Improving Construction Productivity on Alberta Oil and Gas Capital Projects

A report submitted to:

Alberta Finance and Enterprise

Prepared by:

Dr. George Jergeas PEng
Professor of Project Management
Department of Civil Engineering
Schulich School of Engineering
University of Calgary
Alberta, Canada

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MANDATE

Alberta Finance and Enterprise is proceeding on the Minister's mandate to develop policies, initiatives and tools to help Alberta's businesses improve their productivity and global competitiveness. Alberta Finance and Enterprise is establishing Productivity Inc, an Alberta umbrella program, whose purpose is to take productivity, innovation and strategic competitiveness to new levels of awareness and application.

Alberta Finance and Enterprise has developed a set of broad guiding principles that provide direction for Productivity Inc. These principles are based on a collaborative network approach among clients and stakeholders including Alberta Finance and Enterprise, Alberta-based construction industry, industry associations, community-based economic development agencies and post secondary educational institutions (Albertan, national and international) to develop and establish a productivity framework for Alberta.

Alberta Finance and Enterprise has engaged Professor George Jergeas PEng of the Schulich School of Engineering at the University of Calgary to:

1. Determine the productivity improvement needs and identify factors affecting construction productivity in the delivery of oil and gas capital projects.

2. Categorize and prioritize these productivity factors.

3. Determine gaps in available construction productivity literature and programs, services and information.

The report following which is formatted in a journal style describes the approach taken and the findings of the study.

Improving Construction Productivity on Alberta Oil and Gas Capital Projects

Dr. George Jergeas PEng

Abstract

The current global economic situation and its negative impact on major oil and gas capital projects in Alberta have made construction productivity improvement more and more important. This paper describes the findings of an ongoing research project, presents the most critical aspects that can improve productivity in the delivery of oil and gas construction projects of Alberta. In this study, we have surveyed very experienced personnel from owner organizations, EPC firms and construction contractors to identify factors for improving productivity on future construction projects. Industry recommendations for improving construction productivity are categorized and tabulated into 10 major areas. These areas are labour management, project front-end planning (loading) and workface planning, management of construction and support, constructability in engineering design, engineering management, communication, contractual strategy and contractor selection, government influence and modularization, prefabrication, pre-build in shops.

Introduction

The statistics for major Alberta construction projects illustrates that in 2006, $32.9 billion was spent on construction projects. In five years (2002-2007), construction projects in the oil and gas sector alone were worth $146.7 billion (Alberta Economic Development, 2007).

Although the construction industry represents a substantial portion of Alberta's as well as Canada's economy, the performance and improvement in construction productivity over the past 20 years has been declining (Choy, 2004). The decline in Alberta is consistent with the decline of construction productivity in North America over the past three decades. The decline has been reported by many researchers such as (Business Roundtable (BRT), 1989; Dozzi and AbouRizk, 1993; Hewage and Ruwanpura, 2006; Sharpe, 2006).

There are undue cost overruns, delays and loss of productivity associated with the delivery of major capital construction projects everywhere. Many researchers and practitioners have identified poor management practices that lead to poor performance such as scope changes, design errors and omissions, lack of proper planning and scheduling, improper management of tools, equipment, materials, and labour among many other factors. These researchers and practitioners have tried to overcome these challenges by providing their insights and recommendations, but these recommendations have yet to be implemented with tangible productivity and project predictability improvement.

In addition to the literature search, the author conducted a survey of the opinion of industry professionals and found that a combination of labour issues, project planning, engineering management, leadership, constructability among other issues are the main areas for construction

productivity improvement. A summary of a literature search and the industry survey findings are presented in the sections and subsections following.

Literature Search

This section provides a limited literature review of recent publications relating to construction productivity.

Researchers and practitioners around the world have provided several contributions related to improving the various aspects of construction productivity. Research is being performed world-wide in research centres on many areas related to construction productivity. These research centres include industry associations and academic institutions in Australia, Canada, United Kingdom, and the United States of America.

In Australia research work related to factors affecting productivity such as rework and worker's performance and motivation was performed by Edwards and Love (Edwards et al. 2007; Love et al. 2005).

In Canada, Productivity Alberta in 2008 indicated that construction productivity largely depends on the performance of construction workers. The labour force plays a vital role in the construction process. The improvement in construction productivity needs to be achieved through greater resource allocation and human resource efficiency, effectiveness and engagement; increased innovation and technology diffusion. Productivity Alberta also indicated that improving productivity and innovation is not necessarily expensive, time-consuming, or overly difficult. However, it takes a commitment to identifying areas for improvement, working toward the improvement, and maintaining the improvements over time. (Productivity Alberta, 2008)

The post secondary institutions in Canada such as the Universities of Alberta, Calgary and Concordia are actively performing research work on construction productivity improvement in partnership with major Canadian construction companies. Research performed by the University of Alberta indicated that productivity is a complex issue as many factors influence productivity such as labour, capital, material and equipment. Lack of right materials, tools and equipments, poor communication or relationship between workers and management, disorganized projects, poor supervision, lack of cooperation and communication between different crafts, lack of worker participation in decision making process, and unfair workloads are the some of the factors that affect productivity. Technical problems like inadequate designs or incomplete engineering work can also lead to backlog in productivity. Similarly restrictive and redundant procedures also affect the effectiveness of a project (Dozzi and Abourizk, 1993).

University of Calgary research identified the relative importance of 51 productivity factors which were classified into three groups: Human, External, and Management. The following are the productivity factors identified by Liberda et al. (2003).

- Human factors such as worker motivation, worker boredom and fatigue, worker attitude and morale, worker's physical limitations, worker absenteeism, worker learning curve, worker experience, and worker skills as well as the team spirit of crew.

- External factors such as union rules and influences, adverse weather conditions, noise, dust, radiation, congested work area, change in drawings and specifications, changes in contract, demand for over- quality work, and the nature of project (size and complexity).

- Management factors such as protective gear, unrealistic schedules, overtime, multiple shifts, excessive shift length, disrespectful treatment of workers, parking facilities, salary and benefits, site layout, necessity to re-do work, discontinuity in crew makeup, failure to use worker's skill, incompetent personnel, overcrowded work areas, poor inspection programs, unsafe working conditions, inadequate equipment, inadequate supervision, crew composition, constructability, out of sequence survey work, interruption and disruption, adequate site facilities for workers, lack of co-operation between crafts, inadequate communication, lack of worker training and education, cleanliness of construction site, lack of procedures for construction methods, subcontracting, changes in foremen, lack of detailed planning and non availability of information, materials, tools and equipment.

Zhou (2006) performed a study on motivating construction management professionals and concluded that motivation, when it is combined with work experience and education is an important factor in improving performance.

Hewage and Ruwanpua (2006) and Choy and Ruwanpura (2006) broke down a normal each trade worker's time in detail. The following figures (Figure 1and Figure 2) show the detailed breakdown in carpentry work, which basically shows how the time is spent and that there is a room for increasing the working time.

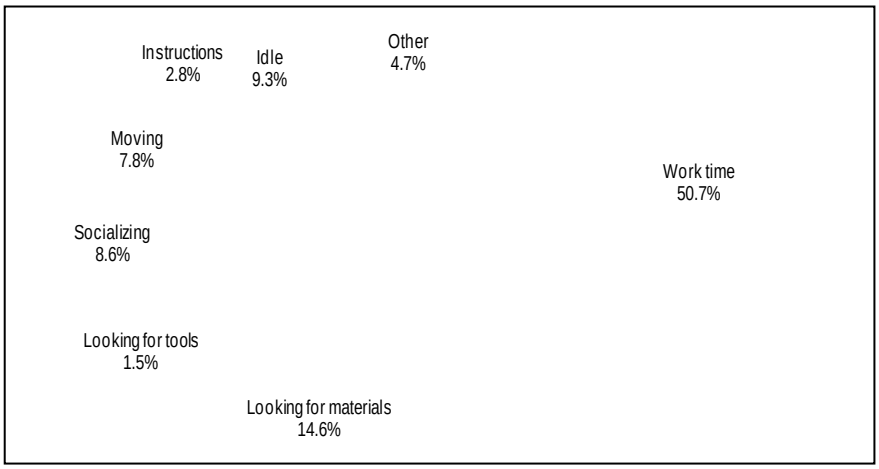

Figure 1: Breakdown of work hours (carpentry work)

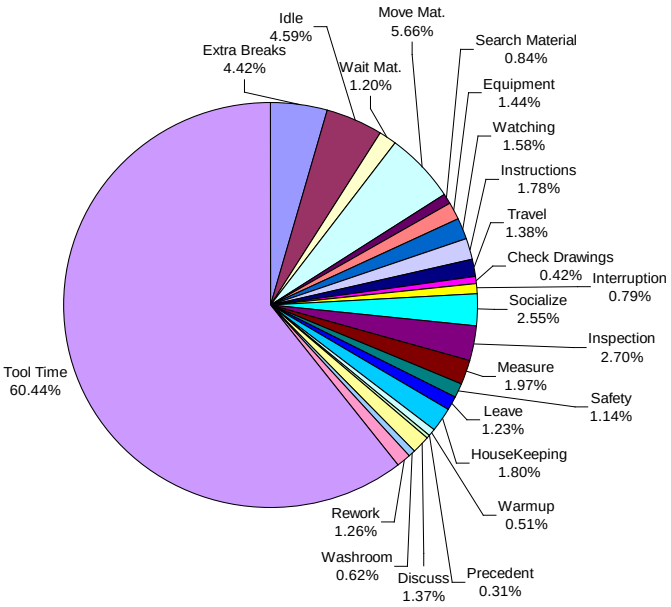

Figure 2: Breakdown of work hours

Da Silva and Ruwanpura (2006) on a study to improve productivity of slab concreting operations on four commercial construction sites in Alberta, indicated that productivity losses during concreting operations were mainly caused due to variability in the pouring rates and site layout factors restricting the movement of concrete trucks on site during concreting.

Hewage (2007) conducted another research based on Liberda et al.'s (2003) fifty one factors affecting productivity. These factors were prioritized and clustered into nine categories. These categories are: design and changes, worker motivation, inadequate communication, worker skills, non-availability of information, lack of planning, congested work areas, inadequate supervision, and adverse weather conditions.

A research project to develop, test and validate better work practices and tools, and to improve the productivity of future construction projects in Alberta and Canada is ongoing at the University of Calgary. The research project is titled "Top Ten Targets for Improving Construction Productivity" (CRCPM, 2009). Following are the top ten targets being investigated.

