Candidate Strategies to Reduce Risks in Large Engineering & Construction Programs

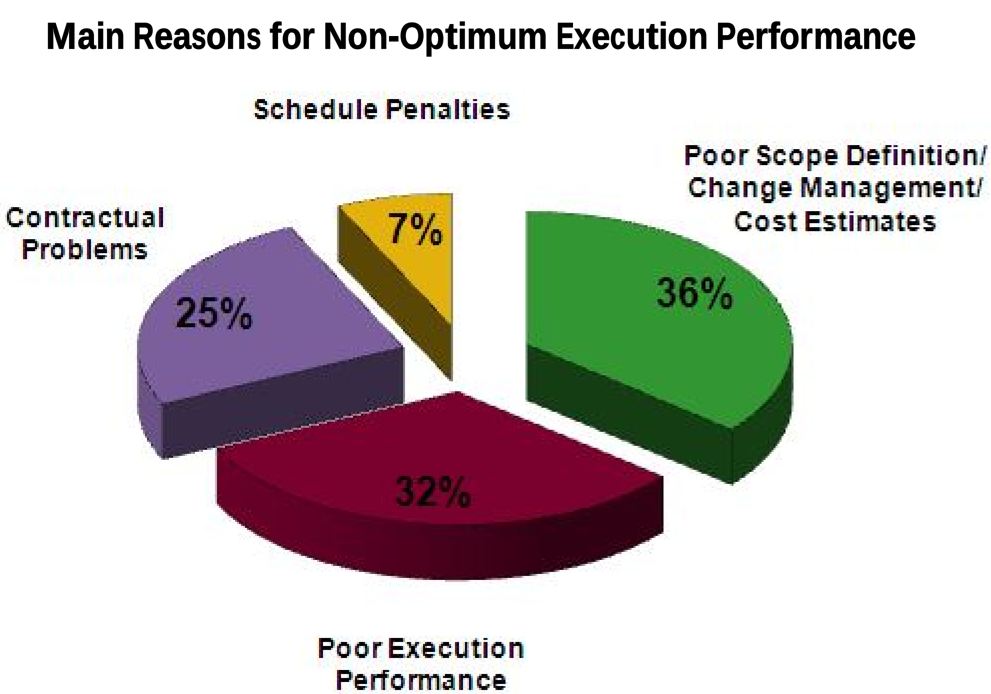
By Bob Prieto

Every large engineering and construction program is different as are the risks it faces. There are no silver bullets for managing and reducing risks in these large programs but there are some recurrent strategies. This paper lays out some candidate strategies organized from a "Triple Bottom Line" or sustainability perspective.

I have chosen this sustainability framework in recognition that a more holistic, life-cycle approach is characteristic in these emerging "giga" programs and consistent with the strategic program management approach I have written about previously.

Not every candidate strategy is viable, necessary or desirable on every large engineering and construction program. Nor is the list of such strategies complete. The purpose of this article is to get the reader started on the process of identify strategic options and tactics to reduce the risks that a major program faces.

While many risks will be driven by externalities, internal performance based risks should not be ignored as they represent some of the greatest risks in the successful delivery of any large scale program. This can be seen in the following figure.



Let's look at these risks and potential candidate strategies utilizing the following sustainability framework:

- Economic
- Social
- Environmental
- Management

Economic

Sustainable program dimensions from an economic perspective include:

- Labor Availability & Cost
- Labor Productivity
- Labor Impacts on Program Location
- Material Availability & Cost
- Long Lead Equipment
- Construction Equipment
- Logistical Costs
- Life Cycle Costs
- Relocation or Reconfiguration Costs
- Industry Creation
- Balance Sheet
- Risk & Insurance Costs

Each of these dimensions lends itself to one or more candidate strategies to reduce risks in large engineering and construction programs.

Table 1 looks at each of these dimensions and suggests candidate strategies for consideration.

