工程風險管理
ENGINEERING RISK MANAGEMENT

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專業 EXPERTISE
- 風險管理與風險評估 Risk Management and Risk Engineering
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- 美國加州註冊土木工程師 (No. C 61731) Registered Professional Engineer, CA, U.S.A.
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著作 PUBLICATIONS
40餘件專業論文及書冊

Agenda

1. Prelude
   前言
2. Risks of Engineering Projects
   工程的風險
3. Risks Materialized – Losses
   風險損失
4. Practice of Engineering Risk Management
   工程風險管理
5. Conclusion
   結論
6. Q & A
   問答

PRELUDE

Origin and History of RISK
「風險」的源起與歷史

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Origin and History of RISK

- In ancient Italian “risicare” means “to dare”.
- “Risk” is an option, not a fate.
- “Risk” appeared in English in 1600s.

RISK means

- Loss and Cost 損失與費用
- Opportunity 機會
- Advantage and Profit 優勢與利潤
- Potential of Change 改變的機會

Development of Risk Management
風險管理的發展

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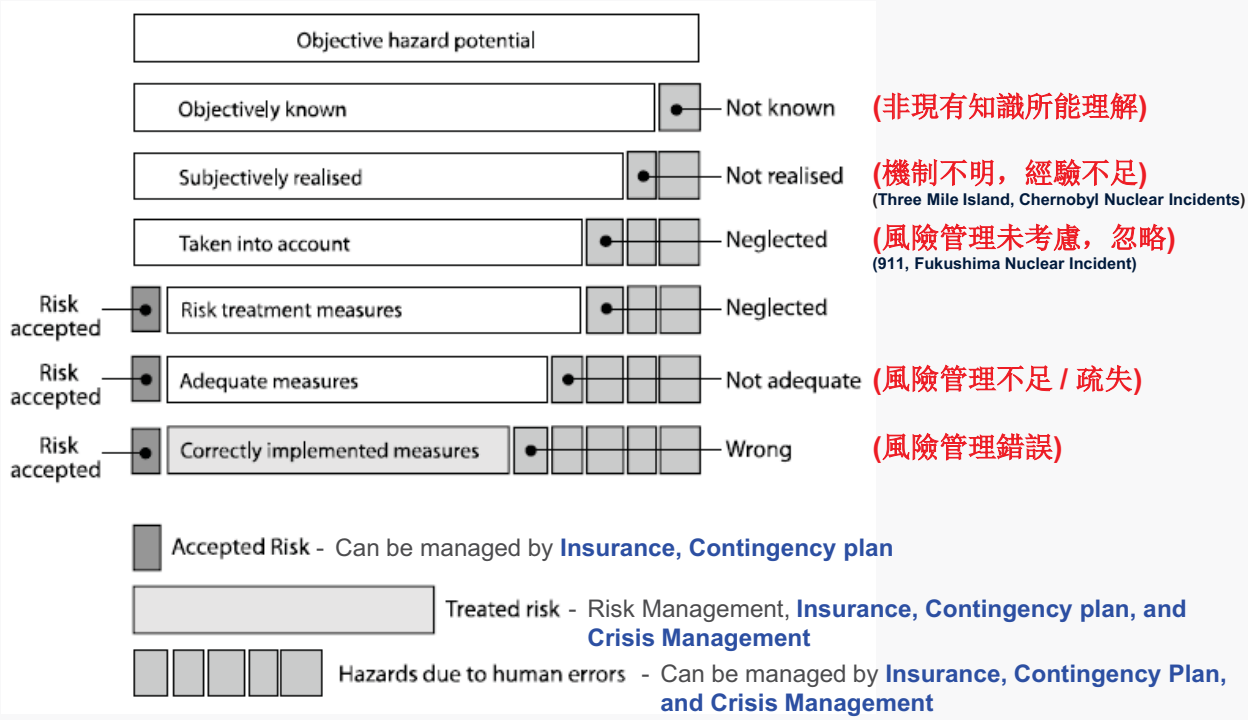
- Long history of risk management with mankind
- Risk Management started its application in insurance (Lloyd’s Coffee House) in 1600s.
- Financial Risk Management (1980’s ~) – 2008 Financial Crisis
- COSO Enterprise Risk Management – Integrated Framework (2004)
- ISO31000 Risk management – Principles and guidelines (2009)

ISO31000 Risk Management 風險管理	COSO Enterprise Risk Management 企業風險管理	Financial Risk Management 財務風險管理

Introduction
簡介

- **Murphy's Law 莫非定律**
  - If any things simply cannot go wrong, it will anyway!
  - If anything that can go wrong, it will!
- **NOTHING is RISK FREE!!! 絕無零風險**
- **Principle of ALARP 合理可行的最低限(ALARP)**
  (ALARP: as low as reasonably practicable)

Risk Types in Risk Management
風險管理中風險的形式



After Faber, M.H., (2006), *Risk and Safety in Civil, Surveying, and Environmental Engineering*, Swiss Federal Institute of Technology, ETHZ, Switzerland.

Combination of Probability and Consequence
機率與後果的組合

- Risk assessment
  - Quantitative
  - Qualitative
  - Semi-quantitative
- Arithmetic Combination (multiplying product)
- Consistency of accuracy (precision)
- Risk Matrices
- Process of prioritization (Target: Most efficient and economical process solution)

Hazard and Risk
風險因子與風險

Hazard
a source of potential harm

Risk
effect of uncertainty on objectives *(ISO31000)*

- Hazards are tangible, real and often physical which can be normally seen and detected through direct measurement.
- Risks are in the vain and normally materialized through loss, damage, or detrimental outcomes.
- A hazard may mean different risks to different risk owners/stakeholders

Natural Hazardous Factors (Natural Hazards/Exposures)
自然風險因子

Meteorological Events (氣象)
- Typhoons, hurricanes
- Snow/ice storms
- Storm surges

Climatological Events (氣候)
- Drought, heat waves
- Wildfires

Hydrological Events (水文)
- Floods/flash floods
- Landslides/debris flows

Geophysical Events (地球物理)
- Earthquakes
- Volcanic activity
- Tsunamis
- Landslides

Geological Hazards (地質)
- Ground subsidence
- Radon gas
- Karst
- Groundwater

Cosmic Events (宇宙)
- Solar storms
- Meteor impacts

Biological Hazards (生物)
- Pandemic diseases (SARS/Ebola)
- Others (Birds strikes)

