CAE Task Force – Follow-up to the Megaprojects Leadership Forum

Final Report

February 2025

THE CANADIAN ACADEMY OF ENGINEERING
L'ACADÉMIE CANADIENNE DU GÉNIE

Canadian Academy of Engineering

Megaproject Leadership Program

Task Force Follow-Up to Megaprojects Leadership Forum

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1. Executive Summary

In March 2024 the Canadian Academy of Engineering (CAE) hosted the Megaprojects Leadership Forum (MLF). The impetus for the MLF was threefold:

- Canada faces a significant challenge, as do many other countries, in planning, designing and executing megaprojects at the scale anticipated over the next two to three decades;
- Delivering these megaprojects on-time and on-budget is key to Canada's future productivity and global competitiveness; and,
- CAE is well-positioned to play a leadership role in successfully addressing the megaprojects challenge, as the membership of CAE includes many Fellows with extensive megaprojects expertise and experience, both in Canada and globally.

A Task Force was established by CAE in late 2024 to build on the results of the MLF and to provide recommendations as to how CAE should direct its future efforts in this regard.

The Task Force recommends CAE focus its near-term efforts on two areas highly pertinent to addressing the megaprojects leadership challenge - Best Practices and Building Capacity. CAE can make a distinctive and impactful contribution toward solutions at the national level, as follows:

- **Best Practices**
  - Establish CAE as the trusted source/advisor for megaprojects in Canada, by creating and maintaining a Canadian Megaprojects Centre of Excellence (CMCE); and,
  - Utilize CAE's unique expertise to broaden the current body of knowledge regarding best practices for megaprojects.
- **Building Capacity**
  - Review, validate and further develop the key elements of the "Building Capacity" framework from four perspectives - Governments, Private Sector, Labour/Trade Unions and Indigenous Peoples; and,

- Assess CAE's potential role in leading or influencing change in each of these areas, with the objective of developing specific recommendations and prioritizing actions to be undertaken by CAE, or by CAE in collaboration with partners.

The Task Force further recommends that two CAE Working Groups be established, one to advance work in each of the above areas. The first, under the leadership of Joy Romero, will address the subject of Best Practices. The second, under the leadership of Howard Shearer, will address the subject of Building Capacity. Both Working Groups will report into CAE via the Future of Engineering Committee (FEC).

The Working Group leaders will work with the FEC and CAE staff to populate the Working Groups and to engage with governments/industry/others to solicit any necessary funding to support this work.

In order to maintain CAE's momentum on the follow-up to the MLF and to ensure the results of further work are timely and relevant, the Task Force recommends the Working Groups complete their work and provide a report outlining findings and recommendations by no later than end-2025.

2. Introduction

The purpose of this report is to outline the findings and recommendations of CAE's Task Force on Follow-Up to the MLF.

The report provides context for CAE's engagement on this topic, provides linkage to the outcome of the MLF, describes the scope and objectives of the Task Force, describes the recommendations of the Task Force and outlines a path forward to advance CAE's work in this area.

This report is not intended to provide definitive outcomes or recommendations in each of these areas, as that is the task of the following Working Groups. Rather, it outlines initial perspectives from the Task Force on each of these topics and provides a framework for further work by CAE, including proposed priorities for the respective Working Groups. The report endeavors to strike a balance between providing the necessary clarity on next steps and at the same time affording the Working Groups and prospective funders the necessary latitude to develop more specific work plans and to determine how the follow-up work should be conducted.

3. Background and Context-Setting

The CAE initiated the MLF, which was held in Ottawa in March 2024. The final report on the MLF can be found at: https://www.cae-acg.ca/wp-content/uploads/2024/06/CAE-MLF-Report-June-2024.pdf .

