Project Management
– An Overview

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MBA 8125 – Fall 2011
15th Nov, 2011
Tacoma Narrows Bridge

**Galloping Gertie – 1940**
Collapsed on 7th Nov ’40
Reason - aerodynamic phenomena in suspension bridges were not adequately understood.

A photographer for Tacoma News Tribune, Howard Clifford was the last man off the Bridge before it collapsed. Now 94 (Apr ’06), Clifford recounts that fateful day.
Agenda

• What is a Project
• History
• Operations Vs Project
• Case Study
• Project Types
• Project Management & Process Groups
• Knowledge Areas
• Skills of a Project Manager
What is a Project?

• A temporary endeavor undertaken to create a unique product, service or result
• Definite beginning and end
• End
  • Project’s objectives achieved
  • Project terminated – objectives cannot be met or need for project no longer exists
• Temporary does not necessarily mean short in duration

History

• Project Management Institute® - founded in ’69
• Premise – many management practices were common to projects in application areas as diverse as construction to pharmaceuticals
• ’81 – PMI Board of Directors approved a project to develop the procedures and concepts to support the profession of Project Management
• ’84 – First PMP certification awarded
• ’87 – PMBOK Standards ; ’96 – A Guide to PMBOK
• > 500,000 members
## Operations Vs Projects

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Operations</th>
<th>Projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labor skills</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Training time</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Worker autonomy</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Compensation system</td>
<td>Hourly or weekly wage</td>
<td>Lump sum for project</td>
</tr>
<tr>
<td>Material input requirements</td>
<td>High certainty</td>
<td>Uncertain</td>
</tr>
<tr>
<td>Supplier ties</td>
<td>Longer duration</td>
<td>Shorter duration</td>
</tr>
<tr>
<td>Raw Materials inventory</td>
<td>More formal</td>
<td>Less formal</td>
</tr>
<tr>
<td>Scheduling complexity</td>
<td>Large</td>
<td>Small</td>
</tr>
<tr>
<td>Quality control</td>
<td>Lower</td>
<td>Higher</td>
</tr>
<tr>
<td>Information flows</td>
<td>Formal</td>
<td>Informal</td>
</tr>
<tr>
<td>Worker-mgmt communication</td>
<td>Less important</td>
<td>Very important</td>
</tr>
<tr>
<td>Duration</td>
<td>Less important</td>
<td>Very important</td>
</tr>
<tr>
<td>Product or service</td>
<td>On-going</td>
<td>Temporary</td>
</tr>
<tr>
<td></td>
<td>Repetitive</td>
<td>Unique</td>
</tr>
</tbody>
</table>
Hubble Telescope Failure

- Hubble Space Telescope launched aboard Space Shuttle Discovery on 24\textsuperscript{th} April ’90
- NASA called it a “New window on the Universe”
- announced failure on 21\textsuperscript{st} June ’90
- Both high resolution imaging cameras showed distortion
- Planning started in ’70 → Congress approved (’78) at a cost of $ 400 M
- Total cost when launched - → $ 2.5 B
- Lessons Learnt (pg 58)
DIA Baggage Handling System

- Denver International Airport (DIA)
- 53 sq. miles – designed to be the largest airport in US
- Initial ground-breaking in ’89 – completion Fall ’93
- Original plan – individual airlines to build their own baggage handling system
- ’91 - United Airlines started their own with BAE
- ’92 – DIA approached BAE to build an airport-wide system - $ 175.6 Million
- “most complex baggage handling system ever built”
- 3100 telecars, 20 airlines, 5,000 optical detectors, 400 radio receiver, 56 bar code scanners......
DIA Baggage Handling System

• Aug 4 ’94, Mayor Webb announced a plan to develop “a temporary, low-tech alternative system for the DIA’s high-tech baggage system.

