Potential CM Research Topics Identified by:

1. UH CM industry advisory board members (fall 2011)
2. CII (2011 RFP)
3. CII (2012 RFP)
4. TxDOT (2012 problem statement)

1. Research Topics Identified by P&I Board Members (Fall 2011)

Topic # 1: 4D Scheduling Integration for Increased Productivity and Earned Value Validation

- Explore the usage and verify the benefit of 4D visualization for progress monitoring and project control

Topic # 2: Correlation of Pre-Employment Physicals and Jobsite Injuries

- Study the correlation between pre-employment screening and job site injuries, and develop a screening process to reduce job site injuries

Topic # 3: What are Logical Break Points for WBS utilizing EVM

- Develop strategies to improve the alignment between cost estimating and field control/earned value analysis

Topic # 4: The Current Educational Status of the Industrial Construction Workforce

- Understand the characteristics of the current workforce and identify expectations and education needs of skilled workers for the next ten years

Topic # 1: 4D Scheduling Integration for Increased Productivity and Earned Value Validation	
	Title: 4D Scheduling Integration for Increased Productivity and Earned Value Validation
	Problem Statement: CPM schedules do not provide a good visual picture of the progress and status of a project. Typically, only a few members of a construction team truly understand "the road ahead" and the phasing of the future upcoming tasks. It is often difficult for the construction team (especially, field craft workers) to understand the work breakdown structure and visualize how/why the project tasks are being scheduled as presented in the project schedule.
	Goal: The goal of the research would be to determine if visual models that are tied to the project schedule will increase productivity of the workers, decrease overall scheduled durations and provide better clarity for the overall status of the project and projected completion dates.
	Deliverables: The research team would need to partner with a member companies and engineering firms currently utilizing 3D Modeling in their normal course of design. The team would provide cost and scheduling support by monitoring and updating the project earned values and schedule. The ultimate deliverable would be a fully integrated budget estimate with estimated and actual Earned Values, a 4D Schedule corresponding to original baseline and actual schedules and analysis of the

	effects of the implementation.
Topic # 2: Correlation of Pre-Employment Physicals and Jobsite Injuries	
	Title: Correlation of Pre-Employment Physicals and Jobsite Injuries
	Problem Statement: Contractors can "inherit" worker injuries in the hiring process. The cost to undergo pre-employment screening can be high. However, the long term cost effects of having an existing condition developing during a construction project can be very extensive as well as hiring an individual whose performance can be hindered by an existing ailment.
	Goal: To determine if a simple pre-employment physical screening can reduce jobsite injuries and save money in the long term.
	Deliverables: Development of a pre-screening process or various levels of screening that could be implemented and documented. The data would be benchmarked against the project safety audit reports from many different projects.
Topic # 3: What are Logical Break Points for WBS utilizing EVM?	
	Title: What are Logical Break Points for WBS utilizing EVM?
	Problem Statement: During the cost estimating phase of a project the overall scope of work is dissecting into many small components that correspond to man-hours and material cost associated to perform a specific unit of that scope or type of work. Ultimately the pieces are combined to make a whole and eventually lead to a complete project budget. For companies tracking productivity using the Earned Value processes, there is often a debate as to what level of detail the budget should be broken down into so that the field can effectively document the tasks worked on during a work day, the number of hours spent on a specific task and the quantity of the task executed for the number of hours spent. Typically, the EV is NOT to the level of detail that the estimating staff actually estimated the cost of the work. The field is challenged to accurately keep track of high level of detail. There is a disconnect between accurately tracking work in place and how projects are estimated. In general, the field labor and work complete is managed at a much broader level of detail.
	Goal: The goal of the research would be to determine at what level of detail can the field accurately execute, track and report man-hours, cost and quantity complete without burdening the field execution while maximizing the alignment with typical estimating WBS processes.
	Deliverables: Project Budgets delivered to the field in varying detail (WBS hierarchy) for the same project to determine the typical ability of project teams to manage the earned values. A tool to facilitate the process and potentially increase the ability and level of detail of the project teams. The development of a Best Practice for most effective level of detail to require when utilizing EVM in terms of job cost/status reporting and forecasting as well as providing Historic Cost Value to the project estimating teams.
Topic # 4: The Current Educational Status of the Industrial Construction Workforce	
	Title: The Current Educational Status of the Industrial Construction Workforce
	Problem Statement: While actively a topic and understood as a need, the construction industry workforce may not be getting the formal education required to provide the most productive, high quality and safely delivered projects. In addition, is our workforce's education aligning with the next decade of need

	in the industry?
	Goal: The goal of the research would be to provide in depth reporting of the Texas Workforce based on contractor input. A standardized "test" would need to be created that would be broadly accepted as a good baseline. The research would document the current status as well as determine by the Industrial Community the vision of the next decade in terms of what type of worker will be in demand and why. As well, market conditions such as the Eagle Ford Shale mobilization will no doubt affect our ability to attain skilled workers as higher wages and urgent schedule requirements are already pulling resources to this region and away from the larger cities.
	Deliverables: Survey of current workforce "status". Expectations for the next ten years of skilled worker needs. Effects of Shale production zones on current work forces and wages.

2. CII Proposed Research Topics for 2011

#1: Improving the Accuracy of Project Outcome Predictions

Essential Question

How do we improve the accuracy of predicted project outcomes (i.e., our forecasts of costs, schedule, and performance) between project authorization and project completion? How do we guard against being overly optimistic or overly cautious?

Background

Periodically, project and construction teams need to provide forecasts of the total costs, schedule, and performance of their projects. These forecasts involve understanding the already completed work and expended costs, and adding them to an estimate of the costs, work, and time needed to complete the project. As a project gets underway, project teams use already identified scope changes, along with variances included in already defined baseline execution strategies, to address issues of cost, work, and time to complete; but, as the project progresses, project personnel still need to identify the trends, potential claims, and issues and outcomes that inevitably present themselves. For example, what is the outcome if the engineering drawing quality is suspect? How much more will construction change orders in the field cost if certain equipment suppliers begin to have fabrication issues? This research could determine best practices (i.e., processes, tools, and methods) associated with improving project predictability and could enable project teams to forecast final costs for interim status reports. Because project outcomes are likely a function of owner/contractor contractual relationships, this research should consider defining both owner and contractor expectations of forecasts.