The impetus for CAE to conduct the MLF and to work with its sister academies on this issue was threefold. The first was the view that Canada is not well-positioned to plan, design and execute megaprojects at the number, scale and timeline required to achieve electrification and greenhouse gas reduction targets by 2050, particularly given this investment will be over and above an ongoing significant level of baseline investment (in areas such as infrastructure, transportation, mining, education, healthcare and defense) and must occur in a global context where many other countries face very similar challenges on very much the same timeline. The second was that delivering these megaprojects on-time and on-budget is key to Canada's future productivity and global competitiveness. The third was the view that the pragmatic and realistic "voice" of engineers, and engineering leaders who will be tasked with designing planning, executing and operating these megaprojects, needs to be more visible and influential in the national dialogue.

While estimates of forward-looking megaprojects investment are inherently uncertain, under any scenario the overall scope of investment is daunting. The most recent Major Projects Inventory (MPI) released by NRCan highlights the very significant planned investment over the next 10 years in the energy, mining and forestry sectors alone: https://natural-resources.canada.ca/science-data/science-research/data-analysis/natural-resources-major-projects-planned-under-construction-2024-2034#a1. That being said, there is a significant potential prize in getting this right. Successful investment in transformational megaprojects would stimulate Canada's domestic economy, contribute significantly to progress toward Canada's greenhouse gas reduction targets, create opportunities for Canada to be an impactful participant and partner in global initiatives and enhance Canada's global "Brand".

As a national organization of distinguished engineers in various engineering fields, the CAE occupies a unique position to significantly contribute to the national dialogue on engineering-related capacity and expertise required to tackle the key megaprojects engineering challenges (scale, cost, schedule, etc.).

The MLF was comprised of 30 senior engineering leaders drawn from both industry and academia, with strong sectoral, regional and Indigenous participation. Industry attendees included representatives from utilities, engineering and construction firms, pipelines, the nuclear industry, mining and others. The full list of participants appears on the last page of the MLF report referenced above.

Five overall themes emerged from the workshops and dialogue at the MLF:

- Developing an Industrial Strategy and "Roadmap" Framework for "Net Zero".
- Addressing the need for policy clarity and regulatory reform;
- Imbedding future-oriented Best Practices in megaproject planning and execution;
- Building Capacity to plan and deliver megaprojects; and,

- Enhancing Canada's megaprojects "Brand".

In each of the above areas, the MLF report identified several priority areas for potential follow-up action for consideration by CAE.

While all the above areas are relevant and important to Canada's megaprojects challenge, CAE's FEC applied a number of criteria to determine near-term priorities for action by CAE. These criteria largely related to CAE's capacity and capability to have a meaningful impact in the near term, interest in the topic from key stakeholders (including governments), and the extent to which CAE could add value relative to other organizations engaged on the same topic.

It was determined that CAE's near-term focus should be on the third and fourth theme areas noted above, namely Best Practices and Building Capacity, with each of these topics to be addressed by a dedicated Working Group. In the current geopolitical climate, it is particularly important for Canada to engage in these areas with a sense of urgency and with a step-change mindset.

4. Task Force

The FEC established a Task Force as a follow-up to the MLF report. In broad terms, the role of the Task Force was to:

- Provide further clarity and specificity regarding the scope of work and expected deliverables for each of the two Working Groups;
- Provide a basis for subsequent discussions with prospective participants in the respective Working Groups, recognizing that it will be important to engage sufficient capacity and the right expertise on these Working Groups; and,
- Provide sufficient clarity regarding CAE's plans in each of these areas to attract funding support (from governments, business, etc.).

The Task Force was encouraged to assess these topics from a strategic perspective, recognizing that Canada's challenges and opportunities in both these areas must be viewed in a global context. In addition, consideration was to be given to the full life cycle of megaprojects, from front-end conceptualization and planning through to operations.

The Task Force was constituted in late 2024 and was comprised of the following members:

- Dave Collyer - Task Force Chair and member of the FEC.
- Robert Crawhall - CAE CEO.
- Joy Romero - Lead for the proposed Best Practices Working Group.
- Howard Shearer - Lead for the proposed Building Capacity Working Group.

The Task Force reported to the FEC, with the FEC Chair and CAE CEO providing the interface to the CAE's Executive and Board of Directors.

The Task Force was requested to provide its recommendations in the form of a report to the FEC, targeted for completion by end-February 2025.

5. Task Force Recommendations

The Task Force has prepared two framework documents, one for each of Best Practices and Building Capacity. These frameworks broadly outline the proposed scope of work for the respective Working Groups and provide further details regarding resourcing requirements, timelines and potential collaboration opportunities. Each of the two frameworks is summarized below, and the complete framework documents are provided in Appendix 1 and 2, respectively.

It is important to note these topics – Best Practices and Building Capacity - should not be viewed in isolation but rather are interdependent in many respects. They represent two key elements in successfully addressing Canada's megaprojects challenge. As noted earlier, they are also not the only themes relating to the megaprojects challenge that need to be addressed, but rather ones where CAE can make a distinctive and impactful contribution toward solutions at the national level.

The primary target audiences for these framework documents are governments (both provincial and federal), regulators, businesses (e.g., owners, contractors, suppliers) and other practitioners involved with megaprojects. They are intended to stimulate interest in and support among this group for the upcoming Working Group deliverables, as well as to provide a basis for potential engagement/collaboration as the Working Group activity progresses over the next several months.

Finally, there are two broad perspectives that have influenced the Task Force recommendations for both Working Groups. The first is that our recommendations are fundamentally directed toward improving Canada's productivity and competitiveness across the entire lifecycle of megaprojects. The second is that these recommendations and resultant actions cannot be a "one-off" but rather must be kept evergreen in the spirit of continuous improvement. These perspectives are reflected in the recommendations pertaining to each of the Working Groups.

Overview of "Best Practices" Framework

The Task Force recommends that CAE focus its efforts on Best Practices in two key areas.

The first is to establish CAE as the trusted source/advisor for megaprojects in Canada, with the objective of continuously improving Canada's competitiveness and productivity. Globally, there are numerous bodies of knowledge in megaproject execution. However, they are generally "pay to play", are not founded on a digital platform that lends itself to timely renewal and collaboration, and do not bring a

Canadian lens to these challenges and opportunities. The CAE Working Group would determine the most effective and efficient way to build and maintain a Canadian Megaproject Centre of Excellence (CMCE) under the auspices of CAE. This would be created and maintained on a digital platform, initially with a Canadian orientation but with the capacity to be extended to the international community over time. Wherever possible, it would leverage existing best practices knowledge and expertise.

The second is to utilize CAE's unique experience and expertise to broaden the current body of knowledge regarding best practices for megaprojects. The full life cycle of megaprojects extends from front-end conceptualization and planning through to back-end transition to operations. The current body of knowledge regarding best practices appears to be somewhat deficient regarding the "front-end and "back-end" segments of the life cycle, both of which are critically important to on-time and on-budget delivery of megaprojects. The CAE Working Group would build out and validate the key elements of the megaprojects life cycle and take a deeper dive to develop and recommend best practices in areas where there are current gaps.

The framework document outlined in Appendix 1 provides further detail regarding the proposed scope of work for the Best Practices Working Group. It also outlines preliminary thinking regarding the key elements of the proposed CAE Megaprojects Centre of Excellence.

Overview of "Building Capacity" Framework

The Task Force recommends that CAE focus its efforts on Building Capacity in two key areas, both also with the objective of continuously improving Canada's competitiveness and productivity as they relate to the execution of megaprojects in Canada.

The first is to review, validate and further build out the key elements of the "Building Capacity" framework. The initial framework document outlines key elements of the megaprojects challenge from four perspectives - Governments, Private Sector, Labour/Trade Unions and Indigenous Peoples. The CAE Working Group would further develop this framework, engaging these groups as necessary for input and review.

The second is to assess CAE's potential role with respect to leading or influencing change in each of these areas, with the objective of developing specific recommendations and prioritizing actions to be undertaken by CAE, or by CAE in collaboration with partners. The primary focus should be on subject matter where CAE has legitimacy and credibility as a thought leader. These recommendations would not only make a step change difference in the efficiency and effectiveness of megaproject execution in Canada, but would enhance CAE's visibility and reputation as the key engineering voice influencing change as it relates to Building Capacity.

The framework document outlined in Appendix 2 provides further detail regarding the key groups influencing the megaprojects supply chain, as well as an initial assessment of overall improvement opportunities in each of these areas. It then more specifically provides an initial assessment as to where CAE might best direct its efforts to make a substantive impact on the capacity to execute megaprojects in Canada.

6. The Path Forward

Joy Romero will lead the Best Practices Working Group and Howard Shearer will lead the Building Capacity Working Group. Both Working Groups will report into CAE via the FEC.

The CAE CEO (Robert Crawhall) and the Chair of the FEC (Oskar Sigvaldason) will provide the interface with the CAE Board.

As noted earlier, these framework documents are to be used to attract both funding and participants for the two Working Groups. The Working Group leads will work with the FEC and the CAE Chief Executive Officer to populate the Working Groups and to engage with governments/industry/others to solicit any necessary funding. Given prior engagement by CAE with the federal government (NRCan) on the MLF, NRCan is expected to be the primary initial source of federal government funding. Provincial governments and Canadian companies with a significant stake in the success of megaprojects are also expected to be a source of funding support. CAE Fellows with extensive knowledge of the subject matter will be the primary initial target for participation in the Working Groups and will be supplemented by others with relevant expertise. Our expectation is that each Working Group should be comprised of about six members, with diverse geographic representation across Canada (Note: The two Best Practices work streams may lend themselves to separate working teams, which can be confirmed as the Working Groups are populated).

While the Task Force has developed these framework documents to better define the scope of work and intended outcomes, we have deliberately provided the latitude for the Working Groups and prospective funders to develop more specific work plans and to determine how the follow-up work should be conducted. Our expectation is that the Working Groups, once constituted, will develop a final Terms of Reference, work plan and organization structure to govern their activities. Additionally, it will be important for this initiative to be effectively integrated with other related activity underway by CAE.

To maintain CAE's momentum on this important topic and to ensure the follow-up work is timely and relevant, the Task Force recommends the Working Groups complete their work and provide a report outlining findings and recommendations by no later than end-2025.

7. Wrap-Up

CAE has both the necessary expertise and credibility to contribute toward solutions to Canada's megaprojects challenge. In advancing the work outlined in the two framework documents on Best Practices and Building Capacity, CAE has an opportunity to make a material difference in areas that are critically important to Canada's future productivity and economic competitiveness. Addressing this challenge, particularly in the current geopolitical context, requires step change rather than incrementalism. The Task Force strongly encourages the FEC and CAE's Board to endorse these recommendations and to assist in addressing the funding and representation necessary to establish and support the proposed Working Groups.

Appendix 1

Framework for Best Practices in Megaprojects Planning and Execution

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Framework for Best Practices in Megaprojects Planning and Execution

Building on the recommendations of the Megaproject Leadership Forum, the CAE Working Group on Best Practices recommends a focus on two key areas.

1. **Establish the Canadian Academy of Engineering as the Canadian/Global Megaproject Centre of Excellence (CMCE)**

    - Globally there are numerous bodies of knowledge in megaproject execution, for example:
        - The American Project Management Institute, Independent Project Analysis and the Construction Industry Institute;
        - The UK Omega Centre;
        - The Australian Institute for Project Management; and,
        - The International Project Management Association (Netherlands), which is a federation of 70 Member Associations.
    - These are all “pay to play”.
    - CAE Fellows have previously been involved in establishing the Clean Resource Innovation Network (CRIN), which provides a potential model for CMCE.

    Next Steps:
    Task Force Working Group
    - What is the most efficient and effective way to build and maintain a Canadian Megaproject Centre of Excellence to developed and maintained by the CAE?
    - **Establish a small team** of CAE fellows to support framing:
        - Set the guiding principles, for example:
            - Does not duplicate what has already been done;
            - Open access;
            - Allows for ongoing evergreen submissions;
            - Can be region- and sector-specific; and,
            - Links to other databases.
        - Determine
            - What is the role of CAE?
            - What is the role of collaboration/partnerships?
            - What is the role of technology/digitization in providing an accessible and evergreen platform?

        - How is the documentation, sharing and implementation of best practices/lessons learned implemented?

Outcome: ***CAE is a trusted source/advisor for Megaproject Execution that will continuously improve Canada's competitiveness and productivity.***

CMCE Example:

Following is an example of the potential construct of a CAE Megaproject Centre of Excellence:

- Host and grow Canadian practitioners, researchers, educators and their body of knowledge by:
    - Creating and maintaining a digital platform that:
        - Canadian megaproject practitioners, researchers and educators can join, creating a searchable directory of experts in this field;
        - Can host the Canadian megaproject body of knowledge, created by the CAE and others within Canada; and,
        - Can be linked to existing bodies of knowledge.
    - Creating a virtual space (e.g., closed LinkedIn group) where practitioners, researchers and educators can interface and learn from each other.
    - Convening practitioners, researchers and educators physically and virtually around topics that support improving the efficient and effective execution of Canadian megaprojects, resulting in greater productivity (these would be recorded and added to the body of knowledge).
    - Building with the capacity and flexibility to expand scope to the international community over time.
- Resources required:
    - Centre of Excellence Manager.
    - In-house IT support.
    - Facilitator.
    - Funding reporting.
- Potential sources of funding:
    - NRCan.
    - ISED – SIF Network support.
    - Industry.
    - Philanthropic Organizations.

2. **Build on the Current Body of Knowledge for Megaproject Best Practices**

- The current body of knowledge for Megaproject Best Practices appears to be deficient in covering the full life cycle from front-end conceptualization and planning through to transition to operations.
- Failure to implement early-stage best practices will result in cumulative issues as the megaproject progresses.
- What are the gaps that need to be closed to complete Megaprojects on time and within budget to achieve the intended outcome?

Next Steps:
Task Force Working Group

- Need to gather/aggregate the current body of knowledge with respect to the full life cycle of Megaproject Best Practices.
- **Establish a small team** of CAE fellows to support this exercise and framing for a workshop:
    - Set the guiding principles:
        - Work with partner academies (specifically in the US, the UK, and Australia), with whom the CAE has previously collaborated to deliver an international workshop.
        - Provide objective and impartial advice to governments and others regarding delivery of megaprojects throughout their life cycles.
    - Determine:
        - Further build out and validate the characterization of the key elements of the life cycle for megaprojects.
        - Highlight areas where best practices are currently well-documented and accessible.
        - Identify key decision-making stakeholders at each stage of the life cycle.
        - Conduct a deeper dive to develop and recommend best practices where there are current gaps (most likely on the front end of the life cycle, where the Owner is the primary driver of the megaproject, and/or in the lack of an integrated or holistic approach to all elements necessary to deliver a successful megaproject).
        - Identify best practices relating to the application of technology to improve productivity for megaprojects.
        - Identify and share best practices as they relate to increasing the participation of underrepresented groups in

the megaprojects labour force, particularly in leveraging underutilized labour in the region where projects are being executed.

- **Host a workshop /determine next steps.**

Outcome: ***CAE is a trusted source/advisor for Megaproject Best Practices that will continuously improve Canada's competitiveness and productivity.***

Illustrative Example:

The following is an illustrative example of a case where the Owners early life cycle work is not being included in best practice material.

This is an excerpt from a Project Management Institute publication with the section in *italics* added by an owner with megaproject experience.

PMI – Planning and Controlling Megaprojects by Frank R. Parth:
Exhibit 6: Combined Program Stage Model
Business Decision Gate 1 - Opportunity Identification
This is the initial decision by the business to begin a new project, or not. For the financial resources which can be made available, what projects should the organization invest in?

- For an oil/gas company, which are the most potentially profitable new fields for development (greenfield projects) at an acceptable level of risk? Or is the money better spent refurnishing and upgrading an existing facility (brownfield project)?
- For a mining company, which are the most potentially profitable new mineral resources we can invest in?
- For a pipeline project, where should the pipeline be routed? How big should it be?
- For a public works infrastructure project, what financial resources are available through taxes or bonds? Which possible projects will return the greatest public benefits?

There is a significant amount of pre-project work that needs be done to ensure success later on.

Owner Experience:
In addition to the above an accountable Lead with access to people with the right expertise would need to develop:

- *Business Need*
- *Organizational Plan*

- *Review Lessons Learned*
- *High Level Scope Development*
- *Technology Development Plan*
- *Risk Registry*
- *High Level Estimate*
- *Financial Modeling*
- *High level Execution Plan:*
    - *Labour Study*
    - *Grid Study*
    - *Engineering Contracting Options*
    - *Procurement Plan – Long leads*
    - *Funding Plan*
        - *Solo*
        - *Partners*
    - *Stakeholder Identification and Communicatiosn Plan*
    - *Regulatory/Permitting/Approvals Plan*
        - *Provincial*
        - *Federal*

The subsequent gates would all have additional Owner's tasks and a need for holistic integration:

- *Business Decision Gate 2 - Feasibility Analysis*
- *Engineering Decision Gate 1 (EG1) - Detailed Engineering Studies*
- *Project Management Decision Gate 1(PMG1) - Project Execution*
- *Project Management Decision Gate 2 (PMG2) - Initial Operations*
- *Business Decision Gate (BG 3) - Achieves Design Intent*

Appendix 2

Framework for Building Capacity in Megaprojects Planning and Execution

Appendix 2

Framework for Building Capacity in Megaprojects Planning and Execution

Part 1 – Overall Framework for Building Capacity

Building on the recommendations of the Megaproject Leadership Forum, the CAE Working Group on Building Capacity would focus initially on building out and validating the following framework and identified improvement opportunities.

1. **Governments -** What can be done better?

   - Stakeholders
     - More effective engagement /input in developing government policy:
       - Longer-term strategic focus.
       - Visionary thinking - proactive, not reactive.
       - Leadership in defining Canada's strategic interests.
       - Greater focus on early resolution of Federal / Provincial jurisdictional responsibilities/ conflicts impacting megaprojects.
   - Greater focus on simplifying regulatory complexities/ Interprovincial trade barriers.
   - Role of Canadian Institutions:
     - Greater support for Secondary and Tertiary education to build capacity. A national supply chain strategy requires deliberate deployment of funding and other resources to impact the future national Supply Chain requirements for a growing economy. Deliberate planning is required to ensure availability of access required skill sets. For example: (1) STEM has been sidelined by the rush to AI as the majority of student cohorts overlook the future needs of other engineering and trade disciplines, and (ii) The number of "seats" for accredited engineering programs is limited by provincial funding decisions, restricting the pipeline of new Canadian engineers.
     - An aggressive program for preparing future generations on the forward-looking Supply Chain requirements in all critical areas of expertise is required.
     - The following institutions must be included; however, which organization will provide leadership for such an initiative and how funding will be provided needs to be addressed:

- Universities
- Colleges
- Technical Training Institutes
- Vocational schools
- Trade Unions
- Companies

- Introduction of Temporary Skilled Workers visa program to induce competition into the labor market, relieving labour shortages:
  - Temporary Foreign Workers Program: Streamline visa processes for skilled labour imports during peak demand periods.
- Strategic Credentials Policy
  - Elimination of Interprovincial certification/credentials barriers for a more robust qualified national & mobile workforce.
- Free trade passage corridors for interprovincial projects critical to economic development (energy corridors, pipelines, etc.).
- Infrastructure for Logistics and Distribution**:**
  - Modernization of ports and rail systems:
    - Upgrade key ports - Vancouver, Montreal, Halifax - to improve capacity & efficiency.
  - Expand rail infrastructure to connect remote regions and reduce transportation delays.
  - Modify regulations on load requirements on highways to reduce delays and cost for the transportation of large infrastructure equipment.

2. Private Sector

- Awareness of challenges and opportunities impacted by global political and economic fluctuations.
- Address the challenge of balancing the opportunity for international projects to provide a key source of income for Canadian firms while potentially limiting resources available for projects in Canada.
- Emphasize both *attracting* and *retaining* talent:
  - Prepare to recruit the best skill sets.
  - Prepare to retain the best skill sets.
- Strategic Planning and Coordination **-** Integration of Project Timelines

- Synchronize project timelines to prevent overlapping demand surges for materials and labor.
- Greater use of predictive modeling to anticipate deviation from critical path mitigating/minimizing bottlenecks and schedule impacts.
- Investment in warehousing and distribution centers.
- Increase warehousing capacity near urban centers and critical infrastructure hubs.
- Incorporate advanced inventory management systems for just-in-time delivery.

- Strengthening Domestic Manufacturing Capacity
  - Increased production of key materials.
  - Localization - encourage domestic production of steel, cement, and other critical construction materials.
  - Leverage mining Industry/resources.
  - Provide incentives for manufacturers to adopt sustainable and efficient practices.
- Strategic Stockpiling
  - Develop regional stockpiles of essential materials strategically deployed to buffer against supply chain disruptions.
  - Create public-private partnerships for resource allocation during emergencies.
- Develop Resilience Against External Disruptions: Risk Management and Redundancy Strategies
  - Diversify sourcing to reduce reliance on single suppliers or regions, particularly for critical imports.
  - Build redundancy into supply chains to mitigate the impact of natural disasters, trade disputes, global political upheavals, trade disputes or pandemics.
  - Plan infrastructure investments with future climate impacts in mind.
- Technology/Digital Tools
  - Implement AI-driven supply chain management tools to optimize logistics and anticipate disruptions.
  - Leverage blockchain for transparency and traceability in procurement processes to ensure QA/QC requirements.
  - Use digital twins for real-time monitoring and optimization of supply chain networks.
  - Modularization designed into in construction methodology.

- Employ predictive analytics to forecast material demand and transportation needs.

- Automation and Robotics
  - Loading, unloading, and material handling processes at ports and distribution centers.
  - Optimize delivery to remote areas by utilizing barges, ports, roads, drones.
- Innovative Financing Models
  - Public-Private Partnerships.
  - Encourage collaboration between governments and private sector investors to share risks and benefits.
  - Establish infrastructure investment funds to attract domestic and foreign capital.
  - Explore user-pay systems, such as tolls, to fund supply chain enhancements.
  - Green bonds to finance sustainable supply chain projects.
- Contract Model Balancing Risk versus Reward
  - Must be structured to incentivize work force performance as it relates to schedule and costs, and be completed before project starts.
  - Contract must also include a mechanism to effectively settle all claims within a short time frame (as they occur), so as not to jeopardize schedule and hence costs.
- Project Management
  - Functions well-executed are central to success of megaprojects - Project Managers must be given the authority and responsibility to make necessary decisions, which include but are not limited to the following:
    - Development of project structure.
    - Standardization of the work breakdown structure (WBS).
    - Schedule baseline and updating of schedules.
    - Analysis of project schedule reports and variances with corrective actions recommendation and actions.
    - Project teams review of the massive amounts of data along the critical path of major infrastructure projects, requiring timely analysis and decision-making crucial to achieving on time and on budget.
    - Development of Team Culture before project starts.

- Maturity of Design: Incomplete or faulty design has a cascading effect on an entire project, impacting costs and schedules [further compounded if the project is “first of a kind” (FOAK)].

- Critical Path (CPM)
  - Defines effective planning for a successful project addressing the roadmap to begin, sustain progress and achieving KPI at completion/commissioning related to costs/budget/ schedule and performance.
  - Division of responsibilities:
    - Project functions: Engineering, Procurement Construction, Material management and Quality are separate and distinct responsibilities, each with defined accountability.
    - Safety must be the #1 priority, the responsibility of every employee engaged on a project and a highly visible KPI to all levels of management, including the Board of Directors - accidents resulting in loss of life, severe injuries and near misses cause site shutdowns, Investigation, delays, financial penalties and loss of morale, severely impacting costs and schedules.

3. **Labour/Trade Unions**

- Workforce Gaps
  - Improvement in Productivity
  - Culture
- Upgrading Skill Sets
  - Establish Strategic Regional Training Centers in partnership with governments, labour, private sector and Indigenous peoples.

4. **Indigenous Peoples**

“Duty to Consult”
The difficulty in reaching agreements within an acceptable timeframe, whether that be month or years, requires a fresh approach to enable outcomes that meet the needs of Indigenous Peoples, the Crown and Project Owners. The potential role of CAE at the table as a neutral party providing factual technical

opinions, similar to the role of *AMICUS CURIAE*, could be effective as a means to reduce delays in regulatory approvals for megaprojects.

- Project Owners - Consultation with Indigenous communities must begin at project conception (or preferably before).
- Consultation and engagement must be underpinned by a meaningful and sustained commitment to economic reconciliation – benefits agreements, equity participation, etc.
- Opportunity for Indigenous communities to upskill current and emerging population, which is even more critical to megaprojects in order to satisfy future projects skill requirements.
    - Requires a long-term economic, trade, skill development strategy supported by all parties.

Part 2: CAE-Specific Opportunities

An initial assessment of potential opportunities for leadership or collaborative engagement by CAE in developing solutions to the Building Capacity challenge.

1. **Government**

   Role of CAE:
   - Establish a program, in partnership with academia, labour to educate/inform owners/investors & government (federal, provincial) decision-makers at the conceptual stage of approval for all megaprojects:
       - Planning requirements for Megaprojects National Credential's policy.
       - Policy support on Temporary Foreign Workers.
       - Support on Infrastructure for logistics & distribution.
       - Assistance in mitigating potential regulatory roadblocks encountered in megaprojects.

2. **Private Sector**

   Role of CAE:
   - Focus on development of Project Management expertise as the foundation of a megaproject's critical path.
   - Educate owner/investors, government decision-makers by providing reference planning platforms to support megaprojects *(covering all topics raised under Private Sector in previous document).*

3. **Labour/Trade Unions**

Role of CAE:

- Support Labor/ Trade unions to establish benchmarks for project teams/trades to meet (EPC) acceptable standards.
- Support Strategic Regional Training Centers (SRTC).
- Focus on retention of skills knowledge.

4. Indigenous Peoples

Role of CAE:

- A neutral 3rd party involved (after acceptance by both parties) in a manner equivalent to *Amicus Curiae* to facilitate resolving issues in a manner fair to both parties.
- CAE's body of expertise and visible engagement could enable solutions by assisting in resolving technical or other issues occurring during the Duty to Consult process, thereby mitigating or eliminating potential major delays to megaprojects.

Background on Indigenous Consultation and Engagement

The following Engineers Canada Guideline on Indigenous Consultation and Engagement provides further relevant context regarding the role of Indigenous Peoples as it relates to megaprojects in Canada: https://engineerscanada.ca/guidelines-and-papers/guideline-on-indigenous-consultation-and-engagement.

The Working Group on Building Capacity will utilize this and other resources, as well as insights from Indigenous Fellows of the CAE, to guide its further work in this area.

THE CANADIAN ACADEMY OF ENGINEERING
L'ACADÉMIE CANADIENNE DU GÉNIE

CAE Task Force – Follow-up to the Megaprojects Leadership Forum

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