Anthropogenic Hazards (Man-made Hazards)
人為風險因子

Sociological Hazards
社會風險
- Crime (Arson, Theft, Genocide)
- Civil Disorder (Strike, Riot, Civil Commotion)
- Terrorism and War

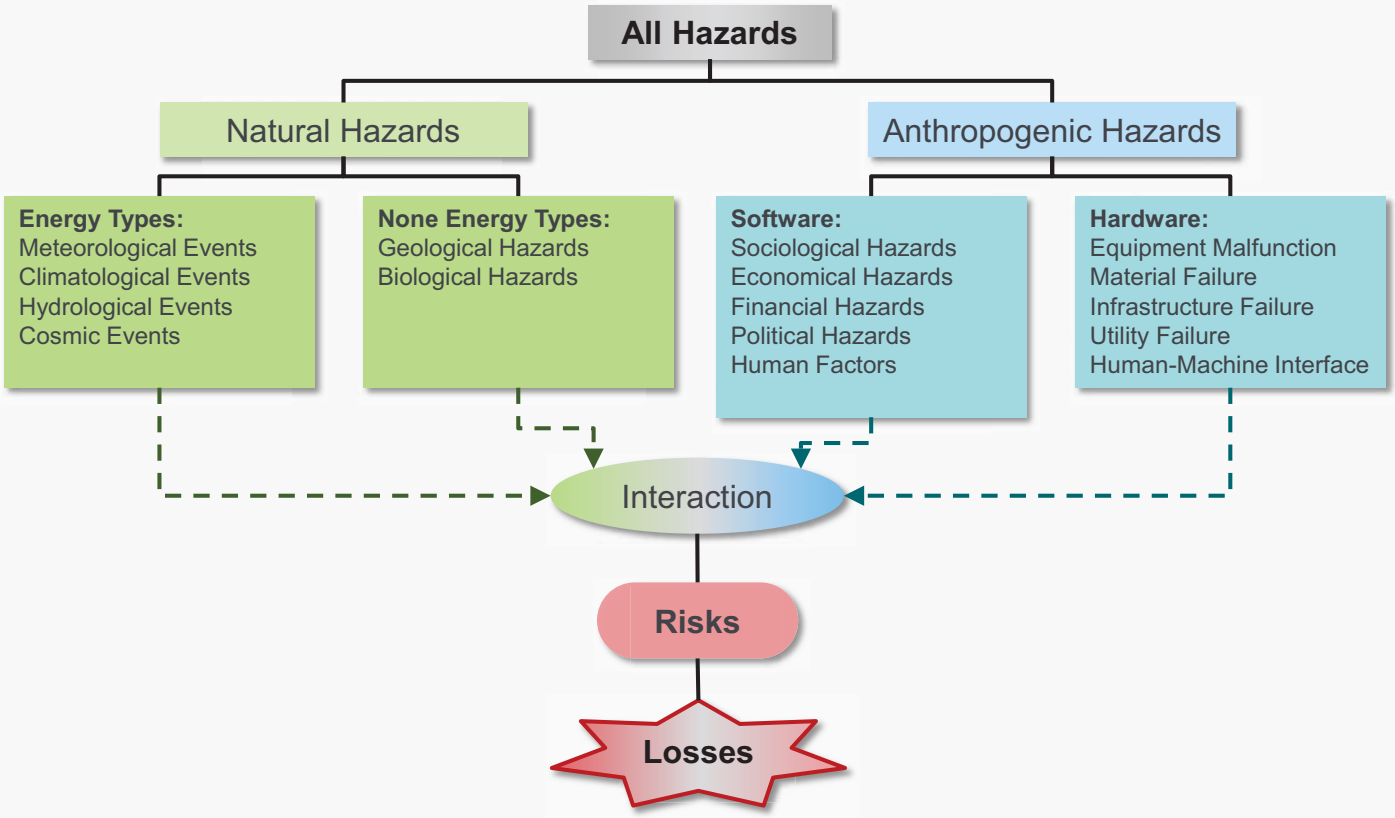
Human Factors - Human Reliability
人因風險
- Negligence or Fatigue
- Collusion
- Error and Omission

Technological Hazards
科技風險
- Industrial Hazards (Explosion, Leakage, Mining Incident)
- Facility Malfunction
- Infrastructure Failure
- Transportation Failure (Aviation, Marine, and Land)
- Utility Failure (Power, Sanitation/Sewer)
- CBRN Contamination (Chemical, Biological, Radiological, Nuclear)

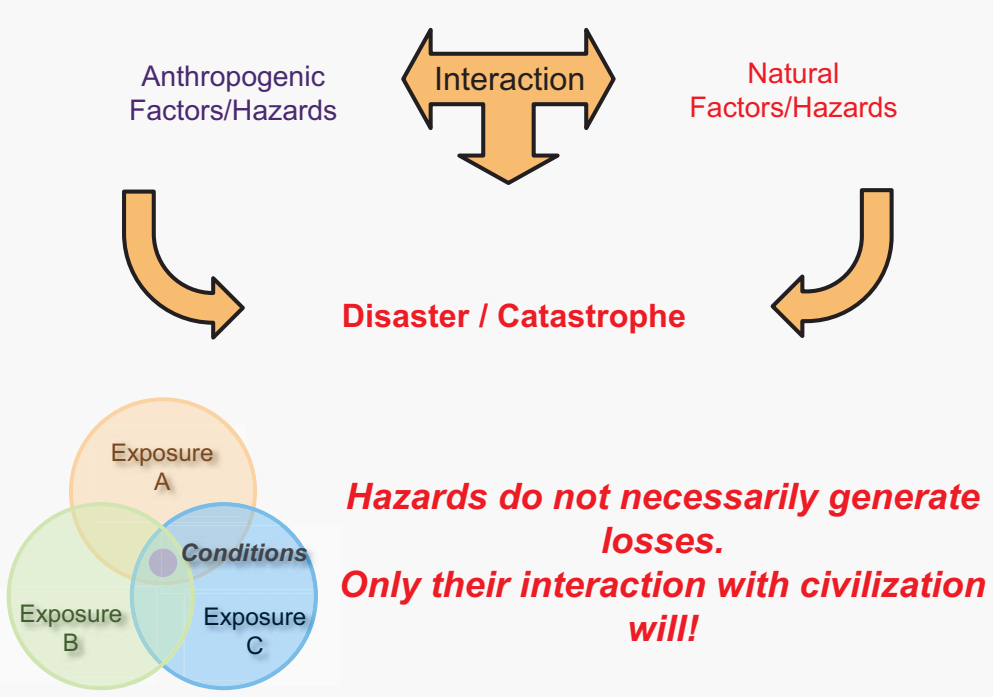
Economical Hazards
經濟風險
- Collapse of Capital Market (Stock, Trading)
- Recession
- Collapse of Institutional Finance (Governments)

Political Hazards
政治風險
- Policy
- Administration
- Others

All Hazards
全風險



Risk Convolution
風險複合



Hazards do not necessarily generate losses.
Only their interaction with civilization will!