#2: Knowledge Transfer from the Near-retirement Generation to the Next Generation

Essential Question

How can the construction industry effectively transfer the knowledge of its employees nearing retirement to the people who remain on the job or are new to the industry?

Background

Most organizations regard the intellectual capital of their employees as fundamental to their success. Many now believe that, because most of the individuals born between 1940 and 1955 will be leaving the workforce within the next decade, the industry needs to do more to capture their most useful experiential knowledge. The main concern is that, without the pro-active transfer of this generation's expertise, this valuable bank of knowledge will be irretrievably lost. Another concern is that the windows of opportunity for this transfer—the moments in which the replacement talent can be matched with the retiring talent—do not coincide. This research should identify the most effective methods for capturing and then disbursing this knowledge to the increasingly global replacement generation.

#3: A Closer Look at Material Planning; a New Look at Jobsite Inventory Strategies

Essential Question

What are the optimal elements, best practices, and documentable benefits of Material Planning (a component of Materials Management)? Further, as part of an enhanced Material Planning process, can project material and equipment inventories (and associated inventory costs) be optimized? Specifically, can an analytical process be devised to select the optimum balance between just-in-time and just-in-case delivery strategies for various types of project materials and equipment without jeopardizing project schedules?

Background

Because this research addresses a relatively unexplored component of Materials Management and requires an understanding of terms more commonly used outside the industry, the following definitions will be helpful. (These definitions are open to research team refinement.)

Material Planning—also known as Material Requirements Planning—is the oversight of the entire project material and equipment life cycle, from conceptual design through project close-out. Material Planning ensures that the right material is in the right place at the right time, with a minimal level of surplus. Material Planning is an essential component of a comprehensive Materials Management program and applies to all materials, equipment, and fabricated components required for a specific project. (Note: Material Planning is not to be confused with a project's material management execution plan.)

Just-in-time (JIT) is classically defined as an inventory strategy that strives to receive goods only as they are needed in the production process and thereby improves a business's return on investment by reducing in-process inventory and associated carrying and handling costs.

Just-in-case (JIC) is classically defined as an inventory strategy that aims to maintain large inventories of in-process supplies, parts, warehousing resources in order to minimize the possibility that adequate inventories will be unavailable in the face of varying or unpredictable production and supply chain contingencies.

[In practice, JIT and JIC can be viewed as two extremes that can be applied in varying degrees to various types of supplies.]

Inventory is classically defined in two ways:

1. From the lean perspective, inventory is waste. In-process inventory has no real value until it is used and incorporated into finished goods (or projects).

2. From another perspective, inventory is an accepted buffer—along with capacity and time—against process variability, including supply chain variability.

#4: Deploying Best Practices in Developing Countries

Essential Question

How do we systematically deploy best practices to achieve successful project results in areas of the world where we have no previous professional or cultural experience?

Background

While many CII member organizations deliver projects globally, the best practices that ensure project success in familiar countries and regions may or may not be readily understood and/or accepted in unfamiliar areas. Cultural differences between newly arrived project team members and local partners and workers may introduce uncertainty when it comes to best practice execution and project performance. In spite of these differences, there will always be a set of project deliverables and measures that will define project success; however, they may have to be achieved in a way that both adapts to local cultural norms and preserves the essential elements and values of the applicable best practices.

#5: Sustainability: The Next Steps for Industrial Capital Facility Delivery

Essential Question

What are the next steps in sustainability for owners, contractors, and the industrial sector as a whole? Are they metrics and tools for life cycle cost investment analysis, a sustainability index, or supply chain sustainability metrics? Or are there other initiatives that would produce greater value in the pursuit of a sustainable future?

Background

CII has expended considerable effort in trying to establish a path forward on the topic of "Sustainability." CII RT 250 developed a primer on sustainability for industrial construction and produced a number of recommendations for future research. These recommendations were supplemented and prioritized by the Sustainability Community of Practice (COP). The top three COP recommendations are the following: 1) develop a life cycle cost investment analysis tool, 2) develop a sustainability index metric for industrial

construction, and 3) investigate supply chain sustainability. CII's BM&M Committee also recommends a life cycle metric that would incorporate sustainability.

Are these the next steps to take in addressing industrial sustainability? Or should CII develop resources or recommendations of greater priority? This research proposes the creation of a CII research team, first to answer these questions and then to undertake the next steps—be they metrics and tools, or other initiatives of greater value.

#6: Metrics for Assessing Emerging Information and Communication Technologies

Essential Question

What are the metrics for assessing the applicability of emerging information and communication technologies (ICTs) and for determining their value in capital project delivery? Demonstrate the use of these metrics to identify the emerging ICTs that are either in development or currently available but not yet broadly adopted.

Background

The construction industry has adopted many software applications for project management, computer-aided engineering, and materials management software. Construction practitioners have developed a healthy skepticism about the possible benefits of further investments in ICT.

By its nature, ICT develops at a tremendous pace, and other industries have been far more successful at rapidly adopting emerging ICT. The construction industry needs to improve its ability to make informed and prudent decisions on the deployment of ICT.

#7: Evaluating Project Incentive Plans

Essential Question

Are the various types of contractual and worker-specific incentive plans (e.g., plans for cost, schedule, and/or safety) in the construction industry effective? Why are certain plans more effective than others?

Background

Owner and contractor organizations have deployed different types of incentive programs over the years, but, to date, there is no research on how best to assess their effectiveness. Since different types of assessments of incentivized performance often produce different, even contradictory, results, the industry needs a data-based evaluation method; companies need to know what evaluative measures are appropriate for the various types of incentive programs they might use. The goal is to help companies create an environment in which incentivized behavior does not simply achieve narrowly targeted production levels, but instead, will contribute to the overall project outcome.

Are there practices for developing incentive plans—plans based on clear, objective, and measurable KPIs—that will reliably lead to the targeted outcomes?

#8: Construction Robotics - What is the future?

