionary?**

Author(s)/Presenter(s): Richard H. Stack, Jr.; Albert P. (Mac) McMillan

Abstract: The Project Production Institute (PPI) held a webinar in October 2020 titled “Does CPM Scheduling work?” Basic premise was that CPM had failed to deliver projects on schedule. PPI recommends abandoning CPM scheduling and applying production planning (PP) techniques, developed for manufacturing, to construction projects. PPI recommended having only a Level 1 Master Schedule for management reporting.

This is a very bold recommendation by PPI. There is no argument that mega projects (>\$1 billion USD) have performed terribly for years on both cost and schedule. CPM has been used to manage most of these project schedules. But is CPM the cause of the failures?

This presentation assesses the merits of both CPM and PPI process to determine:

- Why has CPM not been effective on mega projects?
- Can CPM be “fixed”?
- How can CPM successfully manage large construction projects?
- Are CPM and PP complimentary or exclusionary?

(PS-3850) Utilizing Agile Work Methods in the Schedule Development Process

Author(s)/Presenter(s): Abbas Shakourifar, PSP



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Abstract: Schedule development is one of the primary areas in the project management process. Project teams focus on gathering data and developing their schedules from the early phase of each project. A well-developed CPM schedule is a key to success for every project team. This paper identifies the characteristics of the schedule development process which make it a proper use case for agile work methods. Also, it explains how key schedule statistics and critical path metrics can be used as key performance indicators (KPI) during agile schedule development to improve and optimize the project schedule throughout the process. This is to ensure that the final product is a robust and reliable schedule that can be used for both monitoring of the project and forecasting the end date.

(PS-3854) Planning and Building a New Arena Under an Existing Roof

Author(s)/Presenter(s): Zachary A. Hallstrom, PSP

Abstract: The purpose of this paper is to highlight the creative and effective planning and scheduling tools used during the construction of Climate Pledge Arena in Seattle, WA.

The mass excavation of over 700,000 CY of material was planned and executed while supporting an existing, historic roof structure weighing over 44,000,000 lbs. Phased completion of the excavation allowed new foundation and structural elements to be installed until the existing roof was fully supported by the new structure, thus allowing the temporary supports to be removed.

The project team used a detailed CPM schedule, LEAN techniques including weekly work planning, 4D scheduling, resource loaded schedules, and other techniques to plan work safely and effectively. This paper and presentation will highlight the successes and lessons learned of an extremely complex and unique project.

(PS-3856) Applying Multiple Calendars in a Projects Schedule – Peace of Mind, or Source of Concern?

Author(s)/Presenter(s): Saeid Khademagha, P.Eng. PSP

Abstract: Whenever schedule management is discussed in a project, calendars and accurate utilization of them is one of the most important subjects to the success of the projects schedule.



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The complexity of mega construction projects and contractual environmental and non-environmental restrictions associated with them (i.e., in-water work restrictions, land acquisitions, road or track allowable closures, winter shutdown, resource availability, and etc.) inevitably trigger the creation of different calendars.

Applying multiple calendars, especially when calendars represent different shift start and end times, can sometimes be problematic in assessing and analyzing the schedule evaluation metrics, such as total floats and critical path. Although having multiple calendars in a schedule is accepted, utilizing the calendars with different shift times (which is sometimes necessary for resource loaded schedules or for hourly management of some activities) becomes a dilemma in some cases. Unfortunately, different calendars do not always work well together, and while they may offer peace of mind in terms of capturing variables or restrictions, they can sometimes become a source of concern.

In this article, both negative impacts and effects of utilizing multiple calendars, and ways of handling multiple calendars in a projects schedule and mitigation of such negative impacts and effects will be presented and discussed through a number of happened combinations in some real case study projects.

