

Megaprojects – 50 Years What Have We Learned?



WMATA Dupont Circle Station 1969 (1972)



Alaska Way Tunnel, Seattle 2019

Connecticut Road Builders Fall Meeting

Presentation, October 30 2019

John Reilly, P.E., C.P.Eng.

Presentation Will Cover

1. Megaproject Examples, Lessons-learned
 - Washington DC Metro
 - Boston Southwest Corridor (Transit / HSR / Urban Development)
 - Seattle Alaskan Way Tunnel
2. Management Tools and Systems
 - Cost Validation and Probable Cost - CEVP®
 - Risk Management
 - Contracting and Delivery
 - Team-Alignment and Partnering

We don't have time to cover all this in detail today.

For more information, go to www.JohnReilly.us and download the paper "Megaprojects, Lessons Learned over 50 years."

Previous Papers & Presentations

UCA, Fox Conference New York
January 22nd 2013



Megaprojects – Successes, Lessons Learned

1964年12月25日创刊

现代隧道技术

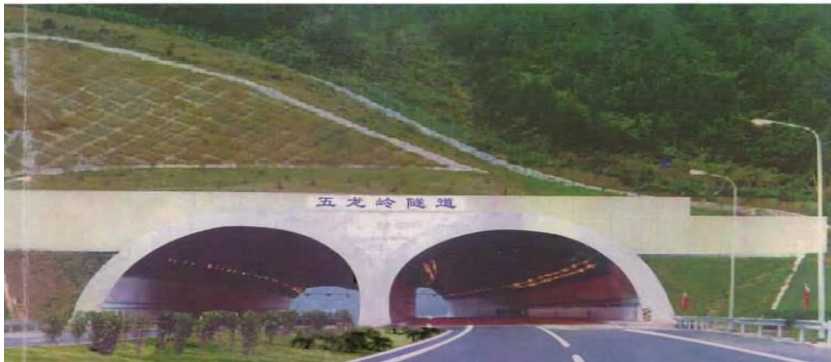
1
2002

Modern Tunnelling Technology

CN 51-1600/U

● 中铁西南科学研究院

● 中国土木工程学会隧道及地下工程分会



John Reilly

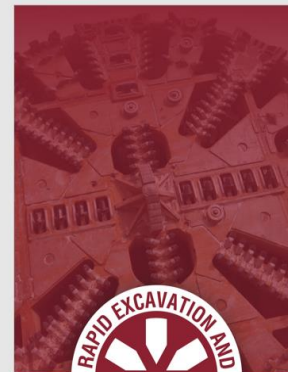


cutting edge

ALTERNATIVE PROCUREMENT & CONTRACTING FOR MEGAPROJECTS

John Reilly, P.E., C.P.Eng.
John Reilly Associates International

Richard A. Sage, P.E., C.C.M.
Sound Transit, Director of Construction Management



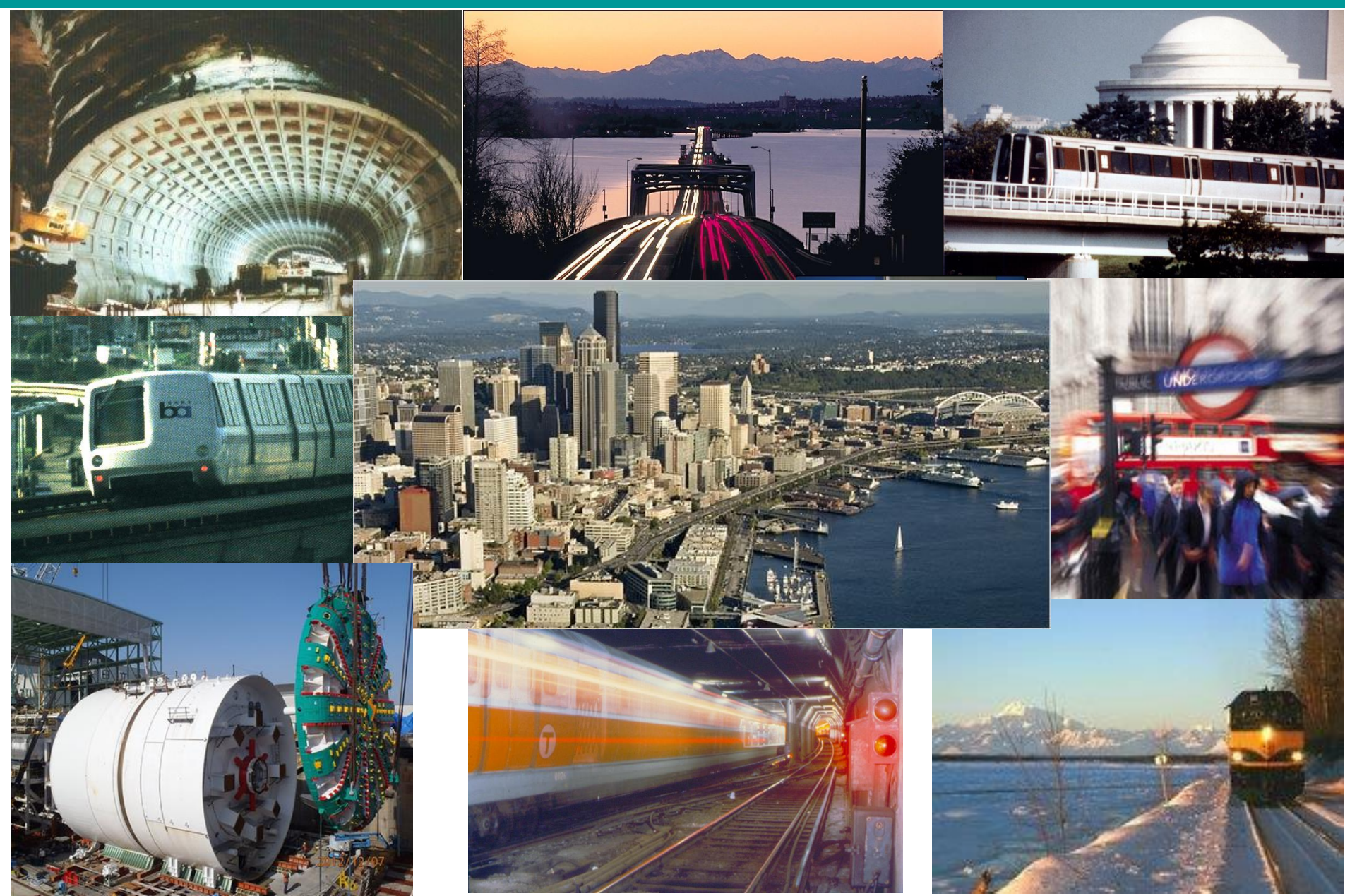
RETC2017

Boston Central Artery/Tunnel Project – Lessons Learned

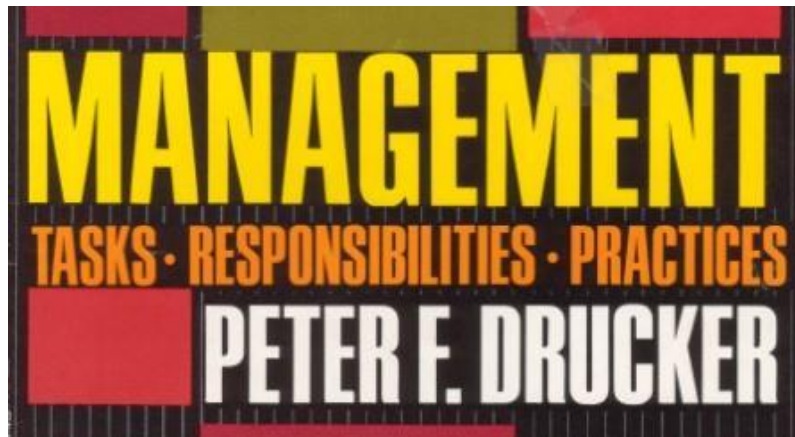
John Reilly, P.E., CPEng.
Fred Salvucci, P.E.
David J. Hatem, PC

June 6, 2017

1. Megaprojects - Examples



The Human Side of Management



- Management is tasks. Management is a discipline. But management is also people. Every achievement of management is the achievement of a manager. Every failure is a failure of a manager. People manage rather than “forces” or “facts”. The vision, dedication, and integrity of managers determine whether there is management or mis-management.

