Evolving Nature of Program Risks in the Engineering & Construction Industry [1, 2]

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The scope and scale of major capital construction programs is growing worldwide driven by a combination of technological and demographic factors. Whether manifested by expanded energy and industrial capacity to meet the world's growing demands or complex infrastructure to replace or renew that of the developed world, today's major capital construction projects are at a scale and complexity that challenges our collective ability to efficiently and effectively deliver them.

But scale and sheer numbers are far from the only challenge. Today's major capital construction programs face an emerging set of risks that extend well beyond the project's battery limits. While such over-arching or multi-project risks have existed in the past in the form of regional or national political risks, labor strife or even common exposure to natural events, today's increasingly networked supply chains face new challenges of a scale and consequence rarely seen in the past.

This paper seeks to outline some of the risks that major capital construction programs are increasingly exposed to today and posits that some of these emerging risks are the result of "industrial" style management and governance models which do not adequately reflect the networked nature of delivery of today's mega-construction programs.

Failure of Financial Sector Risk Management as an Analog

It was spring of 1827 and Robert Brown had just returned from collecting pollen in the Scottish countryside. A botanist, Brown placed some of the pollen in water under his microscope and observed the grains of pollen moving about completely randomly. That random motion, now called Brownian motion after its discoverer is a useful tool in studying truly random events. Many of today's risk models are founded on the principles of Brownian motion, at least as Robert Brown understood them in the spring of 1827.

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[2] How to cite this paper: Prieto, R. (2008). Evolving Nature of Program Risks in the Engineering & Construction Industry, Second Edition, *PM World Journal*, Vol. IX, Issue X, October 2020. Originally published in *PM World Today*, September.

Financial models and their associated risk management tools, built on the randomness underlying Brownian motion, served the financial industries well, at least to the current financial crisis. But recent events have highlighted that many of these risks and financial markets were more tightly coupled than many recognized even if the coupling was not apparently obvious (1). In reality, it was a similar, complex coupling (constantly moving water molecules) that underpinned the apparently random motion that Robert Brown saw on that spring day in 1827.

The effects of this less than apparent coupling between seemingly random elements in complex systems has been seen by the engineering and construction industry across a broad array of engineering failures. Today, analogous forms of tight coupling are creating new risks to be understood and managed in the delivery of major capital construction programs.

Emerging "Correlated" Risks

"Correlated" risks in and of themselves are not new. What is new is the nature of some of these risks and the global nature of their reach. Ten such emerging risks are described below, others exist.

1. Common global demand drivers for natural resources and primary materials

Large, rapidly growing, developing countries represent emerging market shifting drivers for the materials of construction. As these emerging economic powerhouses move through the various stages of development, underlying market drivers are likely to shift in more dramatic ways than we have previously seen. Price points are likely to shift dynamically and spot market volatility likely to increase, reflecting the time lag between growing demand and the ability to increase supply of these basic materials. Industrial policy in China and India may impact cost and schedule of major capital construction programs across all industries around the world. Risk assessment and management strategies must recognize and address this challenge through new supply chain solutions, modified capital expenditure profiles and changed engineering and procurement cycles.

2. Energy security

Growth in worldwide demand for energy, driven in large part by the common global drivers described above, carries with it an additional risk element whose importance has grown as marginal industry capacity is increasingly absorbed. This additional risk element is associated with potential threats to energy security from both state and non-state actors. Energy flows through the Straits of Hormuz and Mallaca are growing (over half of all seaborne oil) and increasingly vulnerable to disruption from terrorist, piracy or accidental events. State actors with an ability to disrupt already stretched global energy flows have

shown an increased willingness to wield their supply concentration power. (Russia; Venezuela)

3. Shortage of Heavy Marine Transport

We deliver major capital construction programs in an increasingly globalized and networked supply chain. This supply chain literally extends around the world and is increasingly managed utilizing the latest tools in logistics management. But for the engineering and construction industry, much of the supply required, travels through this supply chain on heavy marine transport. New construction strategies of pre-fabrication and modularization as well as the reconfiguration of the world's heavy industrial base carries with it a requirement for specialized heavy marine transport. Today's mega-project needs to increasing understand the logistics risks of movement of the materials of supply from source to use and actively manage risks that were often unseen, hidden away in often ignored shipping schedules.

4. Supply disruption from natural events in major areas of supply

In the engineering and construction environment of yesterday, adequate stockpiles and overall industrial capacity existed such that disruptions in supply due to natural events were often seldom felt and where of a relatively transitory nature at worst. This is not the case today, as demand has stretched certain key industries to capacity and global stockpiles are limited relative to global demand levels (less than three months' supply for most base metals). Many areas that represent critical raw, intermediate or final supply sources are vulnerable to the disruptive effects of natural events or disasters. For example, consider each of the following potential scenarios and the impact they would have on major construction programs globally:

- Major cyclone causes extensive damage to iron ore exporting facilities in Western Australia
- Katrina like hurricane destroys refinery capacity on a scale comparable to or in excess of that experienced after hurricane Katrina.
- Major earthquakes cause destructive damage to copper exporting ports in Chile and Peru

Each of these risks is a real possibility. Each carries with it a global impact to mega construction projects worldwide.

