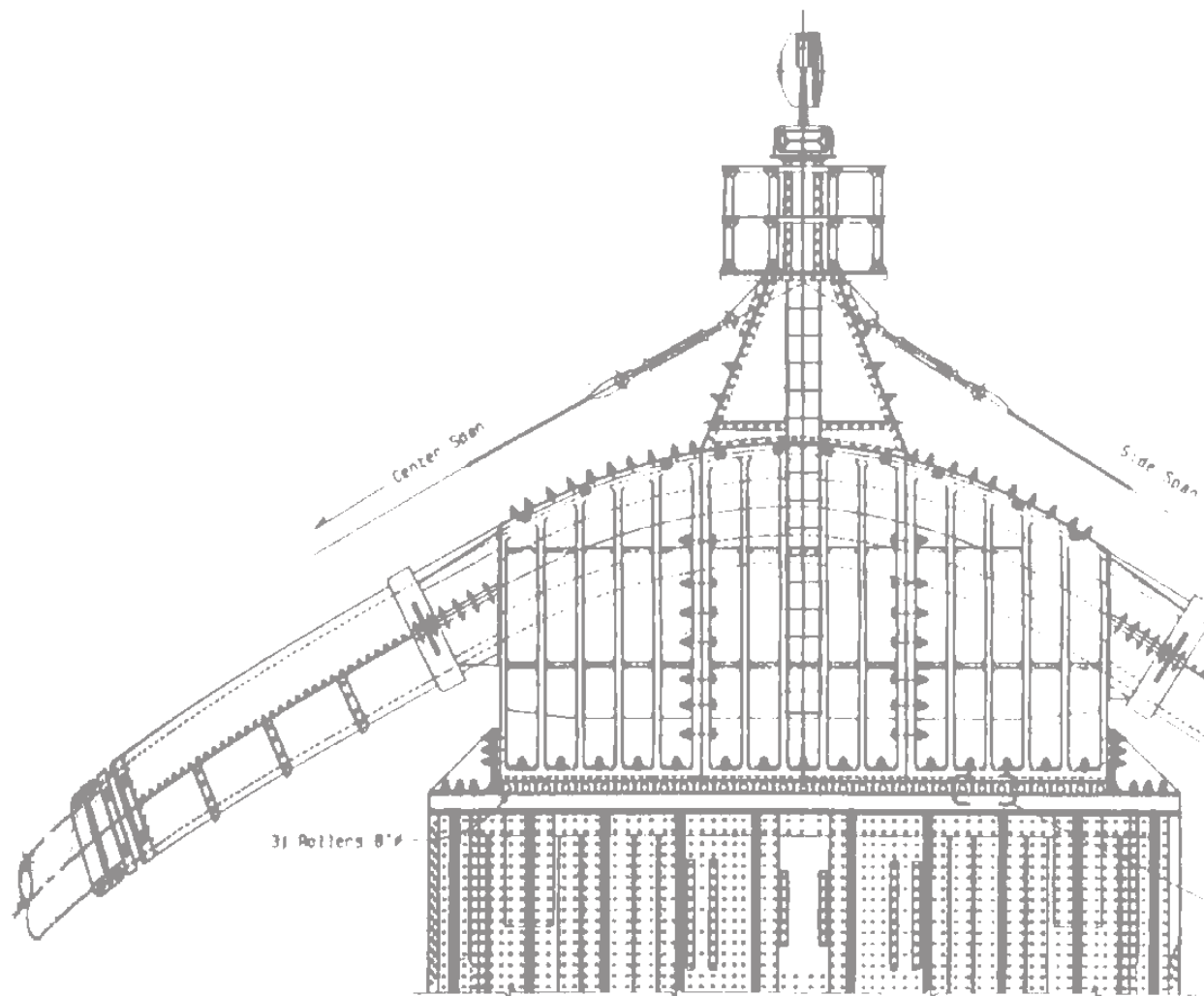




Proceedings for the Golden Gate Bridge International Conference on Public Works for Public Learning

June 20 - 22, 2012

San Francisco, California





CONFERENCE SPONSORS

National Science Foundation
Golden Gate Bridge, Highway and Transportation District
Consortium of Universities for Research in Earthquake Engineering



In Partnership with the
American Public Works Association

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INTRODUCTION

The Golden Gate Bridge, Highway and Transportation District (GGBHTD), San Francisco, CA, in coordination with the Consortium of Universities for Research in Earthquake Engineering (CUREE), Richmond, CA, was awarded a \$3 million National Science Foundation (NSF) grant. The grant was awarded to GGBHTD under the NSF Informal Science Education program whose goal is to promote lifelong learning of Science and Engineering in a wide variety of informal settings such as the Golden Gate Bridge visitor area.

According to Dr. Al DeSena, the NSF Program Director, Division of Research and Learning in Formal and Informal Settings, “The Golden Gate Bridge proposal was compelling. Once executed, the proposed project will so clearly advance informal science and engineering learning, understanding and awareness through a number of innovative strategies included in the proposal. The Bridge is an international icon, visited by millions, and now with NSF funding, the south side visitor area will come alive with interactive educational exhibits.”

There is great potential for giving the general public, who may lack a technical background, glimpses into the science and engineering stories that lie behind the bridges, buildings, and other structures that surround them in everyday life.

The conference, Public Works for Public Learning, will review the project’s efforts, offering practical information on how existing structures can be used to develop fun and effective exhibits to educate the public on the topics of science, technology, engineering, and math (STEM).

We extend a warm welcome to you as you join us in San Francisco, California to share innovative ideas, gain new information, and experience first-hand the history and engineering behind the Golden Gate Bridge, and learn more about public works projects around the world.

Denis J. Mulligan serves as the ninth General Manager and Chief Executive Officer (CEO) of the Golden Gate Bridge, Highway and Transportation District (GGBHTD), since the Golden Gate Bridge opened in May 1937. Mr. Mulligan has 28 years of experience in transportation having served in a variety of positions of increasing responsibility with the State of California, Department of Transportation from July 1982 through February 2001, prior to joining the GGBHTD in March 2001. Before his promotion to CEO, Mr. Mulligan served as the Chief Engineer. The GGBHTD is in charge of maintaining and operating not only the Golden Gate Bridge, but the bus and ferry divisions that are subsidized by the Bridge’s tolls.



Among his many projects, Mr. Mulligan manages the Golden Gate Bridge Seismic Retrofit design and construction project that won the “Outstanding Project and Leadership Award” from the American Society of Civil Engineers in 2007.”

EVENING RECEPTION - Wednesday, June 20

6:00 PM - 9:00 PM

Early Registration and Meet and Greet with presenters and attendees.

