VENTURE INTO THE PROJECT GLORY - UNDERSTANDING THE RISKS
工程風險管理 – 認識風險

姚大鈞 博士
Dr. Daniel Yao, P.E., AVS.

E·R·M
Eos Rhea Metis, Ltd.

Daniel Ta-Chun Yao, Ph.D., P.E., AVS
姚大鈞 博士

首席總監
ERM

學歷 EDUCATION

- 美國科羅拉多大學 博士 Ph.D. University of Colorado at Boulder, U.S.A.
- 美國密西根大學 碩士 M.S. University of Michigan, U.S.A.
- 台灣大學 學士 B.S. National Taiwan University, Taiwan

專業 EXPERTISE

- 風險管理與風險評估 Risk Management and Risk Engineering
- 土木/環境/海域工程 Civil/Environmental/Offshore Engineering

專業資格 CERTIFICATION

- 美國加州註冊土木工程師 (No. C 61731) Registered Professional Engineer, CA, U.S.A.
- 副價值專家 (201212302) Certified Associate Value Specialist, SAVE International

經歷 EXPERIENCE

- Eos Rhea Metis, Ltd.，台北（現任）
- 桃園大眾捷運股份有限公司，桃園
- 逢甲大學，台中
- 環興科技股份有限公司，台北
- 慕尼黑再保險公司北京分公司，北京
- 廣鎂工程顧問有限公司，台北
- 亞新工程顧問股份有限公司，台北
- Engineering Consulting Services, Ltd., Buffalo Grove, IL, U.S.A.
- Fugro West, Inc., Ventura, CA, U.S.A.
- NTH Consultants, Ltd., Farmington Hills, MI, U.S.A.
- 台北市政府捷運工程局，台北

著作 PUBLICATIONS

40餘件專業論文及書冊

Agenda

1. Prelude
   - Case Study
2. Management of Project Glory – Lesson Learned
3. Management Recommendation of Project Glory
4. Introduction of Engineering Mega Projects
5. Conclusion
6. Q & A

Photo Courtesy of Michael Cua

PRELUDE

Photo Courtesy of Michael Cua

What is Project Glory

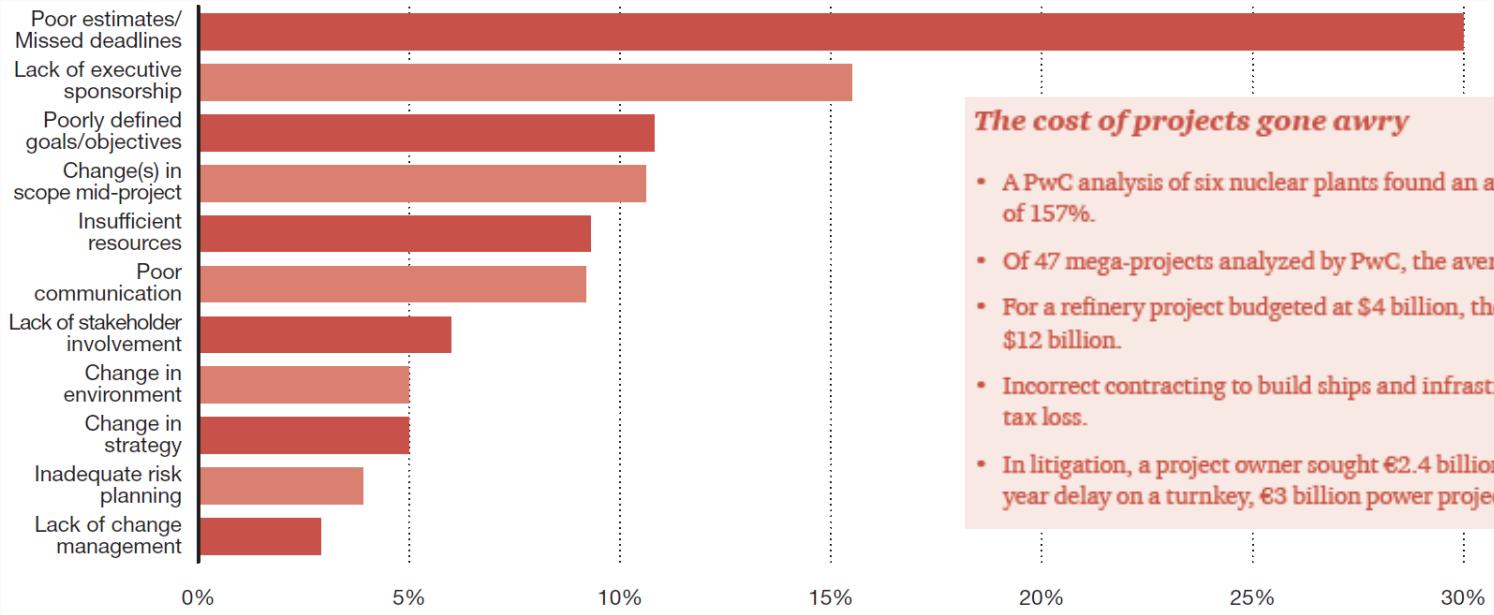
- A project with attributes desired as crowning glory of a person or an entity.
- Everyone from time to time has the zeal to acquire the Holly Grail in his/her Project Glory.
- Characteristics:
  - Colossal
  - Captivating
  - Costly
  - Controversial
  - Complex