Essential Question:

Realistically, what is the potential for the design, development, deployment, and use of construction robotics, now and in the near future; and, if positive, what would the potential benefits, likely barriers, and recommended path forward be for the industry?

Background

In the late 1980s and early 1990s, various highly-informed industry experts predicted that within 10 to 15 years, the use of industrial robots would be commonplace in the U.S. construction industry. Robots were to be used for all manner of repetitive construction activities—a development that was to create a rapid advancement in worker productivity, attract the "video-game generation" to construction, reduce accident exposure, and generally transform the industry. In the years since these predictions were made, the manufacturing sector's use and deployment of robotics have dramatically exceeded all expectations, while the deployment of construction robotics is virtually non-existent, especially in the field.

#9: Strategies for HSE Hazard Recognition

Essential Question

What practices, techniques, and processes are effective in establishing and improving HSE hazard recognition in the construction industry?

Background

Currently, the construction industry employs a number of hazard recognition programs that are intended to improve safety by identifying and eliminating on-site health, safety, and environmental (HSE) hazards. While these programs have been widely adopted, they have produced variable outcomes. What practices should be incorporated into a hazard recognition program, and how can both the practices and the programs be measured for effectiveness? Further, do combinations of practices produce synergistic effects, and can there be destructive combinations? If a program combining best practices were to be developed, how might it be refreshed and maintained as new practices and regulations emerge? How would hazard recognition programs/surveys be implemented/conducted? How might the good result of a successful implementation of practices, techniques, and programs be distinguished from simple good luck? How does one know that a program is working during a project?

3. CII RFP (2012

RTS #1

The True Impact of Late Deliverables at the Construction Site

Essential Question

What is the real cost of late deliverables to a construction site? How are project outcomes (i.e., safety, quality, cost, and schedule) affected when permits, completion of FEED, detailed engineering, P&IDs, special studies, procured items, tagged equipment, bulks, and specialty items arrive later than anticipated?

Background

Project schedules, construction contracts, and subcontracts are all based on assumed delivery dates. Inevitably, some components arrive later than anticipated. In other cases, design/engineering decisions are put off by the design/engineering team because they are not critical; but tracking, monitoring, and closing them out later takes up the execution team's time and effort. These resources could instead be used to get ahead and build in some of the schedule insurance needed for unforeseen events. Design and engineering teams often iteratively review and refine their designs, assuming that any given design/engineering decision can be put off to a later date. This practice is common, even when a project's original execution plan requires that such a decision be made earlier, and even when future planning assumed that the decision would be made as planned. The knock-on effect of several (or many) deferred design/engineering decisions is that the activities on a schedule end up getting stacked to the right, which, in turn, puts unwanted pressure on project goals (i.e., safety, quality, cost, and schedule).

Generally, site construction managers and project managers do their best to work around these issues. Depending on the contractual arrangement, sometimes additional impacts on project costs or schedules are identified in change orders. However, some EPC organizations include no explicit change mechanism in their contracts. Others have found ways to accommodate late deliverables by developing project control mechanisms for predicting such delays, adequately pricing their cost impacts, evaluating the schedule impacts, and then communicating these effects back to the design and engineering teams. This communication is aimed at convincing these teams that they should make the decisions as planned, deliver the deliverables to the field as planned, and ease the unwanted pressure on the field execution team by not using up all of the project float in the design/engineering part of the project.

The hypothesis is that the true costs of late deliverables exceed any that are easily identified and that would typically be contained in costs. For example, if prefabricated pipe is delivered late to site, typical cost collection may cover impacts caused by rescheduling work in the field to accommodate revised work flows, e.g., some crane costs. However, not included are the opportunity costs associated with the revised schedule - Could the fabricator have been released later and the P&IDs released later as a result? What is the wasted effort associated with unplanned work at the workface (e.g., re-work)?

Notes to Team

Consider extending this effort to investigate the impact not only of late deliverables, but of any deliverables with a variance to plan (i.e., whether they are early or late). Consider whether studying the same craft (e.g., piping) on various projects—as opposed to many different crafts across the various projects—would improve data quality and applicability. Focus on quantifying the overall impact rather than proposing solutions for the root cause. The results should be presented in such a way that they are independent of contract type. It is not important who bears the impact contractually; the focus should be what the impact is totally. Also of interest would be an assessment of how effectively current project control mechanisms capture and mitigate the primary and follow-on costs of late deliverables.

Suggestions for Data Collection

Case studies where RT members hire interns to collect data on specific job sites.

Compare actual data with the perceived impact that is only based on "expert opinion."

RTS #2

Using Near Miss Reporting to Enhance Safety Performance

Essential Question

How can near miss reporting be used as a tool to help project teams identify the gaps, learn from the events, and significantly improve safety performance?

Background

In the safety environment, systemic change does not typically occur until after disasters or significant safety incidents occur.

Most project organizations regard near miss reporting as fundamental to their safety success. The Safety Pyramid is widely recognized as a representation of the hierarchy of incidents, and its introduction of near miss reporting to the industry has given organizations opportunities to improve their safety programs. However, the majority of focus has been on injury statistics, with much less on near miss potential. Indeed, near miss incidents are often viewed as a function of luck, and the rigor applied to incident investigations is placed more on injuries and not on events in which there was no injury. The Safety Pyramid has been a valuable safety tool, but it is driven by statistics—and statistics-driven safety programs do not always focus on extremely low-probability, high-consequence accidents.

James Reason's "Swiss cheese" safety model shows how layers of protection against incidents fail after an event. Are project teams focused on gaps in their layers of protection, or are they focused more on lagging indicators? The main concern is that project teams may not be focusing on the gaps in their safety programs, a lack of focus that can lead to more serious incidents. For example, on one project, the project team discovered that daily equipment inspections were not being performed (near misses). Although the gap was addressed verbally, the regular performance of inspections was not verified in the field. Later, the project team suffered a serious equipment failure, resulting in serious injury to the operator. One of the latencies later discovered was that the operator had not completed a daily inspection of the equipment.

Had the near miss report on the lack of inspections been followed up aggressively, this incident could probably have been prevented.