5. Flawed industry financing model

Correlated risks increasingly will deal not only with the physical demands of large-scale engineering and construction programs, but also with financial, human and other risks perhaps not as evident. A clear illustration of the impact of correlated financial risks (1) was

seen in the sub-prime crisis that emerged in late 2007 affecting the entire housing construction (and other) markets. The industry's financing model, when stressed, failed. The effect was not limited to one geography, builder or bank. Rather the highly correlated nature of the industry led to a systemic collapse. Industry financial model risks were clearly not well understood or adequately managed.

The financial crisis has also undermined much of the monoline insurance industry and with it impacted traditional municipal and project financing models. Today we are sensitive to the fact that insurance does not change underlying risks but rather reallocates them. Key however is the ability of the risk assuming party to actually absorb these risks when they materialize. Systemic events or said differently, highly correlated industry financial risks, actually limit the effectiveness of such risk transfer.

One final thought in this regard is in order. Today's increasing complex project financing structures provide for the potential of leverage at multiple levels. Such leverage, while "rationalized" at each level, need to be viewed from a prudent man standard and real, total project leverage clearly understood. Recent international accounting standards seek to recognize and quantify this so called off balance sheet debt.

6. Supply chain "friction" from global events of scale

In the last decade we have witnessed the impacts that SARs, bird flu and the increased security regimes that flowed from the attacks of September 11th, have had on the efficient movement of people and goods. We are in an increasingly networked world and the events in one part can affect the supply chain both globally and permanently. The global economy is becoming increasingly networked and as such the risks associated with such "frictional" events is only likely to increase in frequency and severity.

7. General disruption of major supply chains

In the past we worried about labor strife or political expropriation principally at our construction sites. Today, disruptions can occur globally, including in areas other than our sources of supply or sites of construction and the impacts can be as severe as the risks are unobvious. A strike in a shipyard in Korea might delay a specialized marine vessel required for delivery of modules fabricated in China for use in a project in Australia. Changed visa regimes may limit third country labor supply necessary to complete fabrication of components for a major project supplier. How to identify such risks and more importantly how to manage them is a growing challenge. Tomorrow's risk analysis associated with large capital construction programs will place increasing emphasis on event risk evaluation and scenario planning.

8. Failure of critical infrastructure

Our infrastructure is in a state of decay and the picture is only growing worse by the day. Our physical infrastructure remains susceptible to single point failures, whether they be at a major river crossing or the result of networks which lack flexibility, adaptability or responsiveness. But outright catastrophic physical failure is not the only risk of infrastructure failure we face. The degraded condition of much of our physical infrastructure will also result in deratings. How do you take that 12 ton truck over a bridge that's just been derated to 3 tons?

9. Emergence of new risks associated with changed requirements

This class of risks at one level is not new. All change carries with it risks. But some of the changes we are making today may carry risks to project participants that are not yet fully appreciated or properly allocated. We have seen some of these concerns as Building Information Models (BIM) blur the roles and responsibilities of the various project participants.

Perhaps an even more important example of emerging risks associated with changed requirements can be seen in the new category of "green risks". Who assumes the risk if a "green" project fails to achieve LEED certification. Emerging local sustainability laws introduce a new layer of project compliance with failure to fully achieve compliance resulting in impaired tax benefits, occupancy rates or the premium rates that might be otherwise obtained for leases. Who is best able to absorb and manage this risk?

"Green" risks also exist in the definition of the standard of care that designers must exercise in seeking LEED certification; unexpected delays caused by the LEED process; or, the lack of availability of specified "green" products as this portion of the supply chain ramps up its capacity.

10. Asynchronous program management (Industrial) and supply chain (Networked) models

Today's large capital construction programs are nothing if they are not increasingly complex. The management tools of yesterday are increasingly challenged to deal with the growing complexity that the preceding risks highlight. But new tools are not enough. New management and program governance models must evolve if we are to capture the value of globally networked supply chains and the opportunities for "networked" delivery of major programs that new tools can provide.

Historical command and control models of management, first devised to support repetitive assembly line style, discrete operations will not serve our industry well. Centralized

command and control structures will be increasingly challenged and persistent micro-management or extended decision-making time frames a formula for failure.

The management of today's large capital construction programs must be more "organic" in nature, with feedback mechanisms helping inform and shape actions throughout what will increasingly be an organic program. New skills will certainly be required or perhaps just a changed emphasis on skills already present. Whatever the right answer is it still lies ahead of us. In many ways, this disconnect between management models and project execution opportunities may represent the biggest correlated risk we face.

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Bob Prieto is a senior executive effective in shaping and executing business strategy and a recognized leader within the infrastructure, engineering and construction industries. Currently Bob heads his own management consulting practice, Strategic Program Management LLC. He previously served as a senior vice president of Fluor, one of the largest engineering and construction companies in the world. He focuses on the development and delivery of large, complex projects worldwide and consults with owners across all market sectors in the development of programmatic delivery strategies. He is author of nine books including "Strategic Program Management", "The Giga Factor: Program Management in the Engineering and Construction Industry", "Application of Life Cycle Analysis in the Capital Assets Industry", "Capital Efficiency: Pull All the Levers" and, most recently, "Theory of Management of Large Complex Projects" published by the Construction Management Association of America (CMAA) as well as over 700 other papers and presentations.

Bob is an Independent Member of the Shareholder Committee of Mott MacDonald. He is a member of the ASCE Industry Leaders Council, National Academy of Construction, a Fellow of the Construction Management Association of America and member of several university departmental and campus advisory boards. Bob served until 2006 as a U.S. presidential appointee 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. He 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, he served as Chairman at Parsons Brinckerhoff (PB) and a non-executive director of Cardno (ASX)

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