Different from Secondary Events
不同於次生事件(災害)

Scenario of Convolution
複合的情境

- **Combination** (種類)
  types of hazards
- **Severity** (強度)
  scales of hazards
- **Sequence** (順序)
  array of occurrence
- **Timing** (時間)
  times of occurrence
- **Conditions** (引發機制)
  malfunctioned mechanisms

Risk Treatment
風險處置

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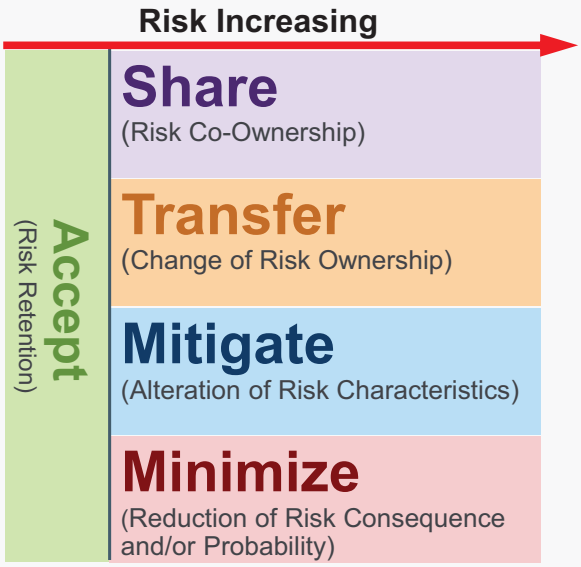
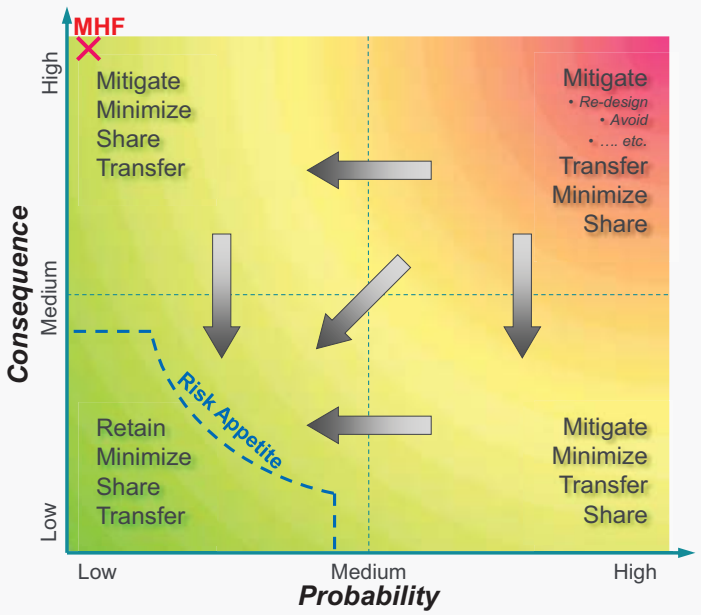
TREATMENT OF RISKS
風險處置



MAP OF RISK TREATMENT
風險處置圖像



Three Pillars to Loss Prevention and Reduction
防損減損的三大支柱

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Risk Management
風險管理

- All known hazards
  所有已知風險
- Loss Prevention
  預防損失
- Cost: High
  Operation: high
  Maintenance: high

Contingency Plan
緊急應變計畫

- Known critical hazards
  重要已知風險
- Loss Reduction
  減少損失
- Cost: Low
  Operation: low
  Maintenance: Low

Crisis Management
危機管理

- Unexpected critical hazards
  重要未預期風險
- Loss Reduction
  減少損失
- Cost: medium High
  Operation: high
  Maintenance: Very low

Why Risk Management – *The Same Reasons for Risk Management To Fail!*
為何要風險管理 – *同時也是風險管理的課題*

- Loopholes in the process – Value Engineering
  程序中的盲點 – 價值工程
- Bad judgment – political/business decision, staffing
  誤判 – 政治/商業決定, 雇傭
- Human errors – erroneous reporting
  人為錯誤 – 錯誤的報表
- Negligence – ignorance and gross negligence
  人為疏失 – 無知及重大疏失
- Collusion – organized crimes
  合謀 – 組織犯罪
- Change – internal and external
  環境變異 – 內部及外部
- Equipment reliability
  設備可靠度 – 設備故障的必然性
- Uncertainty and unknown risks
  不確定性及未知的風險

We need the best assurance available –
Risk Management!

風險管理可提供最佳可得的保障!

RISKS OF ENGINEERING PROJECTS

Risk Assessment/Management in Engineering
工程的風險評估與管理

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"No construction project is risk free.
Risk can be managed, minimised,
shared, transferred or accepted.
It cannot be ignored."

