



# Benefits of Planning for Black Swan Events for Process Safety

David Moore, Chan KengYong  
AcuTech Group, Inc.  
[www.acutech-consulting.com](http://www.acutech-consulting.com)

# Presenter

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## Er. Chan, KengYong, PE (Chemical)

AcuTech Consulting Pte. Ltd.

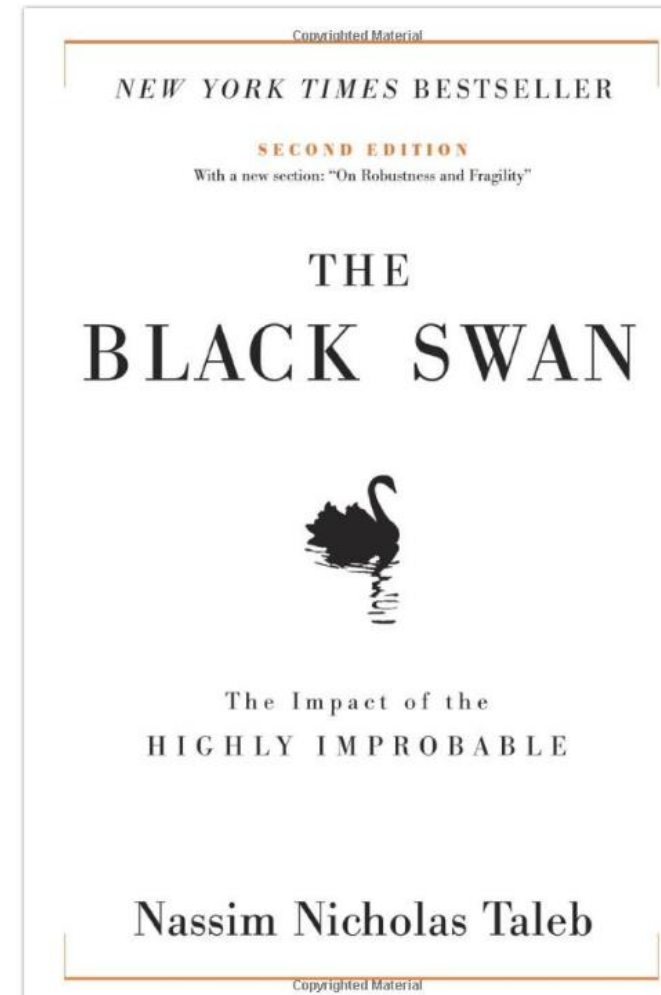
Manager and Principal of Singapore office



- About 24+ years of experience comprising of process and process safety management (PSM) in O&G, chemicals and consulting
- M. Eng (MIT) and B.ChemEng. (NUS Singapore)
- Qualitative and Quantitative Risk Assessment

# Black Swan Events - Introduction

- Black Swan was a common expression in 16th century London, as a statement that describes impossibility, deriving from the old world presumption that “all swans must be white”, because all historical records of swans reported that they had white feathers.
- Aristotle uses the white swan as an example of necessary relations and the black swan as improbable.
- Taleb is credited with popularizing the concept with his publication “The Black Swan”



[1] Taleb, NN. *The Black Swan: Second Edition: The Impact of the Highly Improbable*. New York. Random House Publishing Group, 2010.

# Black Swan Events - Introduction

- Nassim Taleb explained his book was an essay with one single idea: “our blindness with respect to randomness, particularly large deviations.”
- Gaussian distribution should be used at one's own peril.
- Past performance is not necessarily a predictor of future performance (A turkey treated to a nice series of meals before Thanksgiving then served for dinner!)



Figure 40. The Second and Third Refrigerated Trailers Burning. Fire and smoke are visible from two refrigerated trailers burning at the Arkema Crosby facility on September 1, 2017 [40].