• Feb ’95 – 16 months behind schedule - $ 5.2 billion (2 billion over budget)
  • 2 concourses served by manual baggage system
  • 1 concourse served by scaled down semi-automated system

• Lessons Learnt

• ’05 – Fully manual system – Running cost $ 1 M per month

• An update - http://www.youtube.com/watch?v=xx8f4x6C_KY
# Top 10 Corporate IT failures

## Top 10 Corporate Information Technology Failures


**PROJECT:** “Confirm” reservation system for hotel and system for hotel and rental car bookings

**WHAT HAPPENED?** After four years and $125 million in development, the project crumbled in 1992 when it became clear that Confirm would miss its deadline by as much as two years. AMR sued its three partners for breach of contract, citing mismanagement and fickle goals. Marriott countersued, accusing AMR of botching the project and covering it up. Both suits were later settled for undisclosed terms. Confirm died and AMR took a $109 million write-off.

### Snap-On Inc.

**PROJECT:** Conversion to a new order-entry system from The Baan Co.

**WHAT HAPPENED?** Despite three years of design and implementation, a new order-entry system installed in December 1997 costs the tools company $50 million in lost sales for the first half of 1998. Orders are delayed, inventory is miscounted. Snap-On’s operating costs soar 40%, mainly to cover costs of extra freight and temporary workers. Franchisees, frustrated because they can’t operate the new software, turn to Snap-On competitors. Company profits for the period sink 22% compared to 1997.

### FoxMeyer Corp.

**PROJECT:** SAP ERP system

**WHAT HAPPENED?** A bungled enterprise resource planning (ERP) installation in 1996 helped drive FoxMeyer into bankruptcy, the drug distributor claims in lawsuits still pending against SAP AG, SAP America Inc. and Andersen Consulting. FoxMeyer seeks a combined $1 billion in damages, but defendants deny doing anything wrong. Trials scheduled for next May.
# Top 10 Corporate IT failures

<table>
<thead>
<tr>
<th>Company</th>
<th>Project Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>W. W. Grainger Inc.</td>
<td><strong>PROJECT:</strong> SAP ERP system</td>
</tr>
<tr>
<td><strong>WHAT HAPPENED?</strong></td>
<td>Grainger spent at least $9 million on SAP software and services in 1998 and last year, but the ERP system overcounted warehouse inventory and had routine crashes. During the worst six months, Grainger lost $19 million in sales and $23 million in profits. Grainger patiently worked with SAP on fixes.</td>
</tr>
</tbody>
</table>

| Greyhound Lines Inc.     | **PROJECT:** “Trips” reservation and bus-dispatch system                           |
| **WHAT HAPPENED?**       | Greyhound spent at least $6 million in the early 1990s building Trips. But Trips failed miserably when installed in 1993, crashing when Greyhound offered sale prices on bus fares. To avoid using the system, agents wrote tickets by hand while customers waited in line and missed busses. Ridership plunged 12% in one month. Just weeks after rolling Trips out, Greyhound disabled it in some regions while trying to trace problems. The debacle spurred a $61.4 million loss for the first half of 1994. The CEO and CFO resigned. Trips operates today but Greyhound never regained its status as a transport powerhouse. |

| Hershey Foods Corp.      | **PROJECT:** IBM-led installation and integration of SAP, Manugistics Group Inc. and Siebel Systems Inc. software |
| **WHAT HAPPENED?**       | To meet last year’s Halloween and Christmas candy rush, Hershey compressed the rollout of a new $112 million ERP system by several months. But inaccurate inventory data and other problems caused shipment delays and incomplete orders. Hershey sales fell 12% in the quarter after the system went live—down $150.5 million compared with the year before. Software and business-process fixes stretched into early this year. |

| Norfolk Southern Corp.   | **PROJECT:** Systems integration with merger target Consolidated Rail Corp.         |
| **WHAT HAPPENED?**       | Norfolk Southern lost more than $113 million in business during its 1998/1999 railroad merger with Conrail. Custom logistics software wasn’t tested properly and a dispatcher mistakenly fed bogus test data into the system. Norfolk Southern suffered more than a year of train backups, untrackable freight and crew-scheduling mishaps. Norfolk Southern spent an extra $80 million on worker overtime pay and fix-up costs until the system was stabilized early this year. |
Top 10 Corporate IT failures

Oxford Health Plans Inc.  PROJECT: New billing and claims-processing system based on Unix International and Oracle Corp. databases


Tri Valley Growers  PROJECT: Oracle Corp. ERP and application integration

WHAT HAPPENED? A giant agricultural co-operative, Tri Valley bought at least $6 million worth of ERP software and services from Oracle in 1996. None of the software worked as promised; some of it couldn’t even be installed on Tri Valley’s DEC Alpha hardware, the co-op claimed in a $20 million lawsuit filed in February. Tri Valley stopted using the Oracle software and stopped paying the vendor. Oracle countersued for breach of contract. Tri Valley filed for bankruptcy protection in July. Oracle denies all claims.