Key Factors for Engineering Disasters
重大工程災變的主要原因

- Natural hazards
  自然災害
  - Geophysical, meteorological, climatological, hydrological, cosmological
    地理,氣象,氣候,水文,宇宙
  - Geological, biological
    地質,生物
- Anthropogenic hazards
  人為災害
  - Planning, design, construction, operation, management
    規劃,設計,施工,運營,管理
  - Political, sociological, economical, technological (material/machinery)
    政治,社會,經濟,科技(材料/設備)
  - human factors – ethical and accidents
    人因
- Combination of above - convolution
  複合式災害

Causes of Project Delay and Cost Overrun
計畫延誤與超支的因素

- Project delay often results in cost overrun
  計畫延誤通盛將導致計畫超支
- Force majeure and non-force majeure (both natural and anthropogenic causes)
  不可抗力及非不可抗力的原因
- Deviation from the original plan
  偏離原始規劃



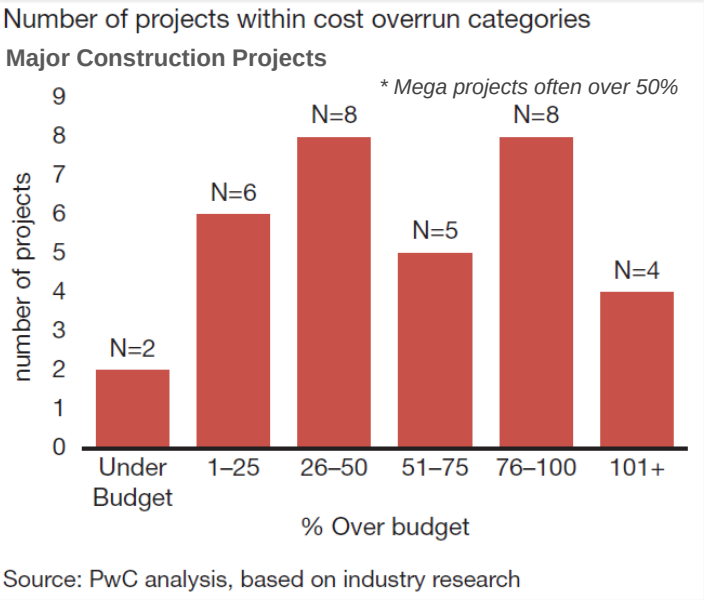
The cost of projects gone awry

- A PwC analysis of six nuclear plants found an average cost overrun of 157%.
- Of 47 mega-projects analyzed by PwC, the average cost overrun was 88%.
- For a refinery project budgeted at $4 billion, the final forecast was $12 billion.
- Incorrect contracting to build ships and infrastructure led to a $2 million tax loss.
- In litigation, a project owner sought €2.4 billion in damages for a three-year delay on a turnkey, €3 billion power project.

Source: *Insights and Trends: Current Portfolio, Program, and Project Management Practices (The third global survey on the current state of project management)*, PwC, 2012.

Causes of Cost Overrun
計畫超支的原因

- Complexity and over-optimism
  計畫複雜且過度樂觀
- Poor execution
  執行的問題
- Weakness in organizational design and capabilities
  組織與能力的缺陷
- Force majeure
  不可抗力因素



CASE STUDY (I) –

SINGAPORE METRO CIRCLE LINE – NICOLL HIGHWAY

Singapore MRT Circle Line – April 20, 2004
Project Outline

- Principal:
  Land Transport Authority
- Main Contractors:
  Nishimatsu/Lum Chang JV
- Scope of works:
  (Total Length : 2.9km)
  - Two C+C stations
  - 1.8 km C+C tunnels
  - 0.8 km twin TBM-bored tunnels
- Contract Value:
  S$274 million
- Period:
  May 2001 to May 2006

on April 1, 2004

Singapore MRT Circle Line – April 20, 2004
Activities at Failure (Overview)

- 0845 First “thung” heard by workers while installing the 10th level struts at S335.
- 0915 Buckling observed and “thung” heard by Contractor’s senior engineer
- 1000 Emergency recognized and evacuation order given
- 1030 Principal notified and more frequent “thung” heard
- 1100 Site preparation for remedy work
- 1330 First attempt of the remedy work (concreting walers)
- 1400 More “thung” heard and more buckling areas observed
- 1500 An urgent meeting held in Principal’s office
- 1510 Remedy work abandoned
- 1530 Total collapse

Singapore MRT Circle Line – April 20, 2004
Final Solution

- Claim and Settlement
  - A claim of around S$400 million based on realignment of new line was filed.
  - In May 2007, a three-way settlement was reached at S$105.5 million.
- Insurance for realignment work
  - Type of policy: CAR / TPL (Builders' All Risk form with DE5 cover)
  - Contract Value: S$357 million
  - TPL Limit: S$10 million any one occurrence
  - Period : 1 July 2005 to 28 Feb 2010 + 18 months MP
  - LTA retains the first $10 million claims in aggregate (inclusive all fees)
  - Tunnelling clause (sub-limit of $100 million)
  - International Joint Code of Practice for Risk Management of Tunnel Works (TCoP)
  - Deductibles are doubled

Points to Take Away

- Almost 7 hours between the first sign and total failure
- Over budget and schedule delay
- Risk convolution
- Contingency plans
- Risk management
  - Flood compartment
  - Failure of bracing system
- Crisis management

CASE STUDY (II) –

SÃO PAULO METRO LINE 4

São Paulo Metro Line 4 – January 15, 2007
Introduction

- Pinheiros Station, São Paulo, Brazil
- Failure at the access tunnel
- NATM construction method (Dia.-18.5m)
- Sign of excessive deformation observed days before collapse
- Cause:
  - Poor design and construction
  - variation of geological formations
- Result: Collapse of crown and crushing invert