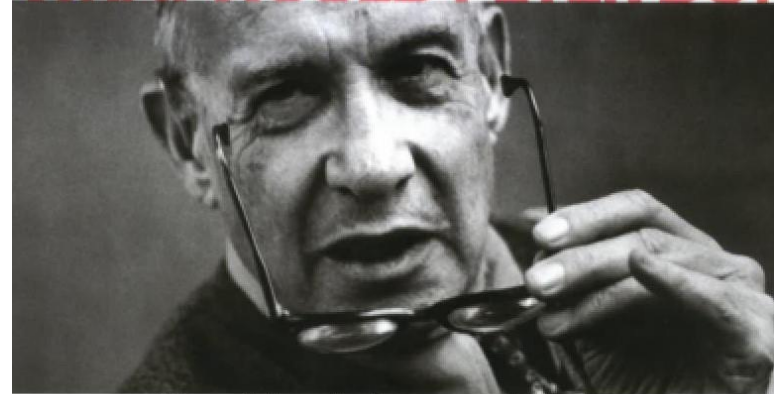
- Management, preface p xiii

Harvard Business Review

hbr.org  November 2009

THE DRUCKER CENTENNIAL

WHAT WOULD PETER DO?



How his wisdom can help you navigate turbulent times

WHY PETER DRUCKER HAD IT RIGHT
Rosabeth Moss Kanter

HOW TO THINK LIKE DRUCKER
Alan Kantrow

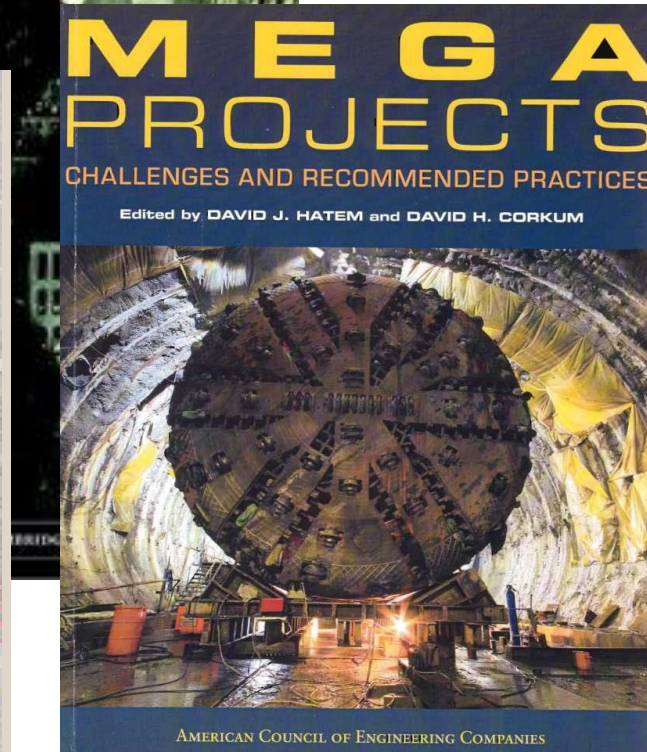
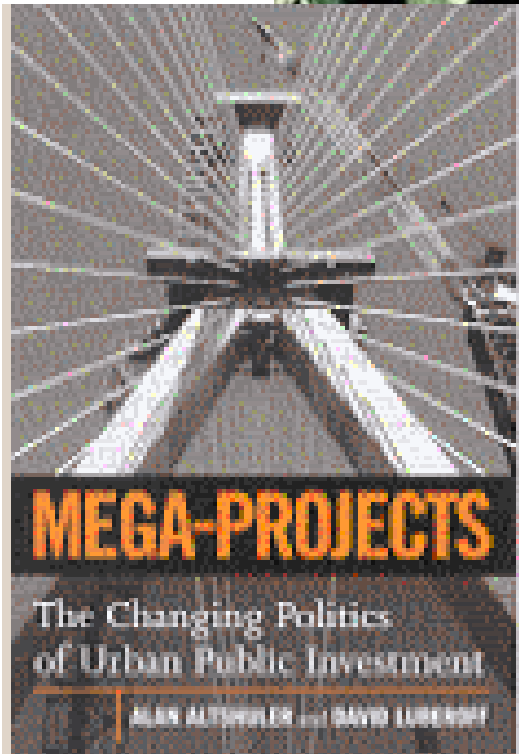
PLUS
P&G's A.G. Lafley, Haier's Zhang Ruimin and other CEOs on **HOW DRUCKER SHAPED THEIR STRATEGY**



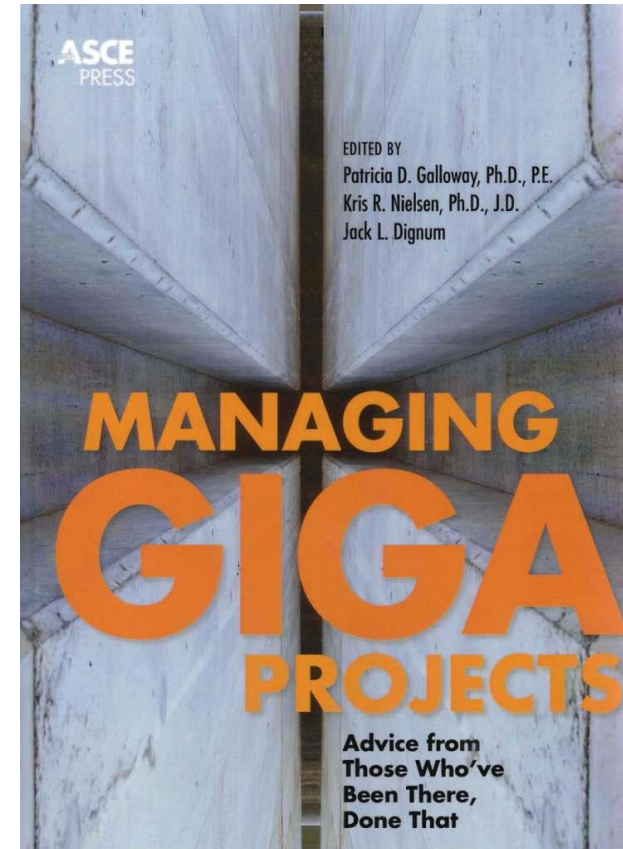
John Reilly

October 2019, CRBA Presentation

Megaprojects - References



Chapter on Cost & Schedule Control



Foreword, Risk, Challenges,

Characteristics of Megaprojects (*)

- **Very large** - multiple billions \$\$
- **Extended schedule**
 - multiple political cycles
- **High level of public involvement** and media coverage
- **Multiple stakeholders** – public, Federal & State Agencies (involvement, requirements)
- **Complex/unusual** in many respects
- **Multiple contractors**, sub-contractors, suppliers
- **Complex**, contractual structures
- **Complex risk structures** e.g. interdependent risk events
- **Require advanced management capabilities**



Governor Gregoire, Mayor Nickels, County Executive Simms announcing the Seattle deep bore tunnel decision, January 2009

The Alaska Way Project took 7 years & 76 alternatives to come to a decision to proceed with the deep-bore tunnel. The Governor made the decision after winning her 2nd election on a recount by 128 votes.

Goals & Objectives, Requirements

Need to create Public understanding and acceptance of the project

– “buy-in”, support, funding, resilience.