Universal Oil Products LLC  PROJECT: Software for estimating project costs and figuring engineering specifications, to be built and installed by Andersen Consulting

WHAT HAPPENED? After a 1991 ERP deal with Andersen resulted in unusable systems for UOP, the industrial engineering firm cried “fraud, negligence and neglect” in a $100 million lawsuit in 1995. Andersen later sued UOP for libel, accusing it of leaking incriminating e-mail by its consultants in an “attempt to publicly harass and humiliate Andersen.” UOP hired another consultancy to implement the system. [Will add sentence on the result of the lawsuits.]

Methodology: Projects are listed in alphabetical order by company name. Selection of the IT projects was based on the amount of financial losses or damages sought in lawsuits. Only IT projects at U.S. corporations – and developed during the 1990s – are included. Government projects are excluded. Thanks to Mark Keil (Georgia State University), Peter Neumann (SRI International), Esther Roditi (“Computer Law & Tax Report”) and Bruce Webster (PricewaterhouseCoopers) and the Computerworld Editorial research team, led by Mari Keefe, for their assistance.
IT Project types

• ERP Implementation
• Software Development
  • Traditional – SDLC
  • Newer Methods - Agile
• Infrastructure – Mailing System migration, Setting up data center
• IT Infrastructure Management – Optimizing IT Operations
Discussion questions for the class

• How many of you all have been **not** exposed to projects?
• How many of you have managed projects?
• What are the biggest challenges?
• How do you measure whether you are on track?
• How do you mitigate risk?
• How many of you all have a “lessons learnt” session?
• How many know about PMP?
Project Management

• Application of knowledge, skills, tools and techniques to project activities to meet project requirements

• **How?**

• Appropriate application and integration of 42 logically grouped project management processes comprising of 5 process groups
  • Initiating
  • Planning
  • Executing
  • Monitoring and Controlling
  • Closing

*Figure 3-1. Project Management Process Groups*
Process Groups

• Initiating – processes performed to define a new project or a new phase
• Planning – processes required to establish the scope of the project, refine the objectives, and define the course of action
• Executing – processes performed to complete the work
• Monitoring & Controlling - processes required to track, review and regulate the progress
• Closing – processes performed to finalize all activities
Project Management Plan

• Project Management plan is iterative and goes through progressive elaboration throughout the project’s life cycle

• Progressive elaboration involves continuously improving and detailing a plan as more-detailed and specific information and more accurate estimates become available
Project Management Office

• An organizational body or entity assigned various responsibilities related to the centralized and coordinated management of those projects under it’s domain

• Responsibility – range - providing project management support to being responsible for direct management

• Functions
  • Managing shared resources across projects
  • Identifying and developing PM methodology
  • Coaching, mentoring, training and oversight
  • Monitoring compliance with PM Standards, templates
  • Coordination communication across projects
Project Life Cycle

A Guide to the
Project Management Body of Knowledge
- PMBOK version 4

Figure 2-1. Typical Cost and Staffing Levels Across the Project Life Cycle

Figure 2-2. Impact of Variable Based on Project Time
Organizational Influences

- Organization Cultures and Styles
- Cultural norms include common knowledge regarding how to approach getting the work done
- Share vision, values, norms, beliefs and expectations
- Policies, methods and procedures
- View of authority relationships
- Work ethic and work hours
Organizational Process Assets

• Processes and Procedures
  • Standards, policies, process audits, improvement targets
  • Change control procedure, Proposal evaluation criteria
  • Templates, Issue and defect management procedure
  • Organization communication requirements
  • Project closure guidelines

• Corporate Knowledge Base
  • Project files
  • Configuration management knowledgebase
  • Financial databases containing information on labor hours
  • Process measurement databases
  • Lessons learnt knowledge base
## Organization Structure