Sponsored by  HDR Engineering, Inc. and Thomas Jee & Associates 

MEETING AGENDA (DAY ONE) - Thursday, June 21

- 8:30 AM Open Meeting and Welcome (GGBHTD)**
- 8:45 AM Project Overview (D. Mulligan)**
- 9:15 AM Learning While Visiting the Eiffel Tower (N. Lefebvre)**
- 9:40 AM Achieving a Balance (Hoover Dam) (W. Schermerhorn)**
- 10:05 AM BREAK**
- 10:25 AM The Panama Canal: Expansion Program and Visitor Center (J. Pincón Pascal)**
- 10:50 AM BRIDGECLIMB: Exploring and Experiencing the Sydney Harbour Bridge (J. Bowe)**
- 11:15 AM Panel Discussion**
- 11:45 AM LUNCH**
- 1:00 PM Overview of Exhibits (R. Reitherman)**
- 1:30 PM The Pedagogy of Designing Exhibitions (M. Garlock)**
- 1:45 PM Designing the Large-scale Golden Gate Bridge Model (S. Black)**
- 2:00 PM Bridge Tour to Exhibition Site**
Move to bus departure point across the street from the hotel on Market and Steuart Streets. (Two buses will transport attendees between the hotel and visitor area at the south end of the Golden Gate Bridge.)
- 7:00 PM BANQUET & KEYNOTE (Dr. G. W. Clough)**

MEETING AGENDA (DAY TWO) - Friday, June 22

- 8:00 AM** CONTINENTAL BREAKFAST
- 8:55 AM** Announcements (D. Mulligan)
- 9:00 AM** Developing Effective Public Works Exhibits (L. Lux) *with introduction by T. Hon*
- 9:20 AM** APWA Panel Discussion - Public Works Concerns (C. Jackson-Fossett / D. Lowry)
- 10:00 AM** Waterworks at Arizona Falls - A Venue For Education (J. Duncan)
- 10:25 AM** San Francisco Bay / Delta Model Renovation (C. Gallagher)
- 10:45 AM** BREAK
- 11:15 AM** Public Education Resources (D. Heil)
- 11:35 AM** Engaging Visitors - Evaluation / Summation (B. Carroll / S. Weiss)
- 12:00 PM** LUNCH
- 1:30 PM** West Point Bridge Design Contest - Public Software for Public Learning (S. Ressler)
- 1:55 PM** History of Research on the Golden Gate Bridge (S. Billington)
- 2:15 PM** Exhibit Design Process (S. Lani)
- 2:35 PM** BREAK
- 2:55 PM** On Striving For Accessible Exhibition Design (B. Ziebarth)
- 3:20 PM** Science Centers and Public Works: Emerging Partners in Education (C. Trautmann)
- 3:40 PM** Creativity, Energy And Innovation: Undergraduates As Informal Science Educators (A. Epstein)
- 4:05 PM** Conference Closes

Keynote

Dr. G. Wayne Clough Secretary of the Smithsonian Institution



“IF YOU BUILD IT, THEY WILL COME”

Public works projects are historic milestones representing some of humankind’s greatest achievements. Engineering marvels from Machu Picchu to the Panama Canal have benefited societies for centuries, informed architects, designers, and engineers alike, and enriched everyone’s understanding of the world. Join Dr. Wayne Clough as he shares his unique perspective as a civil engineer, educator, and Secretary of the Smithsonian Institution, and gives his insight on the power of public works projects like the Golden Gate Bridge to teach important lessons about history, culture, geology, and archaeology.

Wayne Clough is the 12th Secretary of the Smithsonian Institution, the world’s largest museum and research complex. The Smithsonian includes 19 museums and galleries, 20 libraries, the National Zoo and nine research centers.

Since becoming Secretary in July 2008, Clough (pronounced “cluff”) has taken the Smithsonian in new directions. A comprehensive strategic plan—the first of its kind for the Smithsonian—creates a new framework for goals, enterprises and operations. The Smithsonian now focuses on four grand challenges—Unlocking the Mysteries of the Universe, Understanding and Sustaining a Biodiverse Planet, Valuing World Cultures and Understanding the American Experience.

Clough is responsible for an annual budget of \$1 billion with about 6,000 employees. As a federal trust, the Smithsonian receives about 70 percent of its funding from the federal government and generates funding from contributions and business activities such as museum shops.

Since Clough became Secretary, more than 300 exhibitions have opened across the Smithsonian. He has overseen the opening of major permanent exhibitions, including the Star-Spangled Banner at the National Museum of American History; the Hall of Human Origins, both at the National Museum of Natural History; and the new wing at the National Air and Space Museum’s Udvar-Hazy Center.

Before his appointment to the Smithsonian, Clough was president of the Georgia Institute of Technology for 14 years. He received his bachelor’s and master’s degrees in civil engineering from Georgia Tech in 1964 and 1965 and a doctorate in 1969 in civil engineering from the University of California, Berkeley. Clough was a member of the faculty at Duke University, Stanford University and Virginia Tech. He served as head of the department of civil engineering and dean of the College of Engineering at Virginia Tech and as provost at the University of Washington.

Speaker

Nicolas Lefebvre Société d'Exploitation de la Tour Eiffel (SETE)



LEARNING WHILE VISITING THE EIFFEL TOWER

The Eiffel tower has a rich and long history with science and technology. It was a very innovative building when it was erected 123 years ago : the first 1.000 ft tall building, the first 100% iron made building, and one of the first using a prefabricated pieces construction method.

During the first decades of its history, the tower has been a place of significant scientific research : aerodynamics and meteorology led by Gustave Eiffel himself, wireless communication.

In the present time, the tower is still an important site for radio and TV broadcasting : delivering radio and TV signals to 11 million people in the Paris region which switched to digital in 2011. Nowadays, the Eiffel tower operating company, SETE, bases on this rich history its program to enrich the visitor experience.

The view on the city and the discovery of the monument remain of course the main purposes of the visit for the 7 million visitors annually. But it is also the opportunity to learn more on science, technology and the arts in relation with the tower history.

This idea lead several projects recently developed by SETE for the tower : a learning circuit for children, backstage visits for groups, the new scenery of the top floor and of course the complete refurbishing of the first floor presently on progress.

Since May 2006, CEO of Societe d'Exploitation de la tour Eiffel (SETE), the company in charge of operating the Eiffel tower, property of the City of Paris.

SETE registers a 70 M€ annual turnover and a staff of 300 employees.

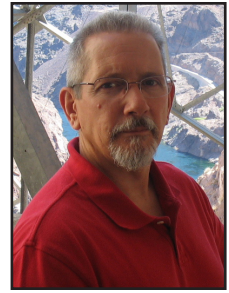
Nicolas LEFEBVRE has been formerly :

- *CEO of Semaest, a urban and economic development company in Paris*
- *CEO of Sofipost, a holding company of La Poste, the French postal service*
- *Advisor to the French minister of Finance and Industry*
- *Vice-President in charge of Telecoms project finance for the bank Dexia*

Graduated in Business administration (ENSPTT - Paris), Economics (Paris I University) and statistics (ENSAE - Paris)

Speaker

William Schermerhorn **Supervisory Apprentice Coordinator** **US Bureau of Reclamation / Hoover Dam**



ACHIEVING A BALANCE

What we have learned in our 75 years of conducting public education and how we have continued to be successful. Main points to include:

- What the public wants to know vs. what we “think” they want to know
- How to convey the information to the public
- Utiliizing technology without chasing it
- How to enact change

William Schermerhorn is currently assigned to the US Bureau of Reclamation’s Hoover Dam Apprenticeship Training Group as the Supervisory Apprentice Coordinator. Prior to this assignment he held a number of positions in the Hoover Dam Visitor Center. Starting in 1999, he was initially hired as a Reclamation Guide, tasked with conveying the historical and operational aspects of the Hoover Dam to the general public as well as to visiting dignitaries. In 2002, he became the Guide Services Coordinator and senior trainer of the public speakers at the Dam. In 2006, he assumed the duties of Customer Service Manager at the Hoover Dam Visitor Center, a position he held until August of 2011. He has been involved in numerous filming at Hoover Dam and can be seen on the History Channel, the Travel Channel and the Learning Channel.

Prior to his employment at the Bureau of Reclamation, Bill served in the United States Air Force for 22 years, starting off as a jet engine mechanic and progressing through that trade until ultimately becoming an aircraft maintenance manager. His last assignment prior to his retirement was as an academic instructor at the United States Air Force Senior Non-Commissioned Officers Academy in Alabama.