[1] Organic Peroxide Decomposition, Release, and Fire at Arkema Crosby Following Hurricane Harvey Flooding Crosby, Texas Incident Date: August 31, 2017

# What is considered a Black Swan Event ?

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Three attributes of Black Swan event according to Taleb:

- It is an outlier as it lies outside realm of regular expectations. Nothing in the past can point to its possibility of occurrence
- It has extreme impact/effects
- After it occurred/first recorded instance, it is rationalized by hindsight making it explainable and predictable



# Examples of Black Swan Events

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Beside financial events, Taleb extends to all major scientific discoveries and historical events

- Internet
- Smart Phone
- Dissolution of Soviet Union
- 9-11 Incident
- Global financial crisis 2008

# Black Swan Events Place in Process Safety Management

- Companies should include consideration of very low probability and high consequence events (“Black Swan Events”)
- When?
  - During the assessment of risk
  - When planning for residual risk management (Emergency and Crisis Management)



# Black Swan Events Place in Process Safety Management

- Includes:
  - Highly disruptive and sudden events,
  - Cascading or domino effects,
  - Large-scale natural events,
  - Larger releases than considered in the typical process hazards analysis studies.
- Are they “Black Swans” or low probability, high consequence events?



Bhopal, India, MIC Plant



# Gaps in Hazard Recognition?

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- Black Swan Events are unique in that they are extremely rare, and often difficult to predict, but they are not impossible
- During PHAs and other PSM activities these extreme outliers are often discounted as not credible and passed over for detailed consideration

# What can happen, will happen...

		Impact →				
		Negligible	Minor	Moderate	Significant	Severe
Likelihood ↑	Very Likely	Low Med	Medium	Med Hi	High	High
	Likely	Low	Low Med	Medium	Med Hi	High
	Possible	Low	Low Med	Medium	Med Hi	Med Hi
	Unlikely	Low	Low Med	Low Med	Medium	Med Hi
	Very Unlikely	Low	Low	Low Med	Medium	Medium

- Are they low likelihood?
- Overconfidence in the integrity and reliability of barriers or emergency management capabilities may be a source of this line of thinking.
- A sense of vulnerability is needed to promote the right culture of PSM readiness.

# What can happen, will happen...

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*Accidents will happen, but forewarned is forearmed.*

Eighteenth-century  
English proverb

# Accidents That May Not Have Been Anticipated

1974: Flixborough (UK) – 28 deaths, > 100 injuries

1976: Seveso (Italy) – Major dioxin release

1984: Bhopal (India) – > 3,000 deaths, 200,000 injuries

1988: Piper Alpha (UK) – 167 deaths, destruction of platform

1989: Pasadena (Texas) – 23 deaths, > 130 injuries

2005: Texas City (Texas) – 15 deaths, 180 injuries

Vale dam disaster: \$7bn compensation for disaster victims – Communities hit by a dam disaster in Brazil two years ago which killed 270 people will get a \$7bn (£5bn) payout.



# Accidents That May Not Have Been Anticipated

## Beirut, Lebanon, Port Explosion

On 4 August 2020, 2,750 tons of ammonium nitrate stored at the Port of Beirut (POB), Lebanon, exploded. Resulted in about 200 deaths, several thousand injuries, \$10–15 billion USD in property damage, and leaving an estimated 300,000 people homeless, and a city and country in economic and political turmoil.

Video of the Blast:

<https://twitter.com/i/status/1290694053550596102>



# Likely to Be Ill-Prepared for Managing the Emergency

- Failure to plan for the potential consequences and impacts of larger scale incidents
  - Damage or injury beyond the expected outcome
  - Logistics and interdependency complications - supply chain impacts
  - Lack of preparedness for the complexities of a large-scale event
  - Mass casualties underappreciated
  - Overconfidence – First responders will be highly effective?
  - Failure to consider business continuity, resilience.