(PS-3866) (Presentation Only) Is it Time to Switch from P6: An Unfiltered Review of Oracle Primavera Cloud

Author(s)/Presenter(s): Jeffrey Milo, PSP

Abstract: Hate sitting through software presentations where they tell you what it does but never show you the software used in actual real life situations? Curious to really see Oracles new scheduling tool? This is the presentation for you. Jeffrey Milo, Senior Scheduling Manager at Landmark Construction, has been using Oracle's new scheduling tool Primavera Cloud since April of 2019. Through his involvement in Oracles Early Adopter program he has had unprecedented access to both the software and its developers. In this presentation he will take you on an all access tour of the first scheduling program built by Primavera from the ground up since P3, show you actual schedules built in the software and explain how Landmark Construction uses the tool every day. He will also give an unfiltered review of the software's strengths and shortcomings in comparison to Primavera P6.

(PS-3897) (Presentation Only) Two Truths and a Lie Game - Fellows Edition



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Author(s)/Presenter(s): Christopher W. Carson, CEP DRMP PSP FAACE; Ronald M. Winter, PSP FAACE; Glen R. Palmer, CFCC PSP FAACE; Kenji P. Hoshino, CFCC PSP FAACE; John J. Ciccarelli, PE CCP PSP FAACE

Abstract: The AACE Fellows have hundreds of years worth of experience in all the cost engineering/project controls disciplines, and this session is an opportunity for Fellows to give back to the community. This year the war stories will all follow a theme of “Recovery and Mitigation Efforts that Went South”

The session will include a Moderator (Carson), three Storytellers (Palmer, Hoshino, Ciccarelli), and a Doubter (Winter), all AACE Fellows. The three Storytellers will each provide three short war stories from their past projects, each of which will include two truths and one lie in their mix of stories, and the Doubter will question each Storyteller and provide challenges and objections in an effort to prove the stories to be lies while the Storytellers defend their stories. Then the audience will get a chance to ask follow-up questions and subsequently vote on whether the story is a Truth or a Lie.

In the past, the Storytellers had trouble coming up with lies that were more extreme than the truths, so the audience eventually just correctly voted "True" on all stories. The Storytellers were chosen this year specifically for their ability to come up with lies as unbelievable as the truths. Come armed with your lie detectors working.

(PS-3905) The Building Blocks for Creating an Effective Construction Schedule

Author(s)/Presenter(s): John Jackson; Claire Brown

Abstract: There are a variety of approaches one can take to build a construction schedule. This paper presents a basic step by step guideline to building a baseline schedule in a manner that reduces frustration and exhaustion, while ensuring the resulting schedule is an effective planning and communication tool for the entire project team. In this paper, the authors will lay out a road map for preparing a baseline schedule from scratch that will make even the most complex schedule a step-by-step breeze.

(RISK) DECISION AND RISK MANAGEMENT

(RISK-3799) An Advanced Risk Analysis Using the Von Neumann and Morgenstern (VNM) Utility Function

Author(s)/Presenter(s): Brahim Seddiki, CCP



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Abstract: This technical paper will examine, assess, and validate an essential key deliverable that has a significant importance to project control practitioners, such as project budget cost baseline. Thus, a baseline has to be realistic, accurate, and able to reflect correctly future monthly expenditures in which cost performance measures are evaluated against it, and changes can be tracked [1, p15]. The development of such critical outcome can be achieved in two steps: Traditional approach which can be categorized as a qualitative analysis, where expert judgment's inputs play crucial role in defining high-level baseline based on historical project's data availability, and any relevant information that may exist at the initial project planning stage. The second step is the subject of the underlying technical paper, which is simply a quantitative analysis approach.

Given the monthly planned cost as described in step one, may not be the perfect cost distribution for project control practitioners to rely-on. Thus, this technical paper, proposes an advance methodology, using mathematical modeling, and exhibit a new way on how to substantiate a cost distribution baseline based on, two main cornerstones theory:

- Decision-making under uncertainty, using Von Neumann-Morgenstern (VNM)'s expected utility function concept, which has its origin back in 1700 during Nicolas Bernoulli's era.
- Portfolio optimization, using Harry Markowitz, mean-variance portfolio analysis.

Utility function, risk appetite, risk tolerance, beta systematic risk, certainty equivalent, risk premium, Sharpe ratio, signal to noise ratio, and risk adjusted value, are the main terminology used to demonstrate and validate the cost baseline.

