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### **(CDR-4214) Integrated Construction Project Subnetworks: Development, Monitoring, and Analysis**

Skill Level: Intermediate

TCM Section(s): 7.1. Project Scope and Execution Strategy Development 7.2. Schedule Planning and Development

Author(s)/Presenter(s):

Eric Anthony, PSP *SOCOTEC*

Abstract: The development and integration of subnetworks is a practical application intended to improve the monitoring and analysis of a construction project schedule. Subnetworks are groups of logically related activities used to independently monitor progress and calculate float. Linking subnetworks to key milestones is an effective method of monitoring phases, areas, structures, systems, or work categories. Subnetworks or fragnets are also incorporated into a contemporaneous unimpacted schedule update to perform a prospective measurement of schedule impacts. After a delay occurs, retrospective or forensic analysis of a complex schedule often requires the identification and analysis of inadequately planned subnetworks. The planned use of integrated subnetworks improves the hierarchical organization of a construction project schedule and supports progress monitoring and analysis.

This technical paper demonstrates the claims and dispute resolution (CDR) advantages of developing and maintaining a highly organized construction project schedule using integrated subnetworks.

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### **(CDR-4216) (Panel Discussion) Owner, Contractor & Subcontractor Perspectives on Subcontractor Claims & Disputes**

Author(s)/Presenter(s):

Donald F. McDonald, Jr. CCP PSP FAACE Hon. Life *Fluor Enterprises, Inc.*

Dr. Stephen P. Warhoe, PE CCP CFCC FAACE Hon. Life *SP Warhoe LLC*

Charles E. Bolyard, Jr. CFCC PSP FAACE Hon. Life *MBP*

Abstract: Many discussions and papers involving construction contract claims and disputes focus time and cost issues from a prime contract perspective. In most EPC / design-build contracts issues subcontractor claims and disputes are an "elephant in the room" and pose interim and final resolution issues for all involved. While the fundamentals of notice, contractual and legal entitlement, causation analysis and quantum development with supporting documentation are fundamentally the same regardless of what level in the contracting chain is being addressed, the addition of subcontractor(s) claims and issues leads to further complications in a journey to resolution and contract(s) close out. This panel discussion brings forward the perspective of an owner, contractor and subcontractor to address common issues and how they are often dealt with on the path to overall resolution.

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### **(CDR-4217) Construction Equipment Disruption Modeling in Claims**

Skill Level: Intermediate

TCM Section(s): 10.3. Change Management 6.4. Forensic Performance Assessment

Author(s)/Presenter(s):

Dr. Wael El Ghandour *Aramco*

Karim El Ghandour *Suncor Energy*

Abstract: Calculating or estimating the equipment's lost productivity is one of the most contentious aspects of construction claims. In addition, assigning responsibility for equipment lost productivity can be challenging. Consequently, the majority of industry studies and protocols concentrate on labour productivity loss rather than equipment productivity loss. In addition, there is no consensus in the construction industry regarding the preferable method for calculating and allocating responsibility for equipment lost productivity. Moreover, an effective presentation of causal relationships facilitates the procedure for claim resolution. In actuality, the improvement of the claim analysis process is contingent upon augmenting the precision and illustration of a claim case.

In the oil sand mining industry, various equipment reliability systems are utilized as a practical instrument for equipment productivity management. This study examined the various causes of equipment productivity loss, its relationship to idle time, the techniques used to calculate idle time, the methods used to calculate equipment lost productivity, and introducing a new equipment disruption model employing Overall Equipment Effectiveness (OEE) method used for equipment lost productivity, discrete-event simulation, and oil sand equipment reliability system.

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### **(CDR-4218) Integrated Disruption Modeling (IDM) using Artificial Intelligence and Discrete-Event Simulation**

Skill Level: Advanced

TCM Section(s): 6.4. Forensic Performance Assessment 9.2. Progress and Performance Measurement

Author(s)/Presenter(s):

Dr. Wael El Ghandour *Aramco*

Belkacem Foura *Aramco*

Abstract: There are several methods for estimating the time and money lost in the construction industry due to decreased productivity. The measured mile method and its variants, the improved measured mile and the advanced measured mile, are among the most essential approaches for estimating the time lost due to a productivity disruption. The most difficult aspect of evaluating a loss of productivity claim is presenting the claim in a manner that is convincing to both the claimant and the defendant. Complex claims for delay must be supported by extensive, high-quality documentation in order to be presented effectively. When presenting a claim for a delay, it may be advantageous to include visual aids, such as computer models, to simplify the technical complexities involved. Consequently, visual evidence has taken on a greater role in the settlement of complex claim cases. This paper builds on previous research presented for the advanced measured mile in order to validate and fathom the study of labor loss of productivity better. It presents a new integrated model by combining its findings using IBM Cloud Pak for the data artificial intelligence platform with the status of scheduled activities and other evidence of disruptions, including schedule updates, monthly, weekly, and daily progress reports, resource histograms, disruption event concurrency, and photographs of the work site. By contrasting the as-built and planned status of the disrupted construction trades, an additional discrete-event simulation model was developed to illustrate the outcomes, validate their veracity, and increase the model's precision.

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### **(CDR-4221) On the Intricacies of Evaluating Delay Damages**

Skill Level: Basic

TCM Section(s): 6.4. Forensic Performance Assessment 9.1. Project Cost Accounting

Author(s)/Presenter(s):

Natasha Dahl, CCP PSP *Delta Consulting Group*

Avi Sharma *Delta Consulting Group*

Dr. Tong Zhao, PE CCP CFCC PSP *Delta Consulting Group*

Abstract: Delays are a regular part of the construction project lifecycle, necessitating contractors' and experts' quantifying delay damages. Drawing upon the authors' extensive experience in claims management, it becomes evident that many approaches exist to assess delay damages. Notably, even for identical delays, divergent quantifications arise among various professionals. This paper explores the multifaceted landscape of quantifying damages within projects beset by compensable delays.

Presented within are thorough analyses of damages scenarios spanning delays in different project phases, delays coupled with mitigation efforts, and terminations. The intricate nature of delay damages within the construction realm is unveiled through the deconstruction of these diverse scenarios.

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### **(CDR-4222) Apples and Oranges: The Need for Comparative Project Guidelines**

Skill Level: Advanced

TCM Section(s): 10.3. Change Management

Author(s)/Presenter(s):

Alessio Loreti, PE PSP *Delta Consulting Group*

Cory R. Milburn, CCP CFCC PSP *Delta Consulting Group*

Abstract: When a measured mile based on similar work in the same project cannot be identified or does not exist, an option that ACE's Recommended Practice No. 25R-03 advises is evaluating productivity on the disputed project and contrasting it with a project of similar attributes (a "comparable project study"). As such, the comparable project study is an important tool when assessing loss of labor productivity within the construction industry. However, there is a lack of standard criteria or guidelines for selection of a comparative project. The claimant bears the responsibility of demonstrating parallelism in project size, magnitude, location, weather conditions, labor dynamics, and other pertinent factors. The closer the alignment between projects, the greater the credibility associated with this method; conversely, a diminished resemblance leads to decreased prospects of successful resolution. This paper highlights the issue of the absence of clear industry guidelines for conducting comparative project analyses, shedding light on its nuanced challenges, and advocating for a standardized framework for identification and evaluation of comparative projects.

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### **(CDR-4226) Forensic Evaluation of Subcontractor Components in CPM Schedules**

Skill Level: Basic

TCM Section(s): 6.4. Forensic Performance Assessment 7.2. Schedule Planning and Development

Author(s)/Presenter(s):

Greg M. Hall, PSP *Kiewit Corporation*

Abbas F. Saifi, CCP EVP PSP *EllisDon Corporation*

Abstract: Because forensic analysis emphasizes a study of a schedule's critical path, and most literature regarding time-based disputes focuses on the owner/general contractor relationship, it is easy to forget about subcontractors' interests when evaluating delay. Subcontractors often have legitimate claims rooted in schedule impact, but not all of them affect the administration of the prime contract. This creates a delay demonstration challenge when impacts suffered by the subcontractor are not visible in the general contract's critical path.

This paper will examine the subcontractor/general contractor coordination required to develop and maintain schedules; methods used on projects holistic and targeted methods for evaluating time impact to a subcontractor's portion of an overall project scope; and recommendations for pursuing a fair and equitable evaluation for all parties.

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### **(CDR-4231) Adjusted Measured Mile Baseline Methodology for Quantifying Lost Productivity Damages in Construction Claims**

Skill Level: intermediate

TCM Section(s): 10.1. Project Performance Assessment 10.3. Change Management

Author(s)/Presenter(s):

Karim Nagui *Diales*

Abstract: Loss of productivity (LOP) is sometimes experienced on construction projects and can result in financial damage. The measured mile/baseline method is often used to quantify LOP by comparing the impacted and the unimpacted/lightly impacted portions or periods of work.

It is not uncommon to rely on a least impacted portion or period of the work as a measured mile baseline, if an unimpacted portion is unavailable. However, such practice may result in an understatement of the LOP experienced by the impacted party, given that the least impacted portion of the work might have been impacted by events that did not occur/impact the impacted portion of the work.

This paper will discuss how to make adjustments to the least impacted portion of the work in order to establish an adjusted measured mile baseline that is more reflective of the impacted party's productivity "but for" the non-recurring impact events suffered during the least impacted period. This paper does not address the entitlement or causation arguments in a loss of productivity claim, it only focuses on the quantification of the loss of productivity.

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### **(CDR-4239) Tales from the Construction Claims Crypt - Lessons Learned**

Skill Level: Intermediate

TCM Section(s): 6.4. Forensic Performance Assessment 4.1. Project Implementation

Author(s)/Presenter(s):

James G. Zack, Jr. CFCC FAACE Hon. Life *James Zack Consulting, LLC*

Abstract: Some construction industry surveys indicate that one of the most common causes of claims and disputes is inadequate contract administration by both owners and contractors. The paper examines twenty construction claims to test the conclusions these surveys. These claims are used to illustrate pitfalls owners and contractors all too often fall into. The paper examines how poor contract administration leads to claims due to inadequate change order administration; use of overly complex scheduling specifications; lack of necessary contract constraints; impact damages due to changes and delays; refusal to accept baseline early completion schedules; the use of no damage for delay clauses; and others. The paper discusses the claims that arose - the how and the why. The paper also describes the outcome of each claim and offers lessons learned from each claim situation - some for owners, others for contractors, and some for both.

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### **(CDR-4255) Seeing Double? How to Address Claimed/Duplicative Costs in Damages and Delay Analyses**

Skill Level: Intermediate

TCM Section(s): 10.1. Project Performance Assessment 9.2. Progress and Performance Measurement

Author(s)/Presenter(s):

Rachel Domingo, PSP *LitCon Group*

Michael R. Martin, Jr. *LitCon Group*

Abstract: Often when a large loss occurs, project parties will silo themselves when analyzing the delay and damages claim elements. As construction claim consultants, it is imperative that efforts are coordinated to avoid duplicative and/or incorrect assessment of damages. If not mitigated early in the process, lack of coordination amongst the experts can necessitate a tedious post-hoc resubmission that extends the claim review and approval timeline. Alternatively, lack of coordination can result in increased client costs as multiple parties prepare various claim analyses such as a productivity or measured mile study.

To streamline this process, this paper will discuss best practices for coordinated and integrated analysis and quantification of the damage and delay claim efforts. The paper's authors, one damages expert and one delay expert, will illustrate how to work in tandem in order to craft a comprehensive and cohesive claim for the client.

Several case studies will be reviewed where claims were impacted or even rejected by the lack of integration between the damages and delay claim sections.

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### **(CDR-4256) (Presentation Only) Recommended Practice 130R-23 - Demonstrating Entitlement to Cumulative Impact Claims in Construction**

Author(s)/Presenter(s):

Dr. Stephen P. Warhoe, PE CCP CFCC FAACE Hon. Life *SP Warhoe LLC*

Abstract: This will be a presentation that goes over the content of RP 130R-23, Demonstrating Entitlement to Cumulative Impact Claims in Construction. Cumulative impact is defined as the net impact of two or more undifferentiated changes, as each is measured or measurable at a certain point in time, being much greater than the sum of the effect of the individual parts. This effect results in the reduced productivity of unchanged work. Due to the complicated nature of construction work, it is not usually well understood by contracting parties and even legal professionals.

This presentation will discuss aspects of demonstrating entitlement to cumulative impact claims.

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### **(CDR-4259) Reconstructing Schedules for Forensic Analysis: Methods, Insights, and Case Study**

Skill Level: Basic

TCM Section(s): 6.4. Forensic Performance Assessment

Author(s)/Presenter(s):

Matthew G. Nichols, PSP *Delta Consulting Group*

Avi Sharma *Delta Consulting Group*

Abstract: When performing a forensic schedule analysis, if a project's schedule is not available in an electronic CPM software format, other than for the simplest of projects, it will be necessary to reconstruct one or more of the project schedules in an electronic format. Recreating schedules in an electronic CPM software format allows the analyst to consider schedule logic and identify critical path shifts while performing a forensic schedule analysis.

This paper provides a comprehensive overview of the existing literature concerning the recreation of schedules within CPM software for forensic schedule analysis. It subsequently delves into guidance on generating, documenting, and validating recreated schedules, and using recreated schedules in a forensic schedule analysis. In addition, the paper offers insights into reviewing a schedule that a third party has reconstructed. To illustrate these concepts in action, the paper concludes with a case study focusing on the recreation of schedules in an electronic CPM schedule format for a forensic schedule analysis.

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### **(CDR-4260) Poor Practices Used in Contemporaneous Schedule Updates to Build Delay Claims**

Skill Level: Basic

TCM Section(s): 7.2. Schedule Planning and Development 6.4. Forensic Performance Assessment

Author(s)/Presenter(s):

Hala Marvan, PSP *Diales Expert Witness Services*

Khaled M. Aziza, EVP PSP *Delta Consulting Group*

Abstract: Schedule revisions in contemporaneous schedule updates are often unavoidable during the project lifetime. Schedule revisions and updates are used in monitoring project progress and keeping the schedule up to date. However, the schedule update process must comply with the contract and scheduling specification requirements and reflect the actual project status to ensure the integrity of the schedule plan. Poor scheduling practices during the implementation of schedule revisions and non-compliance with the contract requirements may result in false or inaccurate reporting of the project critical path and misinformation on project status. This could reflect an artificial or exaggerated delay that leads to miscommunication between the project parties, lost opportunities to control and mitigate delays, and subsequent claims and disputes. This paper highlights issues that should be considered by the contractor and owner throughout the schedule update and review processes, presents examples of commonly implemented poor scheduling practices, discusses certain caveats and recommendations to avoid disputes, and examines two case studies.

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### **(CDR-4274) Practical Considerations for Substantiating Disruption Claims from a Juridical View**

Author(s)/Presenter(s):

Kareem M. Khattab, PE PSP *Ventia*

Dr. Rania Fayed *Hill International*

Abstract: Disruption in construction projects is unanticipated interruption to the regular progress of works, resulting in loss of productivity. It could be due to various reasons like excessive overtime, acceleration or out-of-sequence work. Disruption results in reduction of work efficiency rate which leads to increase in working hours spent (labour and/or equipment) on the relevant disrupted work, not necessarily extra time (i.e., critical delay), which leads to claims to recover such losses. In practice, disruption claims are often difficult to establish due to lack of express provisions in the contract that provide rules or guidance on methodology and qualifying relevant event(s) which caused disruption. This makes it difficult to establish definitive causal linkages and may lead to claims being more global in nature. Meanwhile, assuming evidence is given and it is compelling, it remains challenging to measure and justify the financial impact of disruption in absence of actual records as courts are more impressed by damage calculations related directly to the disputed works and supported by contemporaneous documentation. This paper delves into the practical considerations for conducting a credible disruption analysis in view of US jurisdictions with the objective of introducing contractual provisions and methodology for calculating and substantiating disruption damages.

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### **(CDR-4277) Pacing Delays - Application and Considerations**

Skill Level: Intermediate

TCM Section(s): 10.3. Change Management

Author(s)/Presenter(s):

Dr. Rania Fayed *Hill International*

Kareem M. Khattab, PE PSP

Abstract: Although pacing delay is no longer a new type of delay, this form of delay can be considered, under some circumstances, highly controversial. Either party of the contract may opt to pace the project activities for a parent delay event, yet without reserving its right to claim additional costs due to the parent delay or even legally protect its action. This may turn into a dispute as the party that took the pacing delay decision may lose its entitlement for additional costs if appropriate proof of pacing action is not provided because the pacing action may be confused with concurrency. Although there is a great difference between concurrency and pacing, they are often confused, basically, due to lack of documentation and contractual control. The fundamental difference is that pacing should be a conscious decision taken in reaction and only after a parent delay has occurred. However, while pacing is easily asserted, it cannot be shown by forensic schedule analysis methods alone. This paper discusses the different scenarios for the impact of pacing delays, the practical problems arising from each scenario, the methodology and limitations for application, and the guidelines to facilitate proper management and informed pacing decisions.

