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Failure of Financial Sector Risk Management as an Analog for the Engineering & Construction Industry

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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.

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. 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. In October, 2002, I had the opportunity to deliver a lecture to the Royal Academy in London entitled, "The 3Rs: Lessons Learned from September 11th". In that lecture I looked more broadly than the immediate lessons learned from September 11th and defined five new categories of vulnerabilities that complex engineered systems needed to consider. These five "SMART" categories included:

- - Systems
- - Maintenance and Operations
- - Attitude
- - Risk Taking, and
- - Transitional

While I might argue that elements of each of these vulnerabilities were ignored in the financial sector, I will focus briefly on just some of the System's vulnerabilities and how this class of vulnerabilities might impact the engineering and construction industry.

Systems Vulnerabilities

Seven broad classes of system's vulnerabilities may be defined. These include:

- Failure to recognize the "built environment" as a growing and ever more complex system
- Inadequate "system" understanding
- Positive feedback loop risks
- Centralized control weaknesses in complex systems
- "Tight Coupling" of systems
- Failing to KISS
- Inadequate "core capacity"

Consideration of these vulnerabilities will enhance the resiliency of the engineering and construction industry much in the way that those systems that more fully addressed these considerations responded better on September 11th. Let's look at each of these in turn.

Failure to recognize the "industry environment" as a growing and ever more complex system

This is perhaps the most fundamental risk that the engineering and construction industry faces today. Just as development and infrastructure do not exist in isolation in the physical "built environment", so too, politics, finance, education and supply chain do not occur in isolation in our "industry environment"

This tendency to treat different "offerings" as independent was a large contributor to the difficulties of the financial sector where huge underlying correlations across various "offerings" were exposed under stress.

The engineering and construction industry is exposed to similar "complexity" type risks as factors such as absence of political will, diminishing interest in math and science education and common supply chain drivers (China demand at the moment) create the possibility of systemic challenges to the industry.

To respond to this "complexity" challenge, new industry structures may be required, new project teams with a very different set of skills must be assembled, and national and international risk frameworks created to identify cross cutting systemic risks, common failure scenarios and choke points. This later point should stop short of some of the enhanced regulatory structures being called for in the aftermath of the current financial crisis but be consistent with the larger coordinating role governmental and non-governmental institutions are playing.

Inadequate "system" understanding

It may not be rocket science, or a high-technology defense system, but it is no less important to understand what may go wrong, and how to detect and remedy it when considering the engineering and construction industry structure and regulatory and business frameworks of which it consists.

The recent financial crisis exposed the lack of broader financial system understanding that existed within our financial industry. As one esoteric financial product put demands on a handful of key players, industry liquidity evaporated overnight and the economy's lubricant diminished, creating a frictional effect which is still taking a real toll.

Today's engineering and construction industry faces analogous challenges. What is the impact on a new hospital in middle America if steel prices doubled overnight? Such a scenario is more than possible in today's complex system which comprises the engineering and construction industry and its supply chain. For the middle America hospital, it is exposed to the risks associated with a trade dispute between the US and China, increased infrastructure demand in China (where much of the world's steel will go), and labor shortages in Western Australia which delay new iron ore capacity coming on-line as planned.

The industry's risk managers - the program managers owners engage; the project finance professionals that provide the money and the risk insurers that price the transfer of risk - must all develop a deeper understanding of this system we call the engineering and construction industry.

Positive feedback loop risks

In the aftermath of September 11th, many paid particular attention to positive feedback loop risks, also described as progressive failures. These considerations affected everything from the structural systems of a building, such as we saw induced by fire in the World Trade Center, to feedback mechanisms that degrade other elements of the system. This was seen in the need to relocate the Emergency Operations Center located at 7 World Trade Center.

The most recent financial crisis, perhaps as well as any other event, further highlighted these progressive failure risks. But where are the progressive failure risks for the engineering and construction industry?

Let me suggest that our lack of focus on strengthening our basic education and R&D programs would certainly be a place to start but it does not stop there. Inadequate political action to cause the investments in infrastructure that any strong nation requires certainly comes to mind as we watch our roads, bridges, power generation, transmission and coastal protection slip closer to failure each passing day.

Centralized control weaknesses in complex systems

In large complex systems there is a need for interoperability and an ability to see the situation. Typically, partial decentralization of systems is required. The most recent financial crisis highlighted the difference between interconnectivity and interoperability in complex systems. While information flow and capital movement was fast, the ripple effect of those initially fast flows, and later, slow flows of capital was not well understood. The ability to see the situation was not there and one might even question whether some of the perceived decentralization of financial systems (separation of Mortgage and other financial markets from each other) was indeed real given hybrid products such as Collateralized Debt Obligations (CDOs)

The engineering and construction industry may face a different type of centralized control weakness. Defined central control systems at the international, national and local level are to a large degree non-existent or dysfunctional for the complexity that the industry faces today. This centralized weakness makes it difficult for the industry and others to see the big picture, especially when the industry is under stress or going through a period of rapid or sustained change. Decentralization of the industry may have gone too far with an ability to have nodes of sufficient critical mass to make long term investments in R&D, education and other industry infrastructure sub-optimal in an environment which is increasingly intellectual and financial capital intensive. Ineffective interoperability further limits the effectiveness of such a decentralized industry model. Real systemic risks exist.

