

the Energy to Lead

Paper Study on Review of Approaches for Preventing Catastrophic Events

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Objective

- > Critical and structured review of approaches for preventing catastrophic events, both within and outside the natural gas industry,
- > Select the most appropriate approach(es) and model(s),
- > Identify gaps, develop them further,
- > Prepare the ground for the adoption and/or development of a suitable approach for the sector, and
- > Ultimately issue guidelines for effective implementation in risk models and integrity management programs.

Introduction and Background

- > Catastrophic events are notoriously hard to predict and prepare for
- > These are low-probability high-impact events that do not “behave” well with standard probabilistic tools
- > They are rare and thus cannot properly inform a probability distribution function
- > They are unique, offering only limited learning opportunities from one such event to the next

Introduction and Background

- > Hazard identification, is an exercise that is problematic in the context of complex systems and emergent threats, because hazards may be largely unknown
- > Better catastrophe management plans combines risk analysis with resilience analysis
- > Resilience approaches require preparing for the unexpected, whereas risk analysis proceeds from the premise that hazards are identifiable
- > Several mature approaches seem to capture the essence of catastrophic risk fairly well, but sometimes fail in properly propagating actionable results to any relevant supporting decision-making mechanisms

Threat Interactions

- > Catastrophic events are typically low-probability, high-consequence events
- > The associated engineering systems must confront dynamic and unpredictable environments, causing estimates of likelihood to be unreliable, if at all available.
- > Even more difficult to forecast is the joint probability of the confluence of two or more major events (which is not rare in the context of catastrophic events, cf Fukushima nuclear disaster)
- > They have a far greater combined impact or synergy than when they occur independently

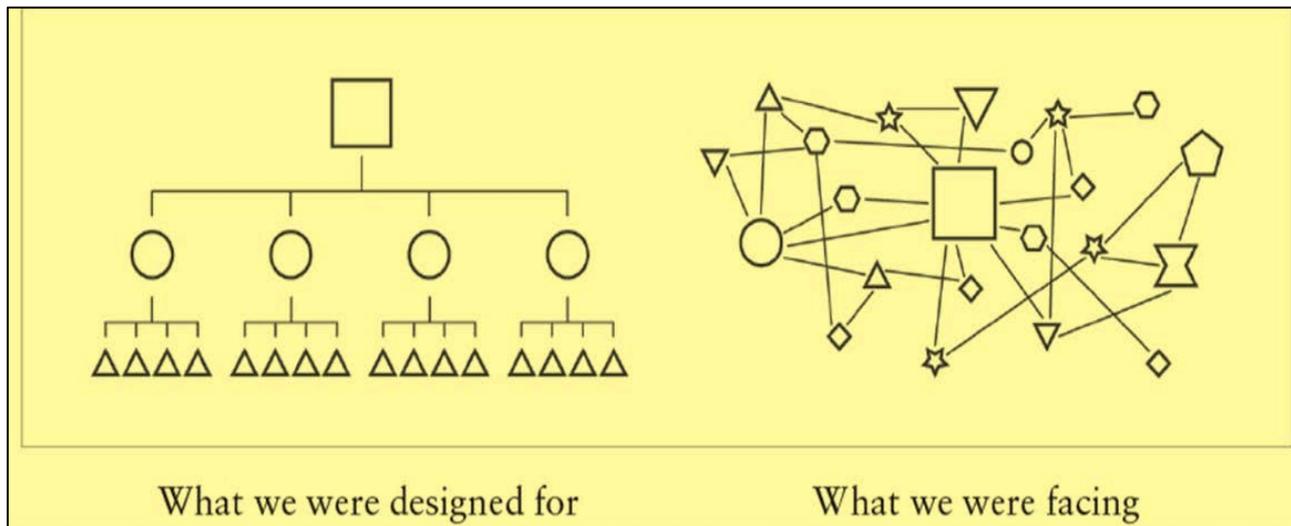
Information Flow in Complex Systems

- > We have a poor understanding of how failures propagate and are amplified within and across a complex systems and Systems of Systems.
- > At least two attributes of complex engineering systems complicate risk analysis:
 - Nonstationarity, path dependencies, changing boundary conditions, or interdependencies generate different responses to identical stimuli that happen at different times; past record is not a reliable predictor of future performance [Ben-Haim, 2013] and
 - Unexpected shocks, wherein extreme (i.e., low-frequency, high-consequence) events lead to failure of the engineered systems
- > Both of these issues can be resolved, at least to a certain extent, by various methods.
- > The goal of this project is to examine proposed and applied solutions to these and similar problems, which can ultimately be applied to the natural gas sector

Management Culture and Systems of Systems

Team of Teams: New Rules of Engagement for a Complex World, General Stanley McChrystal

The pursuit of “efficiency”— getting the most with the least investment of energy, time, or money— was once a laudable goal, but being effective in today’s world is less a question of optimizing for a known (and relatively stable) set of variables than responsiveness to a constantly shifting environment. Adaptability, not efficiency, must become our central competency.



What we were designed for

What we were facing

How to Adapt and Prevent Catastrophes?

- > We will review methods for:
 - Modeling with thin evidence
 - Proper weighting of thin evidence
 - Introducing causal reasoning to models
 - Identifying precursor events such as near misses that may have good data
 - Treating big data (does it help or hinder decision making?)
 - Proper use of reasoning networks in the context of catastrophic events

How to Pay for It All?

- > We will review catastrophes in infrastructure over the past 15 years:
 - Lives
 - Property
 - Environment
 - New Regulation
 - Corporate Image
- > How do the total costs of potential catastrophic events get factored into decision making processes?
- > We will review potential business models for sharing the cost of developing adaptable systems for catastrophe prevention and mitigation

Summary

- > Critical and structured review of approaches for preventing catastrophic events, both within and outside the natural gas industry,
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