### Table 2-1. Organizational Influences on Projects

<table>
<thead>
<tr>
<th>Project Characteristics</th>
<th>Functional</th>
<th>Weak Matrix</th>
<th>Balanced Matrix</th>
<th>Strong Matrix</th>
<th>Projectized</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Manager’s Authority</td>
<td>Little or None</td>
<td>Limited</td>
<td>Low to Moderate</td>
<td>Moderate to High</td>
<td>High to Almost Total</td>
</tr>
<tr>
<td>Resource Availability</td>
<td>Little or None</td>
<td>Limited</td>
<td>Low to Moderate</td>
<td>Moderate to High</td>
<td>High to Almost Total</td>
</tr>
<tr>
<td>Who controls the project budget</td>
<td>Functional Manager</td>
<td>Functional Manager</td>
<td>Mixed</td>
<td>Project Manager</td>
<td>Project Manager</td>
</tr>
<tr>
<td>Project Manager’s Role</td>
<td>Part-time</td>
<td>Part-time</td>
<td>Full-time</td>
<td>Full-time</td>
<td>Full-time</td>
</tr>
<tr>
<td>Project Management Administrative Staff</td>
<td>Part-time</td>
<td>Part-time</td>
<td>Part-time</td>
<td>Full-time</td>
<td>Full-time</td>
</tr>
</tbody>
</table>

### Figure 2-11. Projectized Organization

(Gray boxes represent staff engaged in project activities.)
Knowledge Areas - 9

Integration Management

Scope Management
Time Management
Cost Management
Quality Management

Human Resource Management
Communications Management
Risk Management
Procurement Management
# Process Groups & Knowledge Areas

## Table 3-1. Project Management Process Groups and Knowledge Areas Mapping

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>4. Project Integration Management</td>
<td>4.1 Develop Project Charter</td>
<td>4.2 Develop Project Management Plan</td>
<td>4.3 Direct and Manage Project Execution</td>
<td>4.4 Monitor and Control Project Work</td>
<td>4.6 Close Project or Phase</td>
</tr>
<tr>
<td>5. Project Scope Management</td>
<td>5.1 Collect Requirements</td>
<td>5.2 Define Scope</td>
<td>5.3 Create WBS</td>
<td>5.4 Verify Scope</td>
<td>5.5 Control Scope</td>
</tr>
<tr>
<td>6. Project Time Management</td>
<td>6.1 Define Activities</td>
<td>6.2 Sequence Activities</td>
<td>6.3 Estimate Activity Resources</td>
<td>6.4 Estimate Activity Durations</td>
<td>6.5 Develop Schedule</td>
</tr>
<tr>
<td>7. Project Cost Management</td>
<td>7.1 Estimate Costs</td>
<td>7.2 Determine Budget</td>
<td>7.3 Control Costs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Project Quality Management</td>
<td>8.1 Plan Quality</td>
<td>8.2 Perform Quality Assurance</td>
<td>8.3 Perform Quality Control</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Project Communications Management</td>
<td>10.1 Identify Stakeholders</td>
<td>10.2 Plan Communications</td>
<td>10.3 Distribute Information</td>
<td>10.4 Manage Stakeholder Expectations</td>
<td>10.5 Report Performance</td>
</tr>
</tbody>
</table>

## Figure 3.1. Project Management Process Groups
Break
Knowledge Areas - 9

Integration Management

Scope Management

Time Management

Cost Management

Quality Management

Human Resource Management

Communications Management

Risk Management

Procurement Management
Integration Management

• Develop Project Charter
  • Example of Project Charter
• Develop Project Management Plan
• Direct and Manage Project Execution
• Monitor and Control Project Work
• Perform Integrated Change Control
• Close Project or Phase
Scope Management

- Collect Requirements
- Define Scope
- Create Work Breakdown Structure (WBS)
WBS

Level 1

Aircraft System

Level 2

Air Vehicle
SE/Program Mgmt
System T&E
Training
Data
Peculiar Support Equipment
Common Support Equipment
Op/Site Activation
Industrial Facilities
Initial Spares and Initial Repair Parts

Level 3

Airframe
Propulsion
Application Software
System Software
Com/Identification
Navigation/Guidance
Central Computer
Fire Control
Data Display and Controls
Survivability
Reconnaissance
Automatic Flight Control
Central Integrated Checkout
Antisubmarine Warfare
Armament
Weapons Delivery
Auxiliary Equipment

Aircraft Systems WBS (MIL-IIDDK-001)
Scope Management

- Collect Requirements
- Define Scope
- Create Work Breakdown Structure (WBS)
- Verify Scope
- Control Scope
Time Management

- Define Activities
- Sequence Activities
- Estimate Activity Resources
- Estimate Activity Durations
- Develop Schedule
- Control Schedule
Time Management (Gantt Chart)

<table>
<thead>
<tr>
<th>ID</th>
<th>Task Name</th>
<th>Duration</th>
<th>February</th>
<th>March</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Initiation Phase Begins</td>
<td>0 days</td>
<td>1/15</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Background reading</td>
<td>12 days</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Conduct feasibility study</td>
<td>10 days</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Talk with select group of customers</td>
<td>15 days</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Approval meeting 1</td>
<td>1 day</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Requirements definition phase B</td>
<td>0 days</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Problem definition</td>
<td>3 days</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Needs assessment</td>
<td>5 days</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Approval Meeting 2</td>
<td>1 day</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Functional design phase begins</td>
<td>0 days</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Develop specifications</td>
<td>14 days</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Conceptual system design</td>
<td>5 days</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Approval meeting 3</td>
<td>1 day</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Legend:
- Task
- Split
- Progress
- Milestone
Time Management (PERT)
Cost Management

- Estimate costs
- Determine Budget
- Control Costs

How?
- EVM – Earned Value Management
  - Cost Variance
  - Schedule Variance

NASA IBR Toolkit - 24 Dec 2009
Cost Management

- Estimate costs
- Determine Budget
- Control Costs

- How?
- EVM – Earned Value Management
  - Cost Variance
  - Schedule Variance

NASA IBR Toolkit - 24 Dec 2009
Quality Management

- Plan Quality
- Perform Quality Assurance
- Perform Quality Control
Human Resources Management

• Develop Human Resource Plan
• Acquire Project Team
• Develop Project Team
• Manage Project Team
Knowledge Areas - 9

- Integration Management
- Scope Management
- Time Management
- Cost Management
- Quality Management
- Human Resource Management
- Communications Management
- Risk Management
- Procurement Management
Break
Knowledge Areas - 9

- Integration Management
- Scope Management
- Time Management
- Cost Management
- Quality Management
- Human Resource Management
- Communications Management
- Risk Management
- Procurement Management
Project Communications Management

- Identify Stakeholders
- Plan communications
- Distribute Information
- Manage Stakeholders expectations
- Report performance
Framework for Identifying Risks

• Background
  • $250 billion across 175,000 projects
  • Cost overrun - $59 billion
  • Cancelled projects - $81 billion

• One explanation – Managers are not taking prudent measures to assess and manage risk

• Suggested Steps
  • Identify risks
  • Relative importance of the risks
  • Identified risks to be classified to suggest meaningful mitigation strategies
Framework for Identifying Risks

- Delphi Study – 40 software PM - Finland, HK, US – selected common 11 factors - universal

![Graph showing risk factors identified by all three panels ordered by relative importance.](image)
Framework for Identifying Risks

- Q 1
  - specific risk factors - lack of top management commitment, failure to gain user commitment, and inadequate user involvement.
  - risk mitigation strategies - create and maintain good relationships with customers and promote customer commitment to the project
Framework for Identifying Risks

• **Q 2**
  
  • specific risk factors – ambiguities, uncertainties, misunderstandings in establishing the project’s scope and requirements.
  
  • risk mitigation strategies - emphasize the management of ambiguity and change – avoid “scope creep” – project driven by user community.
Framework for Identifying Risks

- **Q 3**
  - specific risk factors – inappropriate / insufficient staffing, poor estimation, and improper definition of roles and responsibilities
  - risk mitigation strategies - internal evaluations coupled with external reviews to keep project on track
Framework for Identifying Risks

- **Q 4**
  - specific risk factors – changing scope/objectives (due to changes in senior management or the business itself), and conflicts that may arise between user departments.
  - risk mitigation strategies - concepts and tactics associated with disaster planning
Framework for Identifying Risks