São Paulo Metro Line 4 – January 15, 2007 Loss

- 7 killed (4 in minibus)
- Delay almost 2 years

Points to Take Away

- Days between the first sign and total failure
- Interpretation of warning (cracking wall and monitoring data)
- Over budget and schedule delay
- Geological risk – natural variation
- Management risk - negligence
- Principles of risk management SFARP and ALARP

CASE STUDY (III) –

SHANGHAI METRO LINE 10

Shanghai Metro Line 10 – June 25, 2008 Loss

- Hailun Station, Shanghai
- Loss: RMB10,900,312 (FGU) (TBM not included)
- Two TBMs with auxiliary equipments

Points to Take Away

- 13 hours between the first sign and flooding the tunnels
- Not so much on schedule delay and budget overrun
- Contingency plan
- Risk management
- Crisis management
- Risk stakeholders' technical competence

CASE STUDY (IV) –

BEIJING METRO LINE 15

Beijing Metro Line 15 – July 14, 2010
Introduction

- Shunyi Station, Beijing
- Incident description: instability of bracing system with falling strut pipes while raining
- Concrete backfilling for fast stabilization due to lack of backfill material

Beijing Metro Line 15 – July 14, 2010
Loss

- Casualty: 2 fatality and 8 injury
- Result: 3m+ solidified concrete at the bottom of excavation

Points to Take Away

- Risk management
  - Risk awareness
  - Risk culture
- Contingency plans
- Engineering mindset

Better engineering only means less trouble in engineering!

Better management only means less trouble in management!

MANAGEMENT OF PROJECT GLORY - LESSON LEARNED

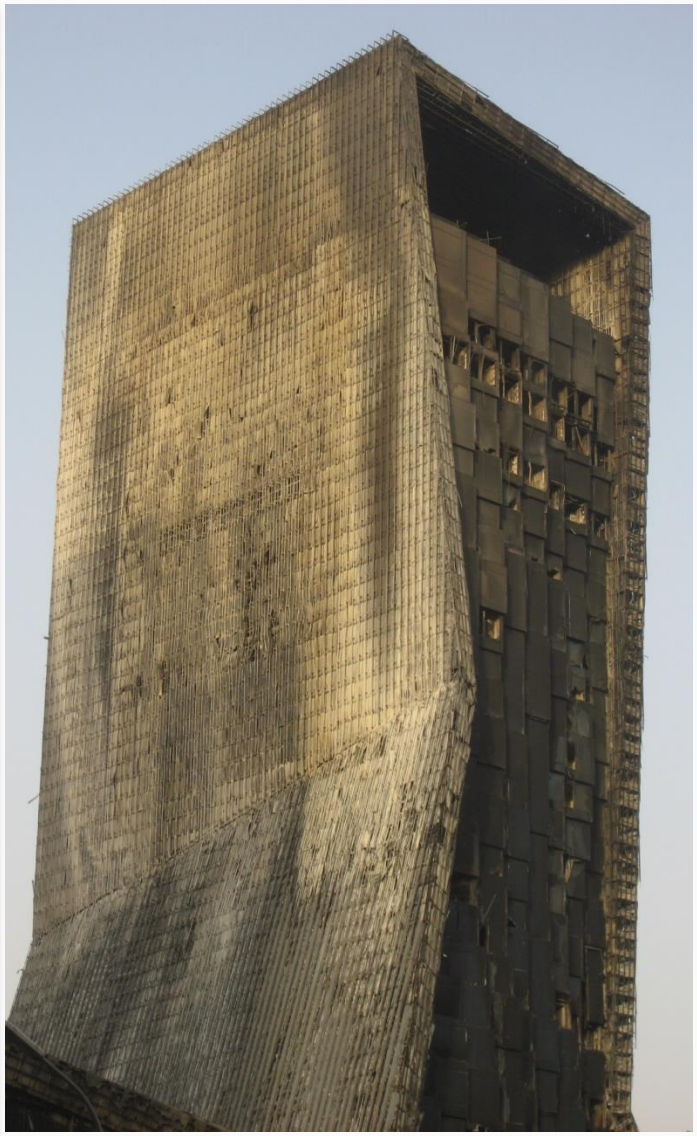
Photo Courtesy of Michael Cua

Primary Causes of Project Failure – for Project Owner
計劃管理的主要問題 – 業主

- Scoping issues
  工程內容與範疇問題
- Inexperienced/unqualified project team
  計畫團隊經驗不足
- Poor estimating
  估算問題
- Poor integration of budgeting & planning
  預算與規劃整合問題
- Incomplete and drifting design
  設計浮動與完整性問題
- Lack of proactive risk management
  缺乏主動風險管理
- Unrealistic schedule
  不合理的工期
- Insufficient project management resource
  計劃管理資源不足
- Poor project management infrastructure
  計劃管理組織與架構問題

How to Detect Problems in Project Glory – for Project Owners 如何發現計劃管理的問題 – 業主

- Periodic independent project assessments
  不定期的獨立計畫評估
- Readiness assessment prior to construction
  施工前準備評估
- Periodic progress/schedule assessment
  不定期進度與工期評估
- Regular project cost reconciliations
  定期計畫費用調節
- Independent validation & reporting of budget variance projections
  獨立的計畫預算變異預期的確認與報告作業
- Tracking contingency draw vs. project progress
  應變成本與計畫進度的追蹤
- Set up project directive council
  設置計畫指導委員會
- Surprise attendance at regular project meetings
  高階管理層突擊參與各級的定期會議
- Regularly update & review project risk register
  定期更新關注計畫風險處置情形
- Implementing earned value cost/scheduled performance indexes
  建立實獲值狀況及進度績效指標