Table 1

Candidate Strategies to Reduce Risks in the Economic Dimension from a Sustainability Framework Perspective

Sustainable Program Dimension	**Candidate Strategies**
Labor Availability & Cost	Module construction in labor rich, low cost location; maximize manhour density in modules shipped
	Aggressive pre-fabrication and pre-assembly strategies
	Use of global engineering centers
	Specific candidate strategies for modularization, pre-fabrication and pre-

	assembly include: • Precast underground duct banks • Precast electrical and telecom pull boxes • Maximize steel fabrication to complete assemblies (stair towers, access platforms) • Pipe support, electrical/instrumentation stanchions all prefabricated and assembled • Tanks shop built • Prefabricated electrical vaults, telecoms buildings, and control rooms • Standardized electrical vault cable tray runs and preassemble (or include in modules as appropriate) • Underground pipes spooled to 80 foot lengths, coated, and tested • Precast concrete sumps and pipe trenches • Maximize size of vendor skids to include all piping, electrical, and controls • Preassemble any overhead cranes not incorporated in modules • All remote pumps mounted on common skids and pre-piped with all controls • Precast road crossings for pipe or cable • Warehouse and workshop as fold-away type buildings with internal frame for overhead crane • Camp buildings fully modular, including mess hall • Precast and preassemble any haul road bridges required • Water treatment skids

	• Tilt-up construction for any electrical fire separation walls • Precast any temporary building foundations • Conveyors completely preassembled, including cable trays, walks, ladders railings, etc. • Conveyor bents fabricated in largest transportable sections • Temporary power skid mounted • Temporary, floating dormitory • Modular construction camp housing • Modular wharf • Standardized modular plant buildings • Floating desalination facilities • Floating power plants
Labor Productivity	More detailed and earlier construction planning integrated into Master Schedule. Emphasis will be identifying coupled constraints (labor, materials, equipment, logistics, etc)
	Early craft training for unique skill sets required by the various projects comprising the program.
	Comprehensive skill based labor needs and availability assessment.
	Craft training at select locations outside the final program location when to the program's benefit (example would be a module yard)
	3D design of modular portions of design to enhance module construction and subsequent relocation of modules if so required
	Protyping of highly repetitive modules or key program elements
	Establishment of a owner owned module yard in a favorable location that would be available to the various project contractors
	Designs will optimize execution not design while meeting requisite criteria.

	Embed architect and engineer in field during critical construction operations.
	Dates established for scope and design freeze to minimize impact of changes
	Industry leading safety program recognizing its impact on site productivity.
Labor Impacts on Program Location	Maximize low value, high impact construction accomplished by pre-fabrication, assembly and modularization outside final program location.
Material Availability & Cost	Maximize standardization across projects to simplify supply chain and gain purchasing leverage
	Put in place select strategic supplier relationships for major material supply categories. Broad multi-project procurement strategies to be considered include: • high value, major process equipment utilized in multiple projects or across multiple program phases • large quantities of supporting equipment (pumps, motors, control valves, signals, switches) • bulk plant materials (piping, valving, cabling, stairways, windows, ladders, grading, roofing, doors, coordinated architectural details or finishes) • materials of construction (steel, concrete, aggregate) • construction consumables (fuel, formwork, safety supplies) • non process infrastructure (camp housing, supporting camp facilities, culverts, administrative or other temporary buildings, concrete chases) • Logistical services (heavy marine, railroad, trucking, expediting, customs, permits, specialized transport)

	• Miscellaneous construction services (temporary power, canteen, sanitary, waste disposal, security, construction vehicle maintenance)
	Identify risks best retained and managed by owner than in individual projects. Strategies include use of commodity hedges, exchange rate risk retention (FOREX) and hedging, wrap up insurance policies either by owner or contractors. Risk arbitrage strategies include: • Fuel cost hedges • Heavy marine transport hedges • Currency hedges • Aluminum hedge • Iron Ore and Metallurgical Coal hedges (steel surrogate)
	Use of more extensive client furnished materials program to secure market pricing and delivery leverage; reduce contractor risk provisions and markups associated with such materials.
Long Lead Equipment	Strategic suppliers engaged in the front end engineering process.
Construction Equipment	Construction equipment forecast and evaluation of assured supply
Logistical Costs	Embed a technical translation function in offshore construction sites.
	Material handling wharfs to avoid handling delays at port main facilities
	“Possessions” of critical infrastructure for transport managed
	Logistical requirements forecast
Life Cycle Costs	Incorporate consumable cost risks and volatility into life cycle evaluations
	Develop approaches that maximize end of life value (re-use; alternative use; recovery of valuable materials facilitated)
Relocation or Reconfiguration Costs	Construct high value facilities in module sizes and weights that lend themselves to transport to future program elements (example: mine