Sir Michael Latham, 1994

- Dam Risk (Safety) Assessment/Management
- Mid-20th Century
- Dam Operation

- Environmental Health Risk Assessment/Management
- Late-20th Century
- Health Impact

- Tunneling Risk Assessment/Management
- Early 21st Century
- Tunnel Construction

Life Cycle of Infrastructures
公共設施的生命週期

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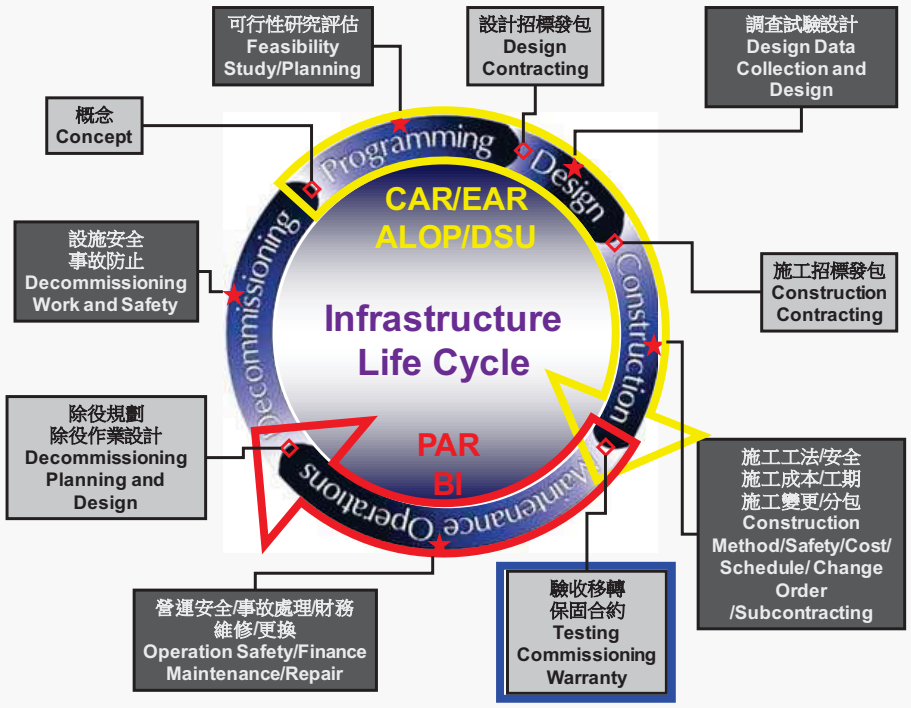

- Life Cycle of Infrastructures
- Main Phases
  - Programming
  - Design
  - Construction
  - Operation
  - Decommissioning
- Primary Phases for Engineering:
  - Design
  - Construction

Stakeholders in Engineering Projects
工程計畫中的相關單位

- Relationships established by
  - Contracts
  - Governance
  - Liability
- Some with same interests but in different priorities respectively
- Some risks transferred via contracts
- Each retains its own risks

Fundamental Engineering Practice
工程基本實務

Desk Work (Plan/Design)
- Feasibility Study
- Theory and Model
- Analytical and Empirical Solutions
- Experiments and Parameters
- Modern Computation and Simulations
- Standards and Codes
- Safety Margins
- Design Certification and Verification

Field Work (Construction/Erection)
- Licenses and Permits
- Regulations, Codes and Specifications
- Safety Protocols and Requirements
- Construction Work and Management
- Construction Supervision and Monitoring
- Quality Control and Assurance Programs

Exposures and Risks of Engineering Practice
工程實務的風險因子與風險

Design
- Substandard Data Quality
- Limit of Information
- Limitation of Tools
- Limitation of Models
- Human Errors and Negligence

Construction/Erection
- Natural Hazards
- Human errors and Negligence
- Defect of Material
- Poor Workmanship
- Risk of Change

Man-made variability and limitation of theory/model
人為變異與理論模型的限制

Limitation of Theory/Model	Man-made Variability

Natural variability and limited knowledge
自然變異與有限的知識

Data Scattering	Formation Variation

Variation over Space and Time
空間與時間上的變異

Precipitation Variation over Space	Precipitation Variation over Time

How are Engineering Risks Managed?
現在工程風險是如何管理?

Principal's Risks
- Schedule delay
- Budget overrun
- Quality defect
- Defective contract
- Political issues
- Compliance issues
- Risk of change
- Goal and mission
- Natural hazards

Consultant's Risks
- Faulty design
- Design schedule delay

Consultant's Risk Management
- Quality Staff (experienced)
- Models and theories
- Data accuracy
- Tools and techniques
- Verification and validation

Contractor's Risks
- Cost overrun/Schedule delay
- QA/HSE (compliance) issues
- Accidents and incidents
- Third party liability
- Natural hazards

Contractor's Risk Management
- Construction method
- Manpower/Machinery/Material
- Construction Management (QA/QC/HSE)
- Construction monitoring
- Third party protection
- Contingency plans

Site Supervision's Risks
- Quality issues
- HSE issues
- Integrity & ethics

Whose risks?
Whose resource?
Who is managing?

Risk Owner-Specific Risk Category for EPC Projects
EPC專案的風險責任類別

Staff Workers 施工人員	Principal 業主	Contractor 承包商
▪ Occupational Health	▪ Schedule	▪ Cost
▪ Occupational Safety	▪ Shareholders' Interests	▪ Third Party Liability
▪ Occupational Environment	▪ Quality	

RISKS MATERIALIZED – LOSSES

Tunnel Failure Case – Cut-and-cover Section
隧道事故 – 明挖段

- Hangzhou Metro, China (15/11/2008)
- 21 killed, 24 injured
- Insurance loss: CNY81,789,834
- Failure in earth retaining system

- Probable Cause:
  - Adverse environmental and geological conditions
  - Faulty workmanship
  - Possibly faulty design

Tunnel Failure Case – NATM Section (Dia.: 18.5m)
隧道施工事故 – NATM段

- São Paulo Metro Line 4, Pinheiros Station, São Paulo, Brazil (15/1/2007)
- Failure at the access tunnel (collapse of crown and crushing invert)
- 7 killed, delay 2 years
- Probable Cause:
  - Poor management
  - Geology variation

Collapse of Works During Construction
施工坍塌

During Forming Work
Willow Island Power Plant (27/04/1978)

During Reinforcement Work
Haiyang Nuclear Power Plant (2/10/2009)

Probable Causes

Willow Island Power Plant (51 fatality)
- New technology (Jump-form scaffolding)
- Low concrete strength due to low temperature
- Missing crucial bolts anchored to the concrete

Haiyang Nuclear Power Plant (Official: 5 fatality)
Detail not disclosed, probably poor support of formwork

Fire During Building Construction
高層建築施工中的火災

- CCTV North Tower, Beijing
- Fire work ignited construction material
- 2009/2/9

- Tamweel Tower, Dubai
- Cigarette butts ignited construction waste material
- 2012/11/18

- Residential Building, Shanghai
- Renovation, 53 Fatality
- 2010/11/15

Equipment Faulty Design at Nuclear Power Plant
核電廠的設備設計問題

- San Onofre Nuclear Generating Station (SONGS), San Diego County, CA, USA
- January 2012
- Premature excessive wear on heat transfer tubes of steam generator, fluid-induced vibration, leak of radioactive coolant
- Faulty design on steam generator (the largest RSG in USA by Mitsubishi)
- Potential Gross Negligence on design analysis/modeling of steam generator
- Potential loss of more than USD 4 billions
- 24 July 2013, permanently shut-down

Heavy Lifting and Hoisting – Review of Taichung Metro Accident on 10 April 2015 (From Risk Management Points of View)

Accident Fact Sheet:

- Taichung Metro Green Line (10/04/2015)
- Erection of girder at curved section
- 4 fatality, 4 injured

From risk management points of view:

- Erection method statement (Lifting Plan)
- Erection execution – HSE staff and construction supervision
- Traffic control – restricted area security

THE CHANNEL TUNNEL
LE TUNNEL SOUS LA MANCHE
英法海底隧道

The Channel Tunnel (The Chunnel)
簡介

- A BOT (Build-Own-Transfer) project
- Construction from 1988 to 1994, at a cost of £4.650 billion, 80% over its original budget and a schedule delay of 19 months
- Operation from 1994 to 2086 (originally to 2051), an initial over-optimistic financial plan with a traffic projection way off marks leads to financial difficulty in operation

February 1986	The Treaty of Canterbury signed allowing the project to proceed
June 1988	First tunnelling commenced in France
December 1988	UK TBM commenced operation
December 1990	The service tunnel broke through under the Channel
May 1994	The tunnel formally opened by Queen Elizabeth II and President Mitterrand
Mid-1994	Freight and passenger trains commenced operation

Engineering Features of The Channel Tunnel
隧道工程

- Tunnels primarily (85%) in chalk marl
- Two 7.6m-diameter rail tunnels, 30m apart and 50km in length
- One 4.8m-diameter service tunnel between two rail tunnels
- 3.3m-diamter cross-passage tunnels (375m apart) linking to service tunnel
- 2m-diameter piston relief ducts (250m apart) linking two rail tunnels
- Two undersea crossover caverns connecting two rail tunnels
- 6 tunnel construction faces (3 from England and 3 from France) met halfway under sea

The Financial Issues
財務的問題

- Cost overrun – schedule delay and claims
- Over-optimistic passenger volume projection – overall one-third of prediction
- Growing competition
  - Counter-reaction of ferry industry – lower prices and better ships
  - Emergence of low-cost (no-frills) airlines – rock-bottom prices of short-haul trips to many European and England cities
- Extension of concession period to 2086
- Finance restructuring to avoid bankruptcy
- Lack of contingency resources

Lesson Learned – The Political Issues
政治問題

- Establishment of The Intergovernmental Commission (IGC) by UK and French Governments to set project scope, approve design, mandate standards of safety/health/design/specification/quality, and coordinate various activities of management/construction/operation
- Funding/budget is not IGC's responsibility
- Democratic system: lengthy decision-making process (IGC belated process) for deliberation to cause delays
- IGC's changes of project scope not considering original concession content

Lesson Learned – The Management Issues
管理問題

- Lack of defined Project scope
- Over-optimistic initial financial plans
- Over-optimistic on risk impacts assessment at project initiation phase
- Unhealthy involvement of bankers
- Conflict of interest from fixed-price contract approach and risk management
- Risks of fixed-price contract in project bidding, awarding, and execution (claims)
- Difficult system integration from English and French specification/culture/practice
- Loss of teamwork and spirits at later phase
- Poor communication among stakeholders
- Intertwined stakeholders' relationships lead to conflict of interests
- Failure to align stakeholders' interests
- Inadequate management of change

Lesson Learned – The Engineering Issues
工程問題

- Tunnel construction completed 3 months ahead of schedule
- No major engineering setbacks during construction
- Technical problems occurred but were solved rather smoothly
- Much attention given to technical risk management in early phases
- Engineering risks were better understood than risks regarding organizational structures, contracts, and finance

Lesson Learned for Risk Management
風險管理

- Importance of contingency resources for known and unknown risks
- Alignment of interests among stakeholders (and risk owners)
- Risk management resources shall be distributed properly among engineering, management (contract and communication), and finance
- Stakeholders' risk appetites, objectives, and priorities shall be clearly and properly addressed in risk management plan

PRACTICE OF ENGINEERING RISK MANAGEMENT

Introduction of ISO31000 (CNS31000)
ISO31000簡介

- Observed by England, EU, Australia, New Zealand, Malaysia, Singapore, China and etc.
- Not for certification – only as principles and guidelines
- Integration of risk management with organization's overall management system
- Organization's culture of risk management

- ISO 31000:2009 Risk management -- Principles and guidelines
- ISO Guide 73:2009 Risk management -- Vocabulary
- ISO/IEC 31010:2009 Risk management -- Risk assessment techniques

Risk Management (Definition by ISO31000):

Coordinated activities to direct and control an organization with regard to risk

Content of ISO31000 (CNS31000)
Risk Management – Principles and Guidelines 目錄


INTERNATIONAL STANDARD

ISO 31000

Risk management — Principles and guidelines

- Foreword
- Introduction
- Scope
- Terms and definitions
- Principles
- Framework
- Process
- Annex A: Attributes of enhanced risk management
- Bibliography


目錄

Content of ISO31010 (CNS31010)
Risk Management - Risk Assessment Techniques 目錄

- Foreword
- Introduction
- Scope
- Normative reference
- Terms and definitions
- Risk assessment concepts
- Risk assessment process
- Selection of risk assessment techniques
- Annex A Comparison of risk assessment techniques
- Annex B Risk assessment techniques
- Bibliography