Requires :

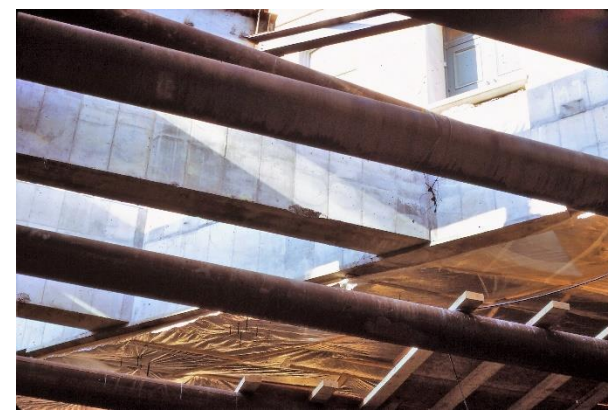
- **Political strategy** – stakeholders, key goals, public process, support
- **Ability to determine** a realistic budget and schedule (CEVP®)
- **Funding** – approval, availability + stability (deal with political changes)
- **Ability to meet** budget and schedule (Management Tools, Risk Processes)
- **Contracting Method** (implicit risk)
- **Alignment** of Agency/Engineer/Contractor
- **Communication**, media involvement



Boston Central Artery
Rose Kennedy Greenway

DC Metro – WMATA 101 Mile System

- Cut and Cover; Earth Tunnels; Rock Tunnels, Rock Stations; Elevated Track Structures, Precedent-breaking underpinning of Monumental Structures, Control Center Building (Phase 1)



Lessons Learned

- The importance of vision, dedication and leadership by WMATA management, GEC and Expert Panel.
Jackson Graham, Carmen Turner, Richard Page.
 - **Alignment** of responsibilities for WMATA, GEC, Panel for design and construction operations.
 - **Advancing new design** & construction technologies – for vaulted modular stations, tunnel drives, Dupont Circle station's innovative rock support, waterproofing methods, improved underpinning methods.
 - **Importance of good architecture** and urban design, contributing to citizen and political support.
 - **Early public communications** and outreach, public process and adoption of full handicapped access.

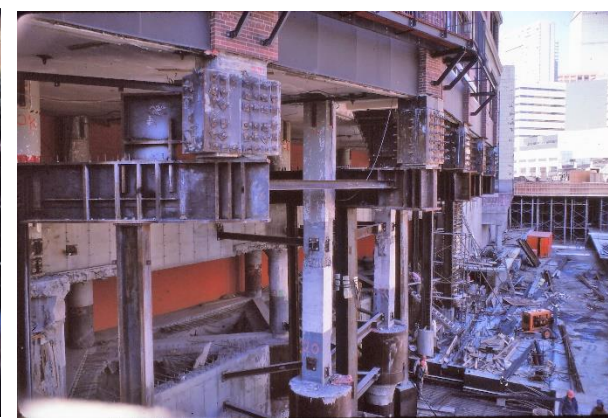
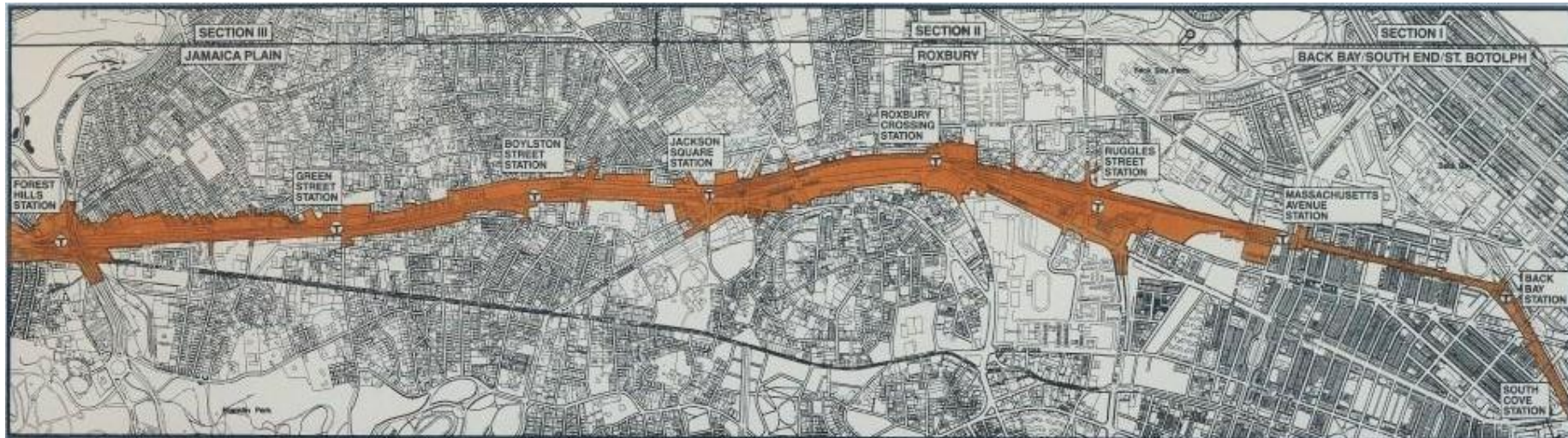
Boston - MBTA Southwest Corridor

- Project Budget for Management, Design & Construction
 - \$750 million US (current cost approximately \$2.5 billion)
- Final Project Cost - \$743 million US 1% under budget
- Initial Project Schedule (1977) - November 1986
- Actual Project Operations – May 1987 (+6 months)
- Consistent with the Boston Transportation Planning Review 1972

Project included rapid transit systems (facilities, vehicles, signals, electrification); civil, structural and tunnels, arterial roadway, 3 high-speed rail lines, urban development, community outreach, educational training, park and parklands + political changes



SouthWest Corridor, Boston



Lessons Learned

A strategy for political changes, management transitions and “black-swan” events.

- The community can be a strong resource for keeping design commitments and “aligning” politicians.
- Management to budget requires discipline to cost with fidelity to community commitments.
- Market forces are a key determinant of cost and outcomes but are difficult to predict.
- The Southwest Corridor Program received numerous design awards including:
 - ASCE Outstanding Civil Engineering Achievement, 1988
 - President’s Design Award, 1988
 - Award for Urban Design Excellence, Boston Society of Architects, 1988