	crushing and screening facilities and sampling stations relocatable to future mine sites)
Industry Creation	Capacity development program coupled with mentor-protégé contracting
Balance Sheet	Acquire select program elements on a non CAPEX basis (DBOM; PPP; delivered service.) Candidates include: • Specialty equipment with strong technical maintenance component or desired extended warranty • Non process infrastructure best treated as part of operating cost vs. consuming limited CAPEX (site based housing, power generation, water treatment) • Non process infrastructure which lends itself to economies of scale by serving multiple programs (offsite power; desalination; wastewater treatment; housing; community facilities; medical facilities) • Common carrier facilities such as pipelines; transmission lines; communication backbones • Logistics facilities best delivered on a multi-user basis (railroad; port & wharf facilities)
Risk & Insurance Costs	Self insured, pooled risk reserves: • Worker's Comp risks • Property risk • Vehicle risks • Escalation risks in select commodities • Benefit & welfare program risks • Builder's Risk • Environmental Risk • Sovereign and regulatory risks

Social

Sustainable program dimensions from a social perspective include:

- Procurement and contractual frameworks
- Craft capacity building
- Management capacity building
- Global leading best practices
- Societal supporting facilities
- Managing uncontrollable growth
- Performance management

Table 2 looks at each of these dimensions and suggests candidate strategies for consideration.

Table 2

Candidate Strategies to Reduce Risks in the Social Dimension from a Sustainability Framework Perspective

Sustainable Program Dimension	Candidate Strategies
Procurement & Contractual Frameworks	Transparent procurement system and process available to and required to be used by all project contractors
	Partnership Against Corruption Initiative (PACI)
	Modern Terms & Conditions reflecting appropriate risk allocation
	Streamlined contract change process to avoid delays
Capacity Building – Craft	Early craft training for unique skill sets required by the various facilities.
	Comprehensive skill based labor needs and availability assessment to be undertaken.
Capacity Building - Management	Skill requirements definition and management training focused on program and project management
	Mentor-protégé relationships with executives from outside the program team
	Task force assignments to gain deep exposure to new areas
Global Leading Best Practices	Industry leading best practices on safety recognizing the value of a human life
	Confirmation of sustainability program as global best practice

Societal Supporting Facilities	Contract with affected stakeholder groups for delivery
Manage Uncontrollable Growth	Early and ongoing labor and logistical requirements forecasts including forecast of indirect human (accompanying persons and families; service labor demand induced by program labor force) and logistical demands (transport, travel, housing, power, water, food, sanitary demands by accompanying persons, families and service labor)
	Location of work sites at distributed locations when possible including execution of work at pre-assembly, pre-fabrication or module yards at remote locations.
	Limiting new permanent facilities to those consistent with longer term growth plans.
	Limited licensing of industrial supporting facilities not desired post construction. Operating needs must be factored into such limitations.
Performance Measurement	Early PMC issuance of common "social" bottom line metrics

Environmental

Sustainable program dimensions from an environmental perspective include:

- Waste streams
- Energy
- Water
- Recyclable/reusable materials

Table 3 looks at each of these dimensions and suggests candidate strategies for consideration.

Table 3 **Candidate Strategies to Reduce Risks in the Environmental Dimension from a Sustainability Framework Perspective**	
Sustainable Program Dimension	**Candidate Strategies**

Waste Streams - General	On-site use of select waste streams (heat, water, compostable materials)
	Pre-fabrication, pre-assembly and modularization as strategies to "leave waste streams behind"
Energy	Waste energy use for central heating or cooling of nearby housing or community facilities
	Implement energy reducing strategies during construction. Specific strategies include: • Consolidated shipments to the site • Renewable energy to meet onsite construction power needs • Use of micro grids • Onsite power storage of excess generation • Cut and fill balancing • Reduced number of lifts and working at height • Energy control devices to shut off idle equipment • Proper maintenance of heavy equipment • Improved insulation of camp facilities • Waste stream reduction to reduce handling and transport of waste streams • Use of natural heat sinks • Incorporation of shipping reinforcement in final module design (no removal; no waste transport) • Emphasis on efficient laydown areas • Improved workface planning