(RISK-3803) Implementing Qualitative Project Risk Management

Author(s)/Presenter(s): Jessica M. Colbert, PRMP PSP; Kimberly D. Forbes, PSP

Abstract: Everyone can remember that one perfect, flawless project, right? No? Neither can the authors. Projects are messy and challenging, full of risks that threaten its schedule and budget. Risk management is a critical component to project success, yet so many project teams and organizations fail to put it into practice. If an organization has no formal risk program or is early in its implementation, project risk management can be inconsistent and often ineffective. This paper explores various strategies to implement qualitative risk management on any project,



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discover how qualitative risk management can be injected into typical project processes without consuming significant resources or budget and develop strategies for continued use throughout the project life cycle and for historical management. These project-level implementation strategies can later evolve to quantitative risk management at the project level and formal enterprise level programs. Finally, the authors discuss common hurdles project teams experience with risk management implementation and solutions to prevent or overcome these challenges.

**(RISK-3812) Choosing Between Strategic Alternatives Using Risk Analysis in
Decision Modelling of Project Alternatives**

Author(s)/Presenter(s): Dr. David T. Hulett, FAACE; Keith D. Hornbacher

Abstract: Project organizations make decisions about projects including whether to pursue the project, its technical configuration, how to organize it, locate it, finance it, what “done” means, how long will it take and how much will it cost. These decisions take studies, analyses of alternatives and expert judgment before the project is sanctioned. During the gestation period for any significant project strategic decisions are being made, and one of the main considerations will include the balance of risk in any alternative. This paper addresses analyzing risk in a decision model simplified to highlight the important risks that make a difference about which project to do, its configurations and indeed whether to do a project at all.

The purpose of this paper is to describe and discuss some of the risk analysis tools that can be used when these important scoping strategies are being developed by senior management of any project-oriented organization. These important decisions are made well before there is a project plan, schedule and cost estimate. The paper proposes to develop models simplified to highlight the key risk events of an alternative under consideration and some tools that are available currently to address them. These tools bring clarity, transparency, traceability, repeatability and consistency with recommended practices of project risk analysis. Simple models were developed to illustrate two of these methods, probabilistic branching and conditional branching. One of the desired outcomes is to introduce these methods and their use to organizational senior management and engage them in the tools’ development for their project.

(RISK-3822) Principles for Quantitative Project Risk Management

Author(s)/Presenter(s): Dr. David T. Hulett, FAACE; James E. Arrow, DRMP



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Abstract: Affordable, powerful computing and the widespread availability of quantitative risk analysis (QRA) software has helped democratize data analytics in project delivery. This, in itself, is great for the project controls profession and industry at large. However, problems arise when:

- a) project simulations are created without a thorough appreciation of the need for ongoing or continuing project risk management (CPRM),
- b) risk analysts embark on risk computing before establishing the foundation in a competent SRA-ready schedule,
- c) identities and parameters about risks are collected within an environment where individual SMEs cannot or will not provide their candid opinions, or more simply,
- d) risk terminology or processes are invoked that generate bias or noise, undermining risk data quality, potentially, creating more harm than good.

This paper will describe the means for ensuring a mathematically unambiguous and traceable rationale for establishing contingency, with relevance that extends into and throughout project delivery, providing protection against known risk and resilience in the face of emerging risk. This approach is underpinned by integrated cost and schedule risk analysis as the primary method of modeling before project approval and, conducted in such a way that minimizes motivated reasoning and establishes a data feedback loop to support:

- 1) quantitative risk management (QRM),
- 2) increasingly predictable projects outcomes and, ultimately,
- 3) a risk-based competitive advantage.

(RISK-3824) Calibration Assessments: Validation of Subjective Probabilities and Impact Ranges in Risk Analysis

Author(s)/Presenter(s): Francisco Cruz Moreno, PE

Abstract: Risk analysts and project teams must rely on expert judgment to collect subjective probabilities and ranges of potential cost and schedule impacts, especially when they are performing quantitative risk analyses. The main reason for using subject matter experts is the lack of reliable historical data associated with risk impacts. Research shows that subjective probabilities and risk impact ranges consistently yield overconfident and underconfident results, which, in turn, generate inaccurate cost values at selected confidence levels and confident intervals.