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### **(CDR-4284) Shortcomings in the Dispute Resolution Procedure under AIA232-2019 Contract**

Skill Level: Advanced

TCM Section(s): 10.1. Project Performance Assessment

Author(s)/Presenter(s):

Dr. Waleed M. El Nemr *Bechtel Corporation*

Dr. Rania Fayed *Hill International*

Abstract: At the 2023 AACE Conference and Expo, the authors presented a comparison between the AIA (AIA232-2019 edition) and FIDIC (2017 Red Book edition) contracts in respect of the dispute resolution procedures prior to the commencement of arbitration. During the preparation of the paper, several concerns in the AIA's dispute resolution procedures were shared with the attendees. Due to the fact that these observations are a topic of their own right, it was decided then to prepare a separate paper that is a sequel to the 2023 paper that focuses on the observed flaws in the AIA contract pertaining to the dispute resolution process, with the aim of stimulating constructive debate on the topic and, ultimately, encouraging enhancement of the forms. Among the observed concerns is the uncertainty regarding the impartiality of the initial decision-maker (IDM), a critical flaw in the procedure leading to mediation, the impractical time limit for commencement of all claims / causes of action and the leeway given to the IDM to not provide a decision. The paper concludes with recommendations to help alleviate the shortcomings discussed. Throughout the paper, comparisons will continue to be made between the AIA and FIDIC contracts to shed light on some further key distinctions.

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### **(CDR-4285) Claim Avoidance Emphasis in FIDIC Construction Contracts and Selection of ADR Neutrals**

Skill Level: Intermediate

TCM Section(s): 6.4. Forensic Performance Assessment

Author(s)/Presenter(s):

*Luis Otavio Rosa Taroba Eng*

Abstract: FIDIC construction contracts used globally in many jurisdictions are frequently updated with improvements and contribution from users. Recent forms for Design-Bid-Build (Red book), Plant and Design-Build (Yellow book) and EPC/Turnkey (Silver book), called 2017 Rainbow Suite, aim fewer disputes and more successful projects, with emphasis on dispute avoidance. A collaborative approach requires prevention and anticipation, with current information developed during execution of the contract. Standing dispute board is mandatory in FIDIC 2017 Rainbow Suite and should be constituted at the beginning of the contract, with regular meetings and site visits, in order to prevent a claim from becoming a dispute. This type of dispute board is called Dispute Avoidance/Adjudication Board DAAB, formed frequently by three qualified members, independent and impartial. Alternative Dispute Resolution ADR models include DAAB as a consensual method, designed to diminish adversarial behavior. Selection of qualified neutrals to become members for DAAB is important for the success of prevention of disputes. This paper presents the avoidance importance and identify some critical factors and characteristics of professionals to be selected and appointed as DAAB member.

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### **(CDR-4287) Expert Terms of Reference in Arbitration: Guidelines and Applications**

Skill Level: Basic

TCM Section(s): 6.4. Forensic Performance Assessment 5.2. Asset Performance Measurement

Author(s)/Presenter(s):

*Luis Otavio Rosa Tarobá Engenharia*

*Beatriz Vidigal Xavier da Silveira Rosa Tarobá Engenharia*

Abstract: Arbitration is a dispute resolution mechanism that has been employed in many construction contracts. There are several institutions that issue arbitration rules that regulate procedural regime and the management of proceedings. The definition of production of evidence is a decision in each arbitration case, as there is no such provision in most important procedural rules. Sometimes is necessary to produce evidence and calculate the quantum of claims, by party-appointed expert or by tribunal-appointed expert. Expert terms of reference is a document used in some arbitration proceedings to establish and regulate the production of evidence and calculation of quantum of claims. This paper proposes guidelines and minimal content to be considered in the terms of reference to be used during evidence production by experts, with related applications and examples.

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### **(CDR-4293) Biting the Hand that Feeds You – The Impact of Litigation Against the Owner**

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Skill Level: Advanced

TCM Section(s): 6.4. Forensic Performance Assessment 10.1. Project Performance Assessment

Author(s)/Presenter(s):

Nickolas Florez, CFCC *Construction Contract Services LLC*

Abstract: For federal projects, the ability to obtain contracts, at least in part, depends on a contractor's past performance ratings that are collected in a database managed through the Contractor Performance and Rating System (CPARS). The CPARS rates contractor performance in several areas with ratings of exceptional, very good, satisfactory, marginal or unsatisfactory. The question is, does litigation against the owner have a negative impact on a contractor's performance rating and thereby jeopardize the potential for obtaining future work? Stated another way, is litigation biting the hand that feeds you? This paper investigates data available from several sources to include the Armed Services Board of Contract Appeals and the CPARS database to help determine if there exists a relationship between litigation and negative performance evaluations in order to provide a more quantitative assessment when considering the risks associated with litigation.

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### **(CDR-4301) Daubert Challenge Paper Revisited: The Landscape Two Decades Later**

Skill Level: Advanced

TCM Section(s): 6.4. Forensic Performance Assessment 7.2. Schedule Planning and Development

Author(s)/Presenter(s):

Kenji P. Hoshino, CFCC *PSP Project Controls & Forensics, LLC*

Abstract: Revisit the professional landscape 20 years after the presentation of the paper that started Claims and Dispute Resolution subcommittee's effort to publish RP 29R-03 for Forensic Schedule Analysis (FSA). In 2003, at AACE's Annual Meeting in Orlando, the author presented "Surviving the Daubert Challenge: A CPM Expert's Perspective" that posed a fundamental question whether there existed a technical standard governing the practice of forensic scheduling. The paper concluded that, at that time, the only technical standard appeared to be that CPM principles be used. Fast forward to now, the landscape is vastly different with the publication and wide-scale adoption of 29R-03. This paper will update how the principles governing admissibility of opinions of expert witnesses fit into the current practice of forensic schedule analysis. It concludes with thoughts about the future direction of the development and use of technical standards in FSA.

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### **(CDR-4311) False Claims Act Regulations and Dispute Resolution in the Construction Industry**

Skill Level: Intermediate

TCM Section(s): 6.4. Forensic Performance Assessment 9.1. Project Cost Accounting

Author(s)/Presenter(s):

Suleiman Al Rai, PSP *Delta Consulting Group*

Cory R. Milburn, CCP CFCC PSP *Delta Consulting Group*

Gregory S. Martin *Martin Hild, P.A.*

Codi K. Cox *Martin Hild, P.A.*

Abstract: An applicable False Claims Act regulation can significantly impact a client if violated. Penalties and even a complete forfeiture of a claim (or worse) may result from a violation. As more states enact False Claims Act regulations, practitioners in the construction disputes field need to understand the scope and limits of these regulations to avoid falling into the mistake of submitting a “false claim” and exposing their client to dire financial consequences. This paper will describe what False Claims Act regulations are and provide a brief history of these regulations, as it relates to the construction industry. In addition, this paper will show how some types of construction claims, such as delay and loss of productivity claims, may be viewed as a false claim, and recommended techniques to avoid these situations.

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### **(CDR-4312) Identifying, Quantifying, and Proving Delay or Disruption Using Linear Schedules**

Skill Level: Basic

TCM Section(s): 6.4. Forensic Performance Assessment 10.1. Project Performance Assessment

Author(s)/Presenter(s):

Benjamin Winsor, PE *Aperture LLC*

William C. Schwartzkopf *Aperture LLC*

Abstract: Critical path method (CPM) schedules are based on the premise that a project has blocks of activities that must be performed in a certain sequence—for example, a foundation must be completed before first-floor framing can be constructed. On many types of projects, the order in which the blocks of work must be performed is mandatory, whereas within a block, the order of work—such as starting at the west or east side of a structure—may be preferential. However, on other types of projects, the blocks of work may be constructed in any order the contractor chooses—for example, on a pipeline project, the segments of the pipeline may be constructed in any order. Projects where the blocks of work may be constructed in any order are often linear or repetitive in nature.

When CPM schedules are used on linear projects, they may provide misleading schedule projections when the sequence of performing the blocks or segments of work changes. CPM schedule analysis is dependent on the order in which blocks of work are completed. As a result, it will give inaccurate results when the blocks of work are performed out of sequence, even though the order is arbitrary, not mandatory. A more useful tool for identifying and demonstrating delay or disruption on linear or repetitive projects is a linear schedule, which allows the easy identification of discrete areas with slow or fast progress and helps identify the impacts causing disruption and delay.

This paper presents examples from actual projects to illustrate how linear schedules can more accurately identify problems on linear projects.

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### **(CDR-4337) How to Impact Activity Durations and Quantify Delay due to Design Changes**

Skill Level: Intermediate

TCM Section(s): 6.4. Forensic Performance Assessment 7.2. Schedule Planning and Development

Author(s)/Presenter(s):

Nathan Swink, *PSP Delta Consulting Group*

John Cleary, *PSP Delta Consulting Group*

Abstract: When baseline schedules are developed using preliminary design information, including but not limited to material quantities, sizes, and types, the baseline activity durations may be impacted once final design is completed. The preliminary-to-final design changes may result in an increase to the various material characteristics, which affect installation production rates, safety considerations, and methods of construction. These impacts may cause an increase in activity durations, which can result in project delays. This paper is written from a contractor's perspective and will demonstrate how to quantify delay by impacting activity durations based on preliminary-to-final design changes. This procedure will be exemplified through a case study that was based on actual project experience. This delay quantification procedure can be used to substantiate change order requests and/or claims when design changes occur.

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### **(CDR-4359) Schedule Delay Analysis: The Intermediary Method**

Skill Level: Intermediate

TCM Section(s): 6.4. Forensic Performance Assessment 10.1. Project Performance Assessment

Author(s)/Presenter(s):

Ryan Clark, PE *Capital Project Management, Inc.*

David Kendall, PE *Capital Project Management, Inc.*

Abstract: It is generally accepted that schedule delays are measured through project substantial completion. Most, if not all, existing standards and recommended practices for evaluating schedule delays primarily rely on measuring shifts in the project's substantial completion date. However, depending on the project's unique conditions, this approach may not always be the most suitable, casting doubt on the accuracy and practicality of applying existing standards and recommended practices.

Introducing an infrequently utilized but circumstantially beneficial approach known as the "intermediary method," this paper aims to address this limitation by measuring delays through interim milestones. This method reduces the uncertainty of changing projections of modeled downstream work. As the schedule analyst evaluates project progress and critical path, he or she would measure delay to the established milestone and then update that milestone once actualized or shifts in the critical path are realized. The intermediary method contains echoes of already established protocols and standards such as AACE RP 29R-03 MIP 3.3 or ASCE 67 but offers additional clarity and tools when straightforward application of those protocols is hindered by complicating factors.

In this context, delay measurement using the intermediary method becomes intimately tied to the delays or recoveries near the status date thereby establishing causality between project events and delay. This paper will begin by introducing the intermediary method, providing insights into its practical application, and identifying the specific project conditions that make it suitable. A theoretical exercise will be presented, and a case study will be analyzed to illustrate the method's effectiveness.

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### **(CDR-4398) Time Impact Analysis: Past, Present, and Future**

Skill Level: Basic

TCM Section(s): 6.4. Forensic Performance Assessment 7.2. Schedule Planning and Development

Author(s)/Presenter(s):

Mark C. Sanders, PE CCP CFCC PSP *Alpha 3 Consulting, LLC*

Abstract: As one of the earliest terms applied to forensic schedule analysis, time impact analysis (TIA) has a long history. This paper explores the origins and evolution of the term and the techniques to which it has been applied. Where did the term originate? What did a TIA involve when the term was first applied? What does it mean today, and what will it mean in the future? The paper presents the position that TIA was developed as a modeled, additive technique that still has value in the prospective or contemporaneous evaluation and negotiation of time extensions. However, the technique has been displaced by contemporaneous period analysis (CPA) as the state of the art of forensic scheduling has evolved.

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### **(CDR-4410) Addressing Missing Schedule Logic when Performing a Contemporaneous Period Analysis**

Skill Level: Intermediate

TCM Section(s): 6.4. Forensic Performance Assessment 7.2. Schedule Planning and Development

Author(s)/Presenter(s):

Roberto Leandro *Spire Consulting Group, LLC*

Anthony Springer *Spire Consulting Group, LLC*

Ishmael Smith, PSP *Secretariat Advisors, LLC*

Abstract: Missing logic in project schedules has always been a challenge for analysts when it comes to assessing construction delays using a contemporaneous period or window analysis (Method Implementation Protocol (MIP) 3.3 – Observational / Dynamic / Contemporaneous As-Is and MIP 3.4 – Observational / Dynamic / Contemporaneous Split). The Association for the Advancement of Cost Engineering (AACE International) Recommended Practice (RP) 29R-03 states that the preference of every analyst should be to use the contemporaneous schedules and updates as they existed during the project when implementing a contemporaneous period analysis. However, RP 29R-03 allows for corrections in schedule anomalies, including incorrect and missing logic, as defined in the validation protocols. Hence, RP 29R-03 allows the analyst the option to implement a contemporaneous period analysis with and without conducting schedule logic corrections. This paper contains a representative case study that depicts the implementation of MIP 3.3 using a native schedule with and without corrections. In addition, this paper addresses industry standards regarding missing logic when developing and maintaining project schedules, an overview of AACE International RP 29R-03 regarding schedule corrections, and the implementation of the alternatives for addressing missing logic when performing a contemporaneous period analysis.

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### **(CDR-4414) Overcoming Noisy Data in Measured Mile Productivity Analysis**

**FEDERAL + MEGA-PROJECT**

Skill Level: Intermediate

TCM Section(s): 6.4. Forensic Performance Assessment 9.2. Progress and Performance Measurement

Author(s)/Presenter(s):

Timothy A. Hampson, PE CCP PSP *Ankura Consulting Group*

Justin K. Norman, CCP PSP *FTI Consulting*

Dr. David W. Halligan, PE *Ankura Consulting Group*

Abstract: The measured mile method of estimating productivity loss uses actual project data to compare periods of expected productivity to periods of impacted productivity. The difference between expected and impacted productivity is an evaluation of the productivity loss that, when properly tied to an analysis of cause-and-effect, becomes the basis for determining the quantitative impact of those cause(s) and effect(s) on productivity.

A measured mile analysis requires identification of a reliable baseline to provide insight into the contractor's unimpacted performance as it relates to productivity (hours/unit of measure). When evaluating actual productivity, the period of impacted performance must be identified and isolated to the periods of work impacted by the cause(s) and effect(s) being considered. While this approach is simple in theory, one of the practical challenges encountered is that the available productivity data, for any number of reasons, may include data that is not representative of the actual effort involved or the actual physical work accomplished within a given period. In other words, the information relied upon can be characterized as "noisy" data. Basing an analysis on noisy data can result in inaccurate and unreliable evaluations of productivity loss.

This paper highlights three practical approaches to dealing with noisy productivity data. The first approach provides a method for identifying and discounting ramp-up and ramp-down periods of actual productivity as well as offering recommendations for assessing the robustness of the data sets used in the analysis to assure representative data sets have been selected. The second approach employs rolling averages to analyze achieved productivity rather than the "all-inclusive" averages typically employed. The third approach presents the advantages of using statistical models to identify and treat anomalies and outliers in productivity data. These practical approaches can enhance the accuracy of analyzing productivity impacts using a measured mile.

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### **(COM-4279) (Presentation Only) AACE Transit Forum**

Author(s)/Presenter(s):

Ghaith Al-Hiyari, CCP *Turner & Townsend*

Abstract: The AACE Transit Forum is a thought leadership community dedicated to AACE members that are active in the transit sector. It serves as a think tank and a gathering space for cost engineering and project controls professionals within the transit sector, to work together to address common challenges, share experiences, solutions, resources, lessons learned, and gain additional insights from experts in the field.

The AACE Transit Forum holds quarterly meetings (3 virtual meetings during the span of the year and one in-person meeting at the AACE Annual Conference & Expo). Each meeting will feature a topic led by a transit agency and will tackle issues that are most relevant to the transit sector.

The in-person session at the Annual AACE Conference and Expo is meant to foster relationships, knowledge sharing and networking between AACE members within the transit industry, creating a community within a community experience.

The AACE Transit Forum is an initiative brought to you by the Membership Advisory Committee (MAC), the first of many sector-oriented community initiatives to be launched with the aim of increasing AACE membership value and strengthening ties with the various industries.

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### **(COM-4431) (Presentation Only) AACE Power Forum: The Scale Dilemma - Big Versus Many Small**

**FEDERAL + MEGA-PROJECT**

Author(s)/Presenter(s):

Ghaith Al-Hiyari, CCP *Turner & Townsend*

John R. Baker, Jr. CEP *Battelle Energy Alliance*

Abstract: While improvements in AI, developments in big data and digitization of processes have captured a lot of attention recently, there is another trend with a larger impact on the energy industry: modularization. Many projects in the power industry already involve modularization in one form or another, solar photovoltaic and wind facilities, battery storage facilities, transmission projects and even thermal generation from natural gas. The latest addition is small modular reactors which are being embraced by organizations around the world as a way of generating large amounts of carbon free electricity reliably.