Seattle - Alaskan Way Alternatives 2001

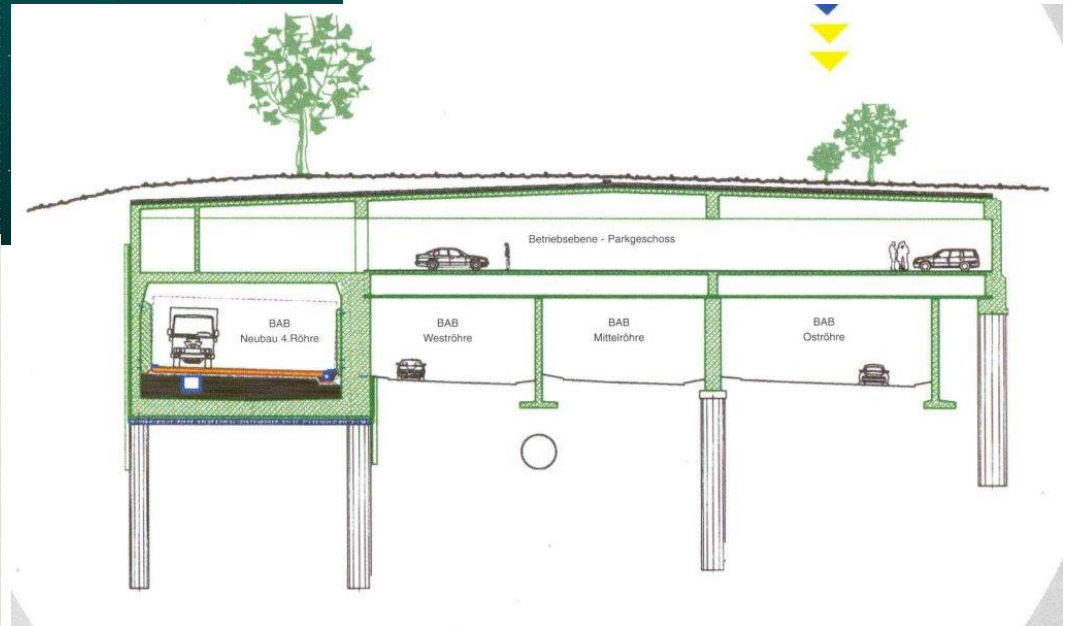
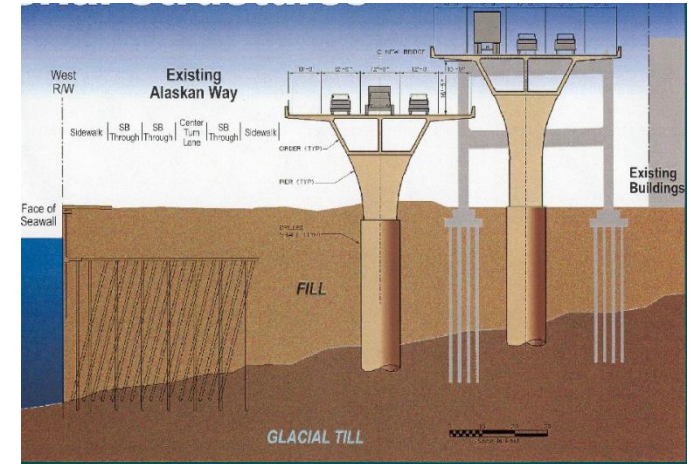
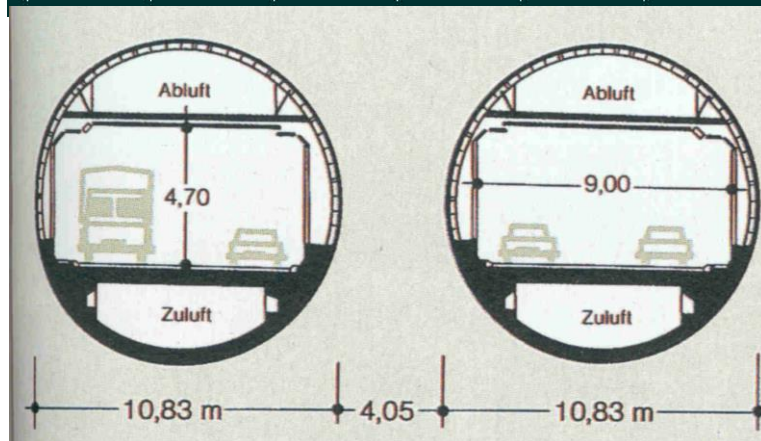
1. Elevated Roadway Along Alaskan Way
2. Cut & Cover Tunnel Along Alaskan Way
3. Deep Bored Tunnels under the City
4. Sunken Tube Under Elliott Bay
5. Deep Bored Tunnel Under Elliott Bay
6. Submerged Floating Tube Under Elliott Bay
7. Cable-stayed bridge
8. Elliot Bay Signature Bridge



Alaskan Way Options - 2001



- Key:**
- Cut & Cover Tunnel
 - ... Bored Tunnel
 - At Grade
 - Aerial Structure
 - Historic District



Lessons Learned

- It was necessary for WSDOT to **use specific management, technical and contracting best practices** for successful delivery of major world-class, complex megaprojects within approved budgets. Created the Urban Corridors Office, reporting to the Secretary of Transportation.
- **Use of a Strategic Technical Advisory Team** was beneficial in management decisions and forming design and contract documents.
- For the Alaskan Way large deep-bore tunnel:
 - Political funding constraints, the desired tunnel configuration and demanding schedule requirements drove decisions that limited flexibility.
 - Management to budget in the preliminary design phase required a constant focus on cost, use of probabilistic cost estimating (CEVP®), aggressive value engineering and scope/cost-reduction efforts.
 - It was essential to perform continuous risk management in design – for input to the probabilistic cost estimating, for risk mitigation and for risk input to the bidders (an indicator of construction risks).
 - The importance of considering low-probability/high-consequence risks has been demonstrated. How such risks should be managed and addressed is not always clear – for underground projects.
 - Input from bidders was necessary to shape contract provisions, contingencies and allowances and to maintain a competitive bidding environment.
 - Alternative Technical Concepts were beneficial in reducing cost, increasing the safety of the initial drive and to identify potential problems with the TBM.

2. MANAGEMENT PROCESSES

- **Core processes:** strategy, organization, design & construction systems, cost & schedule control, quality and safety systems, technical/financial audits, value engineering, expert panel & peer reviews, alignment.
- **Recent developments** (last 25 years):
 - Cost Validation + Probabilistic Range Cost Evaluation
 - Risk Identification, Characterization and Mitigation
 - Disputes Resolution / Escrow Bid Documents
 - Team Alignment Processes - Fully Working in Partnership
 - Advanced Contracting & Delivery
 - Wider use of Design-Build & GCCM
 - Early contractor involvement (ECI)
 - Fixed Price Incentive Fee (FPIF)
 - Alliancing (Relationship Contracting)

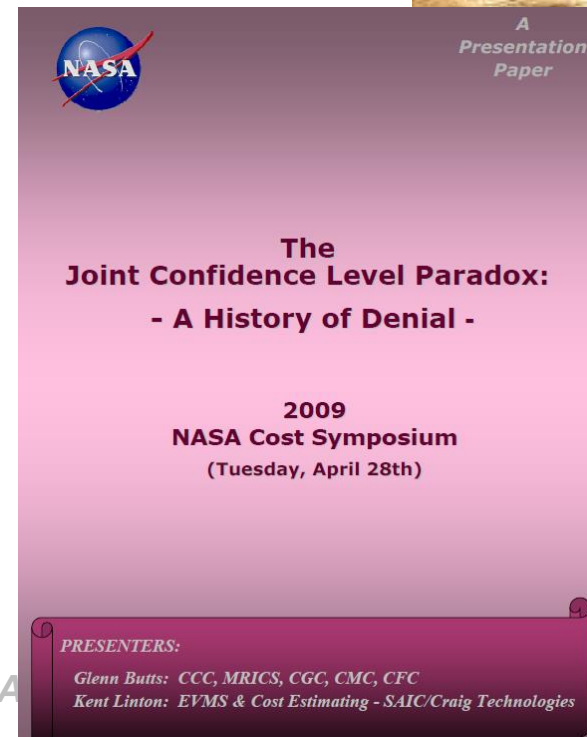
Management - The Cost Issue

- Planning & Scoping – we are optimistic.
 - A PMI study found that the real scope, cost – for a wide range of projects - was about TWICE the initial scope/cost/schedule estimated
 - See NASA 2009, “Symposium – the Joint Confidence Level Paradox, a History of Denial”



*NASA, Apollo 11
(James Webb)*

- Results:
 - Low estimate in the beginning – leads to problems:
 - Cost and schedule over-runs
 - Resource competition – deprives other projects
 - Media – investigations, negative publicity



Not All Projects Exceed Their Budget

- Boston Projects⁽¹⁾ (you normally only hear of the CA/T)
 - SW Corridor Project – 1% under budget, close to schedule
 - Logan Airport Modernization Program
 - within a “few percent” of budget
 - MBTA Red Line – 9% under budget
 - MWRA Boston Harbor Project – 4% over budget, on schedule
 - **Central Artery / Tunnel – 80 to 100% over budget, years late**
- Lessons-learned:
 - We can deliver complex megaprojects on budget and schedule
 - Advanced management & contractual systems are required
 - The stakeholder / political environment is a key determinant
 - Strategic approach & risk-based costing is critical in early planning – a range of probable costs, no single point numbers
 - Early “commitments” are remembered by the public and media
 - Continuity of management policy is essential