Primary Causes of Project Failure – for Contractors
計劃管理的主要問題 – 承包商

- Poor estimating
  估算問題
- Inexperience/unqualified project team
  計畫團隊經驗不足
- Shortage of management resources
  管理資源短缺
- Unfavorable contract
  合約問題
- Negligence of senior management
  高階管理層的疏失
- Design issues
  設計問題
- Overly aggressive schedule
  過度壓縮的工期
- Lack of risk & contingency management
  缺乏風險與應變管理
- Poor project coordination and integration
  計畫協調與整合問題

How to Detect Problems in Project Glory – for Contractors如何發現計劃管理的問題 – 承包商

- Review of bids and contracts (loopholes, legal, claims)
  研析招標及合約文件內容
- Second opinion on project estimates
  獨立費用估算
- Labor/material escalation provisions if uncertain
  人力/材料成本變動補償條款
- Senior management participation in key meetings
  高階管理層不定期參與各級會議
- Active interaction with design
  與設計的密切合作
- More contract contingencies
  提高計畫的應變準備資源
- T&M (overtime) provision for aggressive schedule
  在工期緊湊的計畫上得以採成本加工費法
- Regularly update & review project risk register
  定期更新關注計畫風險處置情形
- Independent “in-flight” project assessment
  計畫執行過程中的獨立計畫評估
- Close interaction with owner team (colocate)
  與業主密切溝通聯繫
- Regular review of earned value metrics & all potential change orders with senior management
  與高階管理層定期檢討實獲值狀況及合約變更情形

MANAGEMENT RECOMMENDATION OF PROJECT GLORY

Photo Courtesy of Michael Cua

As Early As Practically Feasible
實務可行越早越好

- Establishing early core management team
  建立計劃管理核心團隊
- Assigning project-specific roles & responsibilities
  賦予計畫管理人員職責
- Devising project-specific policies and procedures
  建立計劃管理原則與程序
- Obtaining strong support and commitment of company senior management
  取得公司高階管理層對計畫堅定與全力的支持
- Devising project delivery strategy and format
  建立計畫執行的策略與模式
- Devising stakeholder communication plans
  建立計畫相關單位的溝通計畫
- Starting management of project risks
  開始管理計畫的風險
- Having frequent effective and efficient meetings
  定期進行有效率與目的的管理會議

From the Commencement of Project
計畫開始初期

- Utilizing integrated project management systems and controls
  使用整合性的計劃管理與控制系統
  - Creating work breakdown structure
    建立工作分項架構
- Estimating realistic cost and schedule (risk-based)
  估算實際的費用與工期(風險考量)
  - Preparing a baseline schedule
    建立基準工期
  - Establishing a baseline budget
    建立基準預算
- Managing scope change
  管理內容變更
- Managing project risks
  管理計畫風險
- Monitoring and controlling the project
  監管計畫的執行
- Reporting earned value
  計畫實獲值估算管理

During the Project Execution
計畫執行期間

- Conducting assessment and appraisal
  評估與評量
  - Organization – individual & team
    組織
  - Function – finance/cost, readiness, compliance/control, schedule, performance, EVM, risk management
    功能
  - Angles – self and 360°
    角度
  - Transparency – internal & external
    透明度
- Implementing new processes as needed
  必要時建立新的程序
- Integrating staff and resources from next phase – feasibility, design, construction, operation
  整合計畫後續階段的人力與資源
- Lesson learning – internal & external
  案例分享

Capitals to be Considered in Project Glory
重大計畫的資金考量

Risk Capital

計畫的風險成本

Equity capital against which all losses are charged and which takes the full brunt of the effects of failures, misjudgments, uncertainties, and adverse circumstances.

Contingent Capital

計畫的應變費用

Funds that would be available under a pre-negotiated agreement if a specific contingency occurs or a threshold is crossed. A critical capital injection exactly when it is needed without having to negotiate from a position of weakness.

Risk of Organizational Culture
組織文化的風險

E·R·M

ORGANIZATIONAL CAUSE STATEMENT

The organizational causes of this accident are rooted in the Space Shuttle Program's history and culture, including the original compromises that were required to gain approval for the Shuttle Program, subsequent years of resource constraints, fluctuating priorities, schedule pressures, mischaracterizations of the Shuttle as operational rather than developmental, and lack of an agreed national vision. Cultural traits and organizational practices detrimental to safety and reliability were allowed to develop, including: reliance on past success as a substitute for sound engineering practices (such as testing to understand why systems were not performing in accordance with requirements/specifications); organizational barriers which prevented effective communication of critical safety information and stifled professional differences of opinion; lack of integrated management across program elements; and the evolution of an informal chain of command and decision-making processes that operated outside the organization's rules.

- Executive Summary, Columbia Accident Investigation Board, (2003) Report Volume I

Concluding Remarks
結語

- Realistic monetary budget and timeline set at the outset;
- Clearly defined project scope and objectives with critical success factors (CSF) agreed upon;
- Recognition of internal and external risks to the project;
- Senior stakeholder commitment and support throughout the project;
- Talented project team members led by project managers who understand the psychological nuances of managing a team to deliver success;
- Adaptive proactive response to the dynamic environment that encapsulates projects.