"Tight Coupling" of systems

Simply put, an event in one system leads to an event in another in short order. This was the first lesson learned highlighted in my talk to the Royal Academy after September 11th and it was certainly the principle lesson learned in the current financial crisis.

But where is that "tight coupling" risk in the engineering and construction industry today?

Two examples are useful to illustrate tight coupling risk. *"A fire in a small two-story building in Berwyn, Illinois some years ago severely disrupted long distance telephone service across the United States. It seems that most transcontinental land-lines passed through that single building and they were destroyed in the fire. Several years ago, automobile anti-freeze prices in the United States tripled for two years and then went back to normal. It seems that only two plants in the United States produced ethylene glycol and one of them, a small facility in Idaho, burned, reducing the nation's production substantially."*2

Today, we see price and lead times for certain bulk commodities influenced by events well outside industry's control. Increased globalization of supply chains increases risks of disruption whether from a shortage of heavy marine transport or bottlenecks at ports. Major programs, with multiple contractors, are increasingly exposed to cascading delay claims as one or more contractors experience delayed deliveries and contracting structures limit work-around flexibility.

Failing to KISS

No, this is not the romantic in me, but rather the importance of "Keeping It Simple…Stupid." We must recognize some classes of systems and certain technologies are inherently open to chains of failure. In such systems, adding additional safety systems only raises the level of complexity. This is very much the risk that is being assessed as government looks at what new regulation might be necessary in the financial industry.

For the engineering and construction industry the system that is very much in question today, in my view, is the basic programmatic and project delivery models and by extension the industries own business models. In many portions of our industry we sub-optimize delivery in order to avoid a mistake. We segregate design from construction; we conduct financial evaluations often without a robust give and take between finance, design and project delivery, at times loosing sight of underlying strategic business objectives. We use stakeholder engagement as an excuse for avoiding leadership behaviors that inherently have an element of personal risk taking and instead move forward with “Christmas tree” programs that are unaffordable or delay realization of the program’s strategic objectives. To be clear, there are many exemplary owner, program and project delivery models out there, but not to the level the industry needs to avoid the systemic risks which manifest themselves in an industry whose business failure rate is approximately 30% higher than the average industry failure rate in the US.

Inadequate "core capacity"

One of the key lessons highlighted in the aftermath of September 11th is the importance of interconnectivity, flexibility and redundancy to system responsiveness to unplanned events. In the recent financial crisis, much of the intended redundancy was squeezed out of the system by a failure to adequately recognize and price underlying risks as they were repackaged from one financial regime to another. Core capacity was a major factor in New York’s transit systems being able to restructure themselves immediately following September 11th.

Does the engineering and construction industry have the core capacity that the period ahead requires? As owners, suppliers, designers and contractors alike, are we focused on the new skill mix that future success will require? Are we bringing our professional societies along with the changes technically and delivery wise that will be required, or are they protecting a "tradition" which cannot survive? Are our universities sensitive to our changing needs professionally and are craft training efforts (vocational, government or labor sponsored) keeping pace? Is regulation and tort law reflective of the changes the future will require and the changes in risk allocation that will inevitably happen?

Conclusion

Major events like September 11th, Katrina; the Indian Ocean tsunami and the most recent financial crisis afford us the opportunity to stop and think about what we do and how we do it more systemically than our day to day business focus lends itself to. The recent financial crisis was an industry wide systemic crisis in many ways underpinned by a failure to recognize that the fundamental risk model on which much of it was based (independent “Brownian” behavior) was not sufficient is assessing systemic risks.

The engineering and construction industry has been afforded the opportunity to step back and assess its own exposure. Will we? And what might we find?

References:

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Robert (Bob) Prieto is a Senior Vice President for Fluor Corporation, one of America's largest engineering, construction and project management firms where he is responsible for strategy in support of the firm's Industrial & Infrastructure Group and its key clients. He focuses on the development and delivery of large, complex projects worldwide. Prior to joining Fluor, Bob served as chairman of Parsons Brinckerhoff Inc. He is a member of the executive committee of the National Center for Asia-Pacific Economic Cooperation, a member of the board of directors of the Business Council on International Understanding, a member of the board of the Civil Engineering Forum for Innovation, and co-founder and member of the board of the Disaster Resource Network. He currently serves on the National Research Council's committee framing the challenges on Critical Infrastructure Systems. Until 2006 he served as one of three U.S. presidential appointees to the Asia Pacific Economic Cooperation (APEC) Business Advisory Council (ABAC) and served 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. He is also a member of the board of trustees of Polytechnic University of New York.