He holds an Associate’s degree in Aircraft Powerplant Technology, a Bachelor’s Degree in Business Administration and attended Auburn University at Montgomery while pursuing his Master’s degree.

Speaker

Javier Pinzón Pascal **Manager of the Project Controls Office** **Panama Canal Authority**



THE PANAMA CANAL: EXPANSION PROGRAM AND VISITOR CENTER

Born in Panama City, Panama, Javier Pinzón Pascal is a Civil Engineer, graduate of Universidad Santa María La Antigua in Panama, and holds a Master of Engineering Degree in Port Engineering and Management from the Universidad Politécnica de Catalunya in Barcelona, Spain. In addition he is a registered Engineer in Public Works and Civil Construction with the Ministry of Education and Science in Madrid, Spain, and is a certified Project Management Professional by the Project Management Institute and member of the PMI Panama Chapter. Mr. Pinzón Pascal is currently the manager of the Project Controls Office that oversees the Dredging and Excavation Projects under the Panama Canal Expansion Program, the design and construction of a New Spillway for Gatun Lake, and the design and construction of a new bridge over the Canal at the Atlantic Entrance

Speaker

John Bowe **Project Development Manager** **BridgeClimb, Sydney Harbour Bridge**



BRIDGECLIMB: EXPLORING AND EXPERIENCING THE SYDNEY HARBOUR BRIDGE

The Sydney Harbour Bridge occupies a special place in the hearts of Sydneysiders, as with the Golden Gate Bridge for San Franciscans.

Both bridges were constructed in the 1930's during the Great Depression, and each is recognised not only for the outstanding achievement in design, engineering, technology, and transportation, but also as embodying the spirit, character and soul of its city.

In 1998, in a world first, BridgeClimb launched the first ever climb of a bridge, enabling the public to safely and securely explore and experience the bridge structure, to reach the summit and learn of its history. BridgeClimb was the vision of bridge enthusiast, collector and business entrepreneur, Paul Cave, and it quickly became the No. 1 signature tourism drawcard in Sydney. It has been recognised with multiple awards, including Engineering Heritage, Architectural Conservation and Major Tourist Attraction in the National Tourism Awards.

Established at no cost to the public, BridgeClimb provides a significant financial return to the State Government, contributing significantly to the cost of maintenance, and has fully funded the creation of the Sydney Harbour Bridge Visitor Center and the Pylon Lookout Exhibition, where plans, artefacts, models, photographs and film of the design and construction of the bridge are on exhibit. Since opening, 3 million people have safely and securely climbed, without a single incident of significance. At least an additional 1 · million people have visited the Sydney Harbour Bridge Visitor Center and Pylon Lookout.

BridgeClimb operations work to complement and help underpin the maintenance and preservation of the bridge. It also works hand in glove with Government improving the overall culture of safety and security on and within the bridge.

John Bowe was Architect and Project Manager during the development phase of BridgeClimb, joining the business executive just before it opened to the public. He now works as Project Director with Paul Cave's private company, BridgeClimb International, and works on other international opportunities.

Speaker

Robert Reitherman **Project Manager** **Executive Director (CUREE)**



OVERVIEW OF EXHIBITS

With \$3 million in funding from the National Science Foundation, the Golden Gate Bridge, Highway and Transportation District (GGBHTD) is creating a permanent outdoor exhibition at the south end (San Francisco side) of the Golden Gate Bridge. As of the time of the Public Works for Public Learning Conference, the eventual remodeled outdoor gallery space for the exhibition is still in the permit application stage with the National Park Service. Some of the exhibits have been installed on an interim basis. CUREE provides the project management and overall exhibit design services to the Bridge District.

The exhibition will include a variety of models, displays, and interactive exhibits to provide visitors ways to learn about the engineering, construction and maintenance, aesthetics, and history of the Bridge. The basic National Science Foundation goal is to increase the public's knowledge about and interest in STEM: Science, Technology, Engineering, and Mathematics.

The centerpiece of the exhibition will be a large (90-foot-long), stainless steel scale model of the Bridge, revealing its structural features in detail. Locations on the model are keyed to satellite exhibits that surround this large "table of contents" model. Smaller exhibits are on the topics of: the history of the design and construction of the Bridge; wind and seismic effects; how the suspension bridge spans the Golden Gate; the structural roles of the various components of the Bridge; ways of representing the scale of the size and strength of the Bridge in understandable ways.

*Robert (Bob) Reitherman is the Executive Director of the Consortium of Universities for Research in Earthquake Engineering (CUREE), an association of two dozen universities that have large civil engineering research and education programs. For the Golden Gate Bridge Outdoor Exhibition project, he serves as Project Manager. Over the past decade, CUREE has mounted an initiative to extend education about engineering to the general public, including exhibits for the City of San Francisco during the centennial of the 1906 San Francisco Earthquake, the RMS corporation, and for outreach programs for National Science Foundation (NSF) funded research projects. In 2008, CUREE conducted for NSF a study that resulted in a book, *Building Bridges Between Civil Engineers and Science Museums*.*

Speaker

Maria Garlock **Professor, CUREE President** **Princeton University**



THE PEDAGOGY OF DESIGNING EXHIBITIONS

Exhibitions are typically intended to entertain and arouse curiosity, thus promoting learning for the visitor. What is not commonly known is that the same effect is imbued upon the people designing the exhibition, especially if those people are students. This presentation will illustrate three examples of exhibitions designed with students and the pedagogical opportunities present in each. These teaching opportunities include the following: (1) learn to consider constructability aspects of structural design through model building; (2) learn to communicate by drawing; (2) develop a clear vision by learning to simplify ideas into its most fundamental parts; and (3) once that clear vision is established the student learns to communicate ideas to the general public. The communication is made through models, descriptive panels, and a website explaining the theme of the exhibition in layman's terms. As students of structural engineering, these exhibition designs complimented their education by teaching them tools that are not taught in a typical engineering education, yet fundamental to their career.

Dr. Garlock received her Bachelors of Science degree from Lehigh University and a Masters of Science (MS) degree in Civil Engineering from Cornell University. Upon completion of her MS degree, she worked for Leslie E. Robertson Associates (of New York City) as a structural engineer where she had the opportunity to design many interesting buildings including some skyscrapers. Four years later, Dr. Garlock attended Lehigh University again, this time in pursuit of her Ph.D. degree, which she received in 2003. Currently, Dr. Garlock is an Associate Professor at Princeton University in the Department of Civil and Environmental Engineering. She teaches several courses related to structural engineering and does research related to improved design for the response of structures to large earthquakes and large fires. In addition, she studies the best examples of structural designs of the present and past (i.e. "structural art") and uses this to inspire her research and teaching.

Speaker

Sylvester Black **Structural Engineer** **Robert Silman Associates**



DESIGNING THE LARGE-SCALE GOLDEN GATE BRIDGE MODEL

If one were to design a 90 foot long, 10 foot tall metal model of the Golden Gate Bridge and subject it to wind, seismic, and pedestrian loads in one of the country's most corrosive outdoor environments, would the term "Model" still be appropriate? Or would it be simply a bridge in its own right? What began as a Princeton University senior thesis project has evolved into a multi-faceted, multi-year endeavor, culminating in the eventual construction of this spectacular public display. The talk will explore the unique variables affecting "large model" projects, and the elusive balance that must be struck between elements that are simultaneously immense for a model, yet infinitesimally small for a real-world load-bearing structure. From custom parts and assembly tools to specialty stainless steel alloys, the project has demanded new approaches to design, fabrication, construction, and maintenance. Armed with this knowledge and experience, the project team of dedicated students, faculty, and advisers aim to present the best-practices and potential pitfalls of Large-Model construction.