1. Highly motivated, and satisfied workforce
2. Best practices model for supervision
3. Better working relationship model between sub-contractors and the main contractor
4. Efficient materials, tools, and equipment management
5. Tool time optimization by adopting best work practices
6. Optimize work practices and workface planning
7. Information technology based on-site communication framework
8. Better integration between site and office management

9. Weather related issues
10. Project stakeholder issues – owner, architect, changes, etc.

Gannoruwa (2008) conducted a study and found that the average direct effective working time (tool time) of two commercial construction job sites in Calgary was just 53.17%, (Fig. 3). Moving around the site was the largest portion of non-tool time activities. The category "walking" includes looking for materials, looking for foremen, carrying tools and equipment, just walking in itself, and walking to the office, wash rooms, and stopping to chat with fellow co-workers. After working continuously for a long time, it is necessary to have short breaks for smoking, idling, using washroom facilities, but if these breaks last more than 10 minutes then the productivity at that period can be seriously affected (Noor, 1992).

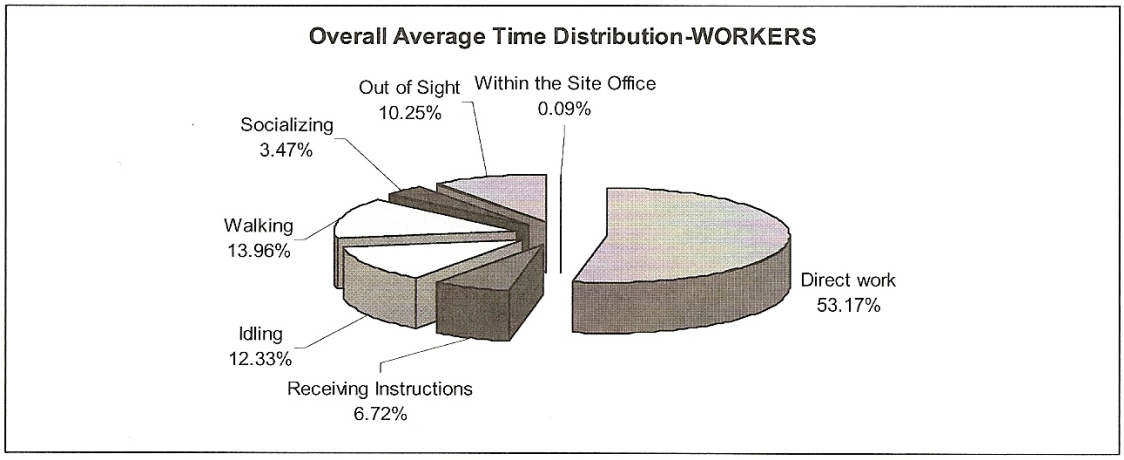

Figure.3: Workers' total working time distribution

Liu and Ruwanpura (2007) developed a "Ten-Week Testing Model" to improve tool time and construction productivity on a high-rise building site by reducing waste in on-site resource management.

Aduagyei, F. and Ruwanpura, J.Y. (2008) identified some of the significant situations that create congestion and reduce the productivity of resources in the work area. Some of the critical situations were over stacking of trades, improper activity sequencing, excessive on-site prefabrication & storage of material in the work area and improper planning of the activities with regards to movement of resources in the work area with the progression of the work.

In the United Kingdom, the Building Research Establishment Ltd. (BRE) has produced many publications relating to construction productivity. BRE also organizes training courses and workshops aiming to improve the technical performance of workers in the construction industry. Additionally the post secondary institutions in the UK have contributed to numerous published research relating to construction productivity improvements. Combining the knowledge and experience of the construction industry with the research expertise of academics, the European Construction Industry Institute (ECI) based in the UK, has published in areas such as design

effectiveness, fast tracking, benchmarking, leadership and innovation and procurement strategy and time skills, knowledge and competence among other publications..

In the United States, the Construction Industry Institute (CII) has developed 14 Best Practices to enhance the business effectiveness and sustainability of the capital projects. Some of these practices directly or in directly affect construction productivity. Relevant CII Best Practices are Alignment, Benchmarking and Metrics, Change Management, Constructability, Lessons Learned, Materials Management, Planning for Startup, Pre-Project Planning, Quality Management, Team Building and Zero Accidents Techniques.

The Center for Construction Industry Studies (CCIS) also in the US has published many studies relating to improving construction productivity. These studies relate to workforce challenges, assignment and allocation optimization of workforce. The Construction Users Roundtable (CURT) publications, on the other hand, included the following relevant works dealing with many aspects of construction productivity.

1. Construction Productivity Measurement
2. Construction Labour Motivation
3. Improving Construction Safety Performance
4. First & Second Line Supervisory Training
5. Project Management Education & Academic Relations
6. Application of Modern Management Systems
7. Contractual Arrangements
8. Integrating Construction Resources & Tech.
9. Construction Technology Needs & Priorities
10. Exclusive Jurisdiction in Construction
11. Scheduled Overtime Effect on Construction Projects
12. Contractor Supervision in Unionized Construction
13. Constraints Imposed by Collective Bargaining Agreements
14. Local Labour Practices
15. Absenteeism & Turnover
16. Impact of Local Union Politics
17. Use of Journeymen in the Union Sector
18. Government Limitations on Training Innovations
19. Utilization of Vocational Education in Construction Training
20. Training Problems in Open Shop Construction
21. Labour Supply Information
22. Administration & Enforcement of Building Codes & Regulations

A detailed catalogue of the literature search and publications is under a separate documents.

Literature Related to Oil and Gas Projects

Research work relating to construction productivity in the oil and gas projects of Alberta is very rare. Only little work has been found as is outlined below.

Significant growth in the oil and gas sector in Alberta, Canada over the past decade has resulted in a trend of constructing “mega” projects that are both capital and labour intensive. While this trend has created tremendous economic opportunities, it has also posed a number of challenges, including significant cost and schedule overruns.

Fiori and Kovaca (2006) defined mega projects as, “a construction project, or aggregate of such projects, characterized by: magnified cost, extreme complexity, increased risk, lofty ideals, and high visibility, in a combination that represents a significant challenge to the stakeholders, a significant impact to the community, and pushes the limits of construction experience. Jergeas (2008) defined mega projects as being huge in magnitude and over $1 billion (CAD) in total installed cost, excluding development costs expended prior to the project being formally approved. These projects are characterized by a significant number of interfaces, interdependencies, complexity, and risks, some of which are strategic and must be managed at a level above the project team.

Jergeas (2008) and Ruwanpura et al. (2006) indicated that a historical review of the major oil and gas in Alberta, Canada, revealed that cost overruns in most cases exceed the total project values. In almost all the projects 50 to 100 percent overruns are evident as identified by the Association of Professional Engineers, Geologists and Geophysicists of Alberta (APEGGA, 2004).

A study conducted for the government of Alberta, Canada (McTague & Jergeas, 2002) found that cost overruns and labour productivity losses on large oil and gas construction projects were the result of many factors such as the apparent "management" deficiency in managing scope, time, quality, cost, productivity, tools, scaffold, equipment, materials, and lack of leadership, among other things. Jergeas (2008) indicated that while these projects are normally successful from an engineering, operational, and safety standpoint, the cost and schedule overruns are a cause for concern and needs attention in many areas including construction productivity.

Jergeas (2008) and Elliot (2005) listed several of the reasons and contributing issues for the poor project results and the major cost and schedule overruns for Canadian oil sand projects. Elliot (2005) provided the following reasons:

1. Lack of experienced owner and contractor sources
2. Overall quality of owner and contractor management capabilities
3. Ineffective organizational and alliance structures for mega projects
4. Inappropriate delegation of owner responsibilities to contractors
5. Lack of clear definition of lines of authority and management responsibilities
6. Lack of discipline and ineffective control of project scope
7. Complexities of major expansions to existing operating plants
8. Customization of owner specification requirements
9. Level of project definition and proximity not well understood
10. Lack of familiarity with the northern Alberta climate, safety requirements, environmental constraints, governmental regulations, construction practices
11. Scarcity of qualified craft workers, high labour costs, inconsistent productivity

12. Many completing mega-projects affecting resources and labour availability
13. Ineffective contractual arrangements and lucrative contracting environment
14. Ineffective material management plans and premature field mobilization
15. Inappropriate management influence of cost estimates to meet economic hurdles and ignoring project reality
16. Ineffective project control systems and project development practices
17. Lack of discipline and consistent application of project code of accounts to allow effective control and collection of actual costs
18. Lack of owner front-end estimating capability and project control personnel
19. Lack of appropriate risk analysis expertise
20. Lack of owner historical project systems and databases which reflect northern Alberta conditions.

Rankin et al. (2005) conducted a study focused on the impact of detailed execution planning for large oil and gas construction projects and identified a number of reasons causing cost overruns including: scope creep, insufficient pre-planning, inadequate project controls and lack of detailed execution planning. Rankin et al. (2005) developed a practitioner's model to assist in implementing detailed execution (workface) planning for large oil and gas construction projects and suggested that this workface planning model would assist the industry to save money and time and increase profits by providing a better, more reliable Canadian benchmark for future large oil and gas construction projects.

Lozon and Jergeas (2008) studied the application of best practices on large engineering and construction projects by conducting a survey of over 200 industry professionals. Which practices should be used, when should they be used and what impact will these practices have on project outcome? Two practices recommended by most professionals are constructability and value engineering. The study indicated that complacency, constrained funding and reluctance to investigate alternate construction and contracting strategies can reduce the impact of these reviews to the point where they can increase cost and schedule. Ruwanpura et al. (2006) concluded that design/engineering is the project phase which could impact the project most in terms of its cost and schedule.

Fayek et al. (2006a) conducted a study to collect and analyze relevant previous data with project starting dates for the period (1990-2003) from heavy industrial construction projects in Alberta. The study also performed two survey questionnaires; one targeted the construction owners and the other targeted the engineering procurement (EP) firms. The main finding was that there is room for improvement in how projects are executed, with problems tending to be more pronounced on larger projects. The study indicated that collecting historical data was found to be an inefficient process and that future project performance studies should be based on sound benchmarking systems that collect data in a timely manner as projects unfold, and on an industry-wide level. The study provided suggestions for steps to control cost overruns and performance deviations on major industrial construction projects.