Water	Select grey water use for agriculture
	Minimize potable water use during construction • Runoff water capture • Use of grey water in wash down operations • Use of grey water in concrete manufacture • Use of grey water in dust control operations • Use of grey water for landscaping operations • Use of grey water for fire protection operations • Use of reclaimed water as makeup water in select power and process applications • Separate potable, grey water and blackwater systems at construction sites • Wastewater (blackwater) mining with limited treatment for use in grey water applications
Recyclable/ Reusable Materials	Scrap recycling (wood, metals, packing materials)
	Specification of recyclable packaging materials

Management

While not a sustainability dimension per se, management's cross cutting nature warrants a separate callout in Table 4 as it relates to candidate strategies to reduce risks in large engineering and construction programs. Many more traditional strategies exist and have not been repeated here. Rather, some less frequently considered strategies have been called out.

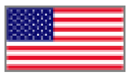
Table 4 **Candidate Strategies to Reduce Risks in the**

Management Dimension from a Sustainability Framework Perspective	
Sustainable Program Dimension	**Candidate Strategies**
Management	Dedicated client elements embedded within the PMO
	Salt and Pepper organizational approach to foster management development within the client organization while maintaining independent PMO role within client.
	Cross cultural training given the nature of the program and the global supply chain it will require
	Time lapse photography to document progress and support subsequent marketing efforts. Select use of IMAX photography for program marketing if a public or high profile program.
	Actively capture procurement and construction lessons learned and make available to all program contractors in an appropriate manner
	Address multiple site document control needs to meet owner requirements.
	Early clarity on applicable codes, standards and inspection requirements and freeze.
	Augmented supplier quality assurance and audits by the PMC
	Robust progress management standard and audit
	Startup readiness risk assessment and planning initiated at outset of program.
	Tollgate process drives schedule
	Knowledge management program initiated across all projects
	Early and ongoing stakeholder engagement and management

ABOUT THE AUTHOR

Bob Prieto

Author



Bob Prieto is a senior vice president of Fluor, one of the largest, publicly traded engineering and construction companies in the world. He is responsible for strategy for the firm's Industrial & Infrastructure group which focuses on the development and delivery of large, complex projects worldwide. The group encompasses three major business lines including Infrastructure, with an emphasis on Public Private Partnerships; Mining; and Manufacturing and Life Sciences.

Bob consults with owner's of large engineering & construction capital construction programs across all market sectors in the development of programmatic delivery strategies encompassing planning, engineering, procurement, construction and financing. He is author of "Strategic Program Management" and "The Giga Factor: Program Management in the Engineering and Construction Industry" published by the Construction Management Association of America (CMAA) and "Topics in Strategic Program Management" as well as over 400 other papers and presentations.

Bob's industry involvement includes recent and ongoing roles on the National Infrastructure Advisory Council's Critical Infrastructure Resiliency Workgroup and the National Academy Committee "Toward Sustainable Critical Infrastructure Systems: Framing the Challenges". He is a member of the ASCE Industry Leaders Council, National Academy of Construction and a Fellow of the Construction Management Association of America.

Bob served until 2006 as one of three U.S. presidential appointees to the Asia Pacific Economic Cooperation (APEC) Business Advisory Council (ABAC), working with U.S. and Asia-Pacific business leaders to shape the framework for trade and economic growth and had previously served as both as Chairman of the Engineering and Construction Governors of the World Economic Forum and co-chair of the infrastructure task force formed after September 11th by the New York City Chamber of Commerce.

Previously, as a senior industry executive, he established a 20-year record of building and sustaining global revenue and earnings growth. As Chairman at Parsons Brinckerhoff (PB), one of the world's leading engineering companies, Bob shaped business strategy and led its execution. Bob Prieto can be contacted at Bob.Prieto@fluor.com.