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This paper explores the limitations of current elicitation approaches to collect and use subjective probabilities and impact ranges to assess uncertainty and risks. It provides several examples of different calibration assessment results and their adequate use to improve the strength of risk input data. It also presents a case for risk analysts to use sound scientific rigor in respect to inputs when performing qualitative risk assessments and quantitative risk analyses in support of decision-making. The author suggests the use of calibration assessment in any modeling approaches using subjective inputs whether they be decision trees, parametric models, Monte Carlo simulation, reference class forecasting, or system dynamics.

(RISK-3826) Doing More with Less: A Data-Driven Approach to Resource Management

Author(s)/Presenter(s): Avi Schwartz; Eric Dembert; Corey Edson; Samantha O'Donnell; Yue Ou; Kimberly Civil

Abstract: Organizations throughout the construction industry are being challenged with managing complex project portfolios with limited resources. This issue has been amplified by the COVID-19 pandemic, as demand in both the residential and commercial construction industries has substantially increased, causing builders to turn away work due to their human capital constraints and surging capacity. Despite resource availability and allocation being common challenges, project managers often lack the tools to identify, anticipate, and communicate resource needs and constraints.

The implementation of a dynamic approach to resource analysis can enable project managers to better track, monitor, and forecast resource demand for their project portfolio by proactively identifying and mitigating risks impacting the project plan. When critical resources are overallocated and additional talent is required, project managers can easily quantify data-driven decisions to their leadership. Ultimately, this data-driven approach can help provide a healthy and sustainable resource outlook, enabling the project team to deliver efficiently and effectively, while helping to reduce the risk of attrition due to burnout. This paper will detail some of the benefits of implementing a resource-analysis strategy, as well as showcase pilots where this approach has been demonstrated for federal agencies.

(RISK-3834) Cost Contingency as the Standard Deviation of the Cost Estimate: An Extension

Author(s)/Presenter(s): Dr. Geoffrey S. Rothwell



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Abstract: This paper extends a 2005 article in Cost Engineering: It shows that the level of contingency is an inexact function of (1) the standard deviation of the cost estimate, (2) the approximate accuracy range of the cost estimate, (3) the level of confidence that the cost will be within the accuracy range, and (4) the risk aversion of the parties paying (e.g., client) or monitoring (e.g., regulator) the cost being estimated. While some of the cost engineering literature suggests cost estimates in a specified range, for example, $\pm 30\%$ with an 80% confidence, the accuracy range could be more or less than $\pm 30\%$ and confidence could be more or less than 80%. Larger standard deviations and accuracy ranges and greater confidence levels imply larger contingencies. If there is no consideration of size (or value) of the project or size (or value) of the firm undertaking the project, then cost estimate user's risk aversion can be modeled as a constant. Taken together, the standard deviation, accuracy range, confidence, and the risk aversion coefficient provide an understanding of the appropriate cost contingency, but do not dictate its value.

**(RISK-3847) The Development of Corrected and Summarized Schedules to
Support Monte Carlo Simulation**

Author(s)/Presenter(s): Dr. David T. Hulett, FAACE; Waylon T. Whitehead

Abstract: Project schedules often have factors imposed on them which degrade them as tools for quantitative schedule risk analysis using Monte Carlo simulation (MCS). The contractor's detailed proposal schedules frequently employ mechanisms encompassing commercial goals, rendering them unsuitable for use in quantitative risk modeling. A good bit of effort is typically required to convert these schedules into reliable tools for risk modeling.

This paper describes these problems and develops processes for identifying them and repairing them to withstand the rigors of simulation. It discusses why such findings often lead to creating summary schedules that strictly adhere to best practices while representing the overall project plan rather than de-bugging the contractor's detailed schedule.

Using standards for critical path method (CPM) scheduling implies that what is needed to support MCS is to follow best practice CPM guidelines. Some of those guidelines have pronounced impacts on the conduct of MCS-based schedule risk analysis. This paper highlights and explains these practices and argues that the best way to proceed with a schedule risk analysis is to create



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a simpler, smaller, but entirely compliant summary schedule rather than simulate the project's detailed schedule with its flaws.

**(RISK-3851) Continuous Improvement of the Project Plan by Effective Use of
Execution Scenario Planning**

Author(s)/Presenter(s): Stephen Uhl

Abstract: Traditional scenario planning has been used by many corporations to help envision plausible alternatives futures, as a way of enhancing decision-making at the business unit or corporate level. These concepts can also be applied effectively in the project execution context. By systematically applying scenario planning to project definition and execution, managers can develop signposts, contingency plans, and alternate strategies to manage major change.

**(RISK-3859) Using an Industry Parametric Risk Analysis Model to Assess
Recommended Cost Accuracy Ranges**

Author(s)/Presenter(s): Carlos Henrique Nobre Magalhães; Cócis Alexandre dos Santos Balbino, P.Eng.; Leonardo Muller, CCP PSP; Sued dos Prazeres Santos

Abstract: It is not uncommon for company procedures and project teams in the process industry to directly use the tabulated expected cost accuracy ranges from Recommended Practice (RP) 18R-97 Cost Estimate Classification System – As Applied in Engineering, Procurement, and Construction for the Process Industries in their estimates, with the incorrect presumption that the range is solely determined by the level of scope definition (i.e., the class of the estimate). This article, based on the Rand Corporation (RAND) parametric cost model for risk analysis and contingency determination from RP 43R-08 Cost Estimate Classification System – As Applied in Engineering, Procurement, and Construction for the Process Industries, evaluated model inputs for distinct project scenarios and compared model outcomes with the expected ranges shown in RP 18R-97's table 1. Built on sample information from the original RAND study (as was done in RP 119R-21, Cost Estimate Accuracy Range and Contingency Determination using Tables Derived from Parametric Risk Models), six scenarios were simulated for scope definition ratings equivalent to FEL 1/Class 5, FEL 2/Class 4 and FEL 3/Class 3, with the manipulation of the model's other parameters of 'new technology', 'impurity' and 'plant complexity'. Results, based solely on these systemic risks, demonstrated frequent RAND model variation from the RP 18R-97 upper ranges when some of the non-definitional risk parameters are reasonably varied. In extreme cases, difficulties were observed in using the Excel NORMINV function to determine the ranges



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for a parametric model. This paper presents an experimentation of the RAND cost model and demonstrates quantitatively how much model results can diverge from the range-of-ranges tabulated in RP 18R-97.

(RISK-3872) Integrating Cost Estimate Accuracy Ranges and Risk-Informed Contingency Estimates

Author(s)/Presenter(s): Suresh Kataria, PE PRMP; David A. Norfleet, CCP CFCC DRMP FAACE

Abstract: AACE has several cost estimate classification system recommended practices (RPs) such as RP 17R-97. These RPs are used for classifying cost estimates based on various characteristics and establish an expected accuracy range for each estimate class using these characteristics.

An important step in establishing a realistic estimate for a project is the development of adequate risk-informed contingency estimates. RP 17R-97 states that estimate accuracy must be evaluated in conjunction with a risk analysis. How those two processes are correlated is not explained in the RP nor is it explained in AACE's various risk-related recommended practices. The question becomes: How does either a risk professional or an estimator, as the case may be, integrate the cost estimate classification system RPs in the risk assessment process? An even more important question may be: Can these two processes be integrated at all? This paper will discuss any direct, or indirect, correlation and how such integration may be utilized in development of a risk-informed contingency estimate.

(RISK-3908) Risk Analysis and Contingency Estimating for Class 10 Estimates

Author(s)/Presenter(s): John K. Hollmann, PE CCP CEP DRMP FAACE Hon. Life

Abstract: The AACE® International (AACE) cost estimate classification system recommended practice (RP) series is likely its most recognized RPs. In 2021, a new Unclassified/Class 10 estimate type was introduced in AACE RP 111R-20, Estimating for Long-Range Planning – As Applied for the Public Sector. However, there is no AACE RP for quantitative risk analysis (QRA) methods for estimating contingency or management reserve allowances for Unclassified/Class 10 estimates.

A goal of the paper is to lay the groundwork for a potential QRA RP for Unclassified/Class 10 QRA recommended practice. It starts by reviewing the concepts of estimate classification in general and Unclassified/Class 10 estimates in particular. Next, it outlines various uses of these estimates such as for asset life cycle cost (LCC) estimating and analysis as part of strategic portfolio



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management or for surety (bonding) valuation. The paper also reviews scenario analysis and other decision analysis methods to identify potentially useful QRA concepts. It also reviews current contingency determination practices for long-range estimates and the limited research on long-range estimate cost growth. Finally, several proposed Unclassified/Class 10 QRA and contingency/reserve allowance determination methods, aligned with AACE QRA principles, are presented.

(RISK-3914) The Importance of Doing a Risk Assessment in Every Project, Early and Often

Author(s)/Presenter(s): Francisco Cruz Moreno, PE; Gino Napuri, EVP

Abstract: Is there a benefit to executing a project risk assessment early and repeating it often? The definitive answer is yes! Developing and executing a risk assessment early in a project reduces the risk of dealing with project threats and opportunities in an unprepared and chaotic fashion when they do occur. Awareness of time, cost, and/or scope risk impacts on a project is crucial. Understanding the extent to which risk affects a project in a planned and coordinated effort improves the probability of successfully completing a project on time and within budget.

It comes as no surprise that the majority of projects fail their estimates to complete as most projects do not execute risk assessments early and often. While other issues may impact a project and lead to failure in addition to omitting proper risk assessments, the inability to manage risk through constant risk assessments is a pivotal reason for failure.

This paper will focus on a process that assists the project team in avoiding the continuous failure of completing a project on time, on budget, and within scope because of a lack of proper risk management. It will also provide suggestions to help avoid risk pitfalls by executing risk assessments in a continuous and consistent pace, not only when the risk arises, but from the beginning of the project through closeout.

The objective of this paper is to encourage project teams to take the appropriate time and effort to assess project risks with the goal of providing an organized and practical approach to project risks and opportunities.

(RISK-3920) A Hybrid Quantitative Schedule Risk Analysis Using Earned Value Management and Risk Drivers Methods



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Author(s)/Presenter(s): Dr. Mohammadjavad Arabpour Roghabadi; Dr. Osama El Sayed Moselhi, P.Eng.; Sedat Akkaya; Angus Johnston

Abstract: Infrastructure projects are becoming increasingly complex given governments' demand for building innovative and smart cities. Forecasting a realistic schedule contingency is a major concern for managing public private partnership (PPP) projects. Existing scheduling models often run based on subjective data collected from members of project delivery team (PDT) without incorporating historical data. This paper presents a hybrid quantitative schedule risk analysis using earned value management (EVM) and risk drivers methods for PPP projects. It makes use and employs past schedule performance data to the project in-hand in combination with a set of schedule risk drivers for forecasting project time at completion. It accounts for correlation coefficient between activities' duration, which is a drawback of the risk-based EVM methods reported in the literature. A comparison study has been conducted to verify the performance of the developed model. The results show that the developed model prevents project managers from over and under estimation of the required time for project completion.

(TCM) TOTAL COST MANAGEMENT

(TCM-3784) (Presentation Only) Best Practices in Cost Engineering

Author(s)/Presenter(s): Dr. Nick J. Lavingia, PE

Abstract: In spite of increased use of sophisticated computer programs for estimating, planning/scheduling, project controls and 3D/4D modeling, industry benchmarking has consistently shown cost and schedule overruns on many projects. This practical presentation will discuss how best practices in cost engineering such as economic analysis, cost estimating, planning/scheduling, benchmarking, contracting/procurement, performance measurement, cost control/forecasting, progress reporting and finance/audit can help achieve pacesetter project performance on a consistent basis. Examples from both large and small actual projects will be presented to show how these practices and tools can be effectively used to provide predictable outcome and achieve business success.

(TCM-3813) Proactive Cost Engineering Techniques to Avoid Common Project Failures

Author(s)/Presenter(s): Christopher W. Carson, CEP DRMP PSP FAACE



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Abstract: Success in project delivery is a function of anticipating the areas of potential failure and managing those risks across the full construction project lifecycle, from the inception for a project to finally turning the completed asset over to operations. Failures in projects almost always relate to cost and time overruns that are directly caused by these risks.