(1) See the foreword in the Gigaprojects Book

Examples- AUA Conf Seattle 2001

Examples of Project Cost Growth, US(*) Percent Over Budget - presented at AUA Conf. Seattle, May 2001

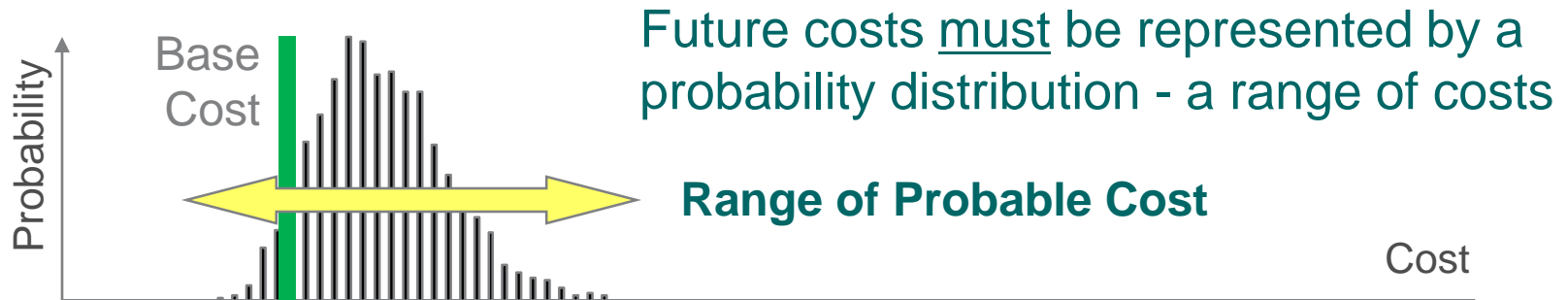


(*) Similar examples exist world-wide

Prepared 2-26-01 by LACMTA Construction Div. Program Mgmt.

WSDOT Policy – Use “range of probable cost”

- In the beginning there is a large potential range for a project's ultimate cost - depending on events that may occur



- A single cost number represents only *one possible outcome*, depending on circumstances and risk events
- These circumstances and risk events are not directly controllable or absolutely quantifiable
- The risk events, if they occur, produce consequences which change the cost/time of the project (opportunities)
- Therefore, cost estimation must include risk (i.e. account for uncertainty) using a logical, structured process

Washington State DOT 1st use of CEVP®

TUESDAY
June 4, 2002



SUNDAY
June 9, 2002



Shocking or not, the Department of Transportation has performed an unprecedented public service with these latest cost estimates. It is a much-needed dose of fiscal reality. The department offered realistic cost-range estimates.

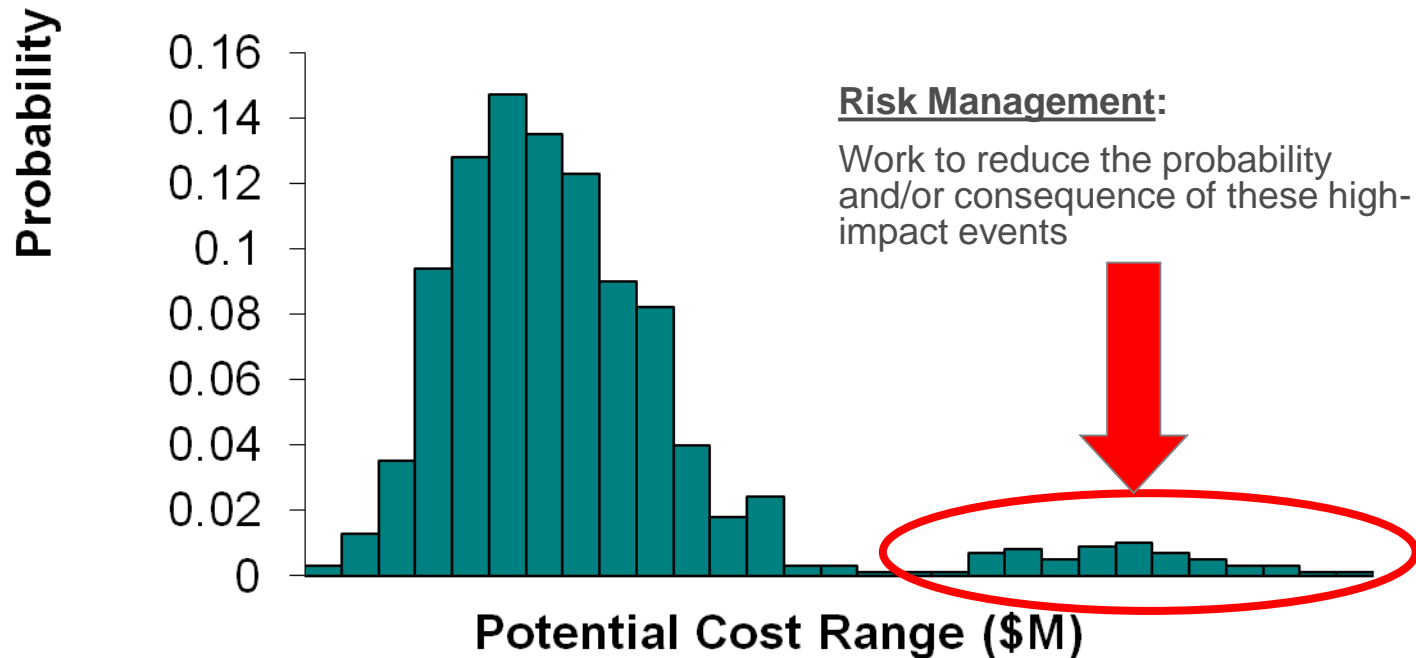
- Seattle Post-Intelligencer Editorial

Giving citizens a range of costs, including full disclosure of the variables, "is not only politically smart, but it's common sense"