Large construction projects continue to encounter significant cost overruns and delays. Given this, some speculate that large, stick-built projects in the construction industry are, or should be, a thing of the past. Are we likely to see large one-of-a-kind projects in the energy industry anymore? Or is the future just going to be a lot of repetition? And if so, what does that mean for project controls?

- Large construction projects in the energy industry frequently go overbudget and are significantly late. What are some reasons you think large projects have a poor track record?

- With electrical demand increasing, there is a need to build new generation quickly. How can the energy industry improve its project performance to meet these needs?

- Some have suggested that it is inevitable large stick-built projects go overbudget and that the solution is to go small, building modular. Do you think we will see fewer and fewer large stick built projects?

- If we do see more modular projects, how will that impact those of us in the project controls profession? Will energy projects become dramatically simpler and thus require less project controls and oversight?

- A key concern with large stick built projects that doesn't exist in modular projects is failure cascades. Are there other solutions to this problem that could make the efficiencies of scale associated with large projects more attractive?

The AACE Power Forum is a thought leadership community dedicated to AACE members that are active in the power sector. It serves as a think tank and a gathering space for cost engineering and project controls professionals within the power sector, to work together to address common challenges, share experiences, solutions, resources, lessons learned, and gain additional insights from experts in the field.

The AACE Power Forum is an initiative brought to you with the aim of increasing AACE membership value and strengthening ties with the various industries.



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### **(COM-4434) (Presentation Only) Section Leadership Meeting**

Author(s)/Presenter(s):

Ghaith Al-Hiyari, CCP *Turner & Townsend*

Dayna L. Anderson *The Vertex Companies, LLC*

Abstract: AACE section leaders are invited to attend an interactive session. Join us to discuss important section topics, network with other section leaders, and exchange ideas.

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### **(COM-4436) (Presentation Only) Asset Planning and Management Subcommittee Meeting**

Author(s)/Presenter(s):

Gino Napuri, EVP *PMA*

Carsten-Florian Bruns

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### **(COM-4437) (Presentation Only) Claims & Dispute Resolution Subcommittee Meeting**

Author(s)/Presenter(s):

Mark F. Nagata, PSP *Trauner Consulting Services Inc.*

Roger Nelson, PE *PSP Spire Consulting Group LLC*

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### **(COM-4438) (Presentation Only) Cost Estimating Subcommittee Meeting**

Author(s)/Presenter(s):

Dave Kyle, CCP CEP *CEOptimize Consulting Ltd.*

Peter R. Bredehoeft, Jr. CEP *FAACE HDR*

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### **(COM-4439) (Presentation Only) Data Science & Advanced Analytics Subcommittee Meeting**

Author(s)/Presenter(s):

H. Lance Stephenson, CCP *FAACE AECOM*

Michael A. Pink *SmartPM Technologies, Inc.*

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### **(COM-4440) (Presentation Only) Decision & Risk Management Subcommittee Meeting**

Author(s)/Presenter(s):

Sagar B. Khadka, CCP DRMP PSP *FAACE TYLin International*

Dr. David T. Hulett, *FAACE Hulett & Associates, LLC*

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### **(COM-4441) (Presentation Only) Planning & Scheduling Subcommittee Meeting**

Author(s)/Presenter(s):

Daniel P. Gilmour, PSP *Brasfield & Gorrie LLC*

Matthew Freih, PE PSP *AECOM*

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### **(COM-4442) (Presentation Only) Productivity, Performance, and Earned Value Subcommittee Meeting**

Author(s)/Presenter(s):

Michael F. Marcell, EVP PSP *K2 Consulting*

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### **(COM-4443) (Presentation Only) Program & Project Management Subcommittee Meeting**

Author(s)/Presenter(s):

Michael S. Pytlik, EVP PSP *mcfa*

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### **(CSC-4372) (Panel Discussion) Are We Done Yet? When Will We Get There? The Best Way to Reliably Predict Realistic Project Outcomes**

Author(s)/Presenter(s):

Thomas Q. Carolan *Barton Malow Builders*

Michael A. Pink *SmartPM Technologies, Inc.*

Mark W. Cohen, PE *J.S. Held*

Abstract: This session will focus on key performance indicators (KPIs) related to project execution from the perspectives of critical project stakeholders, including owners, contractors, construction managers, and data analysts. The discussions will revolve around a sample troubled project that is halfway complete, over budget, behind schedule, and has an inaccurate monthly forecast. How can a realistic and reliable completion date be determined? While most KPIs are retrospective and may not accurately predict the future beyond a limited time horizon, some expertly skilled individuals can produce a guesstimate based on their intuition and experience that proves to be remarkably accurate. During this session, you will hear from a panel of experts with varying degrees of expertise. Additionally, you will gain insights into leveraging digital resources, such as data analytics and artificial intelligence. By the end of the session, attendees should be better equipped to forecast project outcomes more effectively.

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### **(CSC-4375) Definition of a Float-Based KPI for Disruption Evaluation in Complex Project Schedules**

Skill Level: Intermediate

TCM Section(s): 9.2. Progress and Performance Measurement 7.2. Schedule Planning and Development

Author(s)/Presenter(s):

Alberto Lopez Yus *Capgemini Engineering*

Abstract: The construction industry has been carrying out projects of increasing complexity during the last two decades. In this process, change management has become a key activity; however, changes might impact project schedules that, while not always directly affecting the completion date, they do increase the risk of eventual non-compliance.

This paper is the result of a thorough investigation of project schedule float properties with the objective of producing a simple metric to measure the ability of project schedules to absorb disruptive events without breaching the contractual key milestones.

The paper starts by proving the limits of the earned value management (EVM) methodology for the discussed topic and why total float is a flawed metric to measure disruption. It continues showing how the focus can move from tracking activities to tracking project paths within the schedule by calculating a new float metric, which is named path float (PF). PF is based on certain properties of total float and free float that have never been addressed.

Finally, the project baseline PF curve, the contemporary PF, and the contemporary scope-to-complete are used to calculate the target key performance indicator (KPI) named float performance index (FPI).

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### **(DEV-4249) (Presentation Only) Human Skills for Technical Leaders - A Cornerstone for Project Success**

Author(s)/Presenter(s):

Shoshanna Fraizinger, CCP *Shoshanna Fraizinger Consulting Inc*

Abstract: This presentation is designed for current and aspiring managers in technical and project roles.

It provides a review of the essential soft skills required in today's dynamic project environment and includes some deep-dive content on effective communication techniques, and addressing potential barriers to clear communication. It also explores the intricacies of emotional intelligence, offering actionable strategies for fostering understanding and empathy within diverse teams.

Guidance and recommendations for advanced leadership strategies, differentiating between management and leadership, and the importance of ethical decision-making in leadership roles is also covered and supported by real-world anecdotes and case studies. The role of technology in enhancing managerial effectiveness and guidance on integrating digital tools for optimum outcomes will also be touched on.

The intent is to provide invaluable insights into the skills and knowledge an effective leader should know for managing complex client relationships, navigating commercial negotiations, and resolving interpersonal conflicts within complex projects and in project management and controls roles.

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### **(DEV-4320) Introduction to Cost Engineering and Total Cost Management**

Author(s)/Presenter(s):

Dave Kyle, CCP CEP *CEOptimize Consulting Ltd.*

Abstract: This paper is an introduction to a course of study for the new cost engineer that will lead to certification and recognition as a professional in the cost engineering profession. It provides an introduction to the field of cost engineering, the Total Cost Management (TCM) process, the Total Cost Management Framework, and their relationship to the management of the total life cycle cost investment of a portfolio of strategic assets. It is intended to provide a basic level of understanding of the role an effective efficient cost engineering process plays in life cycle asset cost management (the management of an asset from inception to retirement), how it interfaces with other stakeholders in the asset life cycle, and the key expected outcomes. It will also establish a basic understanding of the role the reader has in the overall process.

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### **(DEV-4322) Introduction to AACE**

Author(s)/Presenter(s):

Dave Kyle, CCP CEP *CEOptimize Consulting Ltd.*

Abstract: AACE International is the Association for the Advancement of Cost Engineering. With over 10,000 members in 100 countries, AACE International has been serving the total cost management community since 1956. It is committed to the constructive exchange of ideas between members, development of technical guidance, quality education, and recognition of subject matter experts. AACE members work in a variety of disciplines and across many industries. AACE's body of knowledge is developed, refined, and deployed by industry professionals worldwide.

This paper provides the new member with an introduction to AACE, and the organization's website. It will better enable the reader to fully utilize all that AACE has to offer in the furtherance of their career and the cost engineering profession. It will provide understanding of AACE, cost engineering, Total Cost Management (TCM) and their relationship to each other. It also introduces AACE's purpose and organizational structure, membership benefits, educational opportunities, networking opportunities through communities (online and local), career development through certification and mentorship, body of knowledge expressed as publications (including types, organization, and development process), and communication of the many events occurring globally within AACE (and benefits of each).

The information in this paper provides a summary level introduction to the AACE website, and should not replace a member's exploration of the website, where detailed information of each topic within this paper is provided. All headings in this paper align with the website structure headings, providing simple exploration of the site.

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### **(DEV-4329) (Panel Discussion) Accelerated Career Growth Through Volunteering, an Overused Tagline or a Real Game Changer?**

Author(s)/Presenter(s):

Kim Forbes, PSP MBP

Carlos Ortega *Quantum Global Solutions*

Duan van der Merwe *Delta Consulting Group*

Lucia Vernon *Quantum Global Solutions*

Ghaith Al-Hiyari, CCP *Turner & Townsend*

Abstract: Volunteering within non-profit professional organizations goes hand-in-hand. Volunteering is a great way to not only give back but also gain exposure to new skills, open opportunities for personal growth, and develop oneself professionally, or is it? Will it enhance your resume or take time away from current assignments that could give you the same opportunities if not better career advancement? When assessing your volunteer journey, one should ask questions such as these during different periods in one's career or personal life to ensure each step is fulfilling the growth and development they are looking for. During this discussion, you will hear from five seasoned volunteers not only within AACE but throughout the world impacting a variety of causes. They will highlight how volunteering has driven both their career growth, self-fulfillment, and mental health along with openly discussing the substantial and tangible benefits.

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### **(DEV-4364) Cost Engineering Competency Matrix for Oil and Gas Business**

Author(s)/Presenter(s):

Candra Nugraha, CCP *PETRONAS*

Ashwin Kumar Narayanan *PETRONAS*

Abstract: Cost Estimation is a crucial function in oil and gas business. It is found that many Oil Companies requires engineering background to start as a new Cost Engineer. They may come from civil, mechanical, process, electrical and instrumentation engineering as new entry. The development of competency matrix is established to accelerate the understanding of scope especially on the upstream and downstream capital projects. They need to be familiar with engineering, procurement, fabrication, construction / installation, commissioning, and start-up of the project. The AACE Recommended Practices are utilized as guidance for newcomers in doing the estimate which relevant to Company Guideline.

The inventory of knowledge shall include understanding of scope and verification, quantity analysis, cost estimate techniques and application as applied for any type of contracts, project scheduling as applicable for Basic Level. The Matrix is developed based on rating from Awareness (1) till highest rating for Expert (5). Further the rating is mapped into Inventory Ruler for their Career Progression which require them to step into managerial or professional positions. The mentoring system is established for accelerating competency to support new entries in doing the estimate of projects. The assessment is made once a year to identify skill gaps and training to catch up Business needs in a very challenging oil and gas market.

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### **(DEV-4409) Including the Estimator's Leadership Traits With the Basis of Capital Cost Estimate**

**FEDERAL + MEGA-PROJECT**

Skill Level: Basic

TCM Section(s): 11.2. People and Performance Management 7.3. Cost Estimating and Budgeting

Author(s)/Presenter(s):

Saumil H. Maniar, PE *PMA Consultants*

Abstract: Project controls artifacts like capital cost estimates, schedules, and risk registers can have an outside influence on public agency owners to start or stop a project.

The basis of estimate typically explains the estimator's assumptions, reference documents and methodology. Existing standards, or procurement documents do not capture the cost estimator's leadership traits. Neither are leadership traits rated prior to selecting them, nor are they referenced along with the capital project's estimated cost, planned duration, or risk-based contingency.

The cost estimator's leadership traits can be rated by many factors like authenticity, empathy, influence, persuasion, psychological safety, vulnerability, trust, etc. They form a core part of their ability to debate, listen, analyze, include, and exclude while developing the project artifact, as an individual and in their teams. While these factors are intangible and difficult to quantify, they are a key input variable for planning-level comparison studies, iterative-design artifacts, order of magnitude deliverables, and machine learning applications.

In a 6-month leadership development program, the author examined his leadership journey as a cost estimator on a large capital construction program. The paper utilizes this experience and practitioner articles to suggest a narrow checklist to include with the basis of estimate document.

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### **(DEV-4429) (Panel Discussion) Project Controls Women in Leadership – Is There a Magic Formula to Make it Work?**

Author(s)/Presenter(s):

Tracy Leung, PEng (Moderator) *Ontario Power Generation*

Nishadi Perera, EVP PSP *K2 Construction Consultants*

Shoshanna Fraizinger, CCP *Shoshanna Fraizinger Consulting Inc.*

Abstract: In the world of project controls, and especially in the engineering and construction industry, there have been some observed improvement in having more women join the profession. However, the percentage of women in leadership positions are still lower than the labor market. This hybrid panel/breakout discussion session is an opportunity for conference participants to discuss what the motivators are for a woman in project controls to choose to lead and to excel in doing so. Is there a magic formula that will encourage and retain female leaders in the field? Considerations that one would make in a commitment to a leadership role may include work/life balance, systematic discrimination, cultural norms, unconscious bias, perceptions around roles that are typically male dominated, and many more. Panel speakers will address these considerations and share their experiences, and choices they made in their leadership journeys. As always, all genders and allies are welcomed to the discussions!

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### **(DSAA-4200) From Descriptive to Predictive Analytics**

Author(s)/Presenter(s):

H. Lance Stephenson, CCP FAACE AECOM

Abstract: The project world is seeing dramatic changes that allow us to see into the future, with more clarity, intelligence, and predictability. Once used traditional methods of descriptive assessments, such as comparisons of quantitative, lagging data to regression analysis with evidence-based statistics, are now making way for more mature business technologies and intelligence through predictive analytics, artificial intelligence (AI), and machine learning (ML). This new surge of intelligence is provocative and exciting and provides the project delivery world with profound opportunities to increase efficiencies and effectiveness while decreasing uncertainties. Consequently, this type of intelligence creates endless possibilities for the project controls environment.

With this said the objective of this paper is to provide the reader with a fundamental understanding of how to apply analytics methods in the business and project environment, which includes:

- Assessing and utilizing historical project data and benchmarking information for problem-solving and data analytics.
- Learning business problem framing and turning the business problem statement into an analytics problem.
- Developing an understanding of the predictive analytics process and how AI and ML can be used.
- Learn how to recognize the attributes of data analytics and prepare datasets for modeling.

Data analytics, with new technologies, expedites and refines the knowledge from the past and allows us to predict the future with increased clarity, intelligence, and predictability that provides the necessary influence and focus in establishing and developing our future needs.

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### **(DSAA-4282) Leveraging Data Analytics in Construction Projects to Improve Schedule Predictability and Stakeholder Relationships**

Skill Level: Intermediate

TCM Section(s): 11.3. Information Management 7.2. Schedule Planning and Development

Author(s)/Presenter(s):

Jawahar Maran, PE CCP PSP *Suffolk Construction*

Ben Lamm, PSP *Suffolk Construction*

**Abstract:** The construction industry, renowned for its inherent uncertainty, faces challenges in ascertaining whether the secured project starts with an excessively ambitious contract duration and estimates. Traditionally, project durations are negotiated during the preconstruction phase, relying on performance and data from similar projects, typical production rates, duration estimates from subcontractors and vendors, and preconstruction leaders' skills and expertise. However, this practice has shown a trend of overaggressive and unrealistic duration estimates, resulting in loss of repeat owners/contracts, workforce attrition, negative impacts on the bottom line and ultimately leading to a reputational risk for construction companies. To address these issues, a paradigm shift is underway, with contractors now adopting different data analytics techniques on historical data to develop more achievable plans with owners, specifically during the preconstruction phase.

This shift has proven to be a successful strategy while negotiating contract duration with the owners and improves the level of confidence for contractors before and during contract execution. Also, leveraging the information from the real-time data analytics throughout the lifecycle of a construction project allows contractors to accurately predict schedule variances, identify schedule compression, measure project performance, and make informed decisions to overcome events or changes that might lead to schedule delays. Facilitating a transparent, data-driven approach enables contractors to build robust relationships with owners, fostering collaboration with stakeholders to effectively manage expectations and achieve optimal project success. This paper delves into how construction firms leverage varied data analytics techniques across key WBS elements at different stages of the life cycle to derive a realistic but achievable duration to bolster their competitive advantage and enhance overall project success.

