BACKGROUND INFORMATION FOR COAA POSITION PAPER

PRODUCTIVITY OPPORTUNITIES AND CHALLENGES IN ALBERTA

MAY, 2012

The Construction Owners Association of Alberta (COAA) issued a position paper in May, 2011: "Heavy Industrial Construction and Maintenance Workforce Challenges in Alberta". The Executive Summary is included as Attachment A. Recommendations were presented under three themes:

- Improve productivity of existing workforce
- Develop a long term vision and monitor progress
  (re: numbers and capabilities of the future workforce)
- Improve interprovincial and international access to temporary workers

COAA is in the process of crafting a followup position paper on productivity of the heavy industrial construction sector. As background, summaries of recent scholarly papers and industry reports have been prepared to overview current thinking on this topic. Experts from the COAA Construction Performance Committee identified six papers which were recent and relevant to Alberta heavy industrial construction. Mr. Mohammad Moazzami, a Doctoral candidate at the Schulich School of Engineering, University of Calgary, undertook distillation of these papers.

The summaries affirm that the causes of suboptimal productivity are well understood by both researchers and practitioners. There is no shortage of recommendations for improvement, both incremental and novel, as well as a clear consensus among experienced professionals regarding the areas which should receive the most attention. Perhaps the biggest challenge – and the biggest opportunity – is for leading Alberta companies to put into practice those recommendations which will make them more productive, more competitive and more profitable.

Construction Users Roundtable (2005a)

"Construction Labour: Managing the Construction Workforce"

Owners who proactively establish corporate, site and project labor strategies experience improved labor performance on their projects. Cost and schedule risk is reduced through improved productivity, reduced absenteeism and fewer jurisdictional issues. Owner support for recruitment and training of craft workers on current projects supports development of the future workforce.

Construction Users Roundtable (2005b)

"Construction Measures: Key Performance Indicators"

Owners who proactively establish a quality improvement cycle through standardized work processes and disciplined measures of effectiveness experience better project outcomes. Measurement is a critical tool for improving systems and organizational understanding of productivity best practices.

Dai et al (2009)

"Construction Craft Workers' Perceptions of the Factors Affecting Their Productivity"

The importance placed on "tangible" productivity factors indicates the potential, from the perspective of trades workers, for construction labor productivity to be improved through practical, tangible daily actions taken at the jobsite. Engaging the work force and addressing the most significant factors may not only lead to improvement in crew motivation and project performance, but may ultimately help to attract and retain craft workers.

Jergeas (2009)

"Improving Construction Productivity on Alberta Oil and Gas Capital Projects"

This paper documents a clear consensus among experienced professionals regarding the areas which should receive the most attention in order to improve construction productivity on Alberta mega-projects. Further, it provides detailed recommendations and examples which can be adapted by interested readers for application to their own projects.

McTague and Jergeas (2002)

"Productivity Improvements on Alberta Major Construction Projects Phase I – Back to Basics"

This paper provides a thorough analysis of problems underlying unproductive time on Alberta heavy industrial construction projects, and outlines a menu of recommendations to address the problems. The rewards for improving productivity are substantial: cost savings in the order of 3% to 9% of overall project budget, plus timely delivery of a value-producing capital asset.

Ranasinghe et al (2011)

"Streamlining the Construction Productivity Improvement Process with the Proposed Role of a Construction Productivity Improvement Officer (CPIO)"

This study proposed a dedicated position, the Construction Productivity Improvement Officer, to achieve more systematic improvement on construction sites. This position is analogous to the now well-accepted position of Safety Officer, which has proven effective for driving improvements in safety performance.

Construction Users Roundtable. "Construction Labour: Managing the Construction Workforce" UP-403, March 2005.

The Mission of The Construction Users Roundtable (CURT) is to promote cost effectiveness for American owners by providing leadership on issues that will significantly improve project engineering, construction and maintenance processes, thereby creating value for the owners.

The objective of this study is to optimize use of the existing construction workforce and develop the future construction workforce to meet owner needs.

Corporate, Site and Project Labor Strategy
Owners should develop a corporate construction labor policy to be deployed consistently across their sites and projects. The policy should include the elements outlined in Procedure, below.

Responsibilities
The owner's project team is accountable to ensure that project labor practices support both site and corporate construction workforce objectives; key management responsibilities are listed below:

Project Team Members	Labour Management Responsibilities
Project Manager	• Leads the project team to develop a project specific labor strategy • Ensures that corporate and site construction labor policies are understood and incorporated in the project strategy • Establishes a contractor selection process which ensures that only qualified contractors are considered
Purchasing Manager	• Leads the contractor selection process • Establishes appropriate contract provisions to support the owner's labor strategy
Construction Manager	• Participates in the contractor selection process • Manages contractors to ensure that the project labor strategy is implemented • Provides owner support for project contractors implementing the labor strategy • Reviews labor agreements to ensure that they comply with corporate policy and project labor strategy • Influences schedule and crew size to ensure that overtime objectives are met • Provides active support for contractor training efforts

Timing
The project labor strategy is developed early in the Front-End Planning phase. Implementation occurs during the Procurement phase, when contractors are selected and contracts established, and during the Construction phase, when contractors assemble their workforce and begin their work.

Procedure
The project labor strategy includes the following components:

- Safety
  Safe construction operations are always of primary importance for any construction project. The owner must take a proactive role in ensuring the safety of the construction workforce.
- Labor Posture
  Project labor posture identifies the most reliable source of qualified workers for the project, from the three options: union, non-union or merit. Labor posture is often selected on the basis of a local labor survey, which considers: local business conditions, construction skills assessment, craft labour availability, and local craft training programs. Internal issues which might influence the selection are in-house labor agreements and experience on past projects.
- Contractor Prequalification
  Contractors should be prequalified to ensure their local capability.
- Labor Agreement
  It is important that a consistent form of agreement be used for all trades to reduce complexity of administration. Options include: national construction agreements, national maintenance agreements, local union agreements, and project-specific labor agreements.
- Use of Overtime
  CURT owners recognize that significant productivity is lost with use of extended overtime. These losses have been researched and clearly documented in CURT Publication C-2, "Scheduled Overtime Effect on Construction Projects" Also, it is generally recognized that safety risk increases with the use of extended overtime. CURT owners prefer to use spot overtime for carefully selected critical tasks rather than scheduled extended overtime.
- Support for Industry Effort to Recruit, Train, and Retain Craft Workers
  The construction industry has initiated a number of programs to recruit, train, and retain the workforce of the future. Owners can demonstrate their support in the following ways:
    - Hiring only those contractors who have a craft worker training program
    - Contribute to craft training funds
    - Supporting the National Center for Construction Education and Research (NCCER) through direct contributions or through volunteer efforts
    - Requiring that craft personnel be trained, skilled, and accredited.
    - Donating scrap material and equipment to craft training programs
    - Providing facilities for craft training
    - Providing a safe and healthy workplace

Owners who proactively establish corporate, site and project labor strategies experience improved labor performance on their projects. Cost and schedule risk is reduced through improved productivity, reduced absenteeism, and fewer jurisdictional issues. Owner support for recruitment and training of craft workers on current projects supports development of the future construction workforce.

Construction Users Roundtable. "Construction Measures: Key Performance Indicators" UP-101, September 2005.

The Mission of The Construction Users Roundtable (CURT) is to promote cost effectiveness for American owners by providing leadership on issues that will significantly improve project engineering, construction and maintenance processes, thereby creating value for the owners.

The objective of this study is to define and document measurements that CURT owners have identified as key performance indicators.

Corporate Policy
Most CURT owner members formalize their commitment with a corporate policy that requires project managers to track and report selected measures of construction performance.

Responsibilities
Typical project team members and their measurement responsibilities are listed below.

Project Team Members	Measurement Responsibilities
Project Manager	• Typically leads the Project Team to establish specific project goals • Ensures that both customer and corporate objectives are incorporated in the project goals • Defines measures to track progress against project goals • Establishes work processes for gathering, analyzing, and reporting project measures • Leads the Project Team to identify opportunities for improvement and to implement action plans for positive change based on project measures results • Reports project results to both customer and corporate resources
Project Engineer (Planner / Scheduler)	• Integrates project measurement processes with the Project Controls system • Summarizes measurement reports and forwards to Project Manager
Construction Manager	• Manages work processes to gather and analyze construction-specific measurement data • Identifies construction-specific opportunities for improvement • Establishes and implements construction specific improvement plans • Reports measures and improvement plan status to the Project Engineer

A corporate-level resource is typically assigned to summarize and aggregate project reports at site, business area, regional, and corporate levels. These summaries are available for analysis and for both internal and external benchmarking. Opportunities for improvement can be identified

and corresponding action plans developed. Responsibilities at the Corporate Level are listed below.

Corporate Team Members	Measurement Responsibilities

Corporate Construction Resource	• Establish the work process for reporting and summarizing measured data from multiple projects
	• Aggregate and summarize multiple project reports
	• Analyze summary data
	• Benchmark, both internally and externally
	  o Identify opportunities for improvement at the corporate level
	  o Establish action plans to improve results
	  o Continuously improve corporate standards, work processes, and implementation

Timing
Project construction measures should be defined and the associated work processes established in the early phases of project planning, as soon as project objectives and project scope have been defined. The work processes can then be implemented as soon as the relevant project activity begins.

Information gathered is summarized, aggregated and analyzed regularly, typically monthly. More frequent analysis may be necessary to support improvement action plans.

Procedures
CURT owners typically use a quality improvement cycle, such as the Total Quality Plan-Do-Check-Act (PDCA) cycle, to drive improvements in work processes at both the project and corporate levels. Standardized work processes are established through one or both of: in-house development of custom processes; or adoption of external best practices.

CURT owners typically establish measures at an appropriate level of detail for the following areas:

- Cost
- Schedule
- Change Management
- Safety
- Quality
- Productivity
- Reliability
- Customer Satisfaction

Additional detail on the definitions in the above areas and references to relevant best practice documents are given in the paper.

Owners who proactively establish a quality improvement cycle through standardized work processes and disciplined measures of effectiveness experience better project outcomes. Measurement is a critical tool for continuously improving systems and organizational understanding of productivity best practices.

Dai, J., Goodrum, P.M. and Maloney, W.F. "Construction Craft Workers' Perceptions of the Factors Affecting Their Productivity". Journal of Construction Engineering and Management, American Society of Civil Engineers. March 2009, 217-226.

In this study, a nationwide survey involving 1,996 craft workers on construction jobsites was employed to quantify workers' perspectives on construction productivity. Nine projects were selected across the United States with varying types of construction, union/non-union work force, geographic location, stage of completion and project size.

To develop the research survey questionnaire, focus groups were used to identify and organize the major factors impacting construction productivity from the perspective of craft workers. Eighty-three factors emerged from the focus groups and were grouped into the 11 categories listed in Table 1. The survey was carried out on the nine sites to quantify the relative importance of the above factors. The top four trades represented in the responses were pipefitters, electricians, carpenters, and ironworkers.

Findings

The research survey measured the perceived severity of impact of the 83 factors on construction productivity. To facilitate comparison, the severity score for each factor was normalized on a scale of 100, with higher scores indicating greater severity. The average normalized score for each of the 11 productivity categories are shown below.

	Category	Average Severity Scores
Tangible	Tools and consumables	69.0
	Materials	57.1
	Engineering drawing management	53.8
	Construction equipment	50.5
Non-tangible	Supervisor direction	30.5
	Safety	23.8
	Communication	21.3
	Project management	21.0
	Labor	14.4
	Foremen	8.7
	Superintendents	5.3

The tangible categories were rated as having a greater impact on productivity, compared to the other seven categories. When individual factors were analysed, nearly all of the top ten listed below fall in the tangible categories.

Factor	Normalized Severity Scores
I have to wait for people and/or equipment to move the material I need.	100.0
There are errors in the drawings that I use.	91.7

When there is a question or problem with a drawing, the engineers are slow to address the issue.	89.9
If I need a man lift to do my job, there are not any available.	84.3
When I need a crane or forklift to help me, there are not any available.	86.3
I can't get the consumables I need to do my job.	82.2
I have to search in a lot of places to find the tools I need to do my job.	78.4
When I go to install prefabricated items, work has to be done on them to fix quality problems.	75.2
I cannot get the power tools from the contractor that I need to do my job.	74.7
My supervisor does not provide me with enough information to do my job.	72.0

The importance placed on the factors categories characterized as tangible indicates the potential, from the perspective of the trades workers, for construction labor productivity to be improved through practical, tangible daily actions taken at the jobsite.

It is notable that this basic pattern of severity rankings remains constant whether the results are analysed by union or non-union workforce, by perception of the project as being productive versus being less than productive, or by trade affiliation. There are differences in the perceived relative magnitude of influence of the productivity factors based on the union status and trade affiliation of respondents: these findings will be beneficial for engaging craft workers in productivity improvement. However, there is the overall clear view that the most significant categories affecting the daily productivity are manageable on the jobsite during construction.

Another significant conclusion from surveying 1,996 trades persons is that they have a good understanding of the factors affecting their daily productivity. Engaging the work force and addressing the most significant factors identified may not only lead to improvement in crew motivation and project performance, but may ultimately help to attract and retain craft workers in a less frustrating, more functional construction industry.

Jergeas, G.F. "Improving Construction Productivity on Alberta Oil and Gas Capital Projects" Report for Alberta Finance and Enterprise. May, 2009.

Most of the international literature on construction productivity relates to commercial or civil projects, and therefore is of limited applicability to the heavy industrial mega-projects which are currently common in Alberta. These types of projects are not only "mega" in scope but also have significant numbers of interfaces, interdependencies, complexities and risks which push the envelope of both management experience and systems. This paper surveys the recent literature which is relevant to Alberta projects

To further explore the potential for improving productivity in these types of projects, an industry survey was conducted to identify factors and practices in response to the open-ended question: "What do you suggest to improve the construction productivity in the delivery of oil and gas capital projects?" Seventy-seven industry professionals from owner companies, EPC contractors and construction contractors made 309 specific recommendations for improvement. These recommendations were categorized into the following ten areas.

	Areas	Number of Recommendations	
1	Labour Management, Conditions and Relations	86	27%
2	Project Front-end Planning (Loading) and WorkFace Planning	40	13%
3	Management of Construction and Support	31	10%
4	Engineering Management	30	10%
5	Effective Supervision and Leadership	29	9%
6	Communication	25	8%
7	Contractual Strategy and Contractor Selection	24	8%
8	Constructability in Engineering Design	23	8%
9	Government Influence	11	4%
10	Modularization, Prefabrication, Pre-build in Shops	10	4%
		309	100%

The paper catalogues the improvements suggested by the industry professionals. For instance, under the top-ranked area, Labour Management, Conditions and Relations, detailed suggestions are outlined under the following headings:

- Incentive programs
- Remote locations
- Job-site access
- Labour management and relations
- Resource scheduling (shifts and overtime)
- Training and certification of workforce

Similarly, practical suggestions from the industry professionals are outlined for the other nine areas. This paper documents a clear consensus among experienced professionals regarding the areas which should receive the most attention in order to improve construction productivity on Alberta mega-projects. Further, it provides detailed lists of recommendations and examples which can be adapted by interested readers for application to their own projects.

The author concludes by outlining the key leadership roles which must be fulfilled by owners, EPOC contractors and construction contractors – all have a role to play in improving heavy industrial construction productivity in Alberta.

The importance of Alberta leaders stepping forward to achieve improved productivity is underscored by an observation in the introduction section of this paper: "Many researchers and practitioners have identified poor management practices that lead to poor performance … [and they have provided] insights and recommendations, but these recommendations have yet to be implemented …"

McTague, B. and Jergeas, G.F. "Productivity Improvements on Alberta Major Construction Projects Phase I – Back to Basics" Construction Productivity Improvement Report for Alberta Economic Development / Project Evaluation. May, 2002.

The primary objectives of this study were to identify underlying problems causing unproductive time on Alberta industrial construction projects and to provide recommendations on how to improve the construction performance. The authors estimate the potential reward for improvement as shifting 10% to 30% of project labour hours from non-productive time to direct productive work.

In this study, a total of 208 poorly managed construction activities were identified and described. These activities were grouped under the eight following categories:

1. Material delivery and control
2. Constructability
3. Waiting time
4. Construction equipment
5. Site layout and temporary facilities
6. Poor work planning and utilization of labour
7. Unproductive work
8. Assumptions and authority

The authors suggest, based on their (extensive) personal experience, a detailed set of practical recommendations and corrective actions to deal with many of the 208 poorly managed activities. These recommendations outline methods on how to improve and enhance the Alberta Advantage relative to construction performance.

The authors also propose a tool that enables project managers to evaluate project systems and/or audit performance during execution in order to determine where improvements can be made. Fourteen key components were identified and given a weight to indicating their generic relative impact, based on the authors' experience, as shown on the Project Evaluation Sheet below.

Project Evaluation Sheet

Key Components	Weight (%)	Grade (1-10)	Weighted Grade
Cost management	6%	e.g. 7	e.g. 0.42
Schedule management	10%		
Work planning	12%		
Progress and productivity	10%		
Quality management	8%		
Safety management	8%		
Organization	7%		
Labour relations	7%		
Material management	12%		

Subcontract administration	6%		
Managing construction equipment	4%		
Management of construction tools	4%		
Management of temporary facilities	3%		
Scaffolding management	3%		
	100%		

The above evaluation sheet is a summary of 14 detailed checklists for each of the key components, which include detailed sub-weightings, definitions, discussion and insights provided by the authors. They believe that a major construction project must score at least 7.5 of a possible weighted grade of 10.0 to be regarded as successful.

This paper provides a thorough analysis of the problems underlying unproductive time on Alberta heavy industrial construction projects. It also outlines a comprehensive menu of recommendations to address the problems, based on the extensive research and practical experiences of the authors. This menu, and the associated project evaluation tools, can be adapted to fit the circumstances of individual projects. The rewards for being effective in improving productivity are substantial: cost savings in the order of 3% to 9% of overall project budget, plus benefits to the owner of timely delivery of a value-producing capital asset.

Ranasinghe, U., Ruwanpura, J.Y., and Liu, X. "Streamlining the Construction Productivity Improvement Process with the Proposed Role of a Construction Productivity Improvement Officer (CPIO)" Journal of Construction Engineering and Management, American Society of Civil Engineers, v1 p342. 2011.

In this study, the authors proposed a dedicated position, the Construction Productivity Improvement Officer (CPIO) to achieve more systematic and sustainable productivity improvement on construction sites.

Roles and Responsibilities
The CPIO is a highly experienced construction management professional who will drive productivity improvement on the job site, covering not only contractor issues, but also issues related to subcontractors and suppliers. This position is analogous to the now well-accepted position of Safety Officer, which has proven effective for contractors and owners in driving improvements in safety performance during the recent years.

Preferably, the proposed CPIO should represent the general contractor in the construction management setup and be held responsible for site productivity improvement initiatives. However, depending on the project's contractual arrangements and individual company requirements, sub-trades or the client can assign their own CPIO to focus on the productivity measures.

The CPIO is responsible for productivity planning and monitoring, and effective coordination and liaising with internal and external stakeholders, spanning from the inception of the project to its completion. This must be accomplished with minimum overlap and maximum coordination with other trades and staff.

Services in Different Project Stages
- Pre-Construction / Project Bidding Stage Inputs
  - Providing a competitive advantage on project planning and bidding, based on extensive knowledge of productivity improvement measures
- Project Construction Stage / Execution
  - Implementation of the most applicable productivity improvement best practices and tools for different trades, individuals and operations
  - Identification of the tasks most vulnerable to productivity loss within selected activities and estimation of the impact and preventive measures in advance
  - Site construction staff / human resource availability and competency
  - Continuous monitoring of the implemented productivity improvement best practices throughout the project's life cycle and making the necessary adjustments
  - Identification of areas that need improvement and suggestions for improvements with collective decision making
- Completion and Post-Completion Stages
  - A post implementation analysis with comparison of the initial productivity improvement plan with the actual site accomplishments.
  - A database of the productivity improvement processes and successes should be set up with input from each project, resulting in new standards and norms in construction work practices.

CPIO Working Models

- Contracting Methods
  - Lump Sum Contract: a CPIO can positively impact the productivity of the contractor; but fewer benefits to the client and sub-trades
  - Cost Reimbursable: a CPIO can be effectively used by both the client and contractor
- Site Specific Parameters
  - CPIO team implementation: The CPIO with supporting staff assists the entire of team of contractor and sub-trades. Costs of the CPIO can be shared by the owner and the contractor.
  - CPIO single site implementation: The CPIO assists both the general contractor and the sub-trades on one large site to provide integrated productivity improvement.
  - CPIO multiple site implementation: This model is suitable mainly for sub-trades or contractors with smaller projects. In this model, one CPIO is responsible for several construction projects.
  - "tools only" implementation: if a fully or partially committed CPIO on site is not be financially viable, existing project crews can be tasked with measuring and recording using the CPIO implementation tools.

Potential Barriers for Practical Implementation

- Lack of acceptance due to the current construction management organization structure
- Time lag to realize the benefits of the CPIO
- Up-front cost requirement to implement the CPIO position
- Cross functional misalignment with other areas of operation
- Finding the ideal candidate for the position of CPIO
- Current lack of supporting practical evidence that CPIO implementation works

Trial Implementation of CPIO Position

As a pilot project, a partial implementation approach was adopted on a high rise building project in Calgary, Alberta. Three specific activities - scaffold work, deck form work, and flyer table work, all performed by carpentry workers - were selected and monitored for two periods of ten weeks each.

The results of the pilot project showed that carpentry crew tool time (defined as the time workers spend in producing a tangible output) increased from about 50% to 58%, while non-tool time dropped correspondingly from about 50% to 42%.

The results confirm that, even with a limited implementation of the CPIO concept, the performance of the measured construction activities improved. This pilot project indicates the high productivity and financial potential of full-scale, sustained implementation of a CPIO position.

Attachment A

HEAVY INDUSTRIAL CONSTRUCTION AND MAINTENANCE

WORKFORCE CHALLENGES IN ALBERTA

MAY, 2011

EXECUTIVE SUMMARY

Canada is facing a shortage of construction workers over the next decade—the industry will need to recruit in the order of 320,000 workers from 2011 to 2019, as estimated by the Construction Sector Council (CSC) in its *Construction Looking Forward 2011 to 2019* scenario. About 1/3 will be required to handle growth, while 2/3 will be needed to offset retirements. Nowhere will the scarcity of skilled trades be felt more acutely than in the Alberta heavy industrial construction and maintenance industries. Because heavy industrial projects are key building blocks in the Alberta resource-based economy, constrained delivery of projects will translate to constrained provincial and national economic performance.

To realize Alberta's full potential—and the spinoff benefits in other provinces—this imminent workforce challenge must be addressed immediately by industry and by governments. Owners, contractors, labour providers and governments must work together to get out in front of the challenges.

Resolving the immediate challenges must be done in the context of building the workforce of the future – capable of handling ongoing project demand for heavy industrial construction and maintenance that by the 2020s will be triple or quadruple the volume of the early 2000s. In addition to being much larger, the workforce of the future will be equipped with trade skills, management systems and an innovation culture – the tools of globally competitive quality and productivity. This paper sketches an initial vision for the Alberta workforce of the future, as a starting point for discussion and consensus on the workforce of the future.

The Construction Owners Association of Alberta (COAA) provides leadership to enable the Alberta heavy industrial construction and maintenance industries to be successful in the drive for safe, effective, timely, and productive project execution. COAA is committed to addressing these workforce challenges, both by implementing industry best practices and by working closely with partner organizations and governments.

Recommendations for initial focus are:

- Improve Productivity of Existing Workforce
  - Companies commit to implementation of selected COAA Best Practices
  - Companies commit to effective on-site utilization of apprentices
  - COAA develop a Best Practice for module planning, fabrication, commissioning
- Develop a Long Term Vision and Monitor Progress
  - COAA and stakeholders describe the vision for the Alberta workforce of 2025
  - COAA and stakeholders improve the demand forecast for skilled trades, etc.
  - Government of Alberta improve the provincial supply forecast for skilled trades, etc.
- Improve Interprovincial and International Access to Temporary Workers
  - Government of Canada base Labour Market Opinions on workforce forecasts
  - Companies form co-operative to administer temporary foreign workers
  - Companies address interprovincial recruiting as strategically important