This research should first identify the most effective methods for assessing non-injury events. It should then determine the most effective means of systematically applying these methods to improve organizations' safety programs and to fortify their layers of protection.

Suggestions for Data Collection

- Define "near miss" to standardize terminology and support communication industry-wide.
- Review prior CII research and ongoing research around this topic.
- Catalog near miss practices and identify which are most effective.
    - Survey (one page)
    - Follow-up interviews to identify potential case studies

Observe near miss investigations and results.

RTS #3

Interface Management

Essential Question

What practices, techniques, and processes are most effective for improving the critical interfaces among globally dispersed project teams, multiple project partners, and an increasingly diverse labor force?

Background

The following conditions in the current project delivery environment have made it necessary to properly address interface management issues:

- globalization
- high-value engineering/low-cost centers
- increased technical complexity
- requirements for local content
- complex contracting arrangements
- competing organizational drivers that lead to poor results or outcomes
- increased scope management complexity
- a less experienced workforce due to resource constraints.

As a result of these developments, project delivery teams struggle to overcome these challenges to project success. The capital delivery industry could benefit from discovery of the best practices in interface management. These best practices would ensure that the right information is communicated, that the right practices are used, and that the processes used are employed in a timely and effective manner.

Notes to Team

Examine prior CII research on information management and consider input from the CII Information Management COP. Following are some additional research objectives to consider:

- identification of project situations (e.g., internal, external, JVs, etc.) that require formal interface management
- development of organizational models for implementing interface management (i.e., methods for determining when stand-alone interface managers are needed and when interface management is a normal part of project engineer/manager duties)
- identification of skills required for today's and tomorrow's interface manager
- identification of recommended practices, tools, and/or systems that promote effective management of interfaces
- identification of gaps and needs for improved technologies, information management, or other areas in need of improvement
- approaches to addressing organizational, work process, and terminology interfaces between entities
- prioritization and timing for addressing the following aspects of interface management:
    - human (team building and alignment)
    - organizational (work processes and procedures)
    - physical (information management and mechanical).

RTS #4

Measuring Unintended Waste

Essential Question

How can a project identify and quantify the unintended waste involved in a project?

Background

The execution of a project, in practice, includes *unintended* and—many times—undetected waste. Examples of such waste include excessive engineering rework (including over-analysis), out-of-sequence work, excessive inventory at fabrication shops, unintended overtime, excessive time for suppliers to understand specifications, excessive quality inspection, or a poor commissioning sequencing.

The purpose of this research is to identify the cost of unintended waste so that management can make informed business decisions.

Note to Team

The study should exclude the consideration of waste due to buffers. The study can include both work process and physical waste.

RTS #5

Managing a Portfolio of Projects—Metrics for Improvement

Essential Question

What practices, techniques, technology, and processes are most effective for managing a portfolio of projects?

Background

It appears that, in the next few years, portfolios of companies will have a tendency to move away from the "mega-project." In response to the volatility of today's business market, more and more ventures will be gravitating towards small projects, or to projects within a larger program/business portfolio. While best practices have been developed for project directors/project managers to manage individual projects, these project professionals need to know how to apply these best practices when they manage multiple projects or multiple project managers. How can they maintain the program view and not revert to a focus on individual projects? Some items to consider include the following:

- management skills—how to maintain a business focus versus project focus
- resource management—how to balance manpower, equipment, suppliers, assets, across the portfolio
- financial management—how to focus on integrating cash, sales, and other financial considerations at the portfolio level
- risk management—how to prioritize risks by business need versus individual project need
- metrics - how to determine which metrics are key indicators of the state of the portfolio.

RTS #6

Sustainability Practices and Metrics for the *Construction Phase* of Capital Projects

Essential Question

What are the most effective practices and associated metrics for deploying sustainability-focused initiatives during the *construction phase* of a project?

Background

CII Research Team 250, *Sustainable Design and Construction for Industrial Construction*, documented a number of recommendations to support broad industry interest in *sustainability* initiatives. The research focused on the *full capital project life cycle*, including environmental, social, and/or economic perspectives.

The CII Sustainability COP has proposed a number of follow-on research projects, all addressing the *full project life cycle* perspective. Although the COP proposals have had great support from some CII member sectors, the complexities of the *full project life cycle* sustainability goals and their associated efforts can be daunting.

This research topic is offered as a more practical, *next-step* alternative to the previously offered *full project life cycle* sustainability research pursuits.

This research envisions a more limited, but nonetheless, valuable, scope and objective. It would focus only on the sustainability opportunities available during the construction phase of a capital project, irrespective of the sustainability design, goals, and character of the completed capital facility under construction. Moreover, this research would be consistent with and supportive of CII's strategic initiative to pursue industry sustainability goals and objectives. It would also provide valuable insights into the practical challenges encountered in sustainability initiatives, while demonstrating the kind of positive results that can indeed be realized in this important and high-interest area.

Notes to team

IR 250-3 *Sustainable Design and Construction for Industrial Construction: Implementation Resources* includes a "Checklist for Sustainable Industrial Construction Sites." It provides a battery of practices for many elements of construction operations: site layout; energy use; fleet management; materials handling; control of dust, water, and atmospheric pollutants; and many others. While this checklist provides a general, qualitative description of these practices, it does not include observable or measurable (i.e., it does not provide specific standards). However it can serve as a springboard for further development of sustainability metrics.

RTS #7

Effective Supplier Quality Surveillance (SQS) Processes and Practices

Essential Question

What are the most effective processes and practices for ensuring that project materials and equipment are produced, manufactured, or fabricated in strict accordance with all applicable specifications, and that they are delivered to the project site without any need for rework?

Background

CII has conducted numerous research projects related to classic Quality Control and Quality Assurance practices and processes. A component of such practices and processes is the Supplier Quality Surveillance (SQS) function, responsible specifically for verifying the compliant quality-related performance of suppliers in capital project supply chains. The intent of this research is to explore the scope and objectives of this important function and to identify the most effective processes, practices, and metrics (both traditional and enhanced) for improving supplier quality qualification and performance.

Related subjects include the role, function, and career development of SQS professionals, as well as the sourcing (direct-hire or third-party) of SQS personnel and shop inspection resources.