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### **(DSAA-4300) Supercharging Asset Longevity with IoT Sensors and AI**

Skill Level: Intermediate

TCM Section(s): 11.3. Information Management 2.3. Strategic Asset Management Process Map

Author(s)/Presenter(s):

Rob Coslett *Deloitte*

Shirley Albritton *Deloitte*

Eric Dembert *Deloitte*

Tim Kelly *Deloitte*

Avi Schwartz *Deloitte*

Ephraim Schoenbrun *Deloitte*

**Abstract:** The current state of facility asset management relies upon infrequent inspections leading to fix-at-failure and preventive or scheduled maintenance strategies, which directly contribute to the trillion-dollar federal facilities' deferred maintenance and repair backlog in the United States. To improve asset management programs, many organizations are looking into more technologically advanced maintenance strategies to shift from reactive or preventative facility management to using data to drive their maintenance strategy. Data-driven decision-making is emerging as the cornerstone of effective facility management. Industries are rapidly adopting this paradigm shift, focusing on the escalating importance of accessible and dependable data. This trend is particularly pertinent to aging infrastructure and facilities, where the availability of accurate data plays a pivotal role in curtailing maintenance costs by allowing organizations to allocate funds to those assets in need of maintenance.

This paper describes the integration of artificial intelligence (AI) and internet of things (IoT) sensors to create a transformative predictive maintenance (PdM) solution, allowing asset owners and managers to carefully predict upcoming equipment failures and take the required steps to mitigate them. In cases with modern assets, programmable logic controller (PLC) data may be used and incorporated into AI models. This paper will focus specifically on IoT integration and post-installation on older assets. Use cases, implementation methods, and specific considerations will be highlighted to illustrate the efficacy of this solution. Lastly, the processes of a case study are highlighted to demonstrate how this application was delivered in a real-world scenario. The trajectory of asset management is poised to shift dramatically from traditional reactive maintenance towards PdM strategies, and this solution is a critical component to achieving that goal.

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### **(DSAA-4328) A Case Study on the Usage of Data Analytics and Machine Learning to Measure Schedule Health**

Skill Level: Intermediate

TCM Section(s): 11.3. Information Management 7.2. Schedule Planning and Development

Author(s)/Presenter(s):

Kaylyn Mickelsen, PSP *PFES (Planet Forward Energy Solutions)*

Stephanie Zerkel *PFES (Planet Forward Energy Solutions)*

Joseph Lozada *Planet Forward Energy Solutions (PFES)*

Hamid Sayed *Planet Forward Energy Solutions (PFES)*

**Abstract:** This paper is an exploration and case study into the use of data analytics and machine learning as tools that can be combined with industry standards for schedule health analysis. Utilizing machine learning (ML) algorithms, schedule health data can predict future project schedule outcomes. The concepts presented are combined with current market tools for business intelligence reporting, scheduling, and model creation. The software used in this case study includes Microsoft Power BI, Oracle Primavera P6, and Microsoft AutoML to deliver high-quality schedule health data and forecasted performance on projects in a portfolio. The intent of using these techniques is to make data easily accessible and understandable to allow for enhanced decision-making capabilities throughout an organization.

This analysis supports AACE's proper schedule development adherence [1] and criteria for constructability reviews [2]. The authors will show how machine learning is a natural next step in the data analytics process when building a schedule health dashboard. In this paper, the authors explain the typical machine learning process and compare it to Microsoft's AutoML machine learning tool, which is available as part of their Power BI analytics platform, where the advantages of AutoML are highlighted.

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### **(DSAA-4365) Machine Learning Concept for Offshore Platform Estimate**

Author(s)/Presenter(s):

Candra Nugraha, CCP *PETRONAS*

Kamilah M. A. Jamil *PETRONAS*

Ashwin Kumar Al Narayanan *PETRONAS*

Abstract: The accurate estimate is required to support robust decision for project economic. The process of estimation largely depends on some attributes such as scope definitions and project schedule. On the other hand, the strong database is required to predict the cost based on historical and future market rates. One of the solutions is using probabilistic model to have range of possible outcome for an estimate.

Recently, computing techniques for a quick and accurate estimation has been seen as an alternative to overcome the uncertainty of input parameters. Fuzzy Logic Concept which leveraging statistical approach, nonlinear equations and genetic algorithm programming is used to model the cost. Fuzzy Logic resembles the human decision-making methodology. The metrics are used to supply meaningful and timely management information with regard to techniques and process. Cost Estimate Relationship (CER) is established to model the correlation against the technical deliverables at any particular stage gate process to support the target metrics.

This paper presents an alternative method to estimate the cost which applied on offshore platforms and wells through machine learning as it compares the performance of three different machine learning algorithms i.e. linear regression (baseline model), Ridge regression and Support Vector Regression (SVR). The results show that in spite of the limitation in the amount of data, the algorithms exhibit high performance with SVR recording 3.5 as the lowest RMSE value. The estimated cost then tabulated as a probabilistic number by using in-house probabilistic tools.

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### **(DSAA-4395) Industrial Goods Cost Estimating Using Machine Learning Techniques**

Skill Level: Intermediate

TCM Section(s): 11.3. Information Management 7.3. Cost Estimating and Budgeting

Author(s)/Presenter(s):

Fernando Nahid Leitão *Petrobras*

Adriano Gonçalves da Silva *Petrobras*

Leonardo Carmo de Holanda *Petrobras*

Abstract: The acquisition of industrial goods is essential to ensuring the functionality of equipment, factories, and operational plants in different companies. Unlike simpler or consumer goods, industrial goods do not have their prices published and, generally, are not part of standardized catalogs. Therefore, an accurate forecast of industrial goods prices is essential for achieving favorable outcomes for companies, whether it be through accurate cost estimates or improving the quality of commercial negotiations.

This project involves the application of data mining and machine learning techniques in typical databases of industrial goods. Examples of techniques used include classification algorithms, regression, and neural networks.

In the present work, the techniques were applied to three distinct typical databases: database 1 - items with simple technical characteristics like common materials from the supplier market without manufacturing complexity; database 2 - operational items with specific and standardized technical characteristics; and database 3 - items with complex technical characteristics, normally associated with large equipment.

The work conclusion aims to determine the most efficient machine learning models for each database and develop a guide for estimating the cost of different industrial goods.

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### **(DSAA-4406) Optimization Techniques and Metaheuristics in Project Scheduling: Sustainability and Real-world Applications**

Author(s)/Presenter(s):

Dr. Achintyamugdha S. Sharma *JCMS, Inc.*

Dr. Priyanka Deka *JCMS, Inc.*

Goutam Jois, Esq. *JCMS, Inc.*

Umesh K. Jois *JCMS, Inc.*

Abstract: In this paper, the research team has investigated the potential improvement of its previously developed in-house method of integrating sustainability metrics with critical path method (CPM) schedules, by using metaheuristics and optimization techniques. This previously developed novel method estimates 100-year global warming potential (GWP) CO<sub>2</sub>-equivalent emissions as a function of the CPM schedule at an activity level. The intent of this paper is to explore further automation and optimization of certain aspects of this method of estimating sustainability metrics. Moreover, the application of optimization techniques to develop schedule scenarios with different relationships between activities with an emphasis on reducing environmental emissions in terms of Global Warming Potential (GWP) CO<sub>2</sub>-equivalent is investigated. Prior researchers have applied metaheuristics like genetic algorithm (GA), particle swarm optimization (PSO), simulated annealing (SA), ant colony optimization (ACO) etc. to develop schedules with minimum overall duration under the constraints of limited resources. With a focus on GA, this paper also investigates the real-world applications of metaheuristics to optimize critical path method (CPM) based schedules of projects.

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### **(EST-4203) Independent Cost Estimate's Value on Construction Manager/General Contractor Transportation Projects**

**FEDERAL + MEGA-PROJECT**

TCM Section(s): 7.3. Cost Estimating and Budgeting

Author(s)/Presenter(s):

Dr. Douglas D. Gransberg, PE *Gransberg & Associates, Inc.*

Dr. Milagros Pinto-Nunez *Walter P. Moore Engineering*

Dr. Nils J. Gransberg *Gransberg & Associates, Inc.*

Abstract: Construction manager/general contractor (CMGC) project delivery by state departments of transportation (DOT) has grown substantially since it was originally authorized in 2000. The Utah DOT was an early adopter and other DOTs turned to it for CMGC implementation guidance. The UDOT program includes an "Independent Cost Estimate (ICE) consultant" to furnish a third opinion to validate the CMGC contractor's estimated construction cost and the current agency estimate during construction price negotiations. Conversely, DOTs in Arizona and Florida do not use an ICE. A 2010 NCHRP study reviewed the three DOTs and found no evidence of a difference in project performances attributable to an ICE. This paper revisits the perception of the value of the ICE after a decade of experience by analyzing, recent CMGC solicitations from 25 states compared to the 2010 findings. The paper finds that no quantitative performance difference has been identified between projects with an ICE and projects without; however, the number of DOTs that use an ICE greatly outnumbers those that don't, leading the paper to conclude that there is a perceived value-added by the presence of an ICE and recommending quantitative research to confirm that perception.

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### **(EST-4232) A Technical Approach to Classify Decommissioning Cost Estimates**

Skill Level: Intermediate

TCM Section(s): 7.3. Cost Estimating and Budgeting 3.2. Asset Planning

Author(s)/Presenter(s):

Leonardo Muller, CCP PRMP PSP *Petrobras*

Alberto Carlos Caldeira Costa Coelho *Petrobras*

Cócis Alexandre dos Santos Balbino *Petrobras*

Abstract: Cost estimate classification systems are a practical approach to improve communications among all the stakeholders involved with planning, preparing, evaluating, and using cost estimates. AACE International published many cost estimate classification systems for several industries and asset stages, but no specific recommended practice (RP) for decommissioning cost estimates was issued. Considering the current situation of cost estimates for decommissioning fixed platforms as a case study, this paper analyses the workarounds performed by the industry that can lead to misinterpretation of the RPs – mainly 18R-97 – adopted to perform decommissioning cost estimates. The paper proposes an innovative view identifying three key phases and intermediate transition stages to develop an RP-oriented classification system matrix draft with five estimate classes. The draft can provide a starting point or go-by for any organization's internal procedures or industry debate. This proposal represents a mindset shift towards an RP-oriented approach, which is applicable in other industry sectors to help eliminate the decommissioning RP gap workarounds.

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### **(EST-4304) Evolution of Cost Estimating from the 1950s to Today**

Skill Level: Basic

TCM Section(s): 0.0. General Reference 7.3. Cost Estimating and Budgeting

Author(s)/Presenter(s):

Hetali Doshi *Arcadis*

Douglas W. Leo, CCP CEP FAACE Hon. Life *Cost Consultant*

Abstract: This paper follows the evolution of project cost estimating from the 1950s, to today's current technological advancements. More specifically, it focuses on developments that have shifted the cost estimating process from manual calculations by solo practitioners to the complex, computer-aided analyses performed by estimators, often in teams, whose firms employ the latest and greatest technological advances. Today's professionals analyze the types of production, evaluate the estimating-related issues, apply appropriate techniques, and try new innovations. Among such innovations, this paper will discuss cost estimating tools such as BIM, artificial intelligence, and drone video usage. Other challenges here considered include the employment of sustainable net-zero estimating and the costs of carbon capture and mitigation.

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### **(EST-4349) Estimating Productivity Adjustments**

Skill Level: Basic

TCM Section(s): 7.3. Cost Estimating and Budgeting 7.1. Project Scope and Execution Strategy Development

Author(s)/Presenter(s):

Luke McMullan, CEP *Parametrix*

Ben Crawley *Parametrix*

Catherine Cerruti *Parametrix*

Abstract: This paper examines the utilization of productivity factors as a method for increasing the accuracy of labor cost estimation in construction projects. Traditional labor cost estimating approaches often overlook the intricate interplay of factors influencing workforce productivity. Through a review of productivity loss causes and their observed applications, this study highlights their potential to capture an improved project planning and resource allocation. The paper discusses challenges associated with project constraints, obstacles, and external influencing factors and provides a qualitative solution to accounting for productivity loss. Ultimately, this research contributes valuable insights into bridging the gap between theoretical productivity models and their effective integration into real-world infrastructure development.

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### **(EST-4352) Successful Implementation of Continuous Estimating for Target Costing in Collaborative Contracts**

**FEDERAL + MEGA-PROJECT**

Skill Level: Intermediate

TCM Section(s): 7.3. Cost Estimating and Budgeting 3.3. Investment Decision Making

Author(s)/Presenter(s):

Behrad Kiafar, CEP *PwC Canada*

Daniel Drouin *Drouin Consultants*

**Abstract:** Continuous estimating is a dynamic approach employed for target costing in collaborative contracts, where project costs are estimated iteratively during validation and design phases, providing enough detail to guide the design toward meeting target costs. Unlike conventional estimating, which determines costs at specific design milestones, continuous estimating offers ongoing capital cost data for the entire project based on the latest scope and design changes. These estimates serve various purposes, including validating owner's allowable costs, screening design options, setting target costs, and implementing design-to-target cost or target value design. Continuous estimating promotes collaboration, enhances visibility and transparency in the estimating process, and supports the effective implementation of collaborative contracts.

The challenges in implementing effective continuous conceptual estimating in collaborative contracts include building a trust-based and collaborative environment among stakeholders. Additionally, there's a need to shift the traditional estimating mindset to agile and collaborative methodologies. Gaining access to high-quality historical data is also crucial, along with a sufficient understanding of the cost estimate relationships with the technical parameters of the project, which is essential for developing conceptual models.

This paper outlines a structured framework for the effective implementation of continuous estimating and presents challenges, lessons learned, and key success factors based on integrated project delivery (IPD) infrastructure projects in Canada.

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### **(EST-4363) Cost Estimate Challenges for FPSO Decommissioning**

Author(s)/Presenter(s):

Candra Nugraha, CCP *PETRONAS*

Husaini Md Rasid *PETRONAS*

Abstract: FPSO Decommissioning estimates are very depending on the technical complexity and commercial terms of the contract (Capital/Lease). There are number of challenges that make it difficult to accurately estimate the cost especially on the exposure of hazardous material, environmental conditions at the site, and lack of historical data within the region. The FPSO decommissioning have been estimated in Deepwater Mauritania (2018) and Shallow water Malaysia (2022) are referred for lessons learnt.

Decommissioning process of FPSO can be categorized into two (2) major activities related to pre-execution and offshore execution. The pre-execution includes planning and permitting (engineering, pre shutdown survey, approval of relevant procedures, appointment of subcontractors, etc.). Meanwhile, the offshore execution started from cease of production, pigging & flushing the flow lines and umbilical, securing wells, topside cleaning including contaminated systems, mooring chains disconnection and abandonment till sail away to designated area. It is important to include the activities post decommissioning such as dismantling and scrap, disposal, and post survey to make sure work completion clean and safe. The waste management should be carefully evaluated as part of liability in accordance with Environmental Impact Assessment (EIA). It is found that the unexpected cost may happen due to Naturally Occurring Radioactive Materials (NORMS) appeared and special treatments are required prior to dispose to safe area as per Authority approval. Risks associated with abandonment and decommissioning strategy were anticipated related to interface with Wells P&A, scope demarcation with FPSO owner, delay in approval of permits from government and weather conditions during execution.

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### **(EST-4402) Indirect Costs Estimating Based on Statistical Analysis**

**FEDERAL + MEGA-PROJECT**

Skill Level: Advanced

TCM Section(s): 7.3. Cost Estimating and Budgeting 10.4. Project Historical Database Management

Author(s)/Presenter(s):

Dr. Chunhong Tian *Enbridge*

Prashant K. Srivastava, PEng *Enbridge*

Ryan McPhee *Enbridge*

Wilson Ting, PEng *Enbridge*

Amita Narayanan, CCP *Enbridge*

Nathan Len. PEng *Enbridge*

**Abstract:** Project costs consist of both direct and indirect costs. Indirect costs are those not directly assignable to the end-product or its progress. These include overhead costs for the support teams, general labor costs, transportation costs, insurance, taxes, etc. Indirect costs are often more challenging to control or determine because they represent general cost of the organization generated in favor of more than one project. Estimating these costs can be complex due to variations based on project scope, size, location, and so on.

In this work, a substantial amount of cost data from actual legacy projects analyzed was collected at the work breakdown structure (WBS) level and statistically analyzed. Consequently, recommendations for estimating indirect costs at the line-item level were established based on the data and statistical model.

In the statistical model, scaling factors were introduced to estimate indirect costs for projects across eight different cost bands. Applying the "average - before - fit" methodology, which statistically normalized the fluctuations and random data distribution caused by the heavier weight of small projects, resulted in a significant improvement in the goodness-of-fit, with the R-squared value increasing from approximately 0.1 to around 0.9.