Maximum and most effective proactive resolution of these failures requires a risk-oriented planning and monitoring culture integral to the cost engineering disciplines of cost and time management. There is no simple one-step process, but rather it requires a proactive and planned effort, and includes looking for opportunities to improve as well as threats to performance. Arcadis uses its lessons learned from disputes, resolution, recovery, studies, and projects to build into its cost engineering practices the best proactive approach to identify the symptoms, recognize the potential failures, protect from the negative risks (threats), and exploit the positive risks (opportunities) to achieve successful projects and programs.

This approach addresses specific traditional areas of construction and program management that commonly fail, such as scope definition and change management, and offers proven solutions. This paper provides recommendations for resolution of the potential failure point in each of the phases of the project lifecycle gleaned from lessons-learned from the author's 45-year career.

**(TCM-3825) Fusing Project Controls & Lean Construction Institute(LCI) Techniques
on Fast Track Pharma Projects**

Author(s)/Presenter(s): Britton L. Wolf

Abstract: With increasing project velocities and drive for efficiencies the Pharma industry is continually exploring opportunities to achieve their goals.

By combining the techniques of Project Controls and Lean Construction Institute (LCI), project providers and owners can realize the benefits of increased speed to market and costs efficiencies. The importance of real-time, actionable data through Critical Path scheduling, earned value, cost forecasting and risk control remains critical as ever.

However, the shared goals, engagement and collaboration as well as the focus of removing waste as fostered by LCI adds additional dimensions.

Architecting processes and training for teams to jointly leverage the power of these techniques requires advanced planning, system mapping, contractual requirements and a strong and sustained commitment to incorporate all stakeholders into a successful implementation.



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(TCM-3913) (Panel Discussion) Value and Constructability

Author(s)/Presenter(s): Douglas W. Leo, CCP CEP FAACE Hon. Life

Abstract: A panel discussion of Value and Constructability experts will explore the following topics at a minimum:

What is the understanding of Value and Constructability?

If managed according to TCM, what does this look like which regards to capital projects?

What are the advantages and benefits to the achievement of Value for a project?

Discuss the panelists thoughts on Value being a greater benefit to project far beyond the mere concept of cost savings?

The Value Engineering and Constructibility Subcommittee will be further involved in refining the questions and the focus of the panel discussion.

(TCM-3933) The Project Life Cycle: Preventing Change and Securing Cost Certainty

Author(s)/Presenter(s): H. Lance Stephenson, CCP FAACE

Abstract: Understanding the project life cycle and the concept of change management provides many benefits that can promote improved project success. To minimize downstream impacts from earlier consequential decisions and actions, project teams need to go beyond the traditional aspect of the treatment and control of change management and provide opportunities to prevent or eliminate change. As applied in asset ownership and management who engage in capital project delivery, this paper introduces preventive measures that can influence the decisions and actions made early in the project's development phase. As part of this understanding, this paper will provide readers with the following:

- a case study that emphasizes the types of changes within the life of a project
- defined preventive measures and concepts in relation to the project life cycle
- a road map for implementing improvements

(TCM-3934) The Project Life Cycle: Preventing Change and Securing Cost Certainty

Author(s)/Presenter(s): H. Lance Stephenson, CCP FAACE

Abstract: This paper addresses change management for the project life cycle (PLC) as applied in asset ownership and management and is relevant to stakeholders who engage in capital project



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delivery. With this said, this paper provides the audience with a guideline that practitioners can use as a pragmatic approach to the treatment and control aspects of change management for the entire spectrum of the project delivery (from conceptual development to turn-over and close-out) and the total installed cost (TIC) of building a facility, plant, or other project endeavors. Specifically, this paper will provide readers with the following:

- an understanding of the project life cycle and how changes are applied within stages of this lifecycle
- defined elements of change, including classification, drivers, type, the timing of change, and contingency
- a tactical and prescriptive process workflow that supports the coordination of the fundamental requirements required for effective change management