- John Reilly, quoted in the
Seattle Post-Intelligencer,
June 9 2002

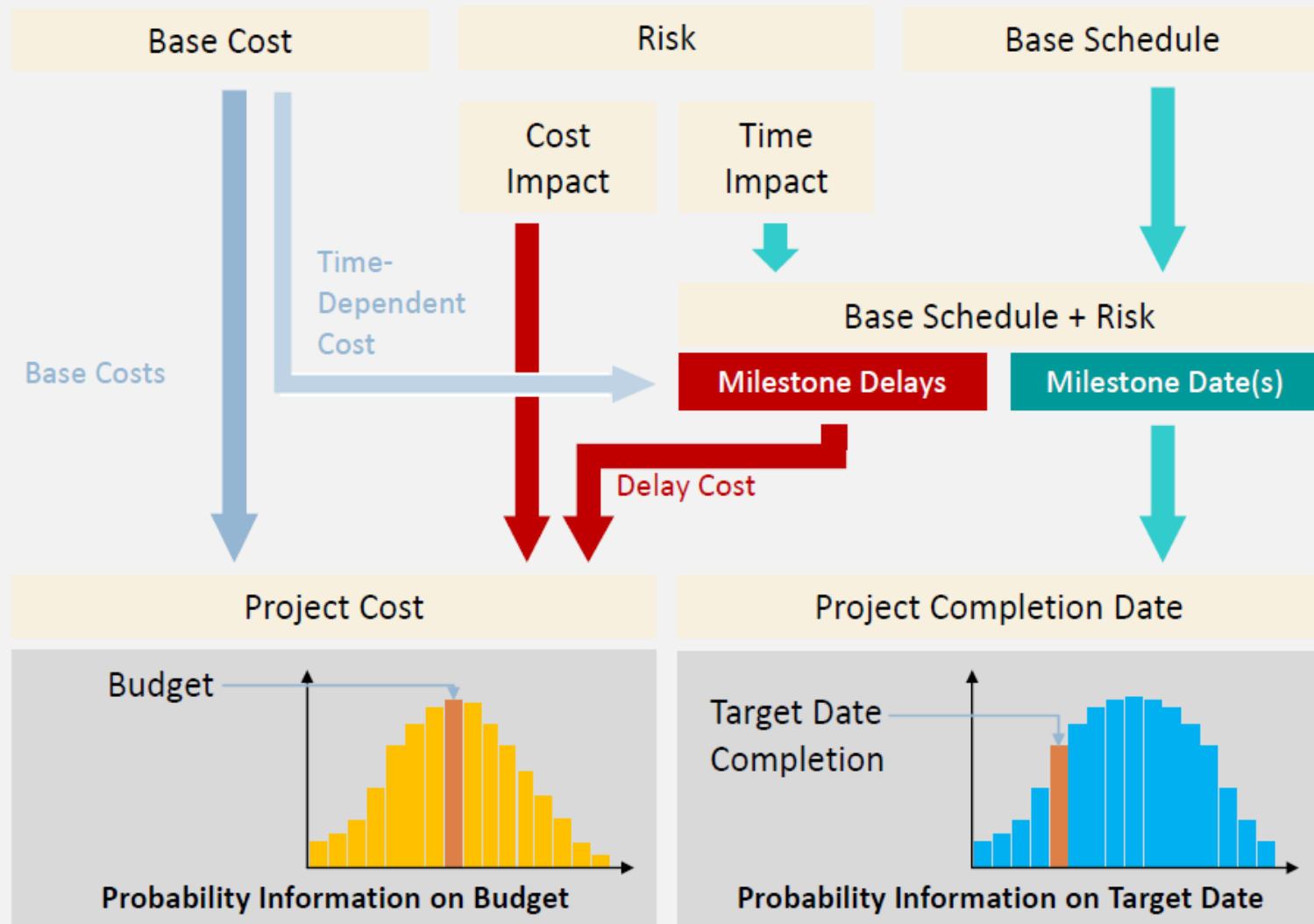
CEVP®: Explicit Management, Cost and Risk

- Risk mitigation / cost-containment actions can be taken, addressing those risks driving high costs – reducing the “range of probable cost”
- Allows structured risk and cost management to approved budgets



Integrated Cost/Risk/Schedule Modeling

Integrated Cost & Schedule Model



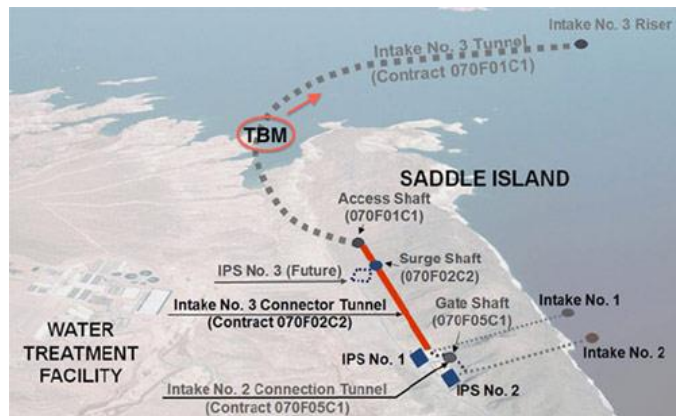
Impact of rare events

- There are rare but potentially very high impact events that can occur
- Their impact is very much out of proportion to their probability
- Because they have very low probability sometimes they are not sufficiently considered in risk mitigation
- It is important that better consideration be given to such events – difficult to do.
- The possibility of “black swan” events



Risk Management Partnership, Lake Mead

- Awarded March 2008 \$447 million
- Compliance with ITIG Risk requirements
- Starter tunnel problems 2010-2011 → delay, cost
- Cost recovered successfully
- Project finished & intake opened to the lake, September 2015.



Tunnel Drive plan/layout



TBM in chamber - production to 391'/week;



Tremie concrete 12,000 cy, 11 days,

Risk Management, Lake Mead

- Contractor and Owner (SNWA) actively worked “in partnership”
- Engaged John Reilly to define advanced risk process, workshop structure, risk compliance reports
- Advanced risk workshops for sensitive operations – e.g. final drive of TBM into sunken intake structure 330’ deep in lake
- Focus on inter-dependent risks and correlation of potential events.
- Successful contract from both Owner and Contractor’s points of view.

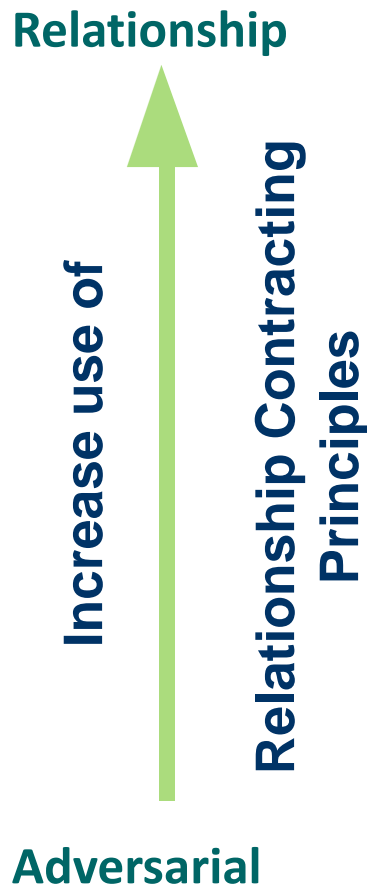


Lake Mead Tunnel Break-thru December 2014

See: Grayson, J., Nickerson, J. & Moonin, E. “Partnering through Risk Management: Lake Mead Intake No. 3. Risk Management Approach”, RETC June 2015 .

CONTRACTING METHODS

Adversarial vs. Relationship Contracts



- Alliancing
- Partnership (true)
- Fixed Price Incentive Fee
- Public Private Partnership
- CMGC / CM@Risk
- Design–Build (DB)(*)
- Design-Bid-Build (DBB)(*)



(*) low-bid environment leads to conflicts

Most Collaborative: ALLIANCING

- Greater benefits and performance can be obtained (e.g. over partnering) by contractually defining project relationships
- First applied to the offshore oil platforms in the North Sea with the following reported cost savings:



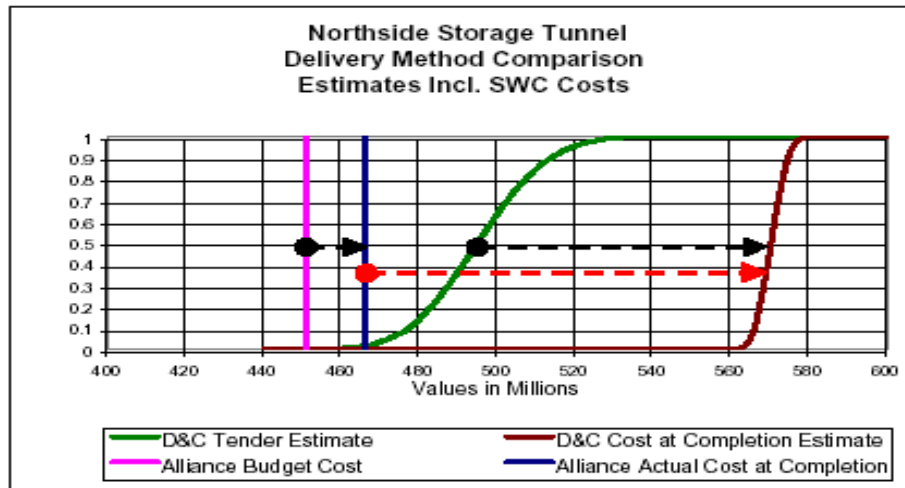
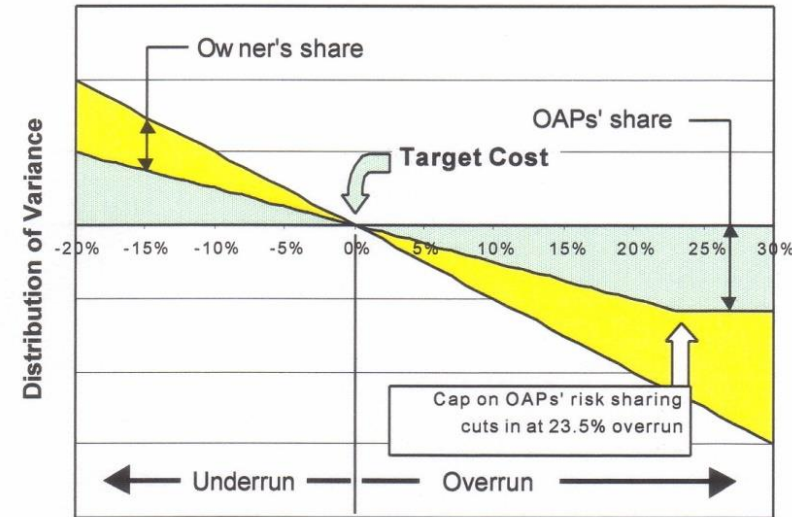
Wandoo Oil Platform, WA

Off-shore Oil Project (All amounts in £M)	Target Cost	Actual Cost	Cost Saving	Percent Saved
Britinnia	1,500	1,200	300	20%
BE ETAP	926	742	85	9%
BP Andrew	373	287.5	85.5	23%
Interconnector	316.5	240	76.5	24%

Examples of Alliancing

➤ Sydney Northside Tunnel Project

- 19.5 km tunnel, 3 TBMs - 6.3, 6.0, 3.8m Ø
- Competitive award components
- Client-engineer-contractor in joint venture open book accounting
- Pain-Gain (risk-reward) agreement
- Comprehensive performance measurement
- Agency satisfied with outcome



➤ Channel Tunnel Rail Link, UK

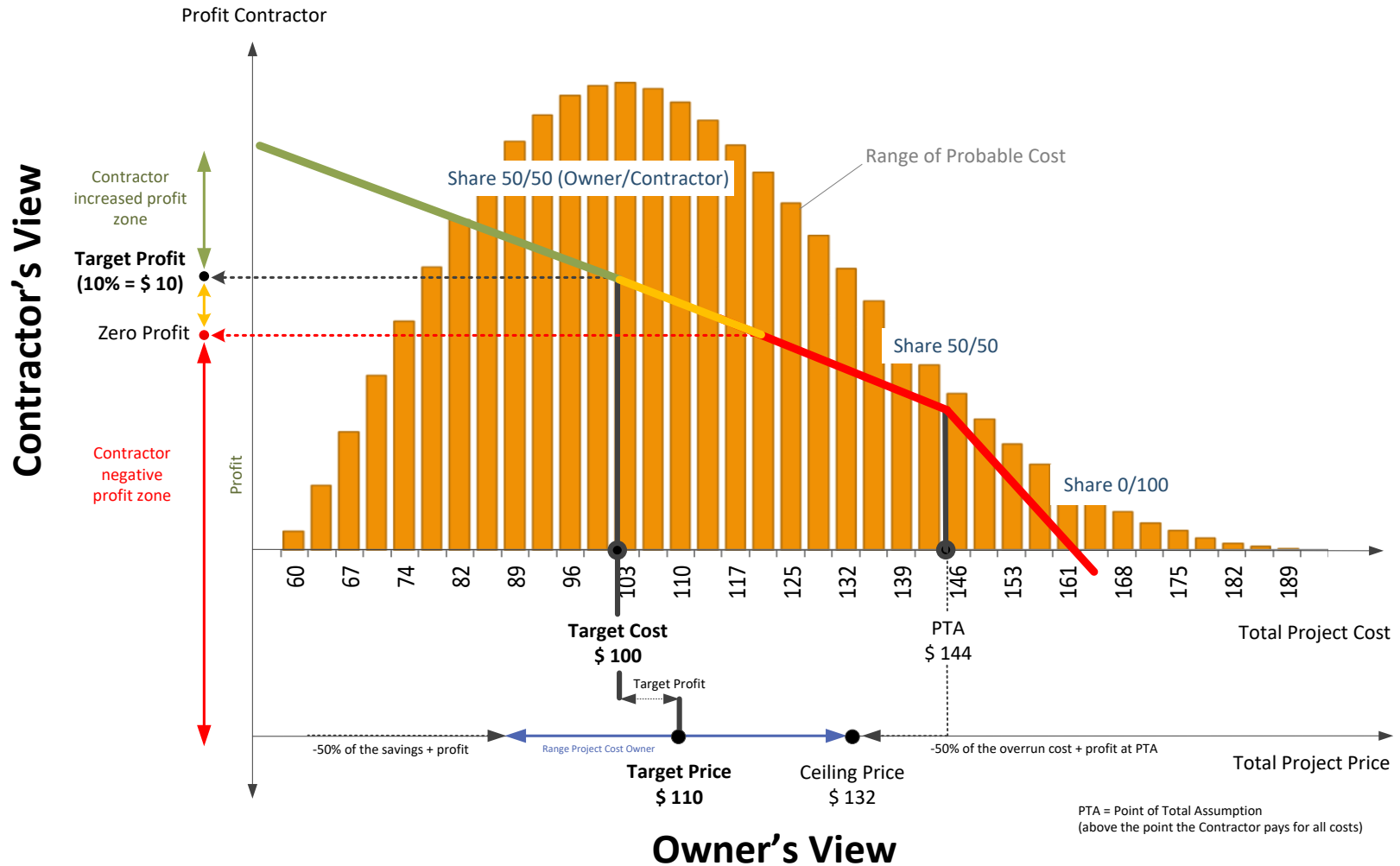
- Completed under target cost, ahead of schedule
- See Task Force Report to the UK Deputy Prime Minister ("Rethinking Construction"),

UK Dept. of Environment, Transport and Regions, London 1998

Fixed Price, Incentive Fee Contract

- From US Dept of Defense procurement strategy - Differentiate 3 types of contractual environments:
 - Well known projects (Firm Fixed Price)
 - Research projects (Cost-Plus-Fee),
 - Large or complex projects with high risk can combine Early Contractor Involvement, Ceiling Price and Incentive Fee resulting in a Fixed Price, Incentive Fee (FPIF) Contract.
- FPIF combines cost-plus and fixed-price structures to manage (allocate) risk between Owner and Contractor.
 - Negotiated Target Cost and Ceiling Price between Owner and Contractor plus Pain-Gain share percentages
 - Incentive for Contractor to reduce cost to improve profit
 - Limits the upside potential cost for the Owner.

Fixed Price Incentive Fee (FPIF)

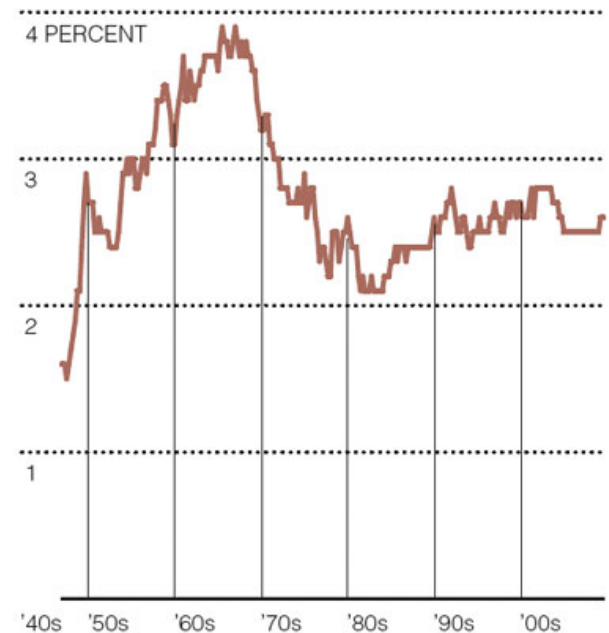


US Megaprojects – Investment needed

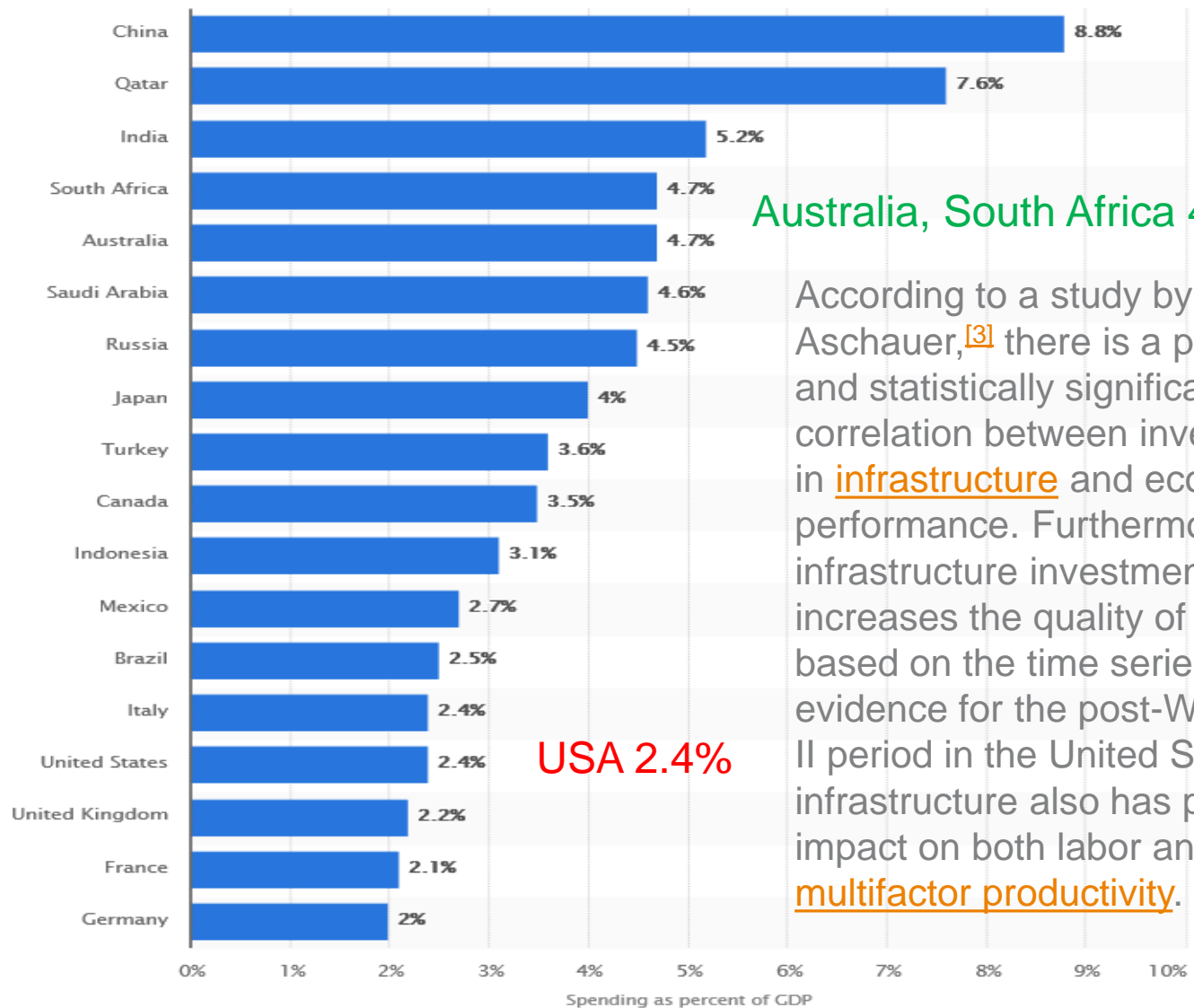
- Generation after generation, giant public works projects have altered the American landscape. In the 1800's The Erie Canal and the Transcontinental Railroad.
- In the 1900's massive urban sewer and sanitation systems, the Tennessee Valley Authority, rural electrification, the Hoover Dam, the Interstate Highway System, major subway networks in NY, San Francisco Atlanta and Washington DC
- However since the mid 1960's the level of US public investment shown in the graph – around 2.5% - is inadequate.
- Lack of vision and a clear responsibility for implementation and funding is a problem.
- e.g. the dispute about the NY-NJ Gateway tunnel - Federal or State responsibility or both?

Public Works Spending

As a percentage of United States G.D.P.



Annual average infrastructure expenditures as a % of GDP worldwide 2008 to 2013



Australia, South Africa 4.7%

According to a study by D.A. Aschauer,^[3] there is a positive and statistically significant correlation between investment in infrastructure and economic performance. Furthermore, the infrastructure investment not only increases the quality of life, but, based on the time series evidence for the post-World War II period in the United States, infrastructure also has positive impact on both labor and multifactor productivity.



- Key topics information can be accessed from the tabs on the left side.
- You can download presentations and papers on Megaprojects Management, Contracting and Risk from the links in the box.
- See also News for recent projects.

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Management Engineering for Complex Infrastructure Projects

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Cost-Risk
Management

Underground
Construction

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For over 50 years, John Reilly has worked on a multitude of projects including large, complex infrastructure programs, highways, transit systems, airports, cities, vehicle manufacturing, buildings and underground facilities.

Services include management, strategic and organizational planning, partnering, team-building and team-alignment, disputes resolution boards, expert and peer review panels, strategic advisory panels, management oversight and management assistance, contracting and delivery methods, risk workshops, risk identification and risk response and probabilistic cost estimating (WSDOT CEVP® process).

John was President of the American Underground Construction Association (1999-2001) and Chair of two International Tunneling Association Working Groups – No. 20 "Urban Problems – Underground Solutions" and No. 13 "Direct and Indirect Benefits of Underground Structures." He is a Charter Member of the Disputes Resolution Board Foundation.



[Click here for more](#)
[Click here to download the CVRResume](#)

Megaprojects and Risk, 2018 BSCE Lawler Lecture

John presented an overview of megaprojects, with examples from 1968 to the present, including success factors, management strategies, cost and risk management, an overview of the Cost Estimate Validation Process (CEVP) he developed with colleagues and the Washington State Department of Transportation in 2002, alternative contracting methods and advanced applications of these processes to his current megaproject in Lima Peru.
[[Click here to download the presentation.](#)]

Megaprojects, Lessons learned over 50 years, 2016

John's paper summarizing megaprojects he has worked on over the last 50 years, with lessons-learned, is published in the Proceedings of the 2016 World Tunnel Conference, San Francisco.
[[You can download the article by clicking here.](#)]

Previously: Keynote Presentations, 2013

John presented strategies on the development, implementation, management and contracting of megaprojects, considering cost and risk, with US and International examples, at the Fox conference in New York, (January – Part 1) and the Cutting Edge conference in Seattle (November – Part 2). You can download these presentations thru the following links:

1. NY – Management of Megaprojects, issues, strategies, cost issues, cost and risk management, contracting and delivery [[Click here to download the presentation.](#)]
2. Seattle – Alternative contracting and delivery for Megaprojects – their characteristics, summary of contracting methods (US and International), new initiatives, case studies and examples
[[Click here to download the presentation.](#)]