The resulting indirect cost percentage recommendations have been integrated into the estimating tool and have been tested with actual project costs benchmarks. The variance between the calculated indirect costs, based on the newly determined percentages, and their actual benchmark costs was found to be less than 5%.

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### **(EST-4430) Navigating Effective Capital Cost Estimate Review and Assurance**

Skill Level: Basic

TCM Section(s): 7.3. Cost Estimating and Budgeting

Author(s)/Presenter(s):

Noorussaadah Bt Yahya *Petronas*

Abstract: It has always been the aspiration of the author's company to have the project capital delivered at optimum accuracy and competitive costs. This will ensure the achievement of sustainable competitive advantages. However, the pace of project costs has increased quickly until it is challenging for the company to effectively predict and estimate the costs. To ensure that the company is always able to be cost-competitive and predictive, relevant usages of cost-estimating fundamental drivers, such as cost estimation systems, tools, and good governance and assurance processes and practices must be effectively leveraged. The objective of this paper is to address the capability of the cost engineering department to leverage cost-estimating review approaches along with the best practices adopted in successfully undertaking efforts to drive projects toward being delivered at manageable, improved accuracy, and competitive costs. This paper will also focus on the cost estimate review methodologies and guidelines in identifying key areas where the estimate may be deficient, and or additional focus is required. The deployment of good cost estimate review governance and assurance processes is to align the expectations and requirements for cost estimations in the application of company standards and quality management systems (QMS).

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### **(EVM-4197) The Value of Earned Value**

Author(s)/Presenter(s):

Sylvia M. Donado *Arcadis, Inc*

John Holincheck *Acuity International*

Abstract: Earned Value Management is a technique that can greatly improve overall project planning, control & contribute to improved communication of project status. Implementation of this technique can prove to be very challenging for many organizations. Success is dependent on several factors and considerations lining up in a manner where tracking and analysis can be done in an objective manner across the entire project. Appropriate level of detail, considering risks while developing the schedule, allocating budgets in accordance with appropriate controls accounts, data collection, & tracking metrics are among these challenges that become critical for a successful EVMS implementation. Furthermore, making sure the entire project team understands and contributes to the planning and control metrics used becomes critical to communicating with the project team in order to facilitate decision-making & forecasting in order to ensure overall project success.

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### **(EVM-4215) Is Cost Performance Index Predictive of Project Performance?**

Author(s)/Presenter(s):

Eric Vyskocil *Laurentis Energy Partners*

Ashrita Srikanth *Ontario Power Generation*

Abstract: The key measure of a metric's usefulness is its ability to accurately predict what will occur in a project. In particular, the ability of a project to be able to accurately predict the total costs associated with the work is essential, allowing the team to take corrective action when necessary. While Earned Value Management (EVM) is a recommended practice by numerous international organizations, it is important to confirm that metrics like the Cost Performance Index (CPI) have predictive power to be able to accurately forecast a project's at completion costs.

Using OP's project historical data warehouse, it is possible to review historical trends in project performance at OPG to assess different metrics and their usefulness in predicting the project's at completion costs. This paper will summarize some of the analyses performed, comparing the predictive value of the CPI against the Estimate At Completion (EAC) forecast by project teams.

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### **(EVM-4373) Time Prediction in Construction Projects with Integral Earned Schedule**

Skill Level: Advanced

TCM Section(s): 7.2. Schedule Planning and Development 2.4. Project Control Process Map

Author(s)/Presenter(s):

Mojtaba Zarei Kesheh, PSP *FTI Consulting*

Abstract: In recent decades, project managers have increasingly relied on earned value management (EVM) methods to integrate time, cost, and technical performance effectively for project oversight. This paper introduces the integral earned schedule (IES) technique as an advanced iteration of the earned schedule (ES) concept, drawing on kinematics principles to fuse time and cost within the EVM framework. The IES method accounts for the ripple and synergistic effects of accumulated changes associated with delays, disruptions, downtimes, stop-work orders, and rework, factors often overlooked in other methodologies. Through computational analysis of 11 real-world construction projects, the study illustrates the superior predictive capabilities of IES-based time forecasting methods, particularly in identifying early warning signals for projects experiencing delays. Results underscore the enhanced reliability and stability of IES when compared to traditional planned value, earned duration, and earned schedule methods proposed by Anbari (2003), Jacob (2003), and Lipke (2003) respectively. The findings emphasize the improved accuracy of predictions, especially in anticipating delays and providing timely alerts during the initial project phases. Leveraging both the integral earned schedule and earned schedule methods alongside the critical path method and risk analysis augments predictive accuracy and furnishes comprehensive project insights for effective management.

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### **(EVM-4408) Basics of Earned Value Management - How & Why**

Skill Level: Basic

TCM Section(s): 10.1. Project Performance Assessment 9.2. Progress and Performance Measurement

Author(s)/Presenter(s):

Carole A. Venters, CCP EVP *Worley*

Abstract: This paper will discuss: what is earned value management (EVM); how is earned value (EV) calculated; when should EVM be used; and above all, why does project management want to know the EV of their projects? This paper will lead the reader through these and other questions often asked by new project controls professionals as well as other project team leads. A brief history of EVM will be discussed, as well as various (typical) equations for determining the EV and the methods for presenting this EV information to the project management team. There are many articles and books which have been written about earned value management; this paper intends to give a brief summation from a few of those articles and books.

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### **(EVM-4419) (Presentation Only) EVM Reviews – Surveillance Reviews vs. IBRs**

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Author(s)/Presenter(s):

Sam Kitchin *Augur Consulting*

J. Greg Smith, EVP *Humphreys and Associates*

Abstract: Successful Earned Value Management (EVM) implementation requires an effective Earned Value Management System (EVMS) and a well-planned performance measurement baseline. Meaningful insight into project performance can only be achieved with this combination of a compliant system with the active planning and management of project execution. A critical method to evaluate adherence to EVM best practices is to conduct reviews. Compliance reviews and surveillance reviews are used to evaluate the sufficiency of the EVMS, while integrated baseline reviews are used to assess the reasonableness of a project baseline. This presentation will compare and contrast these two types of review, demonstrating how and why they differ. Key terminology, stakeholders, artifacts, timeline, and intended results will be discussed. Real life examples may be used.

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### **(EVM-4420) Performance Baseline-Contract (PB-K) Based Independent Estimate-at-Completion (iEAC)**

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Author(s)/Presenter(s):

S. Brian Kong, PE CCP *U.S. Department of Energy*

Abstract: Past performance is a predictor of future performance. This paper provides a unique independent estimate-at-completion (iEAC) technique that factors past performance, control account manager (CAM) & project manager (PM) EACs, risks, and hotel load. This integrated schedule and cost technique using earned value management (EVM) and based on the has proven successful in identifying projects that may breach the approved baseline. This early indicator provides projects to strategically identify and address root causes as well as implement recovery plans. Further, it allows projects to enforce favorable performance.

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**(IND-4336) (Presentation Only) - Industry Showcase - Hatch: A Digital Project Delivery Journey: Taking Project Controls to the Next Level**

Author(s)/Presenter(s):

Leslie E. McMullan, FAACE *HATCH*

Ashwin Lala *HATCH*

Abstract: Digital Project Delivery (DPD) is the use of digital data and models to plan, estimate, engineer, procure, construct, commission and operate facilities. It helps firms adopt or develop technologies that support a collaborative environment, providing the information in a structured and real-time way through a data hub during execution and provides a digital twin for operations.

This presentation describes the journey to an integrated digital project control system for cost effective and efficient project delivery. Results include the enhancement of forecasting and predictability, change management, risk management and earned value. Efficiencies realized by the seamless development of estimating to cost control to benchmarking provide the means for automated analytics and decision opportunities, rather than simply data collection and reporting.

Digital project controls and digital project management is steering towards greater collaboration and efficiencies between project disciplines and stakeholders. It also enhances the role and skills required. With further industry trends and innovation, we imagine a bold and positive future for project controls and estimating, unlocking greater value for owners and stakeholders.

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**(IND-4444) (Presentation Only) - Industry Showcase - TBD**

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**(IND-4445) (Presentation Only) - Industry Showcase - TBD**

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**(IND-4446) (Presentation Only) - Industry Showcase - TBD**

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**(IND-4447) (Presentation Only) - Industry Showcase - TBD**

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**(IND-4448) (Presentation Only) - Industry Showcase - TBD**

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**(IND-4449) (Presentation Only) - Industry Showcase - TBD**

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**(IND-4450) (Presentation Only) - Industry Showcase - TBD**

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**(IND-4451) (Presentation Only) - Industry Showcase - TBD**

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**(IND-4452) (Presentation Only) - Industry Showcase - TBD**

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**(IND-4453) (Presentation Only) - Industry Showcase - TBD**

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**(IND-4454) (Presentation Only) - Industry Showcase - TBD**

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**(IND-4455) (Presentation Only) - Industry Showcase - TBD**

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**(INT-4273) The Challenges of Business Development for Engineering Firms and Contractors**

Skill Level: Intermediate

TCM Section(s): 11.2. People and Performance Management

Author(s)/Presenter(s):

Lan Zhang *Century 3 Shanghai*

Yi Fang *Century 3 Shanghai*

Zhenyu Qiang *Century 3 Shanghai*

Abstract: One of the most significant challenges faced by engineering firms and contractors is the quest for more business leads to enhance their chances of winning additional projects. The conventional method involves identifying requests for proposals (RFPs) and following the bidding process by tracking information from permitting details, new project announcements, funding approval news, or even rumors. While this methodology works well for most companies, it lacks a straightforward direction, resulting in random and unstable outcomes. The question arises: How and where can new business leads be found before the RFP stage? This paper, based on the project execution cycle model from the industrial leader DuPont, analyzes the major phases before the RFP. It explores stakeholders from the business and technical lines, examining their objectives and pain points to identify solutions that may add value for the client. This approach helps companies engage earlier in the process before the RFP, systematically obtaining business leads at earlier stages. The paper presents a business development mechanism, assisting engineering firms and contractors in generating leads systematically and staying ahead of their peers.

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### **(IT-4291) Robotic Process Automation (RPA) for Cost Estimating**

Skill Level: Advanced

TCM Section(s): 7.3. Cost Estimating and Budgeting 11.3. Information Management

Author(s)/Presenter(s):

Sulaiman Alabdulkarim *Saudi Aramco*

Josue E. Garcia, CCP CEP *Saudi Aramco*

Rafael E. Lozada F. *Saudi Aramco*

Abstract: Robotic process automation (RPA) is a rapidly evolving technology that has been widely adopted in various industries for its ability to automate repetitive and rule-based tasks. In the oil & gas industry, estimating is a critical function that involves predicting the cost of a project accurately for planning, funding, and project management purposes. Occasionally, estimator professionals are required to produce multiple types of estimates that are often repetitive and high volume such as onshore maintain potential funding estimates and annual capital program conceptual estimates. This paper presents two cases of RPA implementation in the Saudi Aramco oil and gas industry. The first one is related to the review, validation and endorsement of cost estimates for the onshore maintain potential funding process, and the second one is related to updating annual capital program cost estimates, due to changes in the initial and final execution schedule. The latter are very frequently requested from the estimating division. The implementation of RPA has led to increased productivity, reduced processing times, consistent and accurate estimate production, as well as minimizing the involvement of estimator professionals. The paper provides an overview of the RPA implementation process, the benefits realized, and the challenges faced during the implementation process.

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### **(OWN-4202) Perceived Risk in Project Delivery Method Selection in the U.S. Federal Transportation Sector**

Skill Level: Advanced

TCM Section(s): 4.1. Project Implementation 7.1. Project Scope and Execution Strategy Development

Author(s)/Presenter(s):

Dr. Douglas D. Gransberg, PE *Gransberg & Associates, Inc.*

Daniel D'Angelo, PE *Applied Research Associates, Inc*

Abstract: The project delivery method (PDM) selection decision in transportation projects involves the agency comparing authorized PDMs against project risks to identify the one perceived to permit the owner to best manage risk. A recent Federal Highway Administration (FHWA) study found that state departments of transportation (DOT) rely on a qualitative approach based on the perceived risks inherent to each PDM. This paper reports the results of case study interviews from 11 DOTs, involving rating 19 project outcomes and the value of early contractor involvement portrayed by 15 typical preconstruction services touted as risk management methods in the literature. The analysis was conducted using two approaches: classic Likert scale ratings (risk perceptions) and factorial pairwise comparison (risk mitigation perceptions). The paper finds that the outcome reached by each approach was different. The Likert scale rating indicated that design-build (DB) was the preferred PDM; whereas, the pairwise comparison found construction manager/general contractor (CMGC) to be the preferred method. The paper infers that the difference relates to the need for the agency to surrender control of the design details in DB. When a head-to-head comparison is made on the 34 variables CMGC is perceived to provide enhanced scope certainty as well as cost and schedule certainty when the DOT controls the design.

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### **(OWN-4253) Applying Lessons Learned From Past Schedules**

Skill Level: Advanced

TCM Section(s): 7.2. Schedule Planning and Development 7.6. Risk Management

Author(s)/Presenter(s):

Andre K. W. Chong *Teck Resources*

Abstract: Project end dates represented in contractors' bids are rarely achieved due to a variety of factors. Owners can use historical schedule data to learn how to limit the impact of these factors for future contracts. This paper presents a method to do so.

A table is created that sums up the overall delays to the project end date. The as-built schedule is measured against the Contractor's bid schedule and baseline schedule to identify areas of critical path delay. Each reason for delay is normalized into a percentage. This is called a "lookback table" in the paper.

Before awarding the next similar contract, review the lookback table and develop mitigations. For instance, if equipment breakdowns were causing past delays, the contract could include penalties if availability drops below a certain threshold.

Lookback tables also help Owners quantify risks during contract negotiations. For example, weather delays that impacted the critical path are applicable to other contracts in the same location. Finally, comparing lookback tables from similar project types or the same contractor may reveal patterns that lead to changes in how the organization operates.

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### **(OWN-4268) Effectively Leveraging Schedule Reserve**

**FEDERAL + MEGA-PROJECT**

Skill Level: Intermediate

TCM Section(s): 7.1. Project Scope and Execution Strategy Development

Author(s)/Presenter(s):

Stephen L. Cabano, *FAACE Pathfinder, LLC*

Zachary Ledet *Pathfinder, LLC*

Abstract: The identification of schedule reserve has emerged as an effective approach to acknowledge and manage unforeseen events during project development and execution. Schedule reserve is the practice of allocating extra time within a project schedule to accommodate unexpected delays, risks, and uncertainties. Moreover, the practice of incorporating schedule reserves facilitates the proactive assessment of resources, processes, and technological factors. This focused pre-examination of a project fosters an environment conducive to achieving successful project outcomes. Although the significance of schedule reserve is acknowledged, creating a strategy that leverages time reserve while aligning with other project aspects proves to be a complex task.

This paper is based on an owner project team approach and the value it brings to the owner organization's senior management and business leaders. Drawing upon an extensive multi-industry discourse, this paper explores methodologies for seamlessly integrating and visually representing contingency measures. This study further delves into insights on mitigating unintended added cost associated with contingency development, preventing complacency-driven cultural implications, and circumventing redundant planning endeavors within the framework of implementing and communicating schedule reserve. The primary objective of this study is to enhance the comprehension and assimilation of contingency durations and events, as derived from statistical risk studies, into project schedules. The implementation of these techniques and methodologies have potential to enhance the overall efficacy of project execution and foster more successful project outcomes.



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### **(OWN-4271) PM Responsibilities Comparison Model Between Owner and Contractor for a Theme Park Project**

Skill Level: Intermediate

TCM Section(s): 4.1. Project Implementation 11.2. People and Performance Management

Author(s)/Presenter(s):

Lan Zhang *Century 3 Shanghai*

Kai Wang *Century 3 Shanghai*

Renjun Luo *Century 3 Shanghai*

Abstract: The current study on the responsibilities of project managers (PMs) focuses on the project itself, where the PM is responsible for safety, quality, cost, and scheduling. However, every project has two parties: the owner and the contractor. Owing to the differences in their roles and interests, they have different priorities and common grounds. By identifying these differences, addressing them, and expanding the common ground, a project can be executed successfully and under control toward its objectives. This study is based on the definition of the responsibilities of a PM in a literature review. A comparison model was developed by utilizing the primary scope of the work and the responsibilities of the PM at each phase from the owner and contractor sides. The model was further explained through a case study of a theme park project. The comparison model presents how the owner's PM leads project management, whereas the contractor's PM delivers the project. The model enriches the body of knowledge on project management by analyzing the processes of two major stakeholders to reduce confrontations and increase cooperation.

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### **(OWN-4308) Main Challenges and Strategies in Utility-Scale Solar Projects**

Skill Level: Basic

TCM Section(s): 3.2. Asset Planning 3.3. Investment Decision Making

Author(s)/Presenter(s):

Dennis Y. Bocuzzi *Alvarez & Marsal*

Vitor Ladeira *Alvarez & Marsal*

Abstract: Investments in the power sector increased by around 12% in 2022, surpassing the trillion milestone at USD 1.1 trillion, with 2023 expected to see further growth to almost USD 1.2 trillion. Solar projects represent the largest portion of that amount, with over 300 billion investments worldwide.