- **Q1** - determine if they have the support & commitment
- **Q2** - manage the ambiguity and change associated with establishing system scope and requirements
- **Q3** - select a risk-driven execution strategy
- **Q4** - be able to anticipate and respond to unexpected changes in the environment

*Figure 2. A risk categorization framework*
One Minute Risk Assessment Tool

• Background
  • $2.5 trillion spent - $1 trillion on underperforming projects
  • $75 billion each year

• Examined 720 software project assessments by senior IT managers in 60 large companies

• The relative weights associated with 6 key s/w project risk drivers
One Minute Risk Assessment Tool

- Quick-and-dirty assessment of overall project risk
- “what-if” analysis
Project Risk Management

• Plan Risk Management
• Identify Risks
• Perform Qualitative Analysis
• Perform Quantitative Analysis
• Plan Risk responses
• Monitor and Control Risks
Project Procurement Management

- Plan Procurement
- Conduct Procurement
- Administer Procurement
- Close Procurement
Skills in demand over next decade

<table>
<thead>
<tr>
<th>Skill</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Life skills, such as negotiating, networking, working with cultural diversity</td>
<td>48%</td>
</tr>
<tr>
<td>Problem solving</td>
<td>29%</td>
</tr>
<tr>
<td>Leadership</td>
<td>28%</td>
</tr>
<tr>
<td>Critical thinking</td>
<td>27%</td>
</tr>
<tr>
<td>Ability to collaborate</td>
<td>25%</td>
</tr>
<tr>
<td>Technology proficiency</td>
<td>25%</td>
</tr>
<tr>
<td>Multi-lingual</td>
<td>25%</td>
</tr>
<tr>
<td>Science, technology, engineering and math (STEM)</td>
<td>22%</td>
</tr>
<tr>
<td>Professionalism</td>
<td>16%</td>
</tr>
<tr>
<td>Motivating Others</td>
<td>7%</td>
</tr>
<tr>
<td>Mentoring</td>
<td>7%</td>
</tr>
<tr>
<td>Oral Communication</td>
<td>5%</td>
</tr>
<tr>
<td>Written Communication</td>
<td>3%</td>
</tr>
<tr>
<td>Other</td>
<td>2%</td>
</tr>
</tbody>
</table>

Source: Global Education 20/20, Economist Intelligence Unit, March 2008.
Effective Skills

• Leadership
• Team Building
• Motivation
• Communication
• Influencing
• Decision Making
• Political & Cultural awareness
• Negotiation
Thank you
Questions?
Knowledge Areas

- Integration Management
- Scope Management
- Time Management
- Cost Management
- Quality Management
- Human Resource Management
- Communications Management
- Risk Management
- Procurement Management
References

• Cloud Computing Explained - By Rosalyn Metz -
  http://www.educause.edu/EDUCAUSE+Quarterly/EDUCAUSEQuarterlyMagazineVolum/CloudComputingExplained/206526
  • http://cloudbusiness.info/2009/08/04/cloud-definitions-nist-gartner-forrester/
  • http://www.educause.edu/EDUCAUSE+Quarterly/EDUCAUSEQuarterlyMagazineVolum/ServiceOrientedArchitectureWha/161835
  • SOA ppts from
  http://www.educause.edu/Resources/ServiceOrientedArchitecture/161920
Tacoma Narrows Bridge

A former photographer for the Tacoma News Tribune, Howard Clifford was the last man off the first Narrows Bridge before it collapsed in 1940. Now 94, Clifford recounts that fateful day. April 7, 2006

http://www.youtube.com/watch?v=j-zczJXSx

Tacoma Narrows bridge

_Galloping Gertie_

The significance of the first Tacoma Narrows Bridge, to a large extent, is derived from its startling collapse on November 7, 1940. The collapse brought engineers world-wide to the realization that aerodynamic phenomena in suspension bridges were not adequately understood in the profession nor had they been addressed in this design. New research was necessary to understand and predict these forces. The official investigation into the collapse recommended the use of wind-tunnel tests to aid in the design of the second Tacoma Narrows Bridge and resulted in the testing of all existing and future bridges across the country. New mathematical theories of vibration, aerodynamics, wave phenomena, and harmonics as they apply to bridge design arose from these studies.