Sylvester Black is a structural engineer at Robert Silman Associates in New York, where his projects range from homes and schools to concert halls and office buildings. He earned his bachelors of science in structural engineering from Princeton University, where his life-long passions for design, model-building, and construction were nourished by architecture studios and structural art exhibitions organized by Maria Garlock and David Billington. Constructing a model of Felix Candela's restaurant at Xochimilco for an exhibition in 2008, Sylvester gained insight into Candela's construction-centered approach to design. The following year he began to apply those principles in a thesis entitled "Design of a 1:100 Scale Model of the Golden Gate Bridge." With Maria Garlock and a dedicated team of undergraduate and graduate students, Sylvester looks forward to completing the large model (now 1:80 scale, and 87.5 feet long) and finally bringing it "home" to San Francisco.

Speaker

Larry Lux **Representative of APWA** **Lux Advisors, Ltd.**



DEVELOPING EFFECTIVE PUBLIC WORKS EXHIBITS

This session will introduce the conference participants to the American Public Works Association (APWA) and its on-going education and training program. It will focus on the APWA commitment to develop a training offering entitled “Developing Effective Public Works Exhibits”. The presentation will concentrate on the development of self-guided outdoor exhibits that will educate visitors to the science, technology, engineering and mathematics involved in the design, construction and maintenance of the nation’s public works infrastructure. Several examples current exhibits will be presented and reviewed. Additional input and suggestions will be solicited from conference participants.

Larry Lux has served the Public Works industry for over 48 years in both public and private sector public works and engineering. Larry is President of Lux Advisors, Ltd. a municipal consulting firm that specializes in emergency management issues.

He served for over twenty-two years in public sector engineering and public works activities. He was the Director of Public Works and Engineering for the Village of Barrington, Illinois. Before moving to Barrington, he served for over fourteen years as the Assistant Director of Engineering, Planning and Traffic for the Village of Oak Lawn, Illinois. Between 1986 and 2001, he was employed as an executive manager for consulting engineering firms that specialized in municipal, transportation, structural, mechanical and electrical engineering.

Larry has been a member of the American Public Works Association (APWA) for 45 years and is a Life Member of the Association. Previously he has served as a member of the APWA National Board of Directors. In March of 2006, Larry was selected as one of APWA’s “Top Ten Public Works Leaders of the Year”. He currently serves as an elected member of the Board of Trustees of the Public Works Historical Society. In September of 2011, he was selected to receive the APWA Presidential Leadership Award. He is also co-founder of the “Illinois Public Service Institute” a professional leadership training program for public employees and is also a co-founder of the Illinois Public Works Mutual Aid Network (IPWMAN). Other professional affiliations include; The Institute of Transportation Engineers (life member), and the International Association of Emergency Managers. Mr. Lux also serves on the State of Illinois Terrorism Task Force.

For over thirty years Larry has lectured and taught public officials in the preparation for and management of local emergencies and disasters and has developed many seminars and workshops that have been offered by APWA throughout North America. He has been associated with the FEMA’S Emergency Management Institute as a Public Works subject matter expert, lecturer and Exercise Controller since 1985.

Speaker

Cora Jackson-Fossett **Public Information Director II** **Los Angeles Department of Public Works**



APWA PANEL DISCUSSION - PUBLIC WORKS CONCERNS

Cora Jackson-Fossett is Public Information Director II for Los Angeles Department of Public Works and responsible for directing 14 staff in developing and implementing of strategic communications programs and campaigns that educate and influence behavior change that protect public health and the environment.

Jackson-Fossett is on the APWA National Board of Directors as Director-at-Large -Management and Leadership as well as serves with the APWA Southern California Chapter as co-chair of the Diversity Committee, co-chair of the Congress 2012 Publicity Committee and instructor for the Public Works Institute.

Her public service activities include being president of the Los Angeles Association of Black Personnel, the official representative for City employees of African American heritage, and the only female on the Board of Directors for Los Angeles Professional Managers Association, the bargaining unit representing the City's 500 top level employees.

Jackson-Fossett earned a bachelor's degree at Indiana University, completed graduate courses at Columbia College, and received certificates in marketing management and emergency management.

She previously served as Principal Public Relations Representative for Los Angeles International Airport, and public affairs specialist at the Chicago and Long Beach postal facilities.

Speaker

David Lawry **Director-at-Large (Engineering & Technology)** **Operations of Village of Wauconda, Illinois**



APWA PANEL DISCUSSION - PUBLIC WORKS CONCERNS

David L. Lawry is the Director of Village Operations for the Village of Wauconda, Ill., and manages the departments of Public Works, Environmental Quality, Engineering and Information Technology. Prior to his role with the Village of Wauconda, Lawry worked for the City of Elgin, Ill., for more than twenty years. As the General Services Group Director, a position he held for more than ten years, his duties included the direct supervision of the departments of Public Works, Engineering, Building Maintenance and Water.

Lawry has been a member of the Chicago Metro Chapter Executive Committee since 1999, and has served in all the officer positions at both the branch and chapter levels, including Chapter President in 2007 and Chapter Delegate in 2008. He has served on various chapter committees including the 75th Anniversary Committee. He is a former member of the national Project of the Year Awards Committee as well as the Chapter Advocacy Task Force. Along with his service to APWA, Lawry is a member of the American Society of Civil Engineers, National Society of Professional Engineers, American Water Works Association, United States Green Building Council, and the Public Works Historical Society.

“We need to continue to strive for the recognition we deserve in the public works profession through our advocacy efforts,” says Lawry. “We need to stay ahead of the changing landscape of the profession. Sustainability and how it will affect public works operations, increasing demand for potable water, increasing demand for efficient services, and competition for funding to maintain, improve and expand infrastructure are some examples.”

Speaker

Jim Duncan **Senior Engineering Analyst** **Salt River Project (SRP)**



WATERWORKS AT ARIZONA FALLS - A VENUE FOR EDUCATION

Arizona Falls is a low-impact hydro-electric facility which incorporates part of a retired hydroelectric plant power generation is “fueled” by water flowing through the canal system taking advantage of a 20-foot drop in elevation. The canal system, owned by the U.S. Bureau of Reclamation (USBR), and managed by the Salt River Project (SRP), provides irrigation as well as water to area municipalities.

In the late 1800’s, Phoenicians enjoyed the cooling attraction of Arizona Falls gathering to picnic, socialize, and dance near the cool water. Utilizing the water of the canal to produce power, Arizona Falls became the site of the first hydroelectric plant in Phoenix. Originally built in 1902, the plant was rebuilt by SRP in 1911, and was eventually shut down in 1950. As the years passed and more people moved to the Valley, Arizona Falls was almost forgotten as a place to gather and learn, until today.

Hydro generation was reintroduced in 2003 and as a result of a joint project between the City of Phoenix and SRP, the site was created as a place to learn, interact and reflect. Arizona Falls is designed to be an inviting gathering place for the public where they can learn about the history of the site, the use of water in the desert, and how hydroelectric energy is generated.

Using history as an inspiration, the design uses the existing site and structure in new ways. The floor of the former generator room becomes an outdoor water room lined with desert stone and surrounded by falling water. On either side of the room, elevated aqueducts release water back into the canal, creating a pair of waterfalls. Visitors are also able to access an observation terrace planted with native trees and cross a new pedestrian bridge to the north bank of the canal.