Despite a continuous expected growth for 2023, renewable energy projects face increasing challenges, due to cost and supply chain constraints, which are driving profitability down and, in some cases, having investors rethink such capital allocation. For those reasons, concern with the project execution has arisen further, from development stages, and mainly through contracting and construction phases.

This paper describes the landscape for the deployment of utility-scale solar enterprises in emerging markets (where Brazil is heavily invested), the major risks associated with such projects, and recommended practices and methodologies for owners to achieve their targets regarding cost, schedule, and operational requirements.

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### **(OWN-4348) Reviewing and Validating Third-Party Cost Estimates**

Skill Level: Intermediate

TCM Section(s): 7.3. Cost Estimating and Budgeting

Author(s)/Presenter(s):

Luke McMullan, CEP *Parametrix*

Jack Treval *Parametrix*

Jake Chalin *Parametrix*

Abstract: This paper offers an overview of the typical process involved in reviewing a third-party cost estimate for transparency, estimating methodology, and subsequent validation of the projected cost. Drawing on industry best practices, the paper delves into the crucial stages of receiving, and critically assessing cost estimates, ensuring that they are transparently derived and align with project specifications. It examines strategies for deciphering complex estimation methodologies, clarifying assumptions, and addressing potential discrepancies. Additionally, the paper explores methods for validating the estimate through benchmarking, expert opinions, and comparative analysis, aiming to bolster confidence in the accuracy and reliability of the estimated cost. By providing this comprehensive framework, the paper serves as a valuable guide for construction professionals, project managers, and stakeholders, enabling them to navigate the intricacies of third-party cost estimation and make informed decisions based on robust and transparent cost projections.

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### **(OWN-4386) Setting Up a Cost Engineering Department and a Benchmark of Its Estimating Practice - A Case Study**

**FEDERAL + MEGA-PROJECT**

Skill Level: Intermediate

TCM Section(s): 7.3. Cost Estimating and Budgeting 4.1. Project Implementation

Author(s)/Presenter(s):

Muftau J. Akanbi, CCP *Baker Hughes*

Abstract: In this study, the author reviews the establishment of a cost engineering department (CED) in a national oil and gas exploration and production company. The company was faced with high cost of project delivery, largely attributed to poor estimating practices and lack of unified cost database. In a bid to optimize its project cost and derive the right value for funds invested on projects, the company's management set up a team to establish and run a cost engineering department (CED).

This article reviews problems identified by the team and the short- and long-term strategies adopted to address the identified problems. An in-depth analysis of the established cost estimating process (a key aspect of the short-term strategy) is presented, highlighting the difference with the previous estimating practice and the value derived so far by the organization. A benchmark of the new estimating practice against United States Government Accountability Office (GAO) guidelines for cost estimation was conducted to reveal areas of possible improvements. This paper provides fundamental insights to other owner's company willing to establish similar department in their organization.

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### **(OWN-4392) Equity and Environmental Justice in Early-Stage NNSA Project Planning**

**FEDERAL + MEGA-PROJECT**

Skill Level: Intermediate

TCM Section(s): 7.1. Project Scope and Execution Strategy Development

Author(s)/Presenter(s):

Zachary Matheson *National Nuclear Security Administration*

Abstract: The NNSA mission, which is to maintain the nation's nuclear stockpile, prevent nuclear weapon proliferation and reduce the threat of nuclear and radiological terrorism worldwide, impacts the lives of Americans directly and indirectly. Sometimes this can have devastating consequences to local communities, such as the legacy of contamination at the Hanford site in Washington state. On the other hand, NNSA's unique science and production facilities provide world-class opportunities for educational and career development in historically marginalized communities, including rural communities, people of color, and other minoritized populations. An equity and environmental justice-informed approach to planning within the NNSA can minimize the incidence of negative environmental and health outcomes, maximize the number of opportunities available to historically marginalized groups, and contribute to greater trust of the NNSA mission within minoritized communities.

Several recent executive orders have directed federal agencies to prioritize environmental justice and reduce systemic barriers negatively affecting minority and underserved groups. As an organization specializing in decision support for early-stage planning, the Office of Programming, Analysis, and Evaluation has developed a framework for incorporating equity and environmental justice in analyses of alternatives and early-stage planning studies. This framework will be used to inform decision-makers about potential project impacts from an equity and environmental justice-focused perspective.

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### **(OWN-4416) (Presentation Only) Triage the Sub-Projects: Calculating and Applying Portfolio Contingency**

**FEDERAL + MEGA-PROJECT**

Author(s)/Presenter(s):

Stephen Koellner *Augur Consulting*

Abstract: Risk-adjusted cost estimates are needed to understand the potential range of actual costs through execution. Cost risk analysis produces uncertainty distributions which can be used to calculate an expected cost as well as contingency, which can be thought of as the difference between expected cost and a higher confidence level chosen for planning purposes. In a portfolio of projects, allocating uncertainty at the portfolio level will result in a different risk-adjusted cost than applying the same allocation at the project level, and so it is unclear whether a portfolio should allocate and manage risk-informed contingency at the portfolio or project level. This topic will examine best practices for calculating and managing contingency, using EM 5-22 as a tangible example.

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### **(OWN-4425) Capital Assets Recognition and De-Recognition Process in Oil and Gas Operating Companies**

Author(s)/Presenter(s):

Chad Itagi, PEng CCP CEP PSP *Saudi Aramco*

Nanda Itagi, CCP *Saudi Aramco*

Abstract: Capital projects, which make up the major part of long-term assets on a balance sheet, can be so large for many corporations. Hence, it is essential to decide, how the list of equipment units and facilities ends up on the balance sheet that is called capitalization, it is also called recognition of assets. However, some of the assets will be expenses in the operating statement.

So, it is essential to understand how do oil and gas operating companies recognize the capital assets, which supplies economic benefits over a future period frame. Capital assets are tangible and intangible assets that meet the company minimum capitalization threshold.

The paper illustrates transformation of capital assets cost from the balance sheet over to the income state. Since capital assets are long lived assets, So, apportion of cost over a period will be on income statement. Essential steps of capital assets record creation and tagging will be discussed with obstacle

The paper will illustrate why it is desirable for a cost engineer or project accountant to pick diverse types of depreciation & amortizations. The de-recognition of capital assets including disposal of capital assets for financial consideration with reasonable monetary realization.

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### **(OWN-4427) (Panel Discussion) Leadership Issues Facing Federal Project Decision-Makers**

**FEDERAL + MEGA-PROJECT**

Author(s)/Presenter(s):

Michael A. Peek, PE CCP *U.S. Department of Energy*

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### **(PM-4220) Collaborative Projects: The Ultimate Trust Fall Exercise for Both Vendors and Owners**

Skill Level: Intermediate

TCM Section(s): 8.1. Project Control Plan Implementation 11.2. People and Performance Management

Author(s)/Presenter(s):

Shoshanna Fraizinger, CCP *Shoshanna Fraizinger Consulting Inc.*

Abstract: As the world works to rebound from pandemic-related issues, including an unreliable supply chain and high inflation rates, one can see a trend toward more significant consideration of alternatives to the traditional and often adversarial contracting practices one often sees between owners and vendors on large capital projects. More collaborative agreements and operating models can be found in integrated project delivery (IPD) or project alliancing. Under such models, key delivery partners must work together during a defined preplanning period to develop the project scope, schedule, and budget.

Now more than ever, ensuring the validity and accuracy of the estimates that form ones project baselines need to be a top priority for all parties to ensure the success of these collaborative partnerships. This paper discusses several lessons learned from independent estimate reviews and provides observations and recommendations that take into consideration these earlier engagements and contracting strategies.

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### **(PM-4224) Lessons Learned - A Culture of Moving Forward**

Skill Level: Basic

TCM Section(s): 11.2. People and Performance Management

Author(s)/Presenter(s):

George S. Bekhit *Aecon Group Inc.*

David Jurgeneit *Aecon Group Inc.*

Abstract: Construction projects are very dynamic with experienced teams executing the work. Without capturing the success and learning areas through lessons learned, even the most experienced teams will repeat failures. 3 steps are crucial to ensure a growing lessons learned culture inside construction companies, namely – Identification, Managing & Sharing and finally Formalizing & Standardizing. Even with a robust process in place, there's no guarantee a strong lessons learned culture will thrive. Systems and tools must be continuously evaluated to ensure they are working for the team. Socializing construction excellence through strong corporate communications is also vital to building the lessons learned culture. Finally, strong stakeholder engagement and collaboration with the client are key to a successful lessons learned program and strong culture surrounding it.

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### **(PM-4251) Program and Project Management Insights Gained From an Analysis of Completed Projects**

**FEDERAL + MEGA-PROJECT**

Skill Level: Intermediate

TCM Section(s): 6.4. Forensic Performance Assessment 7.1. Project Scope and Execution Strategy Development

Author(s)/Presenter(s):

Dan Melamed, CCP EVP *FAACE United States Department of Energy*

Kevin Lee *Acuity*

Elizabeth B. Barnett *Acuity*

Bryan A. Skokan, PE *Acuity*

Rodney Lehman *United States Department of Energy*

Richard J. Schassburger *Acuity*

Abstract: Insights on the successful project management approaches for the completed environmental cleanup projects across the United States of America have been condensed and summarized into an AACE recommended practice for the environmental remediation industries which had been supported with information from previously completed projects. This paper examines another successfully completed project, the Fernald Environmental Management Protect, located near Cincinnati, Ohio. This large cleanup project offered a different and broader set of cleanup challenges that included contaminated soils, buildings, inventories of surplus materials, wastes, and a large, contaminated groundwater plume, that all needed to be remediated. This paper examines the project's optimal sequencing/logic, schedules, cost estimating (for both near and far term work), key performance metrics, and project risk minimization and management. This information provides the reader with specific insights which contributed to the success of completed environmental cleanup projects and could thus prove useful for the future efforts in this industry sector.

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### **(PM-4265) Using TCM to Establish a Standard Project Management Methodology for Construction Projects**

Skill Level: Intermediate

TCM Section(s): 2.2. Total Cost Management Process Map 7.1. Project Scope and Execution Strategy Development

Author(s)/Presenter(s):

Rogério F. Cruz *CRASA Infraestrutura*

Marcelino R. Braga *CRASA Infraestrutura*

Ricardo P. Sanches *CRASA Infraestrutura*

Abstract: A methodology is a set of practices, techniques, procedures, and rules used by professionals who work in each field. Within an organization, these elements come together through its culture, an intrinsic ingredient of each corporation. A standard methodology seeks to establish a common way of working and prepare a repetition environment to develop. When a company works in such a way as to repeat the same processes, it is natural that it performs them better and better, becoming faster and more economical. In the context of project management, an effective standard methodology brings many benefits, such as increasing the chances of project success, expanding the availability of the team, eliminating unnecessary decisions, and enabling consistent reporting. This paper approaches the elements of the standard project management methodology that was developed and implemented in a Brazilian contractor from the infrastructure sector, with the Total Cost Management Framework (TCM) as its primary basis. The work presents: (i) the main challenges and elements involved in loading the route towards the standard's mindset, (ii) essential aspects considered to support a sustainable methodology development, and (iii) some practical components of the developed methodology and the benefits obtained from the implementation in a real-life project.

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### **(PM-4283) Managing and Controlling Scope Creep in Construction Contracts: Case Study**

Skill Level: Basic

TCM Section(s): 10.3. Change Management 10.1. Project Performance Assessment

Author(s)/Presenter(s):

Esraa Khaled Abdelraouf Mohammed *Hill International*

Abstract: Under different standard forms of construction contracts, scope creep, which is the uncontrolled increase in the project's requirements, and ultimately, causes an increase in the project's duration. In this technical article, the author is addressing the mechanism of managing scope creep under several standards forms of contract, such as The International Federation of Consulting Engineers (FIDIC), American Institute of Architects (AIA), etc... With an emphasis on the FIDIC standard form of contracts, a case study where several scope alternations took place is illustrated with its results to show the actual methodologies and lessons learned during the construction of a mega and complex project. Consequently, it can be clearly stated that scope creep cannot be prevented, but it can be controlled and managed with the proper contractual mechanism.

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### **(PM-4332) WBS-Based Work Processes: The Missing Component in Stage Gate Processes**

Skill Level: Basic

TCM Section(s): 7.1. Project Scope and Execution Strategy Development 7.2. Schedule Planning and Development

Author(s)/Presenter(s):

Richard P. Helper, *PSP RPH Consulting, Ltd.*

Abstract: As stage gate management systems become more widely developed and implemented, it may be time to consider whether these systems will provide significant improvements in project results. The stage gate process is generally described as a project management technique in which a project is divided into distinct stages, or gates, separated by decision points known as gates. Each gate has objectives, or requirements which must be met to pass the gate. These requirements are broadly defined, which subjects them to wide interpretation. Stage gate checklists provide more detailed requirements, but they still do not provide the granularity needed to properly manage and execute complex projects. What is the missing? Well defined work processes based on WBS accounts that interconnect disciplines and stakeholders and provides qualitatively defined acceptance criteria for technical and managerial deliverables. These processes can be logically connected to create a roadmap to follow between stage gates. This roadmap becomes a methodology that proactively supports meeting project objectives. This paper will demonstrate how to develop and use WBS work processes and why they should be the foundational element of a stage gate process.

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### **(PM-4351) Keep Capital Projects on Track Through Agile Execution and Contracting Strategy**

Skill Level: Intermediate

TCM Section(s): 4.1. Project Implementation 7.1. Project Scope and Execution Strategy Development

Author(s)/Presenter(s):

Virgilio T. Monton, II PEng *CCP Hatch Ltd.*

Abstract: In today's highly competitive global landscape, the success of multi-year capital projects depends on meticulous planning of contracting execution strategies. Owners who execute under an engineering, procurement, and construction management (EPCM) delivery method often integrate a contracting strategy that involves the construction contractor taking on a significant share of the risk burden.

However, if challenges arise during project execution and cause delays in the delivery of direct works, what is the best course of action? Clearly it is essential to adopt a robust change management process. By having project controllers and planners work closely with contract administrators and the entire project execution team, there is a higher degree of success if better forecasting, trend, and change management are practiced.

Alternatively, the project controls and contract administrators can work collaboratively, and advise the project execution team to recalibrate the effectiveness of the project delivery method and contracting strategy to align it with the project's critical schedule.

An integrated project delivery (IPD) framework can be selected in the planning phase or can be introduced later to realign a beleaguered project. This framework promotes collaborative synergy between the owner and EPCM. It involves continuous refinement of predictive models, meticulous risk evaluation, and a strategic overhaul of the contract model. This paper explores the constructive collaboration between various contracting strategies and adept forecasting techniques during project execution, leading to a dependable forecast of final cost and schedule.

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### **(PM-4370) Enhancing Affordable Housing Construction Through Lean Practices, Takt Planning, and Offsite Modular Integration**

Skill Level: Basic

TCM Section(s): 11.5. Value Management and Value Improving Practices (VIPs) 11.1. The Enterprise in Society

Author(s)/Presenter(s):

Roger Nelson, PE PSP *Spire Consulting Group*

Hassan A. Dia *Spire Consulting Group*

Abstract: The surging demand for affordable housing in areas like the San Francisco Bay Area necessitates innovative construction approaches that enhance efficiency and equity. This paper examines the interplay between lean construction, takt planning, and offsite modular integration to address affordability challenges and promote equitable housing.

The study examines lean construction's waste reduction and collaborative principles aligned with sustainability in the context of offsite modular construction. Takt planning, a manufacturing-derived approach, is explored for synchronized construction cycles and to improve labor productivity.

Additionally, the research investigates offsite modular construction as a transformative solution. The workflow enhances quality control, minimizes disruptions, improves worksite safety, and provides access to labor outside of the construction labor pool. The convergence of lean, takt, and offsite modular techniques creates a comprehensive framework enhancing economic viability, quality standards, and streamlined processes for affordable housing construction.

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### **(PM-4432) Maturity Gain With the Application of PEP in Mining and Steel Projects**

Skill Level: Basic

TCM Section(s): 3.1. Requirements Elicitation and Analysis 3.3. Investment Decision Making

Author(s)/Presenter(s):

Jéssica Chequer dos Santos *Alvarez & Marsal U.S.*

Abstract: The warming-up projections with the recovery of the world economy in the post COVID-19 era boost the demand forecasts in the steel and mining sector. Inserted in this global scenario, the companies in these sectors in Brazil have several sustainability and competitiveness projects in their portfolio planned for the coming years.

In this context, the capital project market has been evolving at a fast pace, and theories with little applicability have given way to tools and processes that can be systematically adopted, accelerating the degree of maturity and management of projects.