Jergeas (2008) studied the delivery of mega oil sands projects in Alberta. The research focused on front-end loading, early engineering effort, and change to scope during the early stages of the project life cycle after the appropriation for expenditure (AFE). His findings indicate that

few of the early design milestones could be achieved on time and this is mainly due to scope changes and the stream of trends.

Fayek et al. (2003) studied the impacts and benefits to the various parties involved in industrial construction caused by increasing the utilization of apprentices on industrial construction projects. A pilot study was conducted on a major industrial project to help in quantifying the impact of the use of apprentices in the industrial construction sector and to identify methods of effectively increasing their use while simultaneously enhancing their on the-job learning experience. The methodology was piloted on a major industrial construction project in Alberta, which consisted of a 150 000 barrel per day bitumen upgrader (Fayek et al. 2002). Pipefitters and electricians were chosen for the pilot study because they are two of the most significant trades in industrial construction. Fayek et al. (2003) main finding was that apprentices can be effectively incorporated in industrial construction, and they can be both productive and cost-effective, provided they are given adequate instruction and supervision.

Fayek et al. (2006b) conducted a study to provide an overview of the recent advances and initiatives in workforce training in Alberta within the unionized building trades sector of the industrial construction industry and to highlight the economic significance of these initiatives for mega construction projects. The research was conducted on optimizing the utilization of apprentices in the industrial sector. The study indicated that Alberta has been at the forefront of workforce training, largely as a result of the unique demand for huge numbers of skilled workers for simultaneous mega projects. The initiatives developed in Alberta, such as the apprentice-mentoring and supervisory development programs, can be used as a model in other jurisdictions. Taking these programs to a national level would have significant benefits for Alberta and other provinces, as the construction forces are very mobile. For example, the mega projects in Fort McMurray, Alberta, are heavily dependent on workers from other provinces, not just Alberta.

Additionally, the Construction Owners Association of Alberta (COAA) publications provide a useful reference to elements relating to construction productivity in the oil and gas. These documents are construction execution planning, engineering and field rework and overtime best practices in addition to the workface planning model.

The Gap in the Literature

Having reviewed the published work presented by the most important research centres, around the world, the researcher feels that productivity research is mostly focused on civil or building type of projects and out of date and therefore not suitable for Alberta construction industry. Existing research does not reflect the complexity associated with the delivery of construction projects in the oil and gas sector in Alberta as productivity conditions in Alberta are different due to geographic location, weather conditions, size of projects and contractual arrangements.

The lack of relevant research work in Alberta's oil and gas construction industry provides an opportunity and a need for a specific Alberta related research and hence this pilot work. The

main goal of this pilot work is to identify cost effective methods and strategies to improve the productivity of future oil and gas construction projects in Alberta. This study is a continuation of an ongoing effort to build construction productivity best practices for delivering oil and gas construction projects in Alberta.

Pilot Study

The researcher has conducted an industry survey of 77 highly experienced professionals and engineers from the oil and gas industry in Alberta representing owner organizations (34), EPC contractors (30) and construction contractors (13). The only goal of this study is to identify and prioritize factors and practices that have the potential for improving construction productivity in the delivery of Alberta oil and sands projects. To achieve our goal, industry professionals were asked the following simple question:

What do you suggest to improve the construction productivity in delivery of the oil and gas capital projects?

Industry responses were specific and provided strategies and ideas for improving construction productivity on oil and gas capital projects of Alberta.

Research Findings

Industry opinion and ideas were collected, tabulated, analyzed, grouped and prioritized in accordance to the number of times quoted by respondents. Industry professionals made 309 specific recommendations for construction productivity improvement. Table 1 following lists the top 10 areas for construction productivity improvement and shows the number of recommendations received by each area and % of the overall observations.

Rank	Target Areas	Number of Recommendations	%
1	Labour Management, Conditions and Relations	86	27%
2	Project front-end Planning (Loading) and Work Face 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	3.5%
10	Modularization, Prefabrication, Pre-build in Shops	10	3.5%
		309	100%

Table 1: Top 10 areas for Construction Productivity Improvement in the Oil and Gas Industry

The Top 10 Areas for Improvement

The following lists the top 10 areas for improving construction productivity with a list of specific actions and strategies for improving construction productivity on oil and gas capital projects.

1. Labour Management, Conditions and Relations

This area brought 27% of comments and feedback and is divided into six categories. These categories are incentive programs, remote locations, access to jobsites, labour management and relations, resource scheduling (shifts and overtime) and training and certification of workforce both local and foreign labour.

1.1 Incentive programs

The following ideas and strategies were provided regarding incentive programs:

- Include incentives for efficiency and for achieving milestones.
- Consider bonus incentives at the trade, foreman and management levels.
- Bonus schemes must be competitive across work groups.
- Some bonus/incentive system must filters right down to the worker. This means if a group working on installing lighting finishes on or under budget time, they should be rewarded.
- Performance based incentives targeting not just management, but more so on direct/trades persons.
- Recognition programs for work: quality, quantity, HSE, milestones. Awards/rewards for no lost time accidents.
- Negotiate with crews and provide incentives to complete work packages (WP) on time and quality without rework. As many WPs as they finish sooner directly relates to as much money as they make.
- Promote a healthy competition between crews in terms of safety and results by posting performance by crew in selected locations across the site (safety and performance by crew).
- Accountability of scope, time and cost. Maybe even a little bit of friendly competition.
- Care for employees is an incentive. This means the flexibility to meet workers needs, consistent with project needs.
    - Monitor worker moral and watch for early warning for problems.
    - Full access to comprehensive employee and family assistance programs. Reduce distractions of many kinds.
    - Aggressively address undesired behaviour. Harassment is less of a human rights and safety concern, more of a performance killer. The Respect In The Workplace program is a good start.
- Implement incentive programs for construction contractors and engineering firm.
- Trades people, labour and all other associated workers should have bonus incentive clauses (today as in the past they try to make the project last as long as possible).
- Engage foremen with management and support them.

1.2 Remote Locations

Because a large number of projects are constructed in Ft McMurray in the Athabasca region with difficulty to access, industry professionals provided the following suggestions focussing on transportation to site and camp facilities.

- Improve the Highway and build the train line between Calgary – Edmonton – Fort McMurray to transport people and move large modules.
- Avoid HWY 63 due to its psychological burden on workers because of safety concerns and accidents on drive to or from sites in Fort Mc Murray.
- Improve ground and air transportation. Fly-in, fly-out for craft labour.
- Supply best in class accommodations and ensure good quality food and extensive recreation facilities at remote camps.
    - Make worker accommodation close or closer to worksite. Place a camp at site to reduce travel time.
    - Have high quality camp facilities and camp facilitator to ensure "quality of life off work" is appropriate.
    - Respectful planned and managed camp and transportation will reduce turnover.

- Build the site infrastructure to fit the project. On one site, the crew peak was projected at 1700 or so, but later exceeded 7000. Site infrastructure was wholly inadequate.

1.3 Access to job-site

With regard to access to job site we received the following:

- Improve job site access for workers. On one project (name deleted by the researcher) thousands of workers had to be in parking lot at 6:30am but do not start productive work until 8:30am at earliest. Then work stops at 4pm, transportation leaves parking lot at 5:30pm – eight thousands workers on site.

1.4 Labour management and relations

Better labour relations means to treat workers better, they perform better.

- Provide incentives for attraction, education and retention for skilled labourers.
- Foster a culture of productivity with an aim to get productivity to 65% plus.
- Only hire skilled workers for jobs that require skills.
- Create a good sense of ownership (have a personal benefit) for individual tasks. i.e. authority and responsibility with resources.
- Loyalty (layoffs).
- Periodic (monthly) awards/bonuses for full attendance by employees
- R & R time periodically for workers to visit family/friends and get some down time.

- Managers to spend a day walking in workers shoes to experience firsthand what issues are around delays, equipment, shortages, tool shortages, etc.
- Improve first line leadership (foreman) which may include training / coaching / mentoring.
- Ensure adequate field supervision and management of workforce.
- Work with unions. This included ideas such as:
    - Work with unions collaboratively, or minimize their influence or even eliminate unions.
    - During slowdowns and economic downturns engage unions in discussions on how to reduce costs and potentially reduce benefits to members.
- Drug test everyone regularly and randomly and implement zero tolerance on drug use. (must check legal requirements)
- Import skilled but cheap outside labour. Alberta workers can (improve) based on learning from international trades.
- Ensure union training funds are fully and properly utilized.
- Cross trade agreements in contracts (i.e., HVAC can do piping…)
- Along with safety oriented risk assessments, crew should engage in task briefing and debriefing.

1.5 Resource scheduling (shifts and overtime)

This issue has a significant impact on labour productivity. Industry professionals provided the following insights:

- Develop good work schedules that respect workers home needs both local to area and external to area. This means provide balance between safe site and happy home life. More work is accomplished using 5 x 10 hr shift vs. 4 x 12 hr shifts. Expensive overtime does not always lead to better productivity due to declining rate of return. Shorter work hours or limited work-hours with a cap on overtime are strongly recommended. A tired worker is not productive and is not safe.
- Manage overtime effectively by focusing on the critical path work.
- Overtime to compete for workers is doubly costly.
- Avoid overlapping of trades which can lead to delays.
- Ensure that project deliverables and milestones (including engineering milestones) are achieved in a timely manner. Avoid misleading milestones.
- Make the project conditions attractive to attract quality skilled workers.

1.6 Training and certification of workforce

Training programs for both local and foreign labour help companies achieve greater success. Feedback regarding this subsection can be summarized as follows:

- Encourage more organizational training for lower level supervisors who are directly responsible for people on the tools. Provide training, mentoring for front line supervision.

This should include crew planning, management of absenteeism, management of break times.

- The people at the top know what they want done but the message gets lost on its way down.
- Provide project management training to field/plant personnel.
- Ensure proper job training to construction worker to enhance experience.
- Promotion of building trades versus office/clerical in educational alternatives.
- If other-country resources used then foreman must speak same language.
- Investment in apprentice training is required. Proper mentorship programs will maximize both work performance and training effectiveness.

2. Project Front-end Planning (Loading) and Work Face Planning

Front end planning is the process of developing sufficient strategic information with which the project team can address project scope and requirements that allows the project to be executed successfully. On the other hand, WFP enables craft persons to perform detailed planning and scheduling to achieve quality work in a safe, effective and efficient manner.

Proper front-end planning and workface planning issues raised by industry respondents are summarized as follows:

- Do a more complete job of defining long-term plan, scope and objectives, rather than jumping into design and construction quickly. If long term planning and goals are more concretely defined, re-work can be limited. Define scope of project more completely and reduce conflicting scopes.
- Teams need to plan projects in detail before starting. If you had a plan and completed engineering according to that followed by construction planned around this, projects would be smoother.
- Ensure proper amount of front end loading (FEL) is complete.
- Owner Company Business Units and Construction must plan a program of projects on a yearly basis. Better decision making process with regard to going forward with a project or killing the project.
- Business Units must get up to speed with the project delivery and execution process.
- Improve planning phase of the project including organization, clear division of responsibilities, scope of work, for all parties involved.
- Strategic planning done by the oil sand developers to assess resource allocation before embarking on several projects with overlapping schedule.
- Implement Work Face planning (detailed construction planning) and buy-in to it. Provide realistic and properly detailed schedule for on site co-ordinators to follow.
    - Planning: define activities, tools, supplies accurately.
    - Sequencing: schedule similar activities in series so workers can apply learning to repeated tasks.
    - Plan to plan more: Prepare additional staff to assist with planning
- Work Face planners to ensure:
    - Look ahead
    - Material management - timely material arrival.
    - Letting workers know in advance plans for their work.
- Provide workface assessment and audit.
- Good collaboration between schedulers and foremen in developing work Face plans.
- Plan for at least a 4-week window in advance to have efficient control on construction activities, materials and inventory control at site.
- Optimize construction sequence and trade(s) utilization.
- Manage construction activities with proper sequencing e.g. timely equipment arrival, material and proper planning. Provide sufficient resources on site to coordinate contractors.
- Upfront planning of all activities.
    - Clear and timely communication with staff.

    - Supervise the proper implementation of the planned activities.
    - Monitor the performance.
    - Ask workers for their suggestions on how to improve productivities and implementing their suggestions.
    - Take away obstacles to worker availability.
    - Get workers the tools, equipment and materials before they need it.
    - Anticipate problems and plan for them.
    - Include regulatory requirements and maintenance activities for major mobile equipment.
    - Adopt risk and mitigation/back up plan to eliminate all uncertainties in project execution.
    - Ensure washrooms nearby
    - Bring coffee out to work areas instead of having workers travel back (if possible).
- Apply flexible and realistic project controls and scheduling.
- Put in place a good cost and productivity controls systems.

3. Management of Construction and Support

In this category, industry professionals have identified many areas for improvement and suggested the proper management of:

- **Tools.**
- **Equipment.**
  - Central logistics planning group for large equipment, transport, and erection to utilize limited heavy transport and erection equipment.
- **Access to site and site layout (see area 1).**
- **Camp facilities (see area 1).**
- **Travel (see area 1).**
- **Health programs.**
- **Scaffolding**
  - Allow contractors to rent/supply construction scaffolding vs. an owner central group. On some recent mega projects silos stood around waiting for scaffolding.
- **Safety**
  - Ensure safety program is front and centre providing a safe work environment with a goal of zero incidents. Safety equipment, safety training, safety communication are paramount.
  - Provide neat, safe and clean work environment. Safety meetings i.e., orientation, tail gate meetings etc. are mandatory and necessary, but need to be streamlined so that they do not interfere with productivity.

- **Management of change and rework minimization**
  - Minimize changes to the project whenever possible.
  - Ensure clear understanding and consistent application of management of change during all phases.
  - Resolve discrepancies and agree on changes in a timely manner.
  - Develop and follow rigorous management of change procedures.

- **Material management and Supply Chain Management**
  - Ensure all materials are available in a timely manner. Dedicated follow up on procurement activities to avoiding idling at project site.
  - "Look ahead" materials management and logistics plans.
  - Provide more resources: Engineering, Land, E &PS, surveyors, drafting, construction supervisors, contractors, material availability.
  - The right materials at the right time and ensure accountability.
  - Owner supplied materials often delays installation.
  - Build relationships with suppliers. Become a preferred client.
  - Ask vendors (they may now give more answers in these times of low oil prices).
  - Implement material management and controls in advance.

- **Quality**
  - Appoint an on-site QA/QC technical representative to watch for errors quickly and provide solutions for problems.

- **Contract administration**
  - Efficient construction management and contract administration.
  - Reward policy for timely completion (see 2).
  - Better handling/dealing with subcontractors/sub vendors by prime contractor.
  - Timely approvals/action by owners and EPC side.

- **Progress measurement**
  - Inspectors measuring progress for work functions to keep on track production such as X many inches of weld per day or X many m3 of concrete per day.

4. Engineering Management

Feedback relating to engineering management included the following suggestions:

- Be ready before starting the project. Incomplete engineering leads to delays and rework. Engineering and procurement need to be sufficiently advanced to allow timely delivery of plans, materials and supports. Engineering delays probably cause more performance loss than any other factor. "Constructors drink downstream from the engineers' feedlot."
- Spend more time (not rushing) on front-end engineering to reduce the rework during detailed engineering thus avoiding hold-ups during the construction. Complete engineering deliverables including clarity in scope of work (work packages) definition prior to construction. Many projects begin with a small amount of engineering done (less than 50%). Do engineering before construction starts and adherence to and strict enforcement of the 80-100 rule. This means among other things:
    - 80% of engineering complete before mobilizing to site.
    - 100% of "Issued For Construction" (IFC) drawings and specifications issued on time and must be completed before construction. One respondent commented that he has not seen the IFC stamp for 10 – 15 years. According to him, construction drawings are stamped "Not for Construction".
- Understand limitations of engineering organization structure towards setting up condition for successful execution/construction. Enhance the quality of the engineering discipline, which will help construction be more productive.
    - Small focussed work groups and small work packages.
    - Standardize and simplify design.
    - Process review and simplification: Can any steps be eliminated? More done in parallel? More simplified?
- Consider giving individual work packages to people where possible and establish individual ownership responsibility. (i.e., 6 hr or multi-day work packages).
- Ensure design is completed and reviewed by construction and operation before construction is sent to site or material is ordered (i.e. no more fast-tracking).
- Avoid or reduce the practice of fast tracking. With the current economic conditions and what happened in the sub-prime market because of greed, may be investors will be more patient to wait for return. Patience on the part of everybody in the industry worldwide could help. Sit back, plan, design, build! With more time better designs will be created and construction inefficiencies can be engineered out. (see also area 2)
- Can just scale up work processes from larger projects to mega projects.

5. Effective Supervision and Leadership

For this area of construction productivity improvement, industry professionals provide the following recommendations.

- Labour to supervision ratio of 1 – 8 to 1 – 20. Should not exceed 20.
- Oversight with experience and authority.
- More formal process to enforce company failures. Less subjective and quicker to find. Too many chances to improve with limited impact in event of systemic failure.
- Accountability of scope, time and cost.
- Organized management:
    - All materials for construction available
    - Design completed for construction (80/100 rule)
    - If construction in brown field, make sure personnel not waiting for gas tests etc, have testing staggered to have efficient use of time.
    - Better overall planning.
    - Providing good site access and housing equals to happy worker.
- Make key decisions on time in all phases of construction and follow through (not evaluate and revision).
- Project manager and senior staff makes leadership decisions and support staff.
- Risk assessment completed on project before each project phase to identify potential new risks that may cause delays (i.e. construction, material delivery).
- The inefficiencies of work on large projects are caused by the lack of organization. The skills required for the coordination are not easily found in the public sector but can be found within the military sectors. By using ex-services people as part of the organizational system may improve project efficiencies.
- Adequate and experienced supervision.
- Effective team based for frontline supervision.
- Ensure adequate field supervision and management of workforce.
- Competent management.
- Select top notch project manager and giving him/her authority to take appropriate actions within organizational goals and objectives.
- Do not assign unfamiliar construction to favoured managers.
- Empower project managers to control all aspects of the project.
- Understand mega project complexity and ability and readiness of company system to manage.
- Too much work for all people.
- Too much interference and conflicts between the project players (contractor – owner – other contractors).
- Enhance communication, leadership & decision making at all levels
- Structured observations to increase tool time by finding and correcting inhibitors.
- Give supervision planning assistance and resources.

6. Communication

Better communication on the projects could significantly improve construction productivity. The following suggestions are provided.

- Work processes need to recognize challenges of communication on mega project.
- Daily communication on construction status and success.
- Clarity of roles and responsibilities and authority.
- Clear lines of communications.
- Minimize levels of communication.
- Provide systems and procedures that are simple, effective and user friendly.
- Be honest with completion reporting. Too often construction states they are "ready". Too often work is rushed and not completed properly to get the equipment to site. Too often equipments and (people sits for months), at site, because construction is not ready after all.
- Improve on site communications between construction manager, foremen, and the labour force. Improved communication and defined directions can increase worker confidence and overall buy in to each task.
    - Clear vision.
    - Clear design – complete prior, less rework and fewer changes.
    - Clear scopes.
    - Clear contracts:
        - ☐ Site standard formats/clauses
        - ☐ Minimum superfluous clauses and attachments
        - ☐ Executed prior to start
        - ☐ Understood & adhered to by all
- Proper and timely contractual documentation and processing. If approvals/requests are processed efficiently, more will be handled & brought forward. Clear expectations communicated to all with regular check-ins with constructors.
- Good communication between owner and contractor.
- Give labour force clearer and more direct instructions.
- Provide timely decisions.
- Clear and effective communication amongst parties (including impact of changes).
- Sound, integrated and realistic schedule with fall backs to adjust if absolutely necessary.
- Well coordinated project team dedicated to project consisting of client, EPC contractor and prime construction contractor.
- Communications should include the big picture. Where is the whole project relative to budget and expectations? What are the challenges? What can be expected through the coming period?

7. Contractual Strategy and Contractor Selection

Contractual strategies adopted for the project and the selection of contractors have been cited as key factors for determining the successful execution of projects. Industry professionals input is summarized as follows.

- Select appropriate contracting strategy for the project in line with the project drivers. Contractual relationships and alliances with large contractors and equipment suppliers to streamline construction input and place more responsibilities on the contractor to improve efficiency and control costs.
- Use Construction Management approach, cost reimbursement with maximum upset and bonus scale.
- Break the project into smaller projects (smaller /and areas). Use multi phase approach.
- Hold the contractor accountable and impose liquidated damages.
- More contract with incentives to be efficient. Most current contracts are cost plus which means the contractor is only motivated to work as fast as the owner makes them. If there were more contracts with target price plus incentives, contractors would be more motivated to work harder and faster.
- Build projects during industry "Bust" periods vs. Industry "Boom" periods. In theory labour rates should be cheaper and productivity will be higher because you should be getting the contractors' "A" team. This means to delay mega projects until slower year.
- Use lump sum contracts.
- Form Alliance with an EPC or several of them based on size, technical complexity.
- Avoid fast tracking projects if possible.
- Make procurement/materials handling the responsibility of single company (engineering company or contractor, but not both).
- Properly and well defined contract on detailed scope, detailed schedules, site constraints.
- Pre-screening of contractors for adequate skills, manpower and safety programs. Selection criteria include contractor's familiarity with company standards & areas for efficiency.
- Align with/utilize contractors that have demonstrated good performance in the past (not necessarily choosing lowest bidder).
- In commercial contract documents, have the documents designed to facilitate success. Too often the contract documents are designed to apportion blame. Use terms and conditions to motivate the right behaviour and pursue the right objectives.
- Use contractors that have history of dealing with problems efficiently.
- Establish a good set of weighted criteria to select a contractor (versus lowest price). Resources to be assessed:
    - Engineering/design
    - Manufacturing/fabrication
    - Construction trades
- Bringing in resources from outside provides issues with unfamiliarity with regards to:
    - Engineering - local engineering requirements (cold weather)/standards
    - Construction - work culture (owner/provincial HSE/OHS, regulations, weather).
    - Manufacturing – same as engineering.

8. Constructability in Engineering Design

The constructability of engineering work is a common long-standing issue within the construction industry; its effects are obvious and evident. Industry opinion follows.

- Involve operation and construction in detailed engineering
- Ensure that engineering deliverables are correct and complete (not issued because the time was up and we needed to get them out) to minimize field changes later. If engineering does their work well construction will not have to fix it later for more expenditure.
- Constructability concerns must be included in the engineering process and design.
    - Timely constructability inputs and involvement of construction team during design. Construction personnel should be involved in FEED phases of the project.
    - Hold constructability reviews on a regular basis through out the project, beginning in early phases.
    - Seek lessons learned, best practices, and hold forums to share ideas.
    - Use "standard" methods that suppliers have "ready" to use.
    - Try to use supplier expertise. Their methods are the most efficient.
    - Standardize design.
    - Build only to industry standards "fit for purpose".

- Provide adequate time & resources to complete constructability reviews and allow early contractor involvement.
- Review and simplify owner processes, procedures and specifications and ensure they are industry standard. For example develop generic thermal specifications rather than expending time and resources to review and approve the constant stream of deviation requests to a SAGD projects. (Conventional specs). Alternately, specifications are taken too literally and vendors/contractors have extreme difficulty meeting requirements.
- Limit exposure of personnel to elements by maximizing the work under controlled environment. Productivity in a controlled atmosphere (workshop) is higher than field.

9. Government Influence

The factors that influence productivity in Alberta's Oil and gas projects do not end at the responsibilities of the owner company managers, labour and EPC firms. It extends to include the Government. Industry provided the following suggestions regarding the Government influence.

- Alberta Provincial Government should have a role in pacing the start up of mega projects and apply higher level of approval measurement to reduce the number of players in the huge oil sands projects. The problem is we had too many mega projects going on at the same time, and the human resources in the market was limited, thus it made the players of the projects increase their incentives to attract people. That drastic competition over workers created higher cost and lower productivity. Government and industry needs to plan work together to ensure projects flow together and there are no peaks and valleys in work force. An overall project schedule of the projects would go a long way to help. This is counter-intuitive to some extent because all produces want their production on sooner.
- Government of Alberta should look at the experience of Norway vs. the UK and the government of Newfoundland concerning pacing projects.
- Government of Alberta should make sure proper amount of front-end loading is complete i.e., withhold regulatory approval until a target FEL is reached.
- Remove cross provincial barriers and trade barriers on skilled labour and professional qualifications or make them consistent. Federal responsibilities to allow for easier access to labour forces from all regions of the country to ease labour availability issues.
- For external influence, tie engineering design to operating permit. EUB follow up.
- Increase royalties during times of high oil and gas prices to be kept in reserve. This money could be used during low oil prices for incentives to stimulate drilling and construction of facilities to help level out the boom-bust cycle.
- Improve infrastructure in and around Fort McMurray such as housing, supporting industry (workshops, car maintenance, hotels etc.) roads, airport, and number of air-carriers.
- Ensure sustainable development (both economically and environmentally) i.e., less development and with more effort on each development.

10. Modularization, Prefabrication, Pre-build in Shops

Prefabrication, preassembly, and modularization can affect the schedule and productivity in a positive manner. High-level recommendations were received:

- Use standardization where possible in plant design and construction and do not reinvent the wheel each time.
- Do as much work in vendor's shops to avoid field work (pre-wiring, modularized skids).
- Standardize drawings on repetitive installations.
- Use consistent construction crews.
- Standardize vendors on repetitive installations (bid once and sole source afterwards).
- Invest in fabrication facilities to increase module fabrication capacity and remove some of the pressure from development site resources.
- Increase construction yards in Edmonton area.
- Modularize as much as possible.
- Use more pre-cast concrete products to reduce onsite construction works (erection of formworks and steel bars and pouring concrete).
- Use more prefabricated units.

Construction Productivity barriers

Attendees to the COAA Annual conference which was held in May of 2009 and after the presentation of the above findings were asked each to list three barriers to improving construction productivity and to provide suggestions as to how to overcome these barriers. Out of approximately 150 people who registered in the construction productivity sessions, 89 people responded. The responses were very useful and confirmed the findings of this survey and also reconfirmed that the same lessons were routinely "learned". Appendix 1 provides the list of the barriers and proposed solutions as identified by the highly experienced attendees.

Conclusions

The findings of this pilot study conducted within the Alberta construction industry in the oil and gas sector is another example of the great need for the development of efficient and effective best practices to improve construction productivity. The prioritization of the 10 areas for improvement as assessed by industry professionals provides a framework and a guideline for productivity improvement on future projects. Future improvements as suggested by industry professionals can be summarized to include:

- Incentive and recognition program
- Transportation systems for people and large modules to remote sites
- Job-site access to workers
- Labour management and relations including working with unions
- Overtime and work schedule

- Training for supervisors and field personnel
- Front-end planning
- Workface planning
- Proper management of tools, equipment, health, scaffolding, safety, management of change, and rework, minimization, material management, quality management, contract administration, progress measurement.
- 80% engineering completion, 100% IFC drawings before construction.
- Supervision and leadership
- Communication
- Contractual strategy
- Constructability in engineering
- Pacing of projects
- Modularization, prefabrication, pre-build in shops

Our analysis of the industry survey findings shows that each of the stakeholders be they, the Owner, the EPC firm or Labour, has a role to play to achieve better productivity and to do a good job in performing their duties. Owner's role may include doing a good job in leadership, engineering, scope, specifications, project requirements, staffing, managing change, contract and contractual arrangements, and communication. EPC firm role includes doing a good job in leadership, organization, communication, cost management, time management, safety management, material management, tools management, equipment management, access management, scaffold management, design management and setting priorities. EPC role also includes doing a good job in supervision and labour relations, subcontract work vs direct hire, work week, large job experience, work density, summer work vs. winter construction, skill of engineering, training, morale, bussing, camp, overtime, shift-work, turnover, rework, progress measurement, contingency plans and work face planning.

For labour on the other hand, their role is basically doing a good job in dealing with availability, absenteeism, continuity, skills and competence, supervision skill, supervision training, and supervision availability, jurisdiction, size of crew, waiting time, walking time, rework, weather, start, quit and break and communication.

How good are we as stakeholders in fulfilling our roles and doing our jobs? This question must be answered by industry, because to improve construction productivity we must improve stakeholder performance in achieving their respective responsibilities. Improving construction productivity is not impossible and can be done. It takes commitment of stakeholders to overcome barriers to implementing the suggested ideas and lessons learned.

APPENDIX 1

CONSTRUCTION PRODUCTIVITY BARRIERS AND SOLUTIONS: INDUSTRY OPINION

Barriers	What to do to Overcome Barriers
Attitude	- Labour and management must have a share of the profits - The money that is saved the larger the payout. Reward folks for improvements
Price Uncertainty/ Market Volatility	- Cap Government & top executive bonuses & wages
Owner trust too low	- Identify goal, team, and incentives early. Select contract model & participants early. Reward trust worthy behaviour
Engineers not accountable for impacts	- Put on cost reimbursable plus fee basis with fee tied to performance of overall project – over/under
Attitude Lack of motivation	- Training, build desired attitude with incentives.
Lack of incentive programs	- Create goal based and fair incentive programs - Instil and respect pride
Attitude (labour)	- Labour attitude towards the job should be improved. They take ownership of the project
Attitude	- Not invented here - Always done it this way so it must be right - Understand the dynamics of change & implications on change management
Do not know what you are measuring against. Productivity against what?	- Systematic sharing of quantities, man-hours and cost
Incentives used improperly	- Excessive use of overtime, retention programs, etc., sends the wrong message for project productivity. Owners should be more disciplined in offering only performance based incentives.
Decreased labour productivity	- Better treatment and incentives/bonuses
Selecting too many initiatives & not resourcing adequately - Inadequate results	- Select initiatives such as safety, housekeeping, WFP & implement properly - will pull other results along
Not a consistent workforce-	- In a union & non-union workforce - foremen need to be developed and recognized as a trade. Have more ability to transfer foreman to other projects - make then more of a staff

always new people	position
Lack of construction managers/contractor input in early stages	- Use consultant or EP house resources and augment with Owner or contractor specialists for input in meetings
Change management has many communications issues	- Projects all have changes, but these changes aren't accurate always communicated to the people that need to know change needs to be approved quickly & communicated well
Attracting people to work on remote location	- Companies need to find creative ways to improve quality of life for all while away from home. Not everyone is into sports or PC's
More competitive labour structures	- "Inclusive" labour relations models such as CNRL- Horizon Project Agreement. Permits owner to access all labour providers.
Address mobility of labour	- Continue to reduce interprovincial barriers to labour mobility through TILMA AIT type Agreements
International Recruitment	- Recognize there is an international construction labour force to facilitate mobility of international construction workers
Labourer attitude (or so I hear)	- I do not know how to overcome as this was hearsay on a project I know of. I do not have concrete information.
Owner strategy and commitment	- Owner's team to develop a project team to guide all steps or appoint a CM/EPC/EPCM
Team building between engineering, owner & constructor at all levels	- Create a cooperative environment between all three participants to develop a high level of trust. Equal partners sharing the risks equally.
Lack of decisions / communication between Engineering/Construction on site	- Develop construction / Engineering team that is empowered to make decisions and work as a team.
Not enough skilled craft	- Government involvement to ensure projects are not all going at the same time - Owners to plan their projects as a one team

labour to build all the projects that are on the go!	
Productivity (High) target	- Need labour force (CLAC or Union) and contractors and owners to work together to improve tool time and overall production efficiency. 65% is great – however getting 50% would improve the competitiveness of Alberta projects immensely.
Poor Communication	Less e-mails. More training/ workshops. Attitude/ Perspective need change. More team, Less adversarial.
Soft issues- worker morale	- Camp, bussing, food, etc. - Make sure the project infrastructure will support the site manpower (plus an allowance for overrunning) so that workers do not have small offsite issues affect their morale at site each day.
Labour management	- Have well defined targets tied to labour KPI's and included in the performance criteria of the project. Data drives good analysis which drives good actions.
Worker engagement	- Find out what worker wants to work at job. Understand drivers and costs. Communicate. Allow the worker to know the plan, goal, etc., to promote interest (and therefore develop commitment)
Supervision effectiveness with transient trades	- Many short-term supervisors pop in and out of the DFL pool. There is a natural reluctance or peer pressure to not lead with project success as the goal. There should be a designated good trade credential/or employer incentive to retain good supervision.
Resistance to change	- Have champions to lead efforts - Owners must take lead & mandate some best practices
Development of site/project construction leadership (effective supervision)	- Mentor with Sr. construction manager - Ensure soft skill development - Establish communication points for discussion on project- check in points - Ensure person is aware of strengths/weaknesses and plan developed before job starts on how to address and mentor
Confrontational positioning by parties on contracting negotiations	- Establish level of trust, to allow win-win scenarios to develop on all negotiations - This could be aided by prospect of long-term relationship between parties.
Accountability and trust	- Need all levels (owner, engineer, constructor and workforce) to be accountable for their work. - -- Blame does not work (passing the buck) and creates negative work environment. People need to be responsible for their actions!
Goals & interests are not aligned between owners EPC, contractors & labour - getting done on/ ahead of	- Realign incentive programs that align top to bottom to meet goals/plans - Develop new strategies (?) to address moral hazard dilemma

schedule equals unemployment	
Owner ability to get construction contractor engagement/ desire to get better	- Contract terms & conditions to get contractor to act like an owner
No collective/ common effort by owner/ contractor & labour to work issues- all on owner	- Get them at the same table
Accountability & turnover, i.e. & E, P & C phases …. Project time line	- Continuity of project resources in early phases to end of project, through collaboration between owner's/ EPCM/major construction contractor
- Insufficient benefit some parties (i.e., generates work for some) - Application of disciplined processes is "Hard work", easier to maintain status quo	- Owner's contract to rewards "good" behaviour from owners, contractors & labour providers - Owner's education on "consequences" of poor planning is required, ie, cost/benefit of thorough FEL against loss consequences.
Trust- Parties do not trust each other enough to work freely and openly	- Try to develop longer term relationships greater than just one project. Select a contractor based on experienced and performance not just price on an incomplete package.
Project execution planning by owner & engineering teams	- Ensure owner & EPCMs plan project fully & have competent staff & the correct amount (number) of engineering resources.
Align EP, C and	- Team building – Continuous – Organizational – Change improvements - (Leadership)

Owner on project goals and strategies	commitment.
Not enough knowledge sharing, learning, standardization between owners, and with contractors	- Don't slightest idea! $64,000 question.
Change attitude of labour, supervision and management	- Educate all on the project execution plan. Explain what has been done during FEL & detail design, to support improved productivity. - Explain how material, tool, scaffold, construction drawings will be delivered to the workface. - Explain the expectations of direct labour & supervision. e.g.; Tool time, absenteeism, key productivity indicators… etc. Do this during the site orientation along with the usual site & safety rules.
Silos between owner, engineering & construction	- Conduct alignment sessions - Select contracting strategy best suited to project conditions - Ensure early input of construction, operations & maintenance.
Technology & Communication	- Require 3-D models in the field. Give folks ability to e-mail each other on site for questions& clarifications - More black barriers!
Lack of operations input in early stages of project	- Have agreements in place with operations to name a resource/ position that will provide input into a project. Avoid all day meetings at the engineering house - instead bring the meeting to the operations rep. or use teleconference/ video conference for their input.
Knowledge	- Includes competencies & qualifications in roles & responsibilities. - Have courage to recommend to senior managers not to proceed unless certain items are "Really" in place:- But need to measure or know what "really" is.
Engineering -Delays -Over thought -Inexperienced	- Involve owner /constructability early - 80/100 rule is a must. No excuses from engineering. - Construction planning needed as engineers do not have enough construction knowledge for smart designs.
Poor data flow and Data management	- Owners need to support a comprehensive data management system
Increase of electronic tools	- Native files not pdf's
Loss of data and related intelligence between project phases	- Capture and leverage all associated data & documents from simulation through decommissioning and make available for collaboration across the enterprise ecosystem.

Incompatible and non-interoperable software	- Conform to standard for data such as ISO 15926
Resistance to changes in technology	- Enable learning early and embrace it in the culture of the project
Resistance to implementation of new technology	- Pilot studies
Communication	- Plan to communicate as part of project. - Be prepared to continue to communicate & adjust plan. Monitor effectiveness of communications to be able to adjust.
Planning	- Provide justification to 'owner' to enable proper planning. The owner is: 1- site owner, 2- contractor, 3- supervisor. This involves communication.
Communication	- Prior to commencement of project, clarify roles/responsibilities/expectations - Decision making (levels and streamline). Ensure clarity on how these are going be made, levels of involvement; ensure open, honest communication
Lack of communication between EPC & construction (Procurement and Construction for example)	- Weekly or bi-weekly meetings between procurement & construction to identify late equipment, so construction has a chance to modify main schedules, etc.
Communication	- Have all parties participate and together define clear expectations of each other's roles and responsibilities. Ensure alignment of expectations. - Define what success for the project means, and recall parties contributions to it.
Late delivery of owner furnished material	- Improve required construction delivery timing on schedule - Drive ENG to order earlier - Improve expediting & order tracking
Communication engagement	- Structure communication & metrics to assure routine productivity indicators are received and get to the right level (front line) i.e. weekly score card.
Incomplete or no use of WFP	- In early phases of project begin with the end results of workface planning. Techniques being the goal. Helps to establish the WBS, EWP's and CWP's. Use 80-100 rule for packages.
Engineering -Delays -Over thought -Inexperienced	- Involve Owner/ Constructability early - 80/100 rule is a must - No excuses from engineering

Basic Competencies in owner PM & PC groups	- Training
Incidents	- Better training programs/Proper qualified staff. - Hazard identification
Skilled workforce	- Ensure that we are training personnel appropriately. Not fast tracking apprentices into journeymen without adequate mentors / training.
Client/Owner construction management Experience insufficient. Contractor picks up slack!!	- Client/ Owner's need to ensure better training for their construction management team.
Lack of supervisory skills	- Train, Train, Train. What does it mean to be a foreman, general foreman and superintendent? What are the activities required to keep your men working productively.
Insufficient number of qualified supervisors (age pyramid)	- More training, better schooling, more focus on quality than getting contracts on boom.
Insufficient project controls personnel of adequate quality	- Progress has to be actually measured and separated daily & weekly in order to avoid late panic overtime and the related issues with it, such as poor productivity. TRAINING
Supervisor training	- Industry requires better training to frontline supervision. This training can not be accommodated at the work place and must be done prior to deployment to the work place. Must be geared to reflect the industrial construction activities experienced on major oil sands developments.
Skills & competency of resources (E,P,C/ craft all)	- Mentoring/ Training programs/Government, owner, EPC's common programs, with longterm strategic view regardless of market factors.
Trained & experienced foremen & supervisors	- Within the trades (CLAC or Union) start a training program to enhance experience and to build-up supervision and management skills.
Resisting change for better	- Additional training & educating on new ways - Avoid those who refuse to change (or remove them from positions of influence)
Inadequate skill	- Educate workers level of skill sets & increase training on the jobsite

sets or lack of training	
Lack of construction management for projects > $1B (contracts)	- External hire experience - Train in-house people to grow & - Leverage corporate expertise
Loss of experienced project people in design, ops & construction management	- Improve people training & career path planning - Identify gaps & hire contract staff to fill if can't develop fast enough
Poor implementation	- Train project team on work process, procedure, and R+R. - Conduct internal audits - Foster "Buy in" attitude
Skill level of supervision	- Provide leadership and planning training - Mentor - Empower & support
Poor project execution plans; tons of procedures	- Take the time to prepare a document that is actually being used on a daily basis
Contracting Strategy	- Reimbursable type contracts do not have much influence on performance.
Contracts	- Most construction, procurement and engineering projects do not start with the end in mid and the disciplines to develop plans to achieve the end goal as it relates to cost, schedule, quality, safety, etc. The contract strategy needs to create the correct behaviour and establish the right field behaviour.
Adversarial relationship between parties- not working towards common goal	- Set up contractual & work systems that create common goals
Contract Management Cost increases (Contract strategy)	- Involve construction management in constructability and contract development - Communicate/share contract with those who need to manage it - Clearly define scope with contractor- What is in/out? - Ensure clear understanding of change order process both owner and EPC
Restrictive union contracts	- Renegotiate contracts to provide flexibility
Cost and Production	

prevent having the right people involved in the "Issued for Basic" package and "IFR" package	
Contractual issues re Quality and competency of labour force	
Scope growth/poor control leading to compressed schedules	- Establish clear and agreed to project objectives (is/is not) - Agree on criteria for evaluation of scope changes - Management of change program
Owners	- Stop changing the plans (i.e.; ADD to SCOPE)
Scope definition	- Identify clear scope & communicate well to the team - Solid foundation of technical expertise (right resources)
Scope of work	- Ensure the objective of the project is clear & this means a detailed scope of work needs to be invested in
Poor contracts, always grey areas in the contracts	- All contracts especially scope of work needs to be reviewed by construction.
Scope definitions in contract	- Owner's need to know what the scope is
Scope changes/Revisions	- Lack of FEL caused rushed designs with flaws and oversights. Many revisions and changes result in late IFC drawings and last minute changes of whole systems. Follow 80/100 Rule! (We must in future)
Lack of skilled resources	- Proper identification of resources. This to include both people and machinery. Complication is to show impact of other projects & their scope growth
Scope definition, i.e.; fixing the scope, at a specific time/set time line	- Clear line of communication, i.e. decision making & reduce the level of communication - Specs & standard of project's design to be set and ready for implementation in very early in phase of project.
Defining scope	- Extend a "Gated Process" throughout execution
Scope & quantity growth after AFE	- Rigorous evaluation of FEL - Get engineering sequence right (e.g. get process engineering done early).

Scope Change, Specifications change, Any Change	- More complete Engineering before construction - Freeze design by owner after construction starts
Scope definition	- Owners don't know what they want before they engage their contractors. Often the project is oversold to senior sponsors and executives
Engineering deliverables	- A real teamwork of EPC to work hand in hand on achieving goal
Engineering deliverables	- Don't start work until we have all deliverables & material available for a work package
Deliverables	- Timely delivery of deliverables to the work site to support the schedule (drawing, equipment, materials). Allow contractors (on site) to purchase minor material shorts to allow work in progress to be completed instead of waiting for the EP house to purchase material at their convenience.
Not enough material	- Establish target backlog of material before execution of work
Procurement - Material shortage, deficiency in deliverables from vendor FAB	- Expedite - Early PO. - Alternate work schedule
Equipment and material delivery	- Include supply chain in construction planning
Material/Tools/ Equip. availability	- More workface planning and verification. That materials and equipment/tools are on site. There is too much talk and not enough true follow through.
Owner's deadlines	- Owners must set realistic goals for the project. Establish clear success criteria.
Material Management/ Coordination between different engineering firms software & constructors onsite software	- Industry standardized labelling & tracking. Not realistic. So instead, better interfaces between different software packages. To assist uploading, downloading of materials information.
Tool management	- Worker incentives to return tools undamaged, stolen etc. - Worker accountability for tool usage

- Barrier is increased Control vs. supply	- Management incentives for tool supplies i.e., all the money we save is lost, stolen, and damaged. Tools should be used to incentivize different behaviour
Workface planning	- Detailed work planning including materials, tools, labour, drawings, schedule and specifications.
Availability of deliverables (Drawings, materials, equipment, etc.)	- Plan early - Start construction later - Implement workface planning
Compressed schedules	- Give the contractors enough time to complete the project
Poor planning & plan management	- Continuous Schedule & Plan reviews
Scheduling	- Need to allow proper time to do each stage of the project successfully. Keeping end date stiff w/o recognizing the schedule impact along the way create extra costs by not allowing proper planning due to lack of time
Engineering deliverables out of sequence with construction	- Engage construction management and/or contractors as early as possible in engineering and plan EPC schedule to path of construction
Rushing all project phases: perceived value of this to the business case	- Provide owner management with the probable cost impact of different schedules. - Fast schedule: High cost vs. “Good” schedule: Low cost. Let them pick.
Time-schedule (“rushing” to stay on schedule-short cutting)	- Project thinking has to change - some activities may need extra time to be implemented but will make the project better in the end
Patience with planning	- Scheduling at the front of a project is essential to it’s success and cost savings. Do not rush the plan, make sure it is thorough. Provide adequate resources up front to make a plan, not delay the plan
EPC integration	- Ensure from conception EPC integrated schedule. Lot of time this is being done at macro level. This needs further divided to micro level. Schedules are typically integrated at level 2 & field construction is executed at level 4/5 schedule
Schedule challenges- self imposed or production	- Longer term planning: Leave time for EPC in logical order; rigorous discipline for staged project process

driven	
Execution - decisions based on "schedule driver projects"	- Education – Making effective business decisions
Poor engineering - (not constructable)	- Engage workface planning at the FEL stage and throughout
Front end planning / Work face planning	- This must begin at the DBM phase and there needs to be stakeholder agreements and joint ownership for success. Applying gates and good decision criteria will help to understand risk and look for joint agreement on the risks. Without this it becomes a blame game.
Lack of leadership commitment to proper front end planning	- Business leaders must listen to professionals and allocate resources ($ + people + time) to do proper front end planning - Professionals must stand up to management/ business leaders against incomplete FEL
Underestimation of impact of incomplete design (FEL + detailed design) by business leaders & many project directors	- Proceed to AFE only after complete FEL - Proceed to construction only after 100% completion of IFC.
Owner company budgeting/cash flow practices	- A big reason for not doing adequate front end engineering and also having inflexible finish dates are hard & fast cash flow targets. Owners need to be more flexible in this regard.
Material Control/Delivery	- Lack of FEL and rushing schedule created rushed material orders and scope changes. The rush orders bumped up prices and some material not being delivered on time forces us to rob from the other design areas. Understaffing created lack of follow up. Material control system broke down and now we do not know where everything is and must reorder. This has caused further delays, incomplete modules and long punch lists.
Constructability	- Lack of FEL caused rushed designs w/ little thought to constructability resulting in rework, NCR's, RFI's and revisions. This plays havoc with rushed schedules and costs sky rocket.
Money - it costs more money upfront to do something from the start	- Way of thinking has to be changed- have to be able to see that spending $ up front will mean less cost in the end

Preparation/ availability of work site	- More focus on FEL and pre-job coordination
Time for productivity analysis, i.e.; access to job site infrastructure	- Develop deep knowledge related to these issues and assure they are planned up front (FEL). Resource the planning phases to assure all the topics are covered and integrated.
Incomplete FEL (Design related)	- Implement stage gate process
80% design complete/100% IFC	- Projects are fast tracked & changes have no impact on end date for time system to work
Relax end dates on Fast track	- Do risk-benefit analysis including for alternative execution plans using financial impacts & other quantitative & qualitative analysis to show that sometimes relaxing end date costs less and has more benefit than compressing schedule. Our company is doing this with some benefits
Qualified resources	- Allow fast tracking of TFW
Fast-track projects	- Have a committee of qualified (construction) that is empowered to delay the project
Fast track projects when oil goes up	- Not to do it!
Understand the issues with fast tracking projects	- Create a cost & schedule factor to add the cost estimate so that management understands the implications upfront.
Fast tracking	- Eliminate or reduce use of fast tracking
Incomplete designs (Take pride in your work)	- Incomplete, poor, late engineering seems to be more common place than in the past. Adding more pressure on Construction is not beneficial to a project. Construction needs to plan around poor designs while trying to keep the workforce productive. The workforce takes less pride in their work when it is apparent the design was not complete…..Too many changes.
Accepting risks (i.e., start action) before plan is sufficiently complete	- Owners set and hold to planning and engineering development standards and not given to fast tracking mentality.
Start construction before ready for	- Agree need high level of engineering completed before in field and packages as part of WFP. Engineering support in the field.

field	
Engineering	- If engineering is not to total IFC status have design engineering resources at the project site to take immediate decisions with regard to engineering issues.
Engineering	- Have engineering complete prior to starting construction
Incomplete engineering	- Engineering resources must be adequate to complete 100% of design prior to construction start
Owner executives Fast track projects due to business drivers	Executive Education on PM
Defaulting to a fast track mentality for shareholder's sake	- Take the time necessary to proper plan & procure materials - Educate shareholders that rushing to market only increases the overall capital cost, reduces quality, and negatively affects start up, results in less than desirable plant-all of which negatively affects shareholder value. Take the time to do it right the first time.
I.F.C. packages & materials late & consistently lacking.	- Need to eliminate " Fast tracking" - Plan projects with a much longer view-term view (i.e., > 5 – 10 yrs) When prices drop as in Q3/Q4 of 2008, that is the time to build not to stop.
Executing multiple "Mega" projects simultaneously	- Mega project defined as large enough to impact provincial/ Federal economies. Collaborative sequencing of projects**.** Try the "LASA" approach of air pollution.
Low morale/Spirit	- Social programs & proper breaks
Compressed schedules/ Arbitrarily set completion dates leading to incomplete project planning	- Use "standardised" project schedules (Front end + execution). Provide business planning decisions - Must be mandatory use.
Incomplete site construction logistics planning	- Make this a mandatory part of all project planning, i.e.; planning is incomplete unless logistics have been considered for anticipated project size and complexity.
Construction Permitting	- Develop KPI's for measurement - Obtain Buy-in from operations and construction team on KPI's
Late engineering	Planning - Provide/ schedule overtime - Provide incentives
Reasonable	- More measurement and Comparative analysis

expectations	
External ties not factored in project plans	- Impose transfer pricing for scarce resources. If need be offer rebates or other taxes to offset. Example: Highway 63 Toll?
Be exited and positive about Alberta environment vs. 'sour taste' from recent past (owners, EPC & labour)	
Inadequate time (Fast tracking)	- Owner Boards and strategic planning teams to provide adequate time for full project cycle
Infrastructure	- Government to plan infrastructure based on future investment projections. Need to do a better job.
Early involvement of the right disciplines to plan stages prior to construction	- Correctly utilize the path of construction process from initial phases of project
Awareness Timeframe	- Project team needs to be aware of where improvement can be achieved/lessons learned
Contract Style (C+)	- If C+ is used, insure that the parameters & goals post are clear. What is suitable, what is not, who is accountable for task on owner side & EPC side. Clear definition, black and white only. Gray leads to confusions which equal to costs and los of productivity.
Lack of detailed planning before beginning engineering	- Allow time to do detailed, inter-discipline, planning of work before starting engineering. Communicate the plan and commit to executing the plan
Lack of operations experience in engineering process	- Include ops experience in design planning. Owner must commit to scheduled ops reviews, then accept design at the completion of work (mech. completion to be defined)
Poor Construction supervision (owner & contractors)	- Hire qualified construction personnel. Hire employees based on proper qualifications (not friends, etc). Major problem in our projects.
Late issue or incomplete issue of IFC packages	- Start projects earlier - Meet predetermined milestone dates or else push out completion dates

Lack of resources	- Permitting is a limited resource in a live plant. Do not have more construction resources than you can permit in a timely fashion.
Poor FEL	- Provide adequate time to plan, schedule & optimize construction activities.
FEL	- Company timing to get projects approved doesn't match project schedule and resource to do work
Contract strategy	- Quit lump sum to lowest bidder, build relationship with contractor - Unit rates
Safety	- Working safer can/does reduce productivity - Need to challenge, find innovative ways to work safe & fast (good job planning) - Sacred cow to discuss safety & productivity
Lack of management of change program	- Establish rigid MOC program during all phases of EPC execution
Benchmark PF @ ENG 50 / 75 / 100% vs. Construction % completion.	- Monitor the PF of each discipline during engineering execution vs. construction / PF for that same discipline.
Craft experience re Rework, Over building, Poor quality	- More specific training needed for the craft on their specific tasks. Too much emphasis spent on theory and not enough on practical side especially at the school level.
Engineering- Late delivery, Lack of clarity, lack of constructability (Normally found in late stage)	- Increase field resident engineering resource
Construction – Short of resource in WFP. Lack of supervision & leadership	- Early plan. Right supervision
Lack of manpower	- Coordinate or regulate Mega projects
Worker morale 26	- Do not bring 300 men and provide then the work of 50 - Coordinate activities so items are installed once only
Owner team not changing end date when factors suggest they should	- The success factors are generally known on major projects. The owner's team, and generally the senior management part needs to ensure these lessons and experiences learned are followed and applied rigorously.

Evolution of workforce planning	- A high risk exists that WFP is rammed by owners on to the contractors. Some concepts, ideas have and could result in 100's of owner planners working on a Mega project. These planners are not likely available and at the same time we (owner) are doing the work of the contractor. If the scenario develops, I doubt this will improve project execution success.
Starting in the field prior to sufficient engineering progress	- Owner's decision makers (i.e., executives & board members) need to hear the message. This will lead to the right decisions being made at the right time. We never seem to learn this lesson.
Limit overtime	- Get buy in from other owners to stay on a 5 day/week shift.
Lagging field productivity	- Engage workforce planning at the FEL stage and throughout
Proper construction sequence	- Engage workforce planning at the FEL stage and throughout
Apathy: This is from tradesman to construction management & even higher	- Make sure everyone realises that the worker is the costumer. If leadership does not care, worker becomes "Apathetic".
Aging workforce	- More training - amalgamate certain trades or portions of trades. i.e., sheet metal worker/ and insulator - Do electricians really have to pull cable or could supervised labourers do it?
Poor planning or good planning and poor execution	- "All plans are perfect, until they meet the economy". Training & Top down commitment incent good execution of plans"
Incomplete engineering	- Business units need better information and/or less influence. - Realistic mandates for engineers
Lack of proper planning	- Benchmarking to see benefits make strict contractual requirement and audit - Make schedule tool not deliverable
Concept	- Quality improvement (QI) process improvement QA/QC is focussed on minimum STD.S
Flow Management	- Get away from task management towards Flow MGT. How is work as individual affects people/process forward & Backward from our performance? Don't throw over fence to next area
Traditions	- Think outside the box, have courage
Lack of discipline	- Upgrade leaders - PM, legal, Management
Lack of planning	- Take time to plan
Delivery of CWP & IFC	- Front end load to ensure delivered on time. - Firm scope
Supervision	- Ensure adequate supervision to reduce worker idle time waiting for decisions
Labour barrier	- Convert overtime hours to stock options for public companies in oil sands (i.e.;

(work hours)	NEXEN, SUNCOR)
Transportation	- Train one worker to drive the bus to and from to plant site
Engineering Drawings	- Duplicate an existing plant (Drawings are complete), same equipment (lump sum)
Multiple projects create labour, engineering, material and other shortages	- Provide a mechanism to "pace" projects through release of projects – resolutions that ultimately influence the development rate of the resource
Starting construction with inadequate eng., materials, tools, etc Barrier is the illusion that the project will be done faster - Project "euphoria" and enthusiasm to "get going"	- Discipline to wait until all elements of the work packages are ready against the "view" of some elements which drive the project. This is the accepted method to manage turnarounds.
Resistance to change (New methods, approaches)	- Education and implementation of change management theory.
Culture: Reactive vs. Proactive	- Be prepared by being ahead of problems. People getting too much "credit" for solving problems that shouldn't have been there.
No. of regulatory approvals. Is it necessary?	- Alberta needs to evaluate the approval system in order to reduce number of applications and increase efficiency.
Lack of standardisation	- Develop standard designs and repeat them (Design one, build many)
Capturing/Documenting/Sharing "lessons (not) learned"	- Executive commitment at highest levels (INCL. Gov't policy, investor) to capture & share lessons learned
We do not properly value the economic cost of schedule maintenance/Ac	- Education/Modelling

celeration	
Develop/ enhance document (Incl. Review) of project life cycle processes	
Reluctance to invest without proven/demonstrated benefits	- Establish case studies & benchmarking to demonstrate benefits.
Incomplete engineering	- Don't start construction until minimum level of engineering is completed
Inflective supervision	- Provide more training of supervisors, assess their abilities and correct deficiencies, reward good performance and support their decisions
Time constraints Generic forms and time allotted for proper "lessons learned"	
Improper project development and progression	- Remove "LOWEST BID WINS" mindset from all negotiations. These end up forcing or leading parties to make up profit in a fashion detrimental to project. For example, establish two stage bid evaluations, similar to CEA suggestion
Lack of alignment	- Owner/ EPC alignment exercise at the beginning of job and continuing through the P and C phases
Lack of scope	- FEL
Inadequate long term planning	- Pray for a miracle! - Owner – shareholders buy in – mature financial planning - EPC – Owner/ EPC - trust
Time Constraint: Projects typically have short timeframe which gets further squeezed with estimate to final completion	
Following the strategy from	- Clearly align tactics & execution plans with overall strategies. Reward conformity to strategy and plans

top to the front line	
Resource availability (skilled labour) and operations input to design	- Prioritize work (project) based (not all high priority) on requirement & resource availability - Phase out the project to manageable stages (to minimize large WH requirements)
Hwy is congested during rush hours (1-2 hrs each way)	- Govt. to increase infrastructure spending - 4 lane highway (continuous)
Lack of good engineering companies to do mega/large projects. Engineering schedule delays	- Farm out to outside the province, e.g. Toronto/Montreal - Standardize, modularize
Safety	- Priority for safety. Incentives & expectations
Operations/Leadership	- Understanding interface with operations to improve implementation and earlier in design
Planning	- On mega projects there must be an integrated schedule for all disciplines, too often each contractor is doing his own thing that is not good for the overall project.
Planning	- Have the planning in level of detail that permits the construction to be done according to the plan.
Barriers to improving construction productivity: - Lack of owner's urgency and resources to improve - Perception "It's too difficult" - Owner competency on improvement methodologies too low	- Owner's education on "consequences" of poor planning required, i.e., cost/benefit of improving FEL against loss consequence. - Share more case history "success stories" - Create educational offerings on practical solutions
Schedule is easier to measure than	- Improve definition of quality and management (leading indicators)

quality, therefore receives higher priority.	
Competency of industry owners, GWC, EPC personnel	- Requires accreditation, certification process to ensure standards - Stability of industry major project portfolio avoids boom & bust mentality
Keeping construction managers/ supervision and foremen in their roles from start to finish	- Empowered the positions - Incent the positions - Make them part of project team
Proper reporting	- Owner to ensure reporting requirements are known for all contractors with proper definition
Major projects being slowed or stopped, due to commodity price swings	- Plan projects with a much longer term view, (i.e., > 5-10 yrs.). When prices drop as in Q3/Q4 of 2008, that is the time to build, not time to stop
Poor infrastructure, ex., HWY 63, lack of high speed rail to Fort Mac.	- Government & industry to work together (mutual benefit) to these long term commitments
Lack of organizational discipline in following documented project system	- Follow system - Educate all levels of organization
Unrealistic project objectives in areas of cost and schedule	- Proper project basis
Staffing resourcing plans are weak or non existent	- Assure a review of labour/pool is completed & predictable before we start
Get engineering designs more:	- For oil sands mining specifications don't over design with a hydrocarbon specification mentality

- Fit for purpose - Constructable	- Engage the vendors and builders early and in a meaningful way - Get EPC's to be less risk averse in design
Brawn field efficiency is too low	- Get operations and project team aligned, agreed on KPI's, sharing in success
Owners Perception that "We don't have time to plan"	- Educate owner management that planning is essential to effective project execution
In-experienced project teams	- Select/hire/train staff to ensure they have the requisite skill level to perform their role effectively
Outsourcing / subcontracting work for organizations who are not capable/prepared to deliver work	- Chose "partners" based on proven capability of the proposed team or individual people build projects, not companies/tools/systems. - So get the right people (individuals) on the team
Contractor is brought on to the project too late	- Select a contractor based on experience and performance, not just price on an incomplete package
Lack of experience in modularization	- Owner/ Engineers need to study past or current projects to fully understand what is cost effective to modularize.
Business Unit Alignment	- Executive sponsors of large projects must have more than a fundamental understanding of project management
Greed	- During times of high demand, engineering & construction contractors are satisfied with providing under qualified staff producing substandard work but still expect premium margins
Too much non-working Time is built into the work day	- Look at the value of Tool box meetings - Field level risk assessment - Permits - Safety meetings - We need to improve the delivery of safety instructions and job instructions
Unrealistic expectations by owner for budget schedule & schedule "Wants forever to make up his mind"	- Gated approach to project delivery - Allow back end of schedule to float
Engineering is	- Develop realistic engineering schedules for delivery of CWP packages, Engineering

late and under frequent revision	Firms “bow” to pressure of owners to commit to aggressive schedules.
The cost plus approach has been a major drag on productivity	- Foster development of “joint and severally liable” EPC contracts
Bad Preplanning	- Take the right amount of time on preplanning. Redoing, replacing etc. not only takes time but frustrates contractors
Set realistic goals and communicate so they become everyone’s goals	- Communication from top down will positively affect moral which affects productivity
Lack of empowerment	- Empower the worker, the supervisor, the superintendent, the contractor to make decisions
Incomplete or poor project execution plan	- Implement stage gates process
Owners Buy-in to realistic cost & schedule	- Benchmarking – re capacity, durations, costs
All stakeholders buy-into 80-100 rule	- Understand it, Try it, Prove it, Commit to it, ** It Works**
Insufficient skills for the amount of work in timeframe expected – All disciplines, owner, EP & contractor	- Long-term workforce development
Poor owner – EP – Construction contractor contracting (unclear requests, expectations, resp. etc.)	- Take time to do it right (much longer contract formation cycle time, more comprehensive).
Execute in accordance with	- Ensure that accountability for each step in the planning and execution of work faces is understood by all and that there are no gaps in accountability

workface plan	
Tired workforce	- Scheduled overtime for long durations should be avoided - Avoid bidding war for labour

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