目錄

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2. 引用規準
3. 用語及定義
4. 風險評鑑概念
4.1 目的與效益
4.2 風險評鑑與風險管理架構
4.3 風險評鑑與風險管理過程
5. 風險評鑑過程
5.1 一般
5.2 風險鑑別
5.3 風險分析
5.4 風險評估
5.5 文件化
5.6 監測與審查風險評鑑
5.7 生命週期階段中風險評鑑之應用
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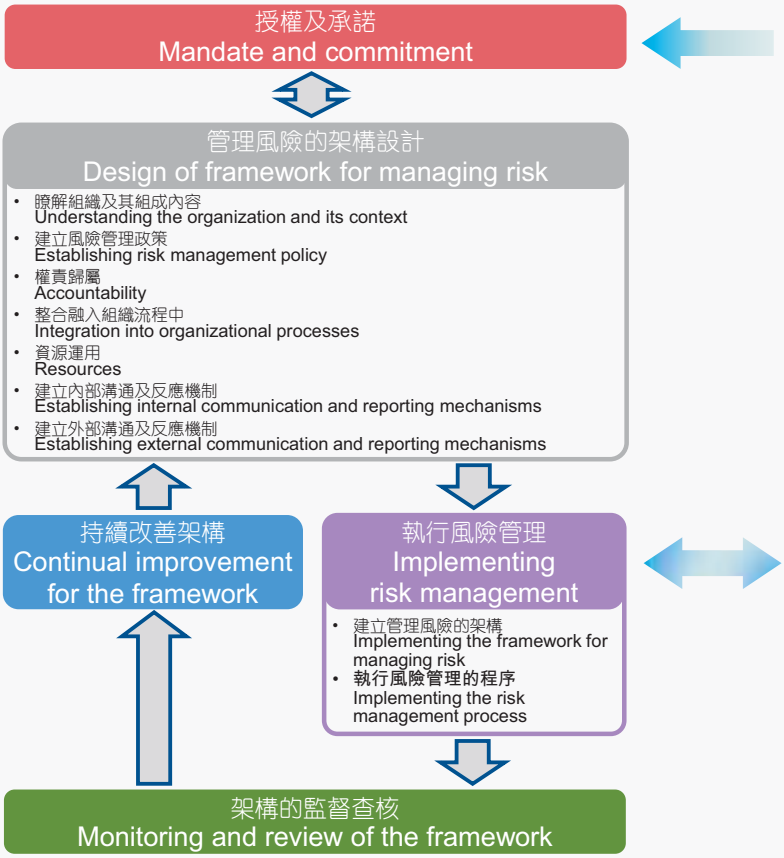
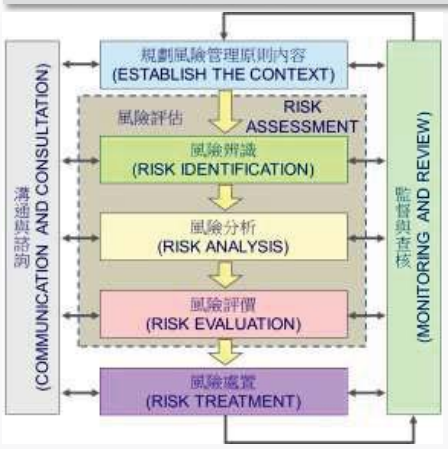
6.6 生命週期階段中風險評鑑之應用
6.7 風險評鑑技術之概要
附錄 A(參考)風險評鑑技術之比較
附錄 B(參考)風險評鑑技術
參考資料

Relationships between Principles, Framework, and Process in ISO31000 原則,架構及程序的關係

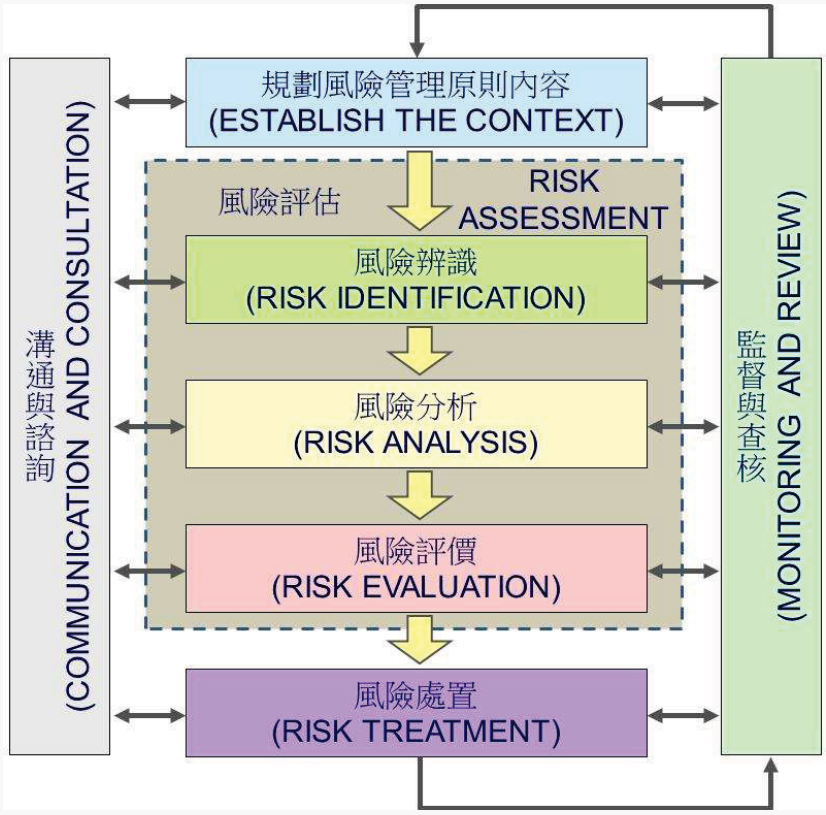


Principles

- Create and protect values
- An integral part of organizational processes
- Part of decision making
- Address uncertainty explicitly
- Systematic, structured, and timely
- Based on the best available information
- Tailored
- Consider human and cultural factors
- Transparent and inclusive
- Dynamic, interactive and responsive to change
- Facilitate continual improvement and enhancement of organization



Process – ISO31000 Risk Management
ISO31000的程序



- An integral part of risk management
- Embedded in the culture and practice
- Tailored to the business processes of the organization
- Contents
  - Communication and consultation
  - Establish the context
  - Risk assessment (ISO31010)
  - Risk treatment
  - Monitoring and review

Probabilities of Engineering Risks
工程風險的機率問題

- Preferably and theoretically derived from a complete set of database (probability density function, pdf)
  缺乏完整的歷史數據資料-機率密度函數
- Most likely lagging performance indicators
  可能是滯後統計指標
- Definition of Probability – by frequency of loss occurrence? Over a year, a project time, or the task of risk?
  定義-機率？每年，工期，工項？
- Biased by the expert's experience and expertise – expert's opinion
  專家專業經驗的偏見
- Issues arising for cross-discipline integration
  跨專業的經驗整合問題

Consequences of Engineering Risks
工程風險的後果(損失)問題

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- Consequence at Loss Value: PML / MPL / MFL / ML / PL
  後果的損失金額定義
  - Maximum Possible Loss
  - Maximum Probable Loss
  - Maximum Foreseeable Loss
  - Maximum Loss
  - Probable Loss (Probability)
  - Possible Loss (Probability)
  - Loss at 5% (?) exceedance
- Project specific consequence estimation
  計畫相關的後果損失估算
- Issues arising for cross-discipline integration
  跨專業的損失估算整合

Risk Ownership
風險責任

E·R·M

Risk Owner (ISO31000) 風險責任人 :
Person or entity with the accountability and authority to manage a risk

RESPONSIBILITY OF RISK OWNERS
風險責任人的職責

Some risks can be retained only by certain risk owners – Political responsibility by government agencies

Risk owners should frequently assess the accumulated loss potential retained against his capacity.

Risk owners should always maintain the accumulated loss potential retained BELOW his capacity.

- **Merging final risk bear with risk owner 讓風險責任人成為風險承擔方**
- **Aligning the liable with the responsible 讓有責任的承擔後果**

Cost Benefit Analysis on Risk Management Work
風險管理的益本分析

E·R·M

$$R = \frac{Benefit}{Cost} = \frac{Risk\ Managed\ （降低的風險）}{Resource\ Spent\ （付出的資源成本）}$$

Risk Management is to maximize the R-factor. (R因子最大化）

- Cost-Benefit Analysis should be part of the risk assessment. （益本分析應為風險評估的一部分）
- But whose benefit and risk are managed? （管理誰的風險與利益？）
- And at whose cost and resource? （使用誰的資源與成本？）
- Is it economically logical to reduce one's risk at the other's cost? （責任人的風險與成本）

The most economical, effective and efficient way to manage a risk is by the Risk Owner who is also the Risk Bearer.
以風險責任人,同時也是風險承擔者來管理風險是最有效率,可能也是最經濟的風險管理方式。

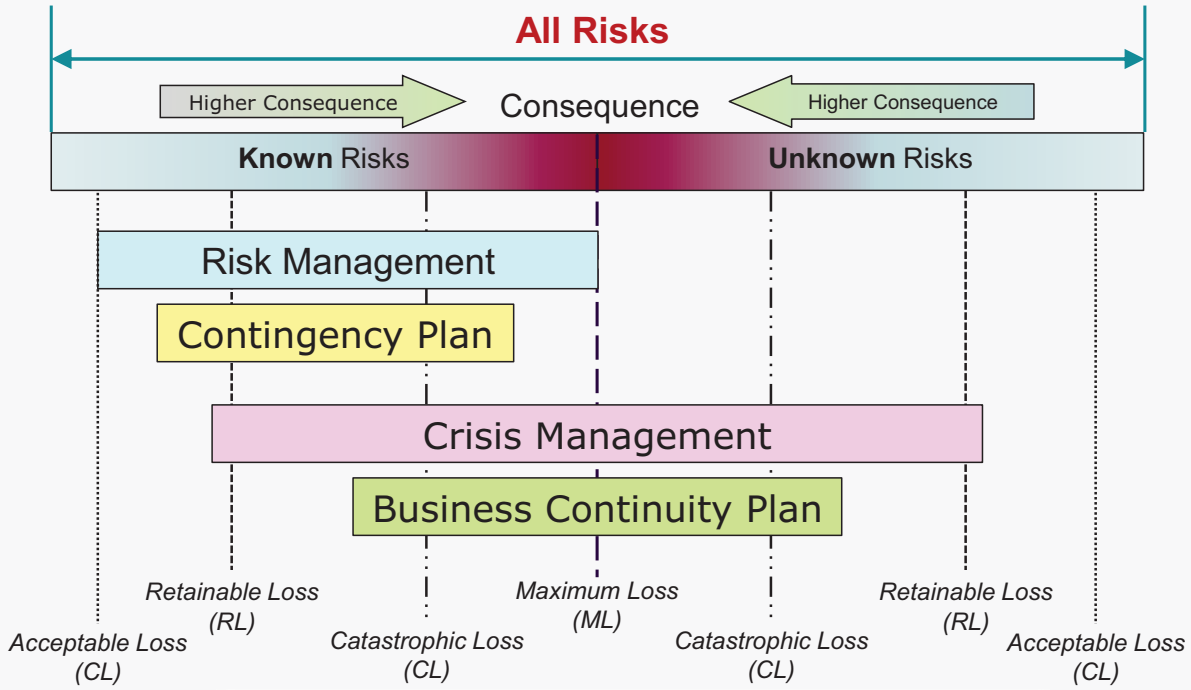
Issues Missing in Most Engineering Risk Management
工程風險管理中的重要議題

E·R·M

- Whose risks?
  - Same hazards may mean different risks to different stakeholders
  - Shared interests may not have the same priorities in different stakeholders
  - Different retained risks for different stakeholders
- Whose resources to treat the risks?
  - Is the resource used effectively?
  - At whose expense?
- Who's managing the risks?
  - Risk owners may not be the risk bearers
  - Risk owner may not have the capability
- Who's making the risk management plan?
  - For whom this risk management plan is?

CONCLUSION

Spectrum of All-Risk Management
全風險管理的圖譜



Executive Decision on levels of losses:

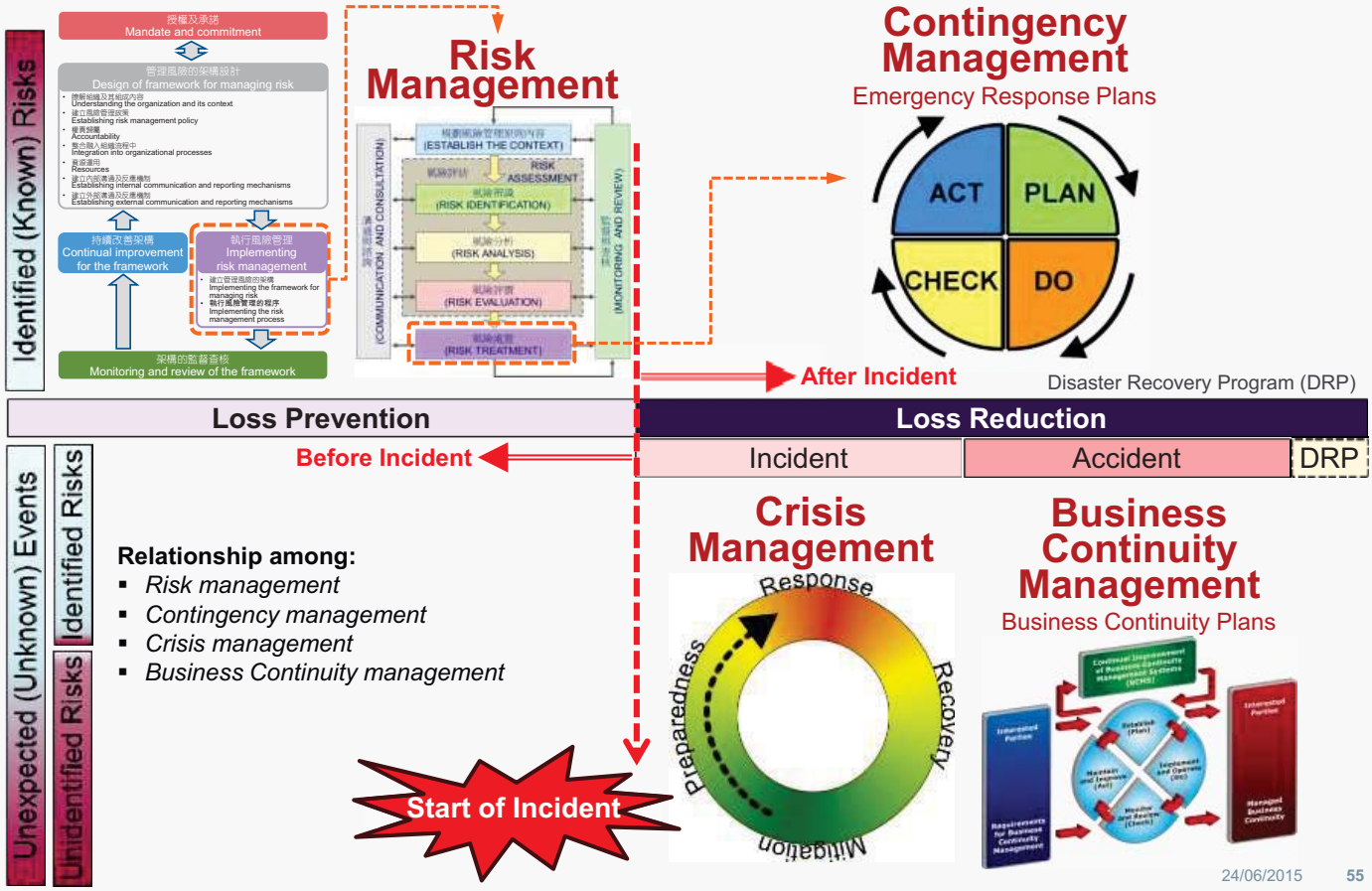
Acceptable Loss: Level defined with ALARP principle

Retainable Loss: Level of loss with minor impact to business operation

Catastrophic Loss: Level of loss with major impact to business operation

Maximum Loss: Level of loss with total destruction to business

A Comprehensive Framework of All Risk Management
全風險管理的完整架構



Four Pillars for Business Sustainability
企業永續經營的四大支柱

Risk Management 風險管理	Contingency Program 緊急應變計畫	Crisis Management 危機管理	Business Continuity Program 營運持續管理
▪ All known risks 所有已知風險	▪ Key known risks 重要已知風險	▪ Unexpected critical risks 未預期之重大風險	▪ Unexpected critical risks 未預期之重大風險
▪ Loss Prevention 防損	▪ Loss Reduction 減損	▪ Loss Reduction 減損	▪ Loss Reduction 減損
▪ Cost: High Operation: high Maintenance: high	▪ Cost: Low Operation: low Maintenance: Low	▪ Cost: medium High Operation: high Maintenance: Very low	▪ Cost: very High Operation: Very high Maintenance: high

All-Risk Category
全風險分類

E·R·M

All Risks 全風險

Insurable Risks 可保險風險

Insured Risks 保險風險

Indemnifiable Losses
可求償之損失

Insurance Liability for
- Known Risks
- Unknown Risks

Non-indemnifiable Losses
不可求償之損失
- Deductibles
- Loss over limits
- Under-insurance
- Depreciation

Not insured Risks
未保險之風險

For example:
- Business Interruption
- Terrorism
- Part of Exclusions etc…

Non-insurable Risks
不可保險之風險
- Competition (Loss of Market/Order, Advanced Technology)
- Reputation Damage
- Poor Management
- Poor Strategy
- Market/Price Downturn
- Part of Exclusions
- Unknown Risks

Lower-level **Management Risk Ownership (管理層風險責任)** Higher-level

Loss Reduction Application
(減損管理)
Risk Management/Enterprise Risk Management (Contingency Plans)
Business Continuity Management (Business Continuity Plans)
Crisis Management

Where are your organization's risks?
Are you prepared at your best?

Effect of Climate Change on Engineering Risks
氣候變遷對工程的影響

E·R·M

- Increasing number of events and amounts of losses
  自然災害的事件及損失有逐年增加的趨勢
- Increasing number of extreme events and magnitudes of severe weather
  極端事件的數量(機率)及規模(損失)有逐年上升的趨勢
- Trend of more losses and higher loss amounts than historical record on engineering risks
  導致工程損失的數量及金額也有逐年上升的趨勢(較歷史數據為高)
- Abnormal becomes normal – facing the unexpected: **Contingency Plan & Crisis Management**
  異常事件的發生成為常態 – 面對不預期的事件 : **緊急應變計畫與危機管理**

Concluding Remarks for Risk Management

- Murphy's law, "If anything can go wrong, it will."
- Nothing is risk free but risk can be managed.
- To risk owners, risks reveal themselves in two ways:
  - Cost – price for risk management and treatment
  - Loss – price for lesson learned
- Contingency plan should be a part of risk management program.
- Always do All-Risk Management.
- ***Ask not for the price tag of a good risk management, but do ask for the one without!***
- The essence of risk management is to ***manage risks to the greatest extent with minimum resources***.

THANK YOU VERY MUCH FOR YOUR ATTENTION

Q & A

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