In addition, recommendations from the SQS function to other EPC functions could be among the research deliverables.

Note to Team

Although counterfeit materials can be a threat to supply chain reliability and performance, the issue of counterfeit materials should not be a particular focus of this research.

RTS #8

Mitigating Threats of Counterfeit Materials in the Capital Projects Industry

Essential Question

What are the necessary, prudent, and most effective processes and practices for ensuring that counterfeit construction materials and equipment do not enter capital project supply chains?

Background

CII Research Team 264, *Product Integrity Concerns in Low-cost Sourcing Countries*, dramatically documented the variety, scope, and impact of counterfeiting threats affecting the capital projects industry. Since the RT 264 research was published and presented, the scope, variety, and significance of the threat has only increased. Although RT 264 included some recommendations for mitigating the threat to capital project supply chains, a more detailed exploration of effective and reliable mitigation strategies, practices, and methods is desired. This exploration should include the potential for collaborative industry action and initiatives.

Note to Team

Further investigation or documentation of examples of counterfeiting is not necessary (i.e., documentation of the threat) unless such additional investigation is required to identify and document effective mitigation strategies, processes, and practices.

RTS #9

Measuring Project Complexity and Its Impact

Essential Question

How do we measure project complexity; and how should the level of complexity drive project-related decisions?

Background

Because project complexity is widely believed to affect capital project outcomes, the industry should have a better understanding of its nature and impacts. This team should define project complexity and the elements that influence the level of a project's complexity. Examples of these elements may include size, schedule, contract strategy, location, technology risks, process scope, diversity of project team, supply

chain reliability, among others. The team should also confirm the cause and effect to project outcomes, and recommend actions to mitigate the risks associated with complexity.

Note to Team

Can a tool be created to guide a company towards applicable best practices and the resources, actions, or responses that are appropriate to addressing the most suitable actions?

RTS #10

Planning—how much is too much?

Essential Question

What is the minimum amount of planning required for successful project execution?

Background

The project controls, project management, and construction management communities have been told for years that detailed planning is a best practice, and that detailed scheduling and control is a prerequisite for project execution excellence. Furthermore, increasingly sophisticated software packages, ERP systems, and interconnectivity have made data collection, dissemination, and analysis easier and ever more powerful. The question is, have we gone too far?

This research would determine the minimum requirements for maintaining proper control of a project. Further, it would investigate whether all the effort we do in project planning is truly worthwhile? Have we reached the point of diminishing returns? Do current practices of detailed planning and controlling now inhibit rather than benefit projects by limiting needed flexibility, creativity, and discretion?

The team should consider whether we need more planning and less scheduling.

Note to Team

Planning is meant to include scheduling as well as project controls feedback.

Data Collection Suggestions

The research team could conduct surveys on the level of controls and scheduling work in place for given projects. It could collect data on how much time and effort is put into this work. It could also collect data on the experience level of the scheduling engineer or the controls person to determine its effect on project success. Project team members (i.e., project engineers), as well as the controls group and the discipline engineering groups, could be interviewed to determine whether the amount of planning on a project helps or hinders its success. A comparison on the perspectives of each group would be valuable for this effort.

The team could count the number of changes in a given project's schedule occurring over time.

The team could also simulate project performance on projects with and without a high level of planning included up front. It could also use probabilistic simulation to determine whether the level of effort is worth the potential mitigation.

RTS #11

Quantitative Measurement of PM Competencies

Essential Question

What measurements can be used to assess competencies of project managers in order to pinpoint areas for development?

Background

Successful projects are led by project managers with specific knowledge, skills, and behaviors.

Technical knowledge and strong interpersonal and leadership skills and behaviors are some of the characteristics exhibited by successful project managers who are considered leaders in their field. Once the essential characteristics of these leaders are identified, and an approach to measurement is developed, training can be focused on developing strong project managers.

Notes to Team

As this team begins its research, RT 281 will have provided several tools that assess essential PM competencies, but they will not have fully explored the measurement question.

RTS #12

Best Practices for Establishing International Relationships

Essential Question

What are the best practices for establishing international relationships (e.g., JVs, consortia, alliances, partnerships, etc.)?

Background

Larger global projects continue to increase in project complexity. International factors such as differing business practices, cultural backgrounds, governmental regulations, as well as multiple funding sources, all add to the difficulty of establishing effective teamwork. Concerns such as risk management, resource availability, local content, and proprietary technology assume an added dimension of complexity when addressed on an international scale. This research should focus on the practical issues that attend the formation of international relationships, and not on the legalities.

Notes to Team

Investigate any differences between international and domestic relationships, and explore any added complexities at the international level. Coordinate with RT 294.

RTS #13

Effect of Commissioning on Life Cycle Costs

Essential Question

How does commissioning have a quantifiable effect on life cycle costs of facilities, systems, and equipment?

Background

Commissioning has been globally defined as *"A well-planned, documented, and managed engineering approach to the start-up and turnover of facilities, systems, and equipment to the end-user that results in a safe and functional environment that meets established design requirements and stakeholder expectations."* This activity involves planning and testing to ensure that facilities, systems, and equipment meet defined design requirements. In addition, commissioning also includes the collation of documentation (e.g., drawings, specification, manuals, etc.) and the assurance of its accuracy and completeness as turned over to the owner. Finally, commissioning can include the establishment of maintenance strategies for the life cycle management of the facility. These strategies are often developed through Reliability Centered Maintenance techniques and provide a foundation for the life cycle management of facilities, systems, and equipment.

Some people view commissioning as simply start-up and turnover to the owner of facilities, systems, and equipment. Others view this activity as a more robust planned activity, as described above. This research team would explore various approaches and methods used for commissioning and determine a methodology for measuring the long-term life cycle cost of a facility, systems, and equipment. This team should determine the attributes of effective or enhanced commissioning, and those of less than robust commissioning.

Once commissioning approaches can be differentiated, then a measurement methodology for life cycle cost should be developed. This methodology should address operating expense, maintenance cost (i.e., reactive versus preventative cost), repairs (in the form of follow-up capital projects to fix problems), and post-project changes implemented (i.e., changes that address unmet original requirements). Applying this methodology, the team can determine the quantifiable differences in life cycle cost across projects (e.g., impact on operations, operational expense, maintenance, or recapitalization to maintain capability or meet original requirements) so that the appropriate commissioning approach can be applied.

What is the impact of a well-executed commissioning program? What is the impact of a poorly executed commissioning program?

RTS #14

Strategic Use of Social Media Technologies

Essential Question

Phase 1 (complete in one year or less)

How are social media being used in the business world today, and how might they be used in the future? Which areas are relevant to CII member companies?

Phase 2 (complete in one to two years following Phase 1)

Given the results of Phase 1 regarding the technologies relevant to CII members, what are the recommendations for their adoption? Which are most likely to give CII member companies a competitive advantage, and which are not expected to affect or improve performance of member companies?

Background

The use of social media (i.e., web-based and mobile technologies used to turn communication into interactive dialogue and allow for the creation and exchange of user-generated content) in the construction industry is not well-understood by many CII member companies. Social media includes, but is not limited to online magazines, internet forums, weblogs, social blogs, micro-blogging, wikis, podcasts, photos or pictures, video, rating, and social bookmarking. Additionally, social media technologies are continually changing. Following are areas that might be improved by social media:

- team engagement and productivity
- knowledge transfer from the near-retirement generation to the newest generation in the workforce
- rapid and more effective communication of relevant results from lessons learned, benchmarking, best practices, etc.

The team should address security and IP issues related to use of social media. The team may also wish to consider whether advanced analytics may be used to improve current CII and/or member company functions.

Notes to Team

The CII NextGen Community of Practice is a potential source of information. Due to the rapidly changing nature of social media technology, the work should not focus on specific technologies.

During Phase 1, the team could employ undergraduate student teams at multiple universities in various locations, using various social media and networking. A comparison data set could include a group of CII member employees with one to three years of work experience to provide similar data. These CII employees could offer recommendations on ways their companies could utilize social media to foster their careers.

> The report-out on Phase 1 could include an on-the-spot survey of CII member companies—conducted through social media—that would help guide the direction of the Phase 2 research.

4. TxDOT Problem Statement (2012)

1-15 Benefit and Risk Analysis to Determine Construction Inspection Needs

1-73 Evaluation of WMA Mixtures Produced with Recycle Materials

1-74 Improvement of Construction Quality Control by Using Intelligent Compaction Technology for Base and Soil

1-10 A Comparative Study of Construction/Maintenance Project Measurement and Payment Methods

(see the statements of the above topics in the following pages)

Research Problem Statement

RMC:	1	**OPR: (for RTI use)**		**Project #: (for RTI use)**	1-15
Date:		08-02-2011		**Research Program Year:**	**2013**
Project Title:		Benefit and Risk Analysis to Determine Construction Inspection Needs			
RMC Priority:		**What RMC research priority will this project address?** 7			
Project Description:		**What is the problem?** Proper quality assurance inspection ensures the traveling public receives a product of the highest quality that will last for an acceptable period of time. It is not uncommon for an area office to manage more construction projects than inspectors. This research project will investigate the staffing needs for quality assurance inspection based on a benefit and risk analysis. The research project will investigate how to determine benefit and risk associated with a construction project to set staffing needs. These benefits and risks should extend beyond project costs and into variables such as lane mile, ADT, project type, etc. For example, how should benefit of a construction project be defined and what is the risk associated with providing adequate inspection to the project. From a benefit perspective, seal coat projects affect a significant number of lane miles, what benefit should lane miles contribute to the analysis of staffing needs? On the other hand, a rehabilitation project affects significantly fewer lane miles, but should have a longer life. How should the longer life affect the analysis of staffing needs? There are also individual pay items that require different quality assurance inspection. For example, in construction of a bridge, how should the inspection staffing for drilled shafts be determined? How is this compared to the staffing requirements for column and cap construction? Ultimately the goal of the research project is to quantify benefits and risks associated with construction projects and pay items to determine and justify inspection staffing requirements. **Who is impacted by the problem?** Area Office personnel, particularly Area Engineers and construction inspectors (lab personnel as well). District construction staff will also be impacted. Ultimately, this could affect the number of FTEs across TxDOT depending on the analysis. **What is the significance / scope of the problem? (Include any objective data that you can. For instance – how many structures, locations, or offices are impacted?)** This research project affects the way construction inspection is handled throughout the state. The analysis should quantify and define the benefits and risks associated with construction projects. Benefits could include lane miles treated, ADT within the project, projected life of the treatment, while risks should include reduction in project life due to poor construction, vehicle operating costs due to poor ride quality, public safety in the event of failure. The research project should evaluate a variety of construction projects to perform this benefit/risk analysis. This should include everything from district seal coat projects to new construction. **What are the technical objectives of this project?** The technical objectives of this project include defining benefits and risks associated with a variety of construction projects. Costs of the project must also be defined and could include costs above and beyond the capital costs associated with construction. The benefits and risks should be evaluated against the costs to help determine and justify the amount of inspection required on projects. Ultimately, the project should evaluate variables other than project cost to identify the amount of inspection needed. **What benefits would this project deliver, and how would the results be used within TxDOT?** One of the major benefits of this project would be the creation of an analysis to help district		

RMC:	1	OPR: (for RTI use)		Project #: (for RTI use)	1-15
		determine and justify the number of inspectors required for construction. It would also help Area Engineers monitor construction inspection and offer time management suggestions. It would allow districts to evaluate future construction to determine how inspectors should be shared across Area Engineer lines to ensure adequate inspection occurs. The project also provides a perspective on the value of construction projects and quality assurance inspection based on risks and benefits beyond contract costs. This project should be a true benefit and risk analysis of construction projects using many variables that are affected by the project to determine and justify the number of inspectors required on a construction project. **What specific deliverables would help TxDOT implement the findings / results from this project?** A list of benefits and risks considered in the analysis. A justification of how these benefits and risks were quantified and evaluated against costs. An implementation procedure to evaluate current and future projects at the district level to determine and justify quality assurance personnel. **Which District, Division, or Office would be responsible for implementing the results from this project?** Construction staff within each district.			
Developed By:		Charles F. Gurganus, 903-569-2349, Charles.Gurganus@txdot.gov **For TxDOT employees only – Would you be willing to serve as the Project Director or as a Project Advisor, or can you suggest someone else knowledgeable about the problem / issue?** Yes, I am willing to serve. Andy Bollman or Sherri Ralson from Tyler Construction could also provide valuable insight.			
Submission:		**Email completed Problem Statements, as MS Word files, to rtimain@txdot.gov**			

Research Problem Statement

RMC:	1	**OPR: (for RTI use)**		**Project #: (for RTI use)**	1-10
Date:		August 2, 2011		**Research Program Year:**	**2013**
Project Title:	A Comparative Study of Construction/Maintenance Project Measurement and Payment Methods				
RMC Priority:	**What RMC research priority will this project address?** 7. Construction Management Issues – Managing Contracts (Construction and Maintenance)				
Project Description:	**What is the problem?** Efficient construction management is critical to project delivery, contract compliance, and quality assurance in both the private and public sectors of the economy. Of particular importance is how to measure the progress of a construction/maintenance project and pay the contractor accordingly so that the work is successfully completed in the most cost-effective manner. However, there appears to be a lack of TxDOT-funded research that specifically addresses these and other related issues despite their importance to the state agency. The purpose of the proposed study is to fill the void by conducting a comprehensive survey of the construction management systems currently implemented by the DOTs of the 50 states and the District of Columbia in the U.S. to identify the best practices of contract administration and payment under different conditions. The advantages and disadvantages of each traditional or new payment method will be analyzed. Several innovative incentives and disincentives for encouraging contractors to meet or exceed their performance goals will be reviewed as well. The findings from this study will provide TxDOT with a set of guiding principles on the selection of the most appropriate measurement, inspection, reporting, invoicing, and payment processes for the State's construction/maintenance projects under different delivery models with minimum negative impact on the existing traffic. **Who is impacted by the problem?** A wide range of stakeholders will be affected by the problem to be studied, including Texas Government, TxDOT, federal funding agencies, design firms, construction/maintenance contractors, Texas highway users, and Texas taxpayers among others. **What is the significance / scope of the problem? (Include any objective data that you can. For instance – how many structures, locations, or offices are impacted?)** In contrast to the deep cuts in most of the state agencies in Texas, the TxDOT budget will increase by 23% to $19.5 billion in 2012-2013. Consequently, a large number of construction and maintenance activities will be taking place throughout the State next year. To ensure that all the projects are successfully completed in the most cost-effectively manner, TxDOT needs to continue improving its efficiency in contract administration with the current workforce. One way to accomplish this is to adopt the most efficient strategies for different types of projects with an aim to streamline the measurement, inspection, reporting, invoicing, and payment processes. The present research will survey, compare, and analyze various contract management and payment systems currently implemented by the DOTs of the 50 states and the DC in the U.S. to identify the best practices. The results will help TxDOT achieve its mission of providing safe and efficient movement of people and goods, enhancing economic viability, and improving the quality of life for the people that travel in the state of Texas in the				

RMC:	1	OPR: (for RTI use)		Project #: (for RTI use)	1-10

most cost-effective manner.

What are the technical objectives of this project?

The main technical objectives of this project are to: (1) understand and document how a construction/maintenance project is delivered, how its progress is measured and reported, how the work performed is inspected, and how the contractors are paid in the 25 districts of TxDOT, (2) benchmark TxDOT's construction management practices against those of DOTs in some key states, (3) analyze the advantages and disadvantages of each traditional or innovative contract administration and payment method to identify the best practices under different conditions, (4) discuss several effective incentives/disincentives to be used in conjunction with payment strategies to encourage project contractors to meet or exceed their performance goals, and (5) develop a set of guiding principles to aid TxDOT in choosing the most appropriate project measurement and payment systems under each of the design-bid-build and design-build models.

What benefits would this project deliver, and how would the results be used within TxDOT?

The key results from this research project will be a set of guidelines to assist the 25 districts of TxDOT in determining the most efficient contract administration and payment system as well as incentives/disincentives to use for any construction/maintenance project to be undertaken so that the final product delivered is not only cost-effective but also of high quality while the negative impact on the existing traffic is minimized.

What specific deliverables would help TxDOT implement the findings / results from this project?

Reports:
- Complete documentation of work performed, methods used, and results obtained.
- Project summary report.

Which District, Division, or Office would be responsible for implementing the results from this project?

Construction Division of TxDOT

Developed By:

Ching-Chung Kuo, University of North Texas, (940) 565-4749, kuoc@unt.edu
J. Lynn Johnson, University of North Texas, (940) 565-3147, lynn.johnson@unt.edu
Tracey Friggle, Dallas District, TxDOT, (211) 320-6199, tracey.frigglelogan@txdot.gov

For TxDOT employees only – Would you be willing to serve as the Project Director or as a Project Advisor, or can you suggest someone else knowledgeable about the problem / issue?

Submission: **Email completed Problem Statements, as MS Word files, to rtimain@txdot.gov**

Research Problem Statement

RMC:	1	**OPR: (for RTI use)**		**Project #: (for RTI use)**	1-74
Date:		8/19/2011		**Research Program Year:**	**2013**
Project Title:	Improvement of Construction Quality Control by Using Intelligent Compaction Technology for Base and Soil				
RMC Priority:	**What RMC research priority will this project address?** Construction				
Project Description:	**What is the problem?** TxDOT current practice for field compaction quality control and acceptance for base and soil is to determine the compacted density and moisture content by nuclear density gauge (NDG). TxDOT has been working for years to find alternative methods to replace the NDG because of safety reason and other issues. In the meantime, many other test equipment based on stiffness measurement have been developed and considered to replace density measurement because it is more relevant to pavement design. Regardless which test is selected, both density and stiffness measurements are spot tests. They can not represent the entire quality of compaction, and then not guarantee a good uniform quality of construction due to the nature of variable compaction. Therefore, proof rolling has been specified in TxDOT appropriate items, but it is hard to execute due to lack of proper equipment and quantitative criteria. Intelligent compaction technique is a fast developing technology for base and soil compaction quality control and acceptance. It can almost 100% measure the stiffness (may be density too) of the compacted layer under the roller. Proof rolling subgrade and base using the intelligent compaction rollers after completing compaction can effectively identify the weak spots and then significantly improve the uniformity of the compacted layers. Therefore, there is a strong research need to determine and quantify the effectiveness and efficiency of this technique. **Who is impacted by the problem?** All districts. **What is the significance / scope of the problem? (Include any objective data that you can. For instance – how many structures, locations, or offices are impacted?)** All TxDOT construction will be affected. **What are the technical objectives of this project?** Innovative equipment, technology (such as neural artificial technology), and test procedure. **What benefits would this project deliver, and how would the results be used within TxDOT?** Will significantly improve compaction quality of base and soil **What specific deliverables would help TxDOT implement the findings / results from this project?** Innovative equipment, technology (such as neural artificial technology), and test procedure. **Which District, Division, or Office would be responsible for implementing the results from this project?** All TxDOT districts				

RMC:	1	OPR: (for RTI use)		Project #: (for RTI use)	1-74
Developed By:		Jimmy Si, 512-506-5901, Jimmy.Si@txdot.gov **<u>For TxDOT employees only</u> – Would you be willing to serve as the Project Director or as a Project Advisor, or can you suggest someone else knowledgeable about the problem / issue?** Yes			

Research Problem Statement

RMC:	1	**OPR: (for RTI use)**		**Project #: (for RTI use)**	1-73
Date:		August 3, 2011		**Research Program Year:**	**2013**
Project Title:		Evaluation of WMA Mixtures Produced with Recycle Materials			
RMC Priority:		**What RMC research priority will this project address?** Durability of WMA mixtures produced with recycle materials			

Project Description:

What is the problem?

Currently Hot-Mix Asphalt (HMA) mixtures are predominately produced with recycle materials, such as Recycled Asphalt Pavement (RAP) and Recycled Asphalt Shingles (RAS) throughout the state of Texas. The use of recycled materials is also allowed with asphalt mixtures produced with Warm Mix Asphalt (WMA) technologies and additives. WMA produced with RAP and RAS can significantly reduce the cost of asphalt mixtures, conserve energy, and protect our environment. However, recent studies have shown the virgin binder not blending homogeneously with the asphalt binder from recycle materials at production temperatures of 300F and above, although homogeneous blending is assumed in current practice. This issue of non-homogeneous blending may become more severe and detrimental when WMA technologies and additives are required during production at the plant either for reducing emissions and protecting the environment in nonattainment areas (such as Houston, Dallas/Fort Worth, Austin, San Antonio, El Paso, Longview, etc.) or to avoid the expansion of rubber crack sealant materials with the placement of asphalt overlays. The cause of this non-homogeneous blending is because the recycle binder at production temperatures for WMA (generally below 250F) is far less active than that of HMA produced at temperatures above 300F. Consequently, WMA asphalt mixtures produced with recycle materials may potentially have compaction problems in the field thus producing asphalt pavements with high in-place air voids, and may be more prone to cracking and poor long term performance. Therefore, it is important to evaluate the engineering properties and performance of WMA mixtures produced with recycle materials and the associated mixture design procedures currently in practice.

Who is impacted by the problem?
All Districts, especially those in nonattainment areas such as Houston, Dallas/Fort Worth, Austin, San Antonio, El Paso, Longview, and anywhere else in the state of Texas.

What is the significance / scope of the problem? (Include any objective data that you can. For instance – how many structures, locations, or offices are impacted?)
A significant amount of flexible pavement structures in Texas are potentially affected. This issue may become significant if WMA technologies and additives become mandated in nonattainment areas in the near future. Thus, the concern of producing WMA with recycled materials should be evaluated as soon as possible.

What are the technical objectives of this project?
The objectives of this project will be:

1. Survey Districts to identify sections with WMA mixtures produced with recycled materials where applicable and evaluate the performance of those sections and conduct non-destructive testing.
2. Evaluate the impact of WMA technologies including both foaming and additives on the engineering properties of asphalt mixes (both dense-graded and other types of mixtures) with recycle materials in the laboratory.
3. Review best practices for the mixture design of WMA mixtures produced with recycled materials at the national level (such as NCHRP 9-43: WMA mix design

RMC:	1	OPR: (for RTI use)		Project #: (for RTI use)	1-73
		practice) and current practices required by TxDOT. 4. Develop an improved mix design methodology and guidelines for WMA mixtures produced with recycled materials. **What benefits would this project deliver, and how would the results be used within TxDOT?** Utilizing an improved mix design methodology and guidelines for WMA mixtures produced with recycled materials TxDOT not only can save money in the cost of asphalt mixtures, reduce emissions, and eliminate the presence of blisters of overlays, but just as important it will also increase the service life of flexible pavements. The essential goal is to improve and increase long term performance of flexible pavements produced with WMA and recycled materials. **What specific deliverables would help TxDOT implement the findings / results from this project?** 1. Improved mix design methodology for WMA mixes produced with recycle materials 2. Guidelines for selecting WMA asphalt technologies for recycled asphalt mixes 3. Field performance database of WMA asphalt mixes produced with recycle materials **Which District, Division, or Office would be responsible for implementing the results from this project?** Construction Division and Districts, especially those in nonattainment areas such as Houston, Dallas/Fort Worth, Austin, San Antonio, El Paso, Longview, etc.			
Developed By:		Tom Scullion, 979-845-9913, t-scullion@tamu.edu Cindy Estakhri, 979-845-9551, c-estakhri@tamu.edu Fujie Zhou, 979-458-3965, f-zhou@tamu.edu Richard Izzo, 512-506-5832, Richard.izzo@txdot.gov **For TxDOT employees only – Would you be willing to serve as the Project Director or as a Project Advisor, or can you suggest someone else knowledgeable about the problem / issue?** Richard Izzo			
Submission:		**Email completed Problem Statements, as MS Word files, to rtimain@txdot.gov**			