INTRODUCTION OF ENGINEERING MEGA PROJECTS

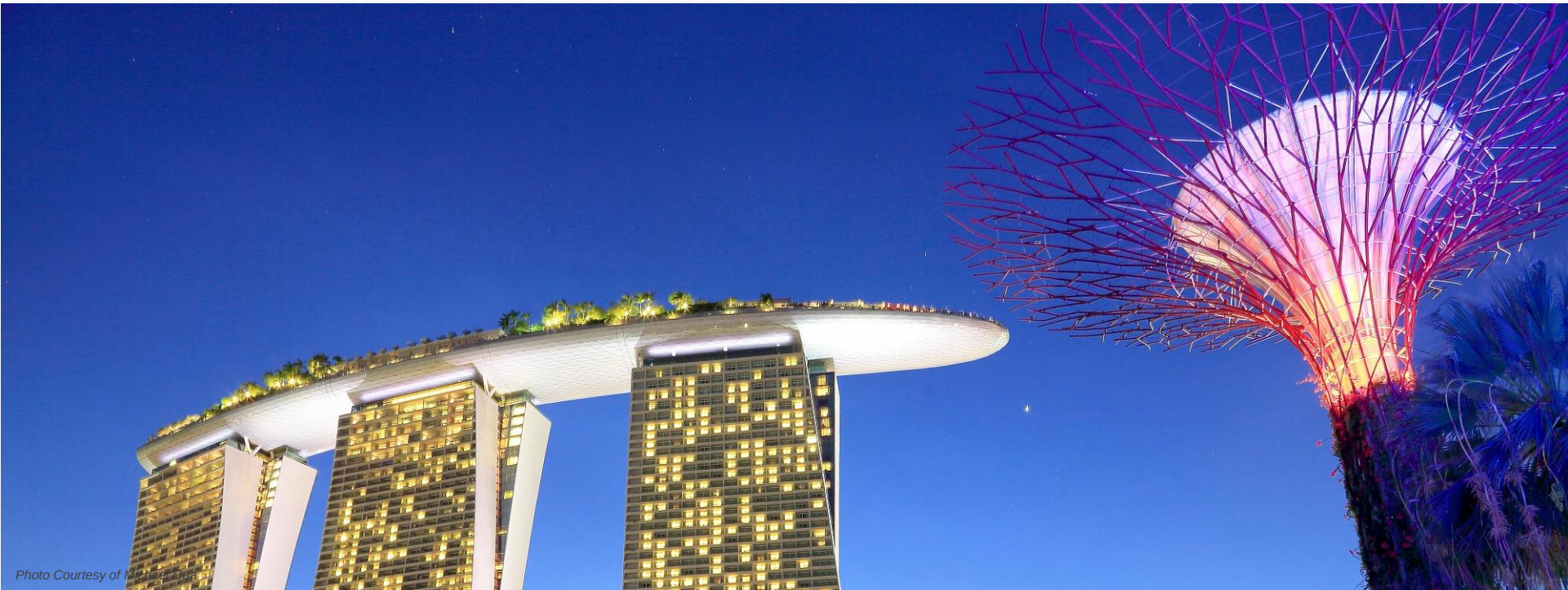
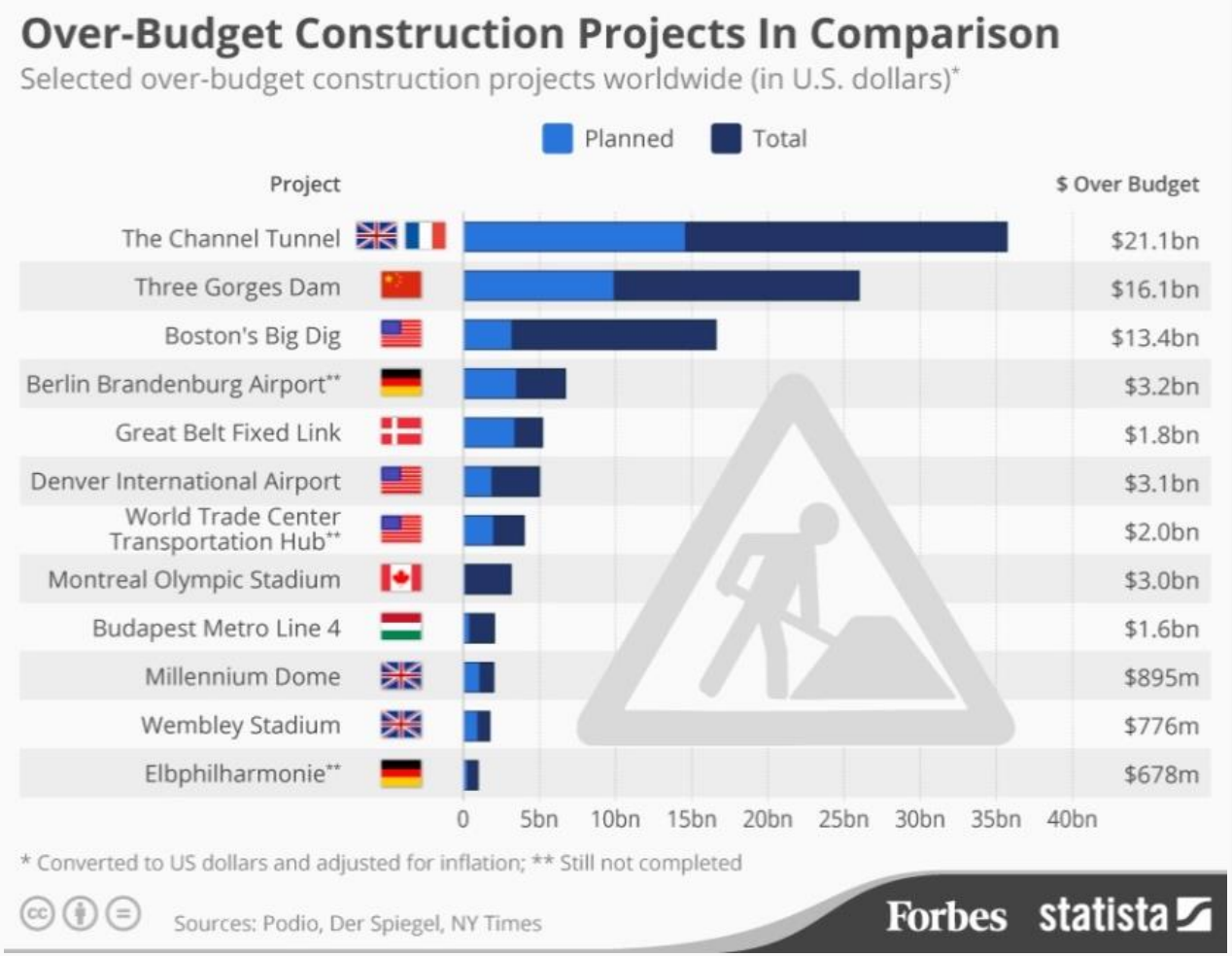


Photo Courtesy of Michael Cun

Mega Projects of Budget Overrun
預算超支的大型計畫



- Nothing to do with the political, legal, financial, social and cultural formats
  與政治,法律,財務,社會,文化無關
- Usually the grander the project the higher the overrun amount, but not necessarily in percentage
  通常愈大的計劃超支金額愈大
- Infrastructure projects usually greater in size
  公共工程計畫通常規模較大

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

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

THE BIG DIG –
THE CENTRAL ARTERY/TUNNEL PROJECT
IN BOSTON, MASSACHUSETTS, USA
波士頓中央動線/隧道工程

Project Goal

- Replacement of outdated infrastructure close to the end of service life
- Alleviation of traffic congestion and reduction of commuting time
- Revitalization of city's environment
- Reconnection of inland communities to waterfront recreation

Project Scope

- **Central Artery Tunnel** (I-93) through downtown Boston (Thomas P. O'Neill Jr. Tunnel) and *Rose Kennedy Fitzgerald Greenway*
- **Extension of I-90** via Logan Airport and under Boston Inner Harbor (*Ted Williams Tunnel*) to I-93
- **Bridge over Charles River** (*Leonard P. Zakim Bunker Hill Bridge*)

Major Infrastructures and Construction Methods

- Leonard P. Zakim Bunker Hill Bridge - cable-stayed bridge (1,432ft, 10 lanes)
- Central Artery Tunnel (Thomas P. O'Neill Jr. Tunnel) – cut-and-cover tunnel
- Ted Williams Tunnel – immersed steel tube tunnel (1.6mi with 0.75mi under water)
- Fort Point Channel Tunnel – immersed tube tunnel/jacked tunnel
- Total project length: 8 miles
- Total tunnel length: 5 miles (3.5 miles under the city)
- Rose Fitzgerald Kennedy Greenway: 27 acres

Engineering Challenges

- Difficult ground conditions – landfill and Boston Blue Clay
- Conflict with underground utility lines
- Protection of historic and fragile structures
- Construction with running traffic and continuous business operation
- Constrained working space
- Water crossing tunneling
- Proximity construction
- Adoption of new technology
- Needs of residents and environmental concerns

Challenges of Project Management

- Change of project scope and priority – increase, redefine, suspend, and adjust
- Change of project schedule and budget/cost
- Change of management roles from design to construction
- Complexity of project
- Negotiation among stakeholders: federal/state agencies, public opinions, community and individuals on various technical, social, environmental, and political issues
- Control of project schedule and cost

Chronicle of Big Dig Project

1982:	Work begins on Final Environmental Impact Statement/Report (FEIS/R)
1985:	Final Environmental Impact Statement/Report (FEIS/R) filed and approved early the next year.
1986:	Bechtel/Parsons Brinckerhoff begins work as management consultant.
1987:	Congress approves funding and scope of Project.
1988:	Final design process under way. Exploratory archaeology digs begin.
1989:	Preliminary/final design and environmental review continue.
1990:	Congress allocates $755 million to project.
1991:	**Federal Highway Administration issues Record of Decision, the construction go-ahead.** **Construction begins on Ted Williams Tunnel and South Boston Haul Road.**
1992:	More than $1 billion in design and construction contracts under way.
1993:	South Boston Haul Road opens. All 12 tube sections for Ted Williams Tunnel are placed and connected on harbor floor.
1994:	Charles River Crossing revised design and related FSEIS/R approved. New set of loop ramps open in Charlestown.
1995:	**Ted Williams Tunnel opens to commercial traffic.**
1996:	Downtown slurry work under way for I-93 tunnels.
1997:	Overall utility work 80 percent complete.
1998:	Enter peak construction years. Construction begins on the Charles River Crossing.
1999:	Overall construction 50 percent complete. **New Broadway Bridge opens.** **Leverett Circle Connector Bridge opens.**
2000:	Nearly 5,000 workers employed on the Big Dig
2001:	Overall construction 70 percent complete.
2002:	Leonard P. Zakim Bunker Hill Bridge completed.
2003:	**I-90 Connector from South Boston to Rt. 1A in East Boston opens in January.** **I-93 Northbound opens in March. I-93 Southbound opens in December.**
2004:	**Opening of the tunnel from Storrow Drive to Leverett Circle Connector**, providing access to I-93 North and Tobin Bridge.
2005:	Full opening of I-93 South, Dewey Square Tunnel, including, Leonard P. Zakim Bunker Hill Bridge. I-90/I-93 Interchange.
2006:	**Reached substantial completion of the Central Artery/Tunnel Project in January.** **Spectacle Island Park opens to the public.**
2007:	Restoration of Boston city streets. Continued construction of the Rose Kennedy Greenway and other parks.

The Lessons of Innovation – the work to manage risks

Project Management Lessons

- Project Director Management Issues
- Financial Planning and Management
- Cost and Schedule Tracking Systems
- Day-to-Day Management

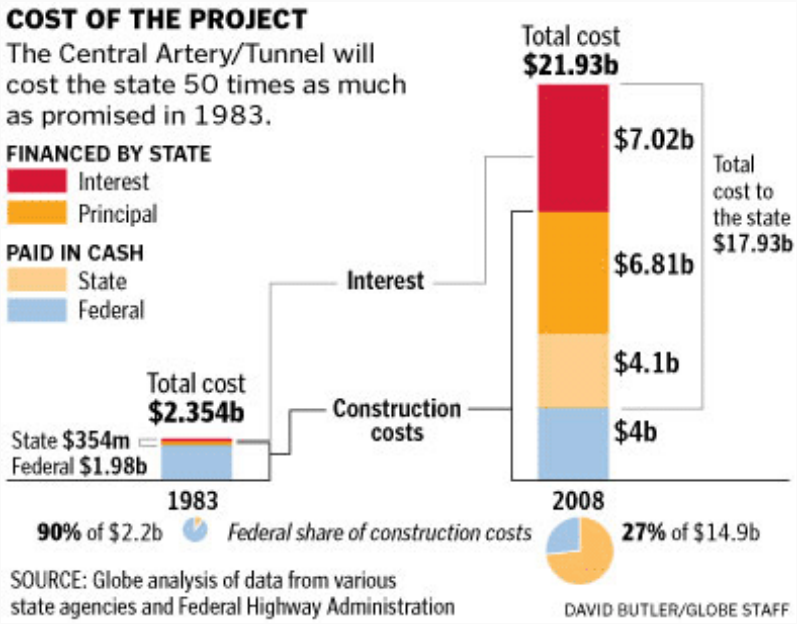
Operations Lessons

- Owner-Controlled Insurance Program (OCIP)
- Innovative Contracting
- Cost Containment Programs
- Environmental and Construction Mitigation Activities

Technology Lessons

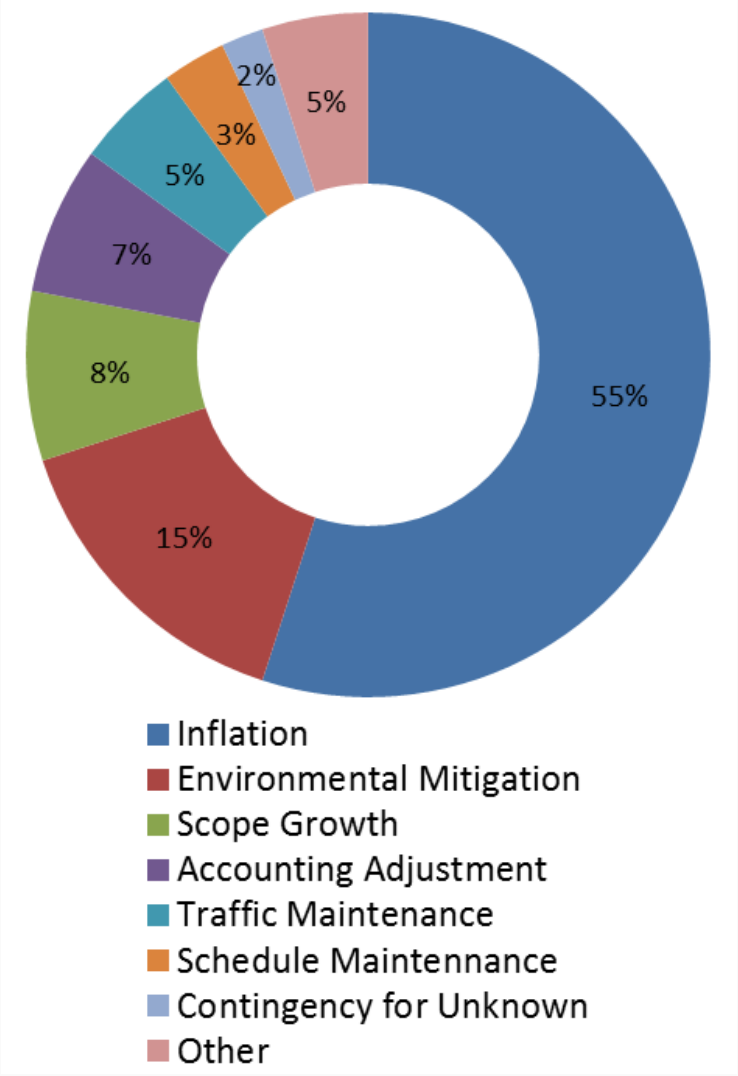
- Urban Application of Slurry Wall Technology
- Soil Improvement Techniques
- ITS/Traffic Simulation Model
- Tunnel Fireproofing and Ventilation Systems

Budget and Cost



- Initial “budget” USD$2.6bn in 1985 based on conceptual design
- USD$5.8bn in later 1991 when construction commenced
- USD$10.8bn in later 1994 when Charles River Crossing work approved
- Final cost of USD$14.8bn
- Approximately USD$1bn per km of project

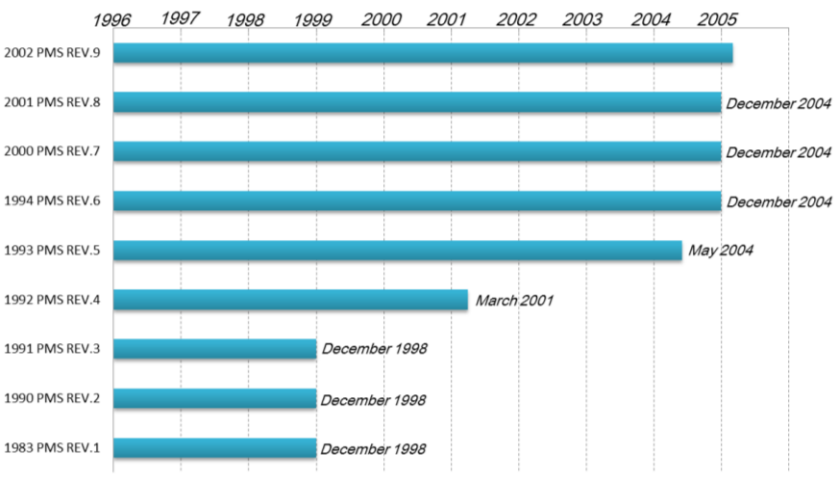
Causes of Cost Increase



- Negotiation with the needs of private, public, and interest groups – to gain public support on the project
  - 1,500 mitigation agreements in billions, 1/3 of total cost
  - Scope change: expand, redesign
- Inflation due to lengthy construction time
- Additional cost of working due to schedule delay
- Accounting adjustment of insurance expense

Key Cost Drivers	USD$ Bn
Inflation	6.4
Environmental compliance and mitigation	3.0
Scope growth and traffic maintenance	2.7
Accounting adjustment (insurance, etc.)	1.2
Acceleration of construction	0.6

The Schedule Delay



- Originally planned completion in 1998
- Major schedule revision:
  - 1991: commencement of construction
  - 1992: major growth of project scope
  - 1994: Charles River Crossing work approved
  - 2005: full opening of major infrastructures
  - 2007: project concluded
- Change of scope
  - Increase
  - Redefine
  - Reprioritize
- Continuous reconciliation with the demand:
  - Private: property owners, business
  - Public: communities, interest groups
  - Governments: city, state and federal agencies, regulation
- Lengthy approval process of authorities

The Overshadowing Issues and Claims

- Cost overrun and schedule extension
- Collapse of tunnel ceiling (2006) – casualty
- “Thousands of Leaks” in I-93 tunnel system (salt/fresh water)
- Use of substandard material – aggregates
- Ginsu guardrails – safety issue and casualty
- Lighting fixtures - galvanic corrosion of incompatible metals
- Claims against Bechtel/Parsons Brinckerhoff – USD$352m for Bechtel and USD$47m for PB

Concluding Remarks
結語

- Never a simple, straightforward, fast, and single solution for mega projects
  大型計劃沒有快速簡單直接的單一管理方式
- Must be a teamwork for the management
  強調團隊合作
- Technical issues shall never be overlooked but seldom are big ones.
  不可忽視技術問題,雖然最後可能不是問題
- Obstacles and setbacks shall always be expected and will eventually be marked as achievement at the end.
  困難與挫折最後都是皇冠上的寶石
- Success shall never be valued on one aspects – completion is a must.
  計畫的成功絕不限於單一因素,但是必須完成計畫
- Quality over quantity is always the key signature of a successful mega project.
  大型計畫的品質一定比規模重要

CONCLUSION

Photo Courtesy of Michael Cua

For Project Glory

- It is hard to say which is more uncertain, the natural hazards or anthropogenic hazard.
  有時真的不知自然風險因子還是人為風險因子不確定性較高!
- One thing is for sure – Nothing is risk free!
  一件確定的事情是 – 沒有零風險!
- The greatest risk – ignorance on risks!
  最大的風險 – 對風險的無知!
- Once out of comfort zone, risks soar up!
  一旦跨出舒適圈,風險將急遽增加!
- Financial feasibility is often undermined by non-financial risks.
  非財務風險經常嚴重影響財務的可行性
- All known risks shall be identified, all risks (both known and unknown) shall be properly managed.
  必須辨識所有已知風險,所有風險(已知及未知)皆須管理!

Concluding Remarks

- Greater the project, more of the risks
  計畫愈大風險愈多
- Nothing is risk free and risks shall be managed.
  絕無“零”風險,風險需要管理
- To risk owners, risks reveal themselves in two ways:
  風險的面向: 費用與損失
  - Cost – price for risk management and treatment
  - Loss – price for lesson learned
- Contingency plan should be a part of risk management program.
  緊急應變計畫應為風險管理的一環
- Risk Management shall be tailor-made and provide risk-based solutions.
  風險管理是客製化並提供根據風險評估結果的處理方式
- ***Ask not for the price tag of a good risk management, but do ask for the one without!***
  風險管理的費用?先思考事故後果的損失影響

THANK YOU

Q & A

姚大鈞博士
Dr. Daniel Yao, P.E., AVS
dyao1966@gmail.com
+886 937835578 (Taipei)
+86 135 2210 5650(Beijing)