# Strategies for Improving Preparedness - Black Swan Events

- The Emergency Preparedness Cycle
  - Preparedness
  - Response
  - Recovery
  - Prevention
  - Mitigation



# What can be done? - Hazard Identification and Risk Assmt

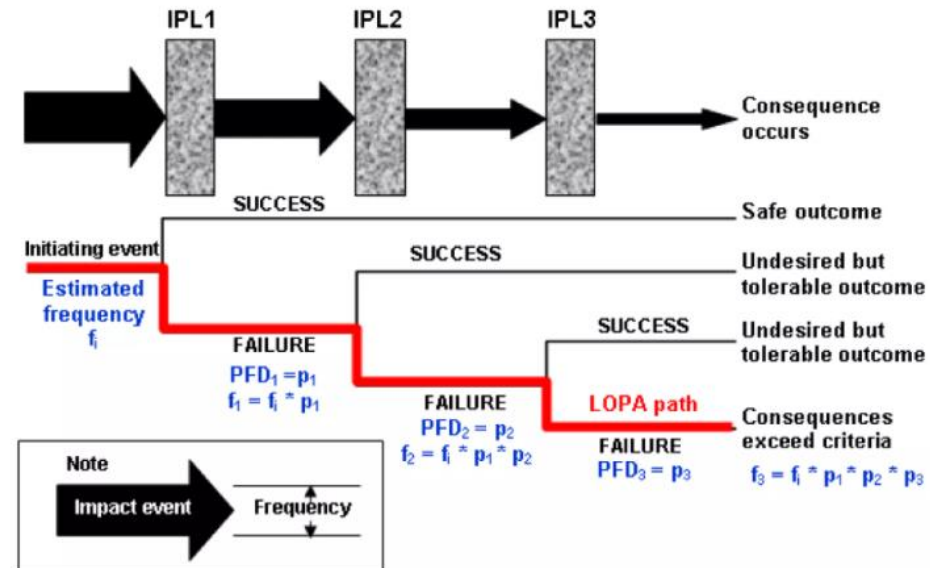
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- Despite believing that incidents are very low likelihood, consider the impacts from them if they occurred.
- Reevaluate the frequency of initiating events, such as floods or extreme temperatures.
- Know your key risks. What is the largest storage accumulation(s) of toxics, flammables, and other hazardous materials?
- It's essential to have a diverse team analyze the situation.
- Brainstorm what processes at your facility could be impacted by an external event
- Look beyond basic code of practice or typical industry practice to the whole of the system, to see if more catastrophic events would be possible and why they may occur.
- Reevaluate your PHA and risk tolerance rules
- Resilience and Recovery Planning



# What can be done? - Hazard Identification and Risk Assmt

- PHA Matrix – is it relevant to your business and providing the right guidance based on your risk tolerance?
- Is the PHA process considering the integrity and reliability of safeguards, such as a LOPA study process?
- Are the assumptions valid and the quality of the barriers known?
- Are ‘catastrophic Process Safety Events’ being fully evaluated?



# What Do I Do Now?

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- Black Swan Events often challenge traditional assumptions about risk and process safety and highlight the importance of being prepared for the unexpected.
- By considering Black Swan Events in your risk management process, process safety professionals can help to ensure preparedness for a wider range of potential events
- Companies will be better equipped to respond to and recover from events.
- Resilience and agility are ‘safeguards’ that should be considered for these events, rather than only typical engineered controls.

# The Moral of the Story

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- “Key is to prepare for the Consequences of Black Swan Events more than worrying about predicting if they can occur.
- One, we have an abysmal record of predicting Black Swan Events.
- Two, by focusing our attention on a few extreme scenarios, we neglect other possibilities. In the process, we become more vulnerable.”
- Taleb, NN, Goldstein, DG, Spitznagel, MW. *The Six Mistakes Executives Make in Risk Management*. (2009). Harvard Business Review. <https://hbr.org/2009/10/the-six-mistakes-executives-make-in-risk-management>. Accessed 22 February 2023.

## ACUTECH CONSULTING GROUP

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### Contact Us

#### Washington, DC

Corporate Headquarters  
AcuTech Consulting Group  
1919 Gallows Road, Suite 900  
Vienna, VA 22182 USA

Tel: +1 703.676.3180  
Fax: +1 703.842.8854

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### Global Offices

Washington DC – Dubai –  
Shanghai – Mumbai – Singapore