In the early phases of planning, it became apparent to all that through a partnership the site could uniquely incorporate elements of history, art, education and clean energy. Through a unique partnership between SRP, the City of Phoenix, and the U.S.B.R. this site has become a major venue for educational experiences at all levels.

Jim Duncan is a Senior Engineering Analyst with the Salt River Project (SRP), the nation’s third largest public power utility and one of Arizona’s largest water suppliers. As part of its charge, SRP manages a canal system of over 131 miles that delivers water to the metropolitan Phoenix area. Mr. Duncan manages a program that allows the use of these canal banks for recreational, educational and public-art opportunities for the public. These projects are created through creative public/private partnerships and financing. Graduating from the University of Arizona with degrees in Landscape Architecture/Urban Planning and Economic Development, Mr. Duncan has over 28 years of experience in utilizing the utility’s infrastructure for aesthetic, recreational and educational opportunities.

Speaker

Chris Gallagher **Park Manager, Army Corp of Engineers** **Bay Model Visitor Center**



SAN FRANCISCO BAY AT YOUR DOORSTEP

The San Francisco Bay/Delta Model is a three dimensional model of the San Francisco Bay and Sacramento/San Joaquin Delta. It was built in 1957 by the U.S. Army Corps of the Engineers as a scientific tool to test the impact of proposed changes to the Bay and related waterways. Today, the Bay Model enjoys the life as an educational facility focusing on the natural and cultural history of San Francisco Bay. Having just completed a \$15.5million renovation Park Manager Chris Gallagher will talk about those changes and obtaining the resources to make it a reality.

Chris Gallagher started her federal career with the National Park Service and moved to the US Forest Service and currently employed at the Bay Model Visitor Center which is owned and operated by the U.S. Army Corps of Engineers in Sausalito, CA. She started at the Bay Model in 1986 and in 2001 was promoted to Park Manager where she still currently serves in that capacity. Chris received her Forestry Degree from Unity College in Unity, Maine and B.A. from Dominican University in San Rafael, CA. Chris is very active within the Corps serving on the National Partnership Advisory Team and committees within the community of Sausalito. Chris is Past President of the Chamber of Commerce and the Rotary Club of Sausalito in addition to numerous non-profit boards.

Speaker

David Heil
President
David Heil & Associates, Inc.



PUBLIC EDUCATION TAKES RESOURCES - HOW DO I GET THEM?

Any public education or outreach project will take resources. The key is to know where to find them and how to secure them. Join David Heil, President of David Heil & Associates, to learn about a range of potential sources of grant funding, in-kind contributions, and human resources available to support Public Works For Public Learning projects. Find out how to succeed in a competitive environment, and get the resources you need to create and sustain a public outreach endeavor in your community.

David Heil is well known throughout the country as an innovative science educator, author, and host of the Emmy Award-winning PBS science show, Newton's Apple. As President of David Heil & Associates, Inc. (DHA), he and his team collaborate with public and private institutions on a range of activities including interpretive exhibit design, research and evaluation of informal and formal STEM initiatives, K-12 curricula and public outreach program development.

Prior to establishing DHA, David worked for the Oregon Museum of Science and Industry (OMSI) for thirteen years where he initiated and administered many of the museum's nationally recognized education and outreach programs, developed hands-on exhibits for national tour and raised millions of dollars in government and corporate support for these initiatives.

David is frequently invited to speak at conferences and public events on STEM education and the rewards of experiential learning and recently co-authored a new book titled, "Family Engineering: An Activity and Event Planning Guide."

David has also taught science and enrichment programs in grades 7-12, conducted research in plant biochemistry and radiochemistry, and worked for the U.S. Fish and Wildlife Service. A native Oregonian, he is active in numerous scientific and educational organizations nationwide. He is a past member of the American Association for the Advancement of Science's Committee on Public Understanding of Science, is the past Director of Informal Science Education for the National Science Teachers Association (NSTA). In 2009 David was recognized with the Distinguished Service To Science Education award from the NSTA.

Speaker

Becky Carroll
Front-end and Formative Evaluations
Inverness Research



Shannon Weiss
Summative Evaluation
David Heil & Associates, Inc.



ENGAGING VISITORS - EVALUATION/SUMMATION

Large federal agencies like the National Science Foundation, as well as many private foundations, require an external evaluator for projects involving public outreach and education. Join members of the Golden Gate Bridge project evaluation team to learn how evaluation can contribute to project success. From informing project planning and development, to measuring final outcomes and documenting lessons learned, evaluation is an important component of any “Public Works for Public Learning” endeavor. Evaluation activities and select findings from the Golden Gate Bridge project will be shared.

Becky Carroll has worked for Inverness Research since 1990. Her work has involved studies of K-12 mathematics and science education, as well as studies of exhibition and program development in the informal science field. In the informal field, her areas of interest include studies of collaboratives and networks, programs for youth, exhibition development projects, and professional development for museum professionals. In the formal field, she has participated in studies of mathematics and science program improvements and teacher professional development. Past and current projects in the informal domain include studies of the TEAMS collaborative; YouthALIVE!; Community Science Workshops; and the Precollege Science Collaborative and ITEST grant programs at the American Museum of Natural History; exhibit development projects at the North Carolina Museum of Life and Science and the Exploratorium; as well as the TexNET and Playful Invention and Exploration networks. On the formal side, projects include the Rapid City Math Science Partnership, the Appalachian Math Science Partnership, the Wyoming Middle School Mathematics Initiative, the Gilbert Systemic Science Plan (LSC), and the Appalachian Rural Systemic Initiative.

Shannon Weiss, Project Coordinator, specializes in the design and implementation of evaluation and market research projects related to DHA's core areas of emphasis in science, engineering, health, and environmental education; and institutional strategic and business planning. Her work serves a range of academic institutions, government agencies, corporations and non-profit enterprises including projects funded by the National Science Foundation and the National Institutes of Health. Prior to joining DHA, Shannon designed and conducted evaluations for Seattle's Woodland Park Zoo, Burke Museum of Natural History and Culture, and the Pacific Science Center. Shannon received a BA in Art History from the University of Evansville in Evansville, IN; an MA in Museum Studies from the University of Washington in Seattle, WA; and was a member of the initial cohort of the University of Washington's IMLS funded New Directions in Audience Research Program.

Speaker

Colonel Stephen J. Ressler **Professor of Civil Engineering** **United States Military Academy**



PUBLIC SOFTWARE FOR PUBLIC LEARNING: THE WEST POINT BRIDGE DESIGN CONTEST

This presentation describes the development and implementation of the West Point Bridge Design Contest (WPBDC), a nationwide competition intended to increase middle-school and high-school students' interest in engineering. Unique among national engineering competitions, the WPBDC entails no cost to participants, is entirely Internet-based, and is achievable by any student with a web-enabled computer. At the heart of the competition is a stand-alone simulation software package, the West Point Bridge Designer (WPBD), that guides students through the process of designing, testing, and optimizing a steel highway bridge. While the WPBD incorporates a highly realistic design scenario, its user interface is simple enough to be used successfully by ten-year-old students. The WPBD allows for a wide variety of bridge types, including simple trusses, arches, multi-span, cable-stayed, and suspension bridge configurations. By leveraging this software and an associated web-based system for automated judging of contest entries, a project team of just three people has provided an engaging engineering design experience to over 100,000 students over the past decade. Feedback from contestants and teachers indicates that students' interest in engineering and understanding of basic engineering concepts are positively affected by their participation in the contest.

Colonel Stephen Ressler is Professor and Head of the Department of Civil and Mechanical Engineering at the U.S. Military Academy, West Point, NY. He holds a B.S. degree from USMA, M.S. and Ph.D. degrees in Civil Engineering from Lehigh University, and a Master of Strategic Studies degree from the U.S. Army War College.