This paper describes the use of the front-end loading (FEL) methodology in steel and mining projects that involves the development of definitions for decision-makers to identify and control risks, minimize threats, make investment decisions, and maximize the potential for success. In this context, the execution of the project execution plan - PEP, is the guide used by the project team intending to deliver the agreed results of the enterprise. This paper seeks to prove, through Monte Carlo simulation, the gain in project maturity with the elaboration of the PEP and the consequent reduction of contingency between the approval gates of FEL 2 and FEL 3.

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### **(PS-4230) Schedule Narratives and Reports**

Skill Level: Basic

TCM Section(s): 7.2. Schedule Planning and Development

Author(s)/Presenter(s):

Delbert E. Bearden, PSP *Bear3 Consultants LLC*

Abstract: Effective communication of project schedules is pivotal to the success of construction and engineering projects. In response to the increasing complexity of these projects, this paper provides comprehensive guidance tailored to professionals responsible for developing influential schedule narratives and reports. The paper delves into the purpose and scope, emphasizing the role of effective communication, collaboration, and understanding among project stakeholders.

The objective is to develop schedule narratives and reports that contribute significantly to project success. Covering critical aspects such as project milestones, progress updates, risk mitigation strategies, resource allocation, and more, this paper seeks to enhance the quality and effectiveness of schedule documentation.

By equipping project professionals with the tools and knowledge to create impactful schedule narratives and reports, the paper aims to positively influence project outcomes, assisting in a timely delivery, adherence to objectives, and overall success in construction and engineering projects.

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### **(PS-4233) How Recommended Practices for Project Scheduling are Becoming Obligations by Project Contracts**

Skill Level: Intermediate

TCM Section(s): 7.2. Schedule Planning and Development 8.1. Project Control Plan Implementation

Author(s)/Presenter(s):

Saeid Khademagha, PEng PSP *EllisDon Inc.*

Ali Yazdani, PEng *EllisDon Inc.*

Abstract: In the last few decades, having an accurate and reliable project schedule as a technical tool for planning, managing, and controlling the time and cost of projects has become increasingly apparent across all industries. Project contracting parties have been trying to structure and discipline the process and procedure of project scheduling and performance measurement by putting industry-accepted principles and recommended practices into practice.

Given the obvious benefits of such recommended practices, some project owners, especially in the public sector, are trying to contractually make them fully or partially enforceable and necessary for contractors to prepare various types of schedules (such as proposal, baseline, progress, recovery, and revised schedules, as well as schedule delay analysis) by including several pertinent clauses and provisions in their contracts for various attributes.

In this article, the stipulated contractual requirements for some of the main components of the project Scheduling Procedure and their related essential actions will be discussed by reviewing different clauses in the contracts of the case study projects.

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### **(PS-4236) Correcting Out-of-Sequence Logic**

Skill Level: Intermediate

TCM Section(s): 7.2. Schedule Planning and Development 9.2. Progress and Performance Measurement

Author(s)/Presenter(s):

Ronald M. Winter, PSP FAACE *Schedule Analyzer Software*

Abstract: Out-of-sequence logic occurs when actual status is applied to a planned CPM schedule. If the actual start date is earlier than the calculated early start date, then the actual date overrides logic. Depending on how the CPM calculation handles this occurrence, the remaining portion of the planned work may be delayed to re-enforce the planned logic. Studies show that approximately 40% of all started activities in typical construction projects are started out-of-sequence.

Most schedulers say that they 'fix' any out-of-sequence activity in schedule updates by modifying the activity or logic. This effort may be misinformed as many schedulers do not fully appreciate the number of out-of-sequence occurrences in their schedules. For example, P6 Professional software only reports on active, direct out-of-sequence activities. This is a small percentage of the actual out-of-sequence in a schedule. Besides, they may be fixing the wrong logic as the indirect out-of-sequence (which P6 Professional does not report) may be the correct activity to fix. This paper looks into the reasons, methods, and pitfalls involved in correcting out-of-sequence logic during updates. Definitive rules are proposed for various categories of out-of-sequence conditions presented in earlier papers.

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### **(PS-4241) The Top Ten Approaches to Avoiding Resource-Related Claims**

Author(s)/Presenter(s):

Glen R. Palmer, CFCC PSP FAACE *GR Palmer Consulting Services, LLC*

Christopher W. Carson, CEP DRMP PSP FAACE *Arcadis*

Abstract: The authors will discuss types of resource issues that impact the schedule and how to prevent many delay and disruption claims due to these problems. Among the issues discussed will be productivity driven duration overruns, risk adjusted resource planning, manpower charts, percent complete charts, and crew loading and analysis. These authors have more than 80 years of experience on both contractor and owner teams and will pass along techniques that have proven successful for the authors in avoiding claims. The session should be entertaining and informative.

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### **(PS-4267) Planning and Scheduling for Workplace Safety**

Skill Level: Basic

TCM Section(s): 7.2. Schedule Planning and Development 11.6. Environment, Health, and Safety Management

Author(s)/Presenter(s):

Mark David Smith *Brasfield & Gorrie*

Daniel P. Gilmour, PSP *Brasfield & Gorrie*

Matthew Smith *Brasfield & Gorrie*

Abstract: Often considered conflicting obstacles to each other's success, workplace safety and project scheduling are not the foes they were once thought to be. This paper will examine how traditional planning and scheduling processes affect workplace safety and how workplace safety measures may affect planning and scheduling. Authored by seasoned experts from the building construction industry with specialties in both scheduling and safety, this paper will also outline the correlation between site safety and schedule performance.





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### **(PS-4315) Schedule Development and Progress Measurement Requirements for Fixed-Price Construction Contracts**

Skill Level: Intermediate

TCM Section(s): 7.2. Schedule Planning and Development 9.2. Progress and Performance Measurement

Author(s)/Presenter(s):

Ricardo Albeny, CCP EVP *NOVA Chemicals*

Abstract: Many bidders complain about rigid and detailed requirements for schedule development and progress measurement included in the owner's bid documentation for a fixed-price contract. These requirements are typically laid out in the request for proposal (RFP) package, covering the full gambit of expectations ranging from safety, quality and, of course, project controls.

The nature of these challenges typically stems from certain team members having a misconception about the level of detail that can or even should be asked of bidders in such a contractual arrangement. This viewpoint can often be characterized with phrases such as: "we don't typically ask for that" or, "that seems too detailed for a lump-sum job". This paper is going to reinforce the importance of ensuring such requirements are included in the bid documentation, while providing an additional purpose for these deliverables (schedule and progress measurement system) on fixed-price contracts, which relates to planning/assessing the payment amounts throughout the execution of the contract.

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### **(PS-4342) A Statistical Approach to Developing Empirical System Durations for Wastewater Treatment Plants**

Skill Level: Advanced

TCM Section(s): 7.2. Schedule Planning and Development 9.2. Progress and Performance Measurement

Author(s)/Presenter(s):

Shreyas Raghavendra *Arcadis U.S., Inc.*

Christopher W. Carson, CEP DRMP PSP *FAACE Arcadis U.S., Inc.*

Abstract: Schedule overruns are a major challenge in the construction and rehabilitation of wastewater treatment plants (WTPs). This can often lead to cost overruns, loss of productivity, construction quality problems, large punch lists, disputes, and claims.

This paper aims to develop empirical system durations for WTPs through the compilation of real-world WTP related as-planned and as-built schedule data and carry out regression analysis to model the relationship between the factors that affect the system durations (such as the size of the plant, the type of treatment process, and the age of the plant) and the system duration itself. This model can then be used to predict system duration based on the identified factors.

The results of the study can be used to improve the accuracy and reliability of WTP schedules by pre-emptively informing planners and schedulers about the numerous factors affecting WTP construction and providing them with empirical system durations which can be used as a reference point. This will help to set realistic stakeholder expectations, reduce the risk of schedule and cost overruns.

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### **(PS-4354) An Efficient Approach to Scheduling Repetitive Projects**

Author(s)/Presenter(s):

Christopher W. Carson, CEP DRMP PSP FAACE *ARCADIS, U.S., Inc.*

Abstract: Many projects consist of strings of activities that are repeated multiple times to generate the full schedule, a good example being a multi-story building. The foundation is subdivided into similar sections, comprised of excavation, layout, pile driving, pile cutoffs, pile caps, grade beams, and backfill. A common approach is to develop the first section and duplicate it, changing the horizontal label, or elevated floors in a vertical environment. This is quick and provides good quality control if done correctly.

The risk to this effort is that the schedule development session is used to establish the standard fragnet in the first section and the sequencing between sections, then duplicated and validated by the construction management team, however, when the full schedule is reviewed, it commonly is not acceptable. This can be because the team has a gut feeling about the overall duration of the entire foundation or the full multi-story facility.

The author worked out an approach that improves this method and minimizes the rework necessary when the final product is not acceptable because that rework might be only 15 changes on the first elevated floor but 300 changes for a twenty story highrise. It can be faster to delete all the duplicated floors, make the changes on the single floor and duplicate it again. This paper will demonstrate the process to enable a standardized approach for an efficient schedule development process which the author calls an "outline schedule development".

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### **(PS-4358) An Overview of Hydropower Projects in Canada Part 2 (Spillway)**

**FEDERAL + MEGA-PROJECT**

Author(s)/Presenter(s):

Ali Montaser, PEng CCP EVP PSP *Comtech*

Ahmed Montaser, EVP *Aecon*

Abstract: Canada is the world's fourth largest generator of electrical hydropower with facilities that have been around for more than one hundred years. Hydropower projects are inherently complex and building them in Canada has an additional layer of challenges due to typically being in remote locations, and having to face severe weather conditions that could reach as low as -50 C degrees. This paper is the second of a series that will provide an in-depth review of specific considerations related to hydropower projects in Canada. The first paper, "An Overview of Hydropower Construction Projects in Canada and Lessons Learned" was published at the AACE Expo 2023 (PM-4071). This paper will focus on Spillway construction, planning, and scheduling. It will also describe the author's lessons learned based on their experiences related to such projects. The paper will do a deep dive into the execution strategy of the Spillway complex. Then it will present the design of a schedule intelligent calendar that automatically changes the activity's duration according to the season in which the activity is occurring. Lastly, it presents tried-and-true coding and sequencing methods for different concrete placement activities.

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### **(PS-4360) (Panel Discussion) 100 Years of Federal Project Scheduling Insights and Lessons Learned**

**FEDERAL + MEGA-PROJECT**

Author(s)/Presenter(s):

Michael R. Nosbisch, CCP PSP FAACE *Strategic Management Solutions LLC*

Diane Bragoni, PSP CPM *Schedule Solutions LLC*

Patricia Bolton, PE *U.S. Army Corps of Engineers*

S. Brian Kong, CCP *U.S. Department of Energy*

Dr. David T. Hulett, FAACE *U.S. GAO*

Abstract: This will be an interactive conversation with seasoned industry and government experts who bring more than ten decades of scheduling experience for complex federal projects/programs spanning from aerospace and defense to construction.

This discussion will dive into key scheduling challenges, offering firsthand insights and actionable recommendations for professionals involved in federal projects and programs. Topics will include schedule resource and cost loading, level of detail, impacts and delays, reserve and contingencies, risk analysis, and more.

Join this discussion to:

- Directly engage with top professionals.
  - Actively participate, ask questions, and get immediate answers.
  - Elevate your understanding with real-world lessons and guidance.
-





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### **(PS-4377) Addressing Schedule Complexity and Optimizing Scheduling Process for Infrastructure Projects**

**FEDERAL + MEGA-PROJECT**

Skill Level: Basic

TCM Section(s): 7.2. Schedule Planning and Development 10.1. Project Performance Assessment

Author(s)/Presenter(s):

David A. Chigne, CCP CEP PSP Alpha 3 Consulting

Shrutika Barwal, PSP Alpha 3 Consulting

Abstract: Effective project scheduling is essential for the successful execution of any project. It serves as a fundamental tool to ensure that projects are completed within their designated timelines, and budget constraints, and with minimal disruptions. However, current requirements in the construction industry present a landscape of scheduling challenges. Various aspects, such as multiple calendars, constraints, lags, resource allocation, and even budget considerations, introduce complexity that can render schedules highly sensitive to changes. Even minor modifications can trigger cascading effects, significantly impacting project timelines, and making schedules difficult to interpret.

This paper closely examines the process of integrating contractual requirements into project schedules with the help of a case study on an infrastructure project to illustrate how this alignment introduces complex scheduling challenges, influencing the critical path, near-critical paths, and/or driving paths for special milestones on different stages of the project.

The goal is to develop a comprehensive understanding of how these complexities underscore the necessity for project schedulers and stakeholders to collaborate effectively, creating schedules that faithfully represent project complexity while fully harnessing the capabilities of the scheduling software.

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### **(PS-4387) Mastering Risk Factors for Renewable Energy Projects So You Don't Get Burnt, Blown Away, or Washed Out**

Author(s)/Presenter(s):

Matthew D. Baker *Watt, Tieder, Hoffar & Fitzgerald, LLP*

Christopher J. Brasco *Watt, Tieder, Hoffar & Fitzgerald, LLP*

Dakus Gunn *Delta Consulting Group*

James F. Timko *Watt, Tieder, Hoffar & Fitzgerald, LLP*

Abstract: Renewable energy projects pose unique scheduling challenges affecting project planning, delivery, and claims resolution. Solar, wind, and hydroelectric projects each involve distinctive supply, sequencing, environmental, means and methods, and risk shifting considerations. These performance exposures must be considered when initially scheduling and then evaluating delays on renewable energy projects. This paper addresses relevant considerations impacting the scheduling of renewable energy projects, provides input on how these considerations practically affect the development of the project schedule, and outlines strategies for mitigating associated risks. As the green energy transition accelerates, renewable energy projects are expected to constitute a growing percentage of the construction pipeline. Appreciating the unique scheduling challenges posed by such projects will help ensure that you don't get burnt, blown away, or washed away on your next renewable energy project.

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### **(PS-4415) (Presentation Only) Schedule Analysis Best Practices for Capital Projects**

**FEDERAL + MEGA-PROJECT**

Author(s)/Presenter(s):

Dave Ingalls, EVP *Augur Consulting*

Abstract: Capital Infrastructure projects are often impacted by challenges in executing schedules per the plan, leading to unforeseen and costly delays to delivery milestones. In many cases, these delays are driven by the complexity of large, dynamic acquisition efforts. However, in some cases delays are simply caused by a failure to follow project planning best practices in the schedule development phase. This presentation aims to cover both the content of Integrated Master Scheduling (IMS) best practices as well as the impact “for better and for worse” inherent in the rigor of that approach. Topics addressed will include approaches for the effective creation and baselining of a project IMS, in addition to best practices for schedule management and schedule analysis in the execution phase. Key metrics for both elements will be covered in order to provide a quantitative anchor of this discussion.

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### **(RISK-4240) Case Study: Use of the Hybrid Parametric and Expected Value QRA Method on the Keeyask Hydropower Megaproject**

**FEDERAL + MEGA-PROJECT**

Skill Level: Intermediate

TCM Section(s): 7.6. Risk Management 3.3. Investment Decision Making

Author(s)/Presenter(s):

John K. Hollmann, PE CCP CEP DRMP FAACE Hon. Life *Validation Estimating LLC*

Raminder S. Bali, PEng *Manitoba Hydro*

Abstract: Keeyask is a new 695-megawatt hydroelectric generating station on the Nelson River in Canada’s Manitoba province developed as a collaborative effort between Manitoba Hydro (MH) and four First Nations – Tataskweyak Cree Nation and War Lake First Nation (operating as the Cree Nation Partners), York Factory First Nation, and Fox Lake Cree Nation – working together as the Keeyask Hydropower Limited Partnership (KHLPP). MH managed the construction and operates Keeyask, which has been fully online since 2022. The primary Keeyask project scope included earth-filled dams and earthen dikes, a powerhouse with seven turbine units, and a seven-bay spillway. In the early stages of Keeyask’s stage-gate process, quantitative risk analysis (QRA) was performed using range estimation. In 2013, prior to the start of construction, Keeyask switched to using cost and schedule QRA applying the hybrid parametric and expected value (P+EV) method along with analyses of specific management reserves and a tipping point (non-linearity) assessment (AACE Recommended Practice 113R-20 covers the P+EV method). This case study reviews the use of the P+EV method on a megaproject during execution.

P+EV has advantages for early stages; however, Keeyask applied it during construction. Identified, but under-appreciated, systemic fragility challenges led to non-linear behavior; total cost increased from \$6.5 to \$8.2 billion Canadian dollars and the first unit in-service milestone slipped 15 months from November 2019 to February 2021. This is not a story of flawless prediction, but is a practical lesson learned guide on applying P+EV on a project in which the nature of the risk and analysis teeters on the brink of statistical disorder. Learnings and recommendations are provided.

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### **(RISK-4247) Defining a Lognormal Distribution Using 3-Point Entry: The J-QPD Distribution**

Skill Level: Intermediate

TCM Section(s): 7.6. Risk Management 3.3. Investment Decision Making

Author(s)/Presenter(s):

John K. Hollmann, PE CCP CEP DRMP FAACE Hon. Life *Validation Estimating LLC*

J. Eric Bickel *University of Texas at Austin*

Abstract: Practical quantitative risk analysis (QRA) methods using Monte Carlo simulation (MCS) for project contingency determination often rely on 3-point distributions. In a typical project QRA workshop, 3-points (e.g., low, most likely, high) have proven to be the extent of the cost and schedule risk impact range input that most analysts can expect to obtain from project teams. In AAACE RP 66R-11, there are only two practical probability distribution functions (PDFs) defined by 3-points: Triangular and PERT. Neither is an ideal representation of naturally occurring cost growth and schedule slip data distributions. Industry research suggests that the Lognormal distribution is a more realistic fit for large projects based on actual project cost and schedule variability. Risk analysts, attempting to be realistic, often resort to PDF variation (e.g., trigonometric) and/or attempt to push teams toward the analyst's opinion of acceptable 3-point input. This manipulation can raise stakeholder suspicions about the reliability of MCS, and rightfully so.

What is needed is a lognormally shaped PDF that can be defined with 3-point input. Recently, researchers at the University of Texas developed a distribution system called the Johnson quantile-parameterized distribution (J-QPD) that is able to match the shapes of common distributions, including lognormal with 3-point input. This paper will review the typical QRA PDF use context, describe the J-QPD distribution and its use criteria, and provide practical examples of its application in an MCS-based QRA method. The authors will propose an RP 66R-11 update and encourage MCS software vendors to include the J-QPD as a distribution choice in their products.

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### **(RISK-4307) Trading Cautiously: Risk Management in the Leapfrogging of Offshore Wind Turbine Technologies**

Skill Level: Intermediate

TCM Section(s): 7.6. Risk Management

Author(s)/Presenter(s):

John Coker *Delta Consulting Group*

Emily J. Byrd *Delta Consulting Group*

Abstract: As the global commitment to sustainable energy and green tech intensifies, offshore wind technology is experiencing significant advancements. These developments, characterized by larger blades and turbines, promise heightened efficiency but also introduce a range of challenges in transportation and installation. This paper delves into the complexities of these advancements, identifying and analyzing the risks they pose—from logistical and regulatory hurdles to financial repercussions. It presents a comprehensive risk management framework, informed by expert insights, designed to address these challenges effectively. The framework provides stakeholders with a structured approach to managing risks associated with the deployment of advanced transport methodologies in the offshore wind turbine sector. By emphasizing proactive risk management, the paper aims to equip stakeholders with the necessary tools to navigate this rapidly evolving landscape, thereby contributing to the sustainable growth of the offshore wind industry. This work stands as an essential guide for industry professionals, highlighting the critical role of strategic risk management in adapting to and capitalizing on technological innovations.

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### **(RISK-4330) Navigating Risk Management Challenges in Progressive Environments: Case of Progressive Design Build Contract Delivery Models**

**FEDERAL + MEGA-PROJECT**

Skill Level: Intermediate

TCM Section(s): 7.6. Risk Management

Author(s)/Presenter(s):

Roozbeh Panahi *Jacobs Solutions Inc.*

Katia Rizkallah *Jacobs Solutions Inc.*

Kyle Mawhinney *Metrolinx*

Sara Martino *Metrolinx*

**Abstract:** Progressive contract delivery models have gained prominence in mega-construction projects, particularly in Canada, owing to distinct advantages such as increased market engagement, refined project definition, early risk mitigation, and project acceleration. A robust risk management practice can play a crucial role in the success of these models. The convergence of all relevant parties at a single platform during the iterative progression of project details during the development/design phase offers valuable insights into necessary changes concerning various risks and corresponding risk management strategies, contributing to the overall success of the project along with a well-defined schedule and cost estimate for the implementation/construction phase. Nevertheless, risk management may face challenges during the development/design phase that can minimize the benefits of progressive models. These challenges can emerge as a result of inadequate information, a dynamic and rapid-paced environment, diverse risk cultures, and limited expertise, among other factors. This article's primary objective is to examine risk management challenges in the context of the Progressive Design Build (PDB) model, a variant of progressive contract delivery during the development phase. In doing so, the article benefited from in-depth analysis of the risk management steps, direct contribution of the team and unstructured interviews with project controls and technical teams involved in relevant projects.

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### **(RISK-4345) (Presentation Only) Review of Risk/Reward Sharing Mechanisms in Collaborative-Based Projects**

**FEDERAL + MEGA-PROJECT**

Skill Level: Intermediate

TCM Section(s): 7.7. Procurement Planning 7.6. Risk Management

Author(s)/Presenter(s):

Dr. Moe Roghabadi *Hatch*

Camelia Bucur *Hatch*

Dr. Farzaneh Golkhoo *Hatch*

Sohiel M. Hassan *Hatch*

Abstract: Collaborative Contracting Models have been receiving worldwide attention, especially in the UK and Australia, with increasingly more countries exploring its use. It is a relatively new delivery strategy in Canada where owner and all non-owner participants (NOPs) work together with integrity and making best-for-project mindset decisions. Risk/reward sharing is an important concept to provide incentive for project participants to enhance the project performance and achieve a win-win scenario for all those involved. There are multiple approaches from the literature that explored how the risk/reward sharing ratio can be optimized to incentivize parties' risk solving efforts. As such, this paper summarizes previous work relating to this topic and compares 2 specific approaches in more detail to serve as a guide and to initiate further future discussion on improved methodology for risk/reward sharing ratio optimization. Key aspects influencing the risk/reward sharing mechanism are defined and serve as the foundation for the comparison. These principal aspects include participants' risk attitudes, cooperative behavior and the stochastic nature of risks, customized risk perception based on risk criteria, and optimization strategies. A numerical case example adapted from the literature is also used to present the relevant methodology and outputs.

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### **(RISK-4356) Enhancing Decision-Making Process through Probabilistic Schedule Analysis Across the Project Lifecycle**

Skill Level: Basic

TCM Section(s): 7.6. Risk Management 11.5. Value Management and Value Improving Practices (VIPs)

Author(s)/Presenter(s):

Abbas Shakourifar, PSP *Chevron*

Dr. David T. Hulett, FAACE *Projectrisk*

Keith D. Hornbacher *Hornbacher Associates*

Steve Uhl *McwayUhl*

Abstract: This paper advocates for a re-imagining of how logic networked schedule risk analysis (SRA) can add value to projects. In the authors' view, SRA should be considered a critical decision-support tool, leveraged to help projects add value by informing executives about risk/rewards trade-offs on many decisions, small and large, throughout the project life cycle.

This approach contrasts with what one frequently observes in practice: SRA used primarily as a highly detailed quantification and assurance tool at the time of final investment decision (FID), to get projects approved and perhaps highlight some risk treatment priorities. These applications are valuable, but they underutilize the potential of SRA for mid-phase incremental decision making while scope and plans are developed, and value is optimized.

This paper offers actionable insights as to how to apply SRA to support incremental decisions. It properly views SRA as supporting asset and project optimization, value and change management: foundational elements of Cost Engineering and Total Cost Management (TCM). A case example is presented, illustrating how one company used SRA to help navigate critical non-FID scope development and planning decisions during Class 4, 3, 2 and execution phase. Highlighted are the many types of decisions that may benefit from the approach, as well as practical tips to use SRA in a more fit-for-purpose manner. In summary, SRA emerges as a dynamic and frequently applied decision-support tool that can add value in new ways during multiple phases in the project life cycle.

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### **(RISK-4367) Challenges Aggregating Multiple, Interdependent Projects into a Program Quantitative Schedule Risk Analysis Model**

**FEDERAL + MEGA-PROJECT**

Author(s)/Presenter(s):

Dr. David T. Hulett, FAACE *Hulett & Associates, LLC*

Ian Bailey *T4 Consultants LLC*

Lorrie B. Tietze *Interface Consulting, LLC*

Abstract: Some complex programs are structured so that several projects must interact with each other to produce the final integrated deliverable. The constituent projects have their own project schedules, that may be large and detailed, and are typically assigned to different entities that may be in the same umbrella company or government agency.

- The constituent projects are specialized entities, focusing on design, fabrication of various components, integration and production of multiple units for the ultimate customer.
- They have their own deliverables and some of those deliverables are required by other projects in the program. Ultimate delivery of the first product, a major program milestone, is built from the efforts of these interdependent entities.
- Each project within the integrated program has its own level of uncertainty and set of risk events. Due to the interdependencies between projects, a delay experienced by one entity, the “giver” of a product, is transmitted to another entity, the “receiver” of that product. If the receiver does not know about the delay early in their own planning, and that delay is probabilistic, the receiver’s forecast of its deliverable down the line will be inaccurate and the ultimate first-product delay, could be weeks to months but will not reflect the uncertainty of the giver’s deliverable.
- There are risk events that affect only one of the specialized entities and others that affect several of the entities. The cumulative effect of a risk event impacting multiple entities could be much larger to the overall program than any individual risk event. The analysis can identify those risks that have been elevated to the program-level. This enables understanding of the risk’s effect on the entire program, how to take it into account when evaluating the risk’s priority, and to allow the risk mitigation to be felt by the entities affected.
- A risk analysis for any giver entity can forecast a delay in giving the receiver needed input. The receiver needs to know about the receipt delay early enough to include delivery risk in its own planning, so the entities’ conduct of risk analysis need to be coordinated.
- In addition, that delay is probabilistic, so should the giver transmit the P-70 date or the entire probability distribution of possible delivery dates.
- The receiver entity needs to incorporate the delay in its own planning. The knock-on effects of the giver’s delay on the receiver’s plans need to be represented somehow so the receiver’s output (may be to another receiver such as the fabricating entity) will correctly reflect the delay.

The consequence of such an integrated program on the final delivery to the customer needs to be understood and probably mitigated in some way for a better result. Prioritization of the risks must account for risks that affect one project, multiple projects or the entire program. Risk mitigation should affect risks where it provides the most benefit to the final program’s delivery to the client.

The risk analyst needs to understand which risks have serious effects on the giver-entity’s delivery, but also what is occurring with other entities working in parallel in another sequence. The program-level review deals with parallel vs. sequential entity work resulting in the final product’s delivery date. Some risks affect more than one entity so the analysis has to reflect the distribution of the effects of risks at the program level, which is made up of its constituent parts. The goal is to optimize the program results, even if that means sub-optimizing an individual entity.

Strategies for developing a program-level schedule must take into account the size of the projects’ schedule, which have thousands of activities. It may not be feasible to build a single interrelated program-level schedule. Other strategies might include developing top-level projects and



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represent the projects' deliverables to other projects in a summary fashion. The chosen strategy must take into account the maintenance required to ensure that the program schedule is truly and consistently representative of the work in the individual project schedules.

This paper will explore these questions:

- Building individual program entities' schedule risk model
- Linking the output of some projects that are inputs to the work of other projects
- Evaluate the integrated program – alternative strategies
- Prioritization of risks for focused risk mitigation across all entities

The paper will use a small representative model of, perhaps,

- Three project entities
- Consolidation with schedule logic to the program level,
- Simulated with handoffs between the entities,
- A few entity-level risks for each entity and
- Several program-level risks. Have to simulate the handoffs

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## **(RISK-4401) Assessing Proposed Risk Mitigation Actions - Mitigation Scoring**

Author(s)/Presenter(s):

Waylon T. Whitehead *sCurve Solutions*

Dr. David T. Hulett, *FAACE Hulett & Associates*

Abstract: Much has been written about best practice project risk analysis. But what happens after the risk analysis concludes that the pre-mitigated project is not going to be successful? Often, the risk analyst is asked to improve the project's funding prospects by assessing the project using post-mitigated risks.

Risks can be prioritized as an output of the quantitative risk analysis. Then, risk mitigation workshops can be held to see if the high-priority risks can be mitigated effectively and economically by adopting new mitigation actions focused on the specific risks. But do the mitigations developed truly have a chance of changing the project's prospects?

To be meaningful, a risk mitigation action must be new, not a continuation of a previous or normal practice. "Continuing to hold weekly meetings with subcontractors" does not qualify. Mitigations for the high-priority risks should be precise and tactical, with an assessment of required support such as funding or hiring. It should cover what will change and specifically how it will be made to change. Alignment should be reached on the mitigations between all the main stakeholders - owner, contractors, subcontractors, commissioning agents, and regulators.

This paper presents a 6-level scale and associated concepts that can be used to evaluate the quality and potential effectiveness of proposed mitigations. Focus is placed on relevance to the risks, practicality of the action within the context of the project, clarity of definition of actions, and stakeholder commitment to the resulting plan.

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### **(RISK-4435) Practical Implementation of AI-Based Risk Analysis on Construction Megaprojects**

**FEDERAL + MEGA-PROJECT**

Skill Level: Intermediate

TCM Section(s): 7.6. Risk Management

Author(s)/Presenter(s):

Rhys Phillips *nPlan*

Dev Amratia *nPlan*

Carlos Ledezma *nPlan*

Richard Bendall-Jones *nPlan*

Vahan Hovhannisyan *nPlan*

Leonie Anna Mueck *nPlan*

Abstract: Recently, AI-schedule risk analysis (AI-SRA) has emerged as a groundbreaking approach to construction project risk management. [1,2] Unlike traditional quantitative schedule risk analysis (QSRA), [3] AI-SRA leverages machine learning models, trained on extensive historical schedule data, to directly predict activity durations distributions based on data embedded in the schedule. As previously shown, AI-SRA surpasses traditional QSRA in both the accuracy of end-date forecasts and activity duration predictions. [4,5] Despite its proven effectiveness, practical implementations of AI-SRA within project organizations have so far been scarce and the practicalities of rolling out this new process are unstudied.

Here, a comprehensive study of how to implement AI-SRA successfully on megaprojects is presented. AI-SRA roll-out on five projects across different sizes and sectors shows that, generally, three challenges need to be overcome: Lack of trust in AI models; the unintuitive nature of AI-SRA results; and AI-SRA differing from tried and tested processes. These challenges can be overcome by clear steps towards understanding AI, visualizations to aid comprehension of the results, and demonstrations of equivalence of AI-SRA to traditional processes. As a case study, the specific application of these principles on a major UK rail project using AI-SRA is discussed.

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### **(TCM-4238) (Presentation Only) The Six Elements of Project Controls**

**FEDERAL + MEGA-PROJECT**

Author(s)/Presenter(s):

H. Lance Stephenson, CCP FAACE AECOM

Abstract: Numerous articles have been written about why projects fail! While there may be disagreement as to the root cause, one common contributor to failure is due to the lack of attention and efforts being applied to the project controls surveillance envelop within a project. This presentation tries to articulate the business value and technical contributions that proper project controls can provide if instituted properly.

With this said, the objective of this presentation is to provide a fundamental understanding of the Six Elements of Projects and the requirements to apply these in the project environment. These include:

- Quality and the impact that errors have on impeding project success.
- Maturity and the necessary focus required on the tasks that each element requires.
- Competency that ensures sufficient knowledge or skill.
- The value of project controls (VOPC) that enhances the delivery of projects that appraise quality, maturity, and competency.

Project controls is simple but yet complex. There are many moving parts and interdependencies. However, once one understands the relationships and the inputs and outputs of project controls, its complexity diminishes. While technology is constantly advancing, the basics and fundamentals of project controls will always remain the same. How we manage this exercise will determine how successful we will be. The six elements of project controls, complemented with the prescribed approaches, provide an objective approach while introducing value to the organization.

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### **(TCM-4314) Desalination Public-Private Partnership: Assessment of Plants Operation Costs**

Skill Level: Intermediate

TCM Section(s): 3.3. Investment Decision Making 3.1. Requirements Elicitation and Analysis

Author(s)/Presenter(s):

Mayar M. Khairy *The American University in Cairo*

Mohamed Abdel Raouf *The American University in Cairo*

A. Samer Ezeldin *The American University in Cairo*

Abstract: With Egypt's current economic crisis and rising inflation, there is an urge to cut costs to avoid cost overruns in public-private partnership (PPP) reverse osmosis (RO) desalination projects. Over fifty percent of these costs comprise operations and maintenance (O&M) costs, which are heavily influenced by a variety of factors. It is crucial to identify those factors and rank them based on their weighted impact on overall O&M expenditures. The paper starts by exploring the key factors that determine O&M costs using a literature review of published research papers, reports, and case studies related to desalination plants and their costs, as well as surveys and interviews with industry professionals. Furthermore, it employs the relative importance index (RII) as an analytical technique to determine the weighted rank of each item and their contribution to overall O&M expenses. Plant characteristics, architecture design, intake, deployed systems, management and financial elements, and governmental charges are among the primary factors that determine O&M costs. Finally, it is revealed that the factors that may have the highest impact on O&M costs can be summarized, but not limited to, as follows: water quality parameters, membrane replacement rate, design considerations, lack of trained maintenance personnel, and energy consumption.

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