COL Ressler is a winner of the 2011 ASCE Outstanding Projects and Leaders (OPAL) Award, the society's highest recognition for lifetime achievement. He has also won the ASEE Civil Engineering Division's George K. Wadlin Distinguished Service Award, the ASCE ExCEED Leadership Award, the ASCE President's Medal, the Society of American Military Engineers (SAME) Bliss Medal for Outstanding Contributions to Engineering Education, the American Association of Engineering Societies (AAES) Norman Augustine Award for Outstanding Achievement in Engineering Communications, the ASEE Distinguished Educator Award, the Premier Award for Excellence in Engineering Education Courseware, the ASEE Dow Outstanding New Faculty Award, the EDUCOM Medal for application of information technology in education, and eight ASEE best paper awards. He was one of Engineering News Record's "Top 25 Newsmakers Who Served Construction" in 2000 and was named a Distinguished Member of ASCE in 2005.

Speaker

Sarah L. Billington **Professor of Structural Engineering & Geomechanics** **Stanford University**



ENGINEERING THE GOLDEN GATE: THE INTERPLAY OF DESIGN AND EXPERIENCE

The presentation will describe the contributions of research to the Golden Gate Bridge over the last century. These will include the theoretical innovations in long-span bridge design that made it possible for civil engineers to imagine a structure crossing the Golden Gate; the need for the bridge as determined by projections of traffic and economic and social growth in the region; the geotechnical and structural research necessary to give confidence in the location of the bridge and the design of its principal components; earthquake and wind engineering studies that led to its subsequent strengthening and retrofitting; studies related to meeting the day-to-day challenges of maintaining the structure and meeting new demands for transportation across the strait; and ongoing research on how to balance the needs of the structure and the people it serves with the needs of the natural environment.

Prof. Billington received her B.S.E. in Civil Engineering & Operations Research with high honors from Princeton University in 1990. She was awarded a Fulbright Fellowship to study civil engineering at the ETH-Zurich (Swiss Federal Institute of Technology) in 1991. She received her M.S. (1994) and Ph.D (1997) in structural engineering from the University of Texas in Austin. Prof. Billington was Assistant Professor of Structural Engineering at the School of Civil and Environmental Engineering at Cornell University from 1997-2002. She joined the Faculty at Stanford University in 2003. She has twice been a visiting professor in the Computational Mechanics group in Civil Engineering at the Delft University of Technology in The Netherlands, first in 1998 and most recently for the 2008-2009 academic year.



Material prepared in conjunction with David P. Billington, Jr., Historian.

Dr. David P. Billington, Jr. is a historian who has written on subjects dealing with the relationship of engineering developments and socioeconomic context, including co-authoring with his father, David P. Billington, Sr. Power, "Speed, and Form: Engineers and the Making of the Twentieth Century."

Speaker

Shawn Lani **Senior Artist** **The Exploratorium**



EXHIBIT DESIGN PROCESS

The Outdoor Exploratorium team has created a small suite of outdoor installations that reveal the Golden Gate Bridge's dynamic structure and motion. We will be installing two outdoor exhibits at the base of the Golden Gate Bridge in 2013 and another at Pier 17 for our opening. The Exploratorium worked with bridge engineers to create a model that replicates most of the structure's major modes of vibration. Visitors can induce these modes at any point on the model.

These pieces exemplify a broader body of work being explored by a small group of Exploratorium designers, engineers, and artists. As informal educators, the Exploratorium seeks to inspire visitors to ask their own questions and seek answers through experimentation and active, direct observations. Examining both built and natural environments side by side create a broader context for our visitor's investigations.

Shawn Lani is a senior artist at the Exploratorium. Most recently, Shawn worked as lead developer for the Outdoor Exploratorium, a series of interactive exhibits at San Francisco's Ft. Mason designed to help visitors explore the subtle phenomena of the everyday world and the complex systems at play in outdoor environments. His work can be summarized as a collection of curios created as accessible objects of wonder; mysterious yet navigable. Ideally, interacting with them leads to the type of investigations common to both scientists and artists: noticing details, asking questions, and exploring phenomena. Shawn is also an accomplished regional artist with large-scale water sculptures in downtown San Francisco and pieces on permanent display in over forty national and international venues. He received a design award from the New Orleans chapter of the American Institute of Architects for his work with fellow Exploratorium artists on a monumental kinetic building facade.

Speaker

Beth Ziebarth **Director** **The Smithsonian Institute**



ON STRIVING FOR ACCESSIBLE EXHIBITION DESIGN

Exhibitions are complex presentations that convey concepts, showcase objects, and excite the senses. However, as museums recognize the diversity within their audiences, they realize that exhibitions must do more: exhibitions must teach to different learning styles, respond to issues of cultural and gender equity, and offer multiple levels of information. The resulting changes in exhibitions have made these presentations more understandable, enjoyable, and connected to visitors' lives.

Accessible design must be a part of this new philosophy of exhibition development because people with disabilities are a part of museums' diverse audience. Discovering exciting, attractive ways to make exhibitions accessible will most directly serve people with disabilities and older adults. But to name an audience who will not benefit by these designs is impossible. Accessibility begins as a mandate to serve people who have been discriminated against for centuries; it prevails as a tool that serves diverse audiences for a lifetime.

Exhibition teams must meet the challenge of synthesizing accessibility solutions into their development processes. The focus of this session is on improving the museum visitor experience through accessible exhibitions. The "Smithsonian Guidelines for Accessible Exhibition Design" will be discussed as a means to finding workable solutions for effectively communicating with a diverse audience.

Beth Ziebarth has a personal interest and professional responsibility in advocacy for people with disabilities. She currently serves as the director of the Smithsonian's Accessibility Program. In her position, Ms. Ziebarth develops and implements accessibility policy and guidelines for the Institution's 19 museums, the National Zoo, and nine research centers, ensuring that the Smithsonian's 30 million annual visitors experience a welcoming environment that accommodates individuals of all ages and abilities.

Ms. Ziebarth develops partnerships between the Smithsonian and disability, educational, and cultural organizations in order to increase the Institution's audience of people with disabilities. She provides technical assistance to Smithsonian units on facility, exhibition and program accessibility issues and coordinates with Smithsonian administration to resolve formal and informal accessibility complaints.

Ms. Ziebarth has been a Smithsonian staff member for over twenty years.

Speaker

Charles Trautmann **Director** **The Sciencenter**



SCIENCE CENTERS AND PUBLIC WORKS: EMERGING PARTNERS IN EDUCATION

As the United States works to increase both the quantity and quality of its engineering student pipeline, research has shown the critical importance of early, out-of-school experiences in laying the foundation for initial interest and subsequent involvement in engineering. Science centers and museum form an important part of the educational infrastructure that can provide these early experiences to our youth. But science centers can't do the job alone and are constantly surveying opportunities for partnerships, with the goal of providing inspiring, hands-on educational content and materials to motivate children to pursue technical careers.

Bridges, buildings, dams, tunnels, and other iconic public works form a vastly underutilized educational resource. Children and their parents are fascinated by these structures, but often have little opportunity to learn more about the science and technology involved. The teachable moment provided by a visit to the Golden Gate Bridge, for example, may be largely lost if a photo and post card are the only goals of a visit.

This paper describes both successful examples and new possibilities for increased use of civil engineering structures as motivators for youth engagement in science and engineering. Science centers have large audiences and years of experience in how to engage the public in science. Public works organizations have a variety of complementary resources, such as public viewing venues, staff, equipment, and/or funding that can be used to advantage in motivating youth.

Given the number of large, innovative civil engineering structures in the U.S., there appears to be a vast, almost untapped opportunity to use these structures in the service of technology education. The new Golden Gate Bridge Visitors Center is but one example of the possibilities.

A side benefit of using public works for education is increased public awareness of the importance and cost-worthiness of maintaining and constantly upgrading our infrastructure. This increased awareness has the potential to reduce the short-term thinking associated with deferred maintenance and instead promote policies that better support ongoing maintenance and improvement of public work

Charlie Trautmann is executive director of the Sciencenter, a hands-on science museum in Ithaca, NY, and adjunct professor of Civil & Environmental Engineering at Cornell University. Charlie has been at the Sciencenter since 1990 and is responsible for overall leadership and planning, including exhibits, programs, staffing, and fundraising. Charlie has served on the boards of the international Association of Science-Technology Centers and the Association of Children's Museums, both based in Washington. Charlie contributes regularly to museum conferences and has published over 90 articles on sustainable non-profit management and civil engineering.

Speaker

Ari Epstein

Lecturer

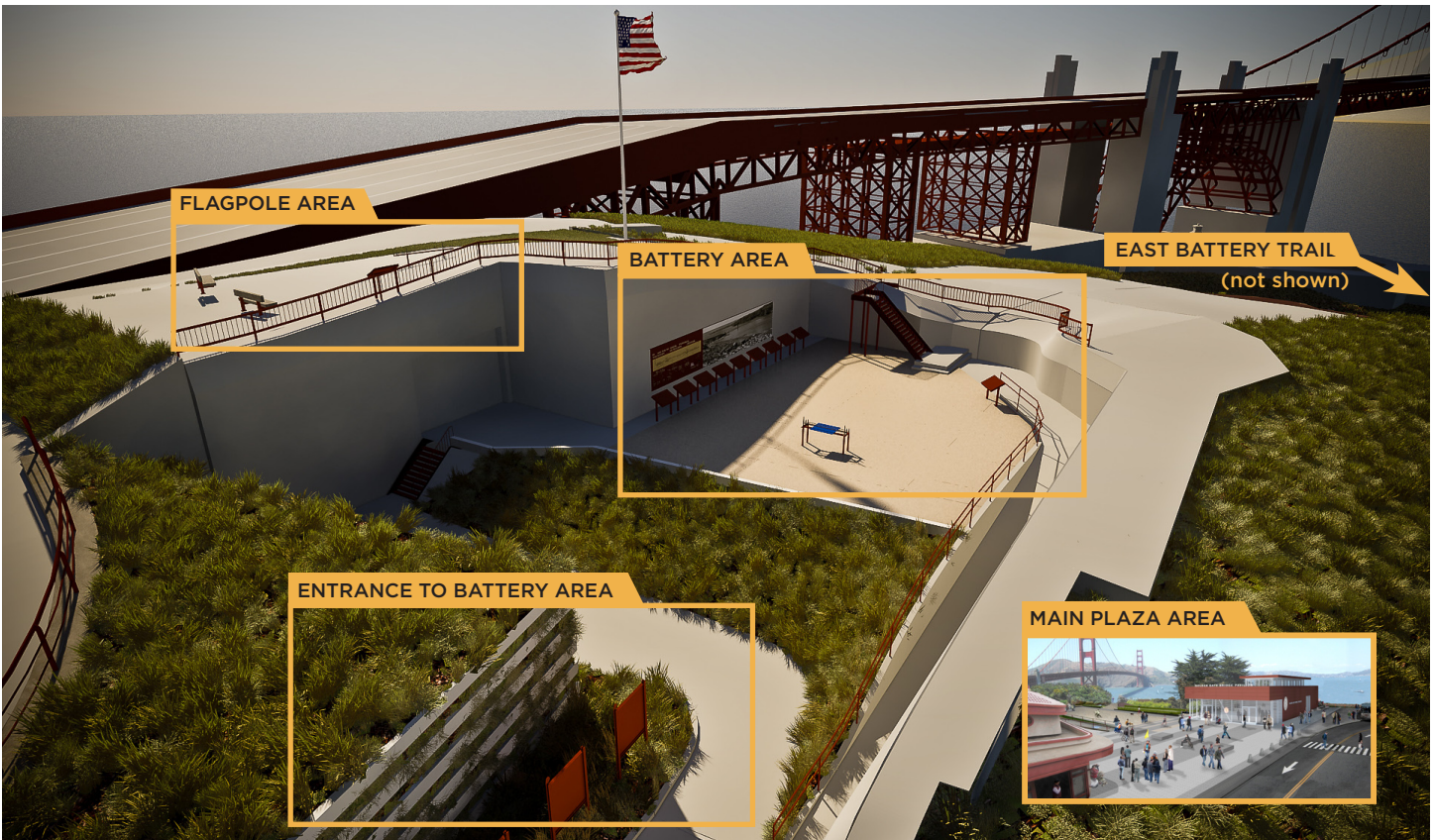
Massachusetts Institute of Technology



CREATIVITY, ENERGY AND INNOVATION: UNDERGRADUATES AS INFORMAL SCIENCE EDUCATORS

Terrascope is a learning community at the Massachusetts Institute of Technology in which freshmen work in teams to address large, complex problems (usually problems involving environmental or earth-system science topics). Terrascope students can take optional classes in which they develop innovative ways to communicate with public audiences on these topics; examples have included radio programs, museum exhibits and multi-player games. The students do not have prior experience or training in these areas, but their unique perspectives, talents and interests, combined with the intensive, team-oriented, project-based learning experiences provided by Terrascope, enable them to create high-quality original work, much of which has been adopted by radio stations, museums and other public venues. Here we describe some of the students' process and end products, and we discuss more generally ways in which organizations engaged in informal science education might draw on the creativity and drive of local undergraduate students.

Ari W. Epstein, Ph.D. is a Lecturer in the Terrascope program and the Department of Civil and Environmental Engineering (CEE) at the Massachusetts Institute of Technology (MIT). Terrascope, part of MIT's Office of Experiential Learning, is a freshman learning community that focuses on team-oriented, project-based learning on complex problems that integrate scientific, technical and societal issues. Epstein co-developed and co-teaches several of the Terrascope classes, including one in which MIT freshmen create interactive museum exhibits and another in which these science and engineering students communicate with general audiences through innovative radio programs. He also co-developed and co-teaches a new implementation of CEE's project-based Introduction to Civil and Environmental Engineering Design. He is particularly interested in developing ways to integrate free-choice learning (the kind of learning promoted by museums, community-based organizations, media and other outlets) into the academic curriculum, integrating formal and informal educational strategies.



ABOUT THE OUTDOOR EXHIBIT

The Golden Gate Bridge, Highway and Transportation District (GGBHTD) is the recipient of a \$3 million grant from the National Science Foundation to establish a permanent outdoor exhibition in the visitor area at the south end of the Bridge. The exhibits will explain the engineering and construction of the Bridge and its history

The GGBHTD proposed an innovative remodeling of one of the military batteries located in the visitor area, Battery Lancaster. Concrete walls that were built in the late 1800's, when the U.S. Army installed a cannon there for the purpose of defending the Golden Gate, form the battery. The plans for the full outdoor exhibition involve making an access way through the battery wall, which will open up the space for visitors. In this space would be installed a detailed 1:80 scale model of the bridge over 80 feet long made of stainless steel, which provides a "table of contents" for twenty satellite hands-on exhibits around it. The interim exhibition put in place in time for the 75th anniversary celebration features many of these smaller exhibits.



The exhibits installed as part of the Outdoor Exhibition project are partially funded by the National Science Foundation.

SUMMARY OF INTERIM EXHIBITS

LOCATED BY THE FLAGPOLE AREA



How the Bridge Vibrates

The Bridge has many modes of vibration, or ways in which it can move in response to wind or earthquakes. This mechanical hands-on exhibit lets visitors “excite” (shake) the model in varying ways to see how it responds. The main span between the towers can sway sideways, back and forth like a swing, or it can take on a snake-like pattern of vertical or horizontal displacement depending on the rate at which it is moved.



Foghorns

When it's foggy, visitors may not be able to see the Bridge, but they get to hear the foghorns. The foghorns of the South Tower (single booming blast) and Midspan (double higher-pitched horn), each has its own rhythm/rate. The display tells the meteorological story of the Golden Gate's influence on weather in the Bay Area. The speed of sound is experienced by the visitor by comparing arrival times of foghorn sounds through the air versus almost instantly by telephone.

LOCATED AT THE ENTRANCE TO THE BATTERY AREA



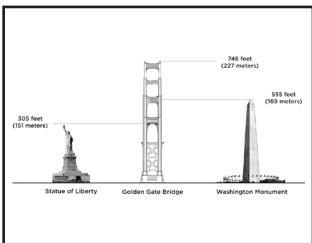
How the Bridge Spans the Golden Gate

Engineers call it a load path - the path taken by the loads (e.g. the weight of the structure and what it carries, the wind forces on it) as they flow through the structure to reach the foundation. The vertical suspender ropes pull the weight of the deck up to the main cables. The main cables carry it to the tops of the towers. The weight goes down the two towers to their foundations. The ends of the cables must be anchored to resist the tension (pulling) force that acts horizontally, inwardly, vertically, and upwardly.



Art Deco on a Grand Scale

Within the limits of engineering necessity, bridge designers have aesthetic latitude in making decisions such as: architectural detailing (which is Art Deco on the Golden Gate Bridge), proportion of main span to side spans, height of tower to span ratio, shape of tower, and form of struts connecting the two tower legs.



Tall and Strong - The Bridge Towers (includes “What is a Rivet?”)

Explains how the entire weight of the bridge deck, with vehicles, pedestrians, bikes, etc., is carried up to the main cables and up over the towers. Where the cables go over the towers they hand off that load. The towers must carry all the weight down to their foundations. This exhibit also explains how a rivet initially looks like a bolt with a head on one end. It is heated red-hot, inserted through the holes of the pieces of steel to be connected, then pounded to form a mushroom-head on the shaft, permanently clamping the pieces together.



Fog, Steel, Salt, Rust, and Paint

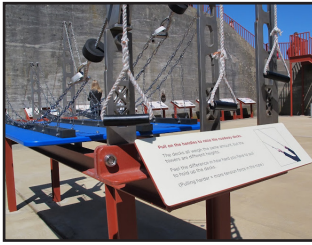
The International Orange color of the Golden Gate Bridge is very much part of its landmark signature. The job of removing rust and painting the Bridge is a constant one, and involves steeplejack or mountain climbing ability on the part of the painters to access hard to reach areas high in the structure. High-performance primers and paint are also required to be durable in the wet and salty environment. A painted and unpainted steel sample illustrate the affects of corrosion at the Golden Gate.

LOCATED IN THE BATTERY AREA



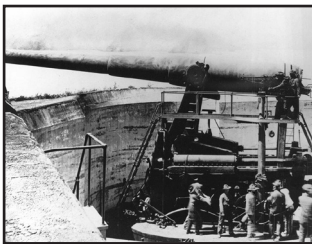
History of the Design and Construction of the Bridge - 9 tabletops

The history of the Golden Gate Bridge has many themes: financial and political challenges to develop it, engineering and construction challenges to build it, the Depression-era workers who worked on it, its effect on the regional economy, and the efforts to maintain the Bridge for future generations.



Suspension Cable Tension vs. Tower Height

The twin cables would slope more steeply if the towers were taller. When the slope is steep, more of the tension (pulling) force in the cables is efficiently directed upward, rather than horizontally. But taller towers (the Bridge's were the tallest in the world when built) mean more structural and construction problems and more cost – a classic engineering tradeoff.



BATTERY LANCASTER (MANEUVERING RINGS) - a *National Park Service display*

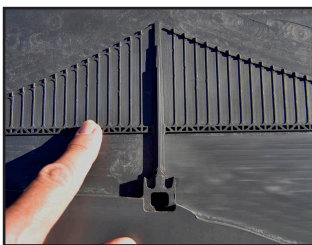
Visitors currently do not know what are the large steel “doorknockers” in Batter Lancaster are. They were used to maneuver the large cannon in that area, when ropes or chains were attached to them and soldiers could tug the cannon into position.

LOCATED IN THE MAIN PLAZA AREA



LIFETILES - Animation of Construction of the Bridge

Using the artistic technology developed by Rufus Butler Seder, this glass tile mural animates as the visitor walks past it, displaying first the Golden Gate before the Bridge was built, then the stages of construction (foundations and towers, main cables, vertical suspender cables, deck).



Braille / Tactile Model of the Bridge

A bronze tactile-readable tabletop model of the Bridge with Braille captions and an 18 inch high replica of a tower is planned for installation next month.

LOCATED NEAR THE PAVILLION



Cross-section of a Main Cable - an *original Golden Gate Bridge exhibit*

This classic exhibit has been at the Bridge for decades, touched and photographed by millions of visitors.

LOCATED ON EAST BATTERY TRAIL



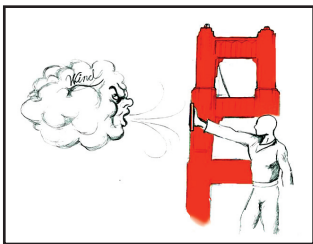
Lattice Strut Retrofit

The original bracing members (struts) in the arch structure and adjacent approach spans were made of hundreds of small pieces of steel riveted together. A seismic retrofit has replaced many of these lattice truss struts with modern one-piece steel tubes - but with triangles carefully laser-cut out so the replacement struts look like the originals. The exhibit explains how U. C. Berkeley tested a replica strut in the laboratory to measure its strength.



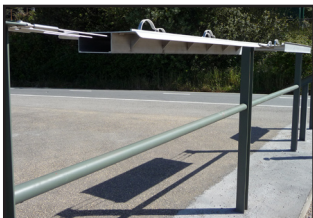
Seismic Isolator

Approach spans to the suspension bridge have been retrofitted with seismic isolators. In an earthquake, the isolator deforms, resulting in the structure above the isolators experiencing a less violent level of shaking.



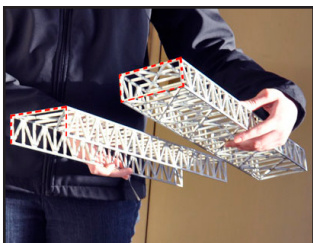
Wind Speed and Wind Pressure

The Golden Gate is a very breezy place, its the only gap in the coast range for hundreds of miles. Cool, dense, high pressure air over the cold ocean pushes its way into the Bay. Wind force varies as the square of the velocity, a fact the visitor can intuitively sense by pushing on this exhibit. They feel how much harder it is to push with a force equivalent to a wind of various speeds.



Bridge Deck Aerodynamics

Wind blowing across (transversely to) the deck of a suspension bridge can make it begin to twist - a very undesirable type of structural response. This exhibit mounts two similar scale-model bridge decks next to each other. One model is aerodynamically superior to the other in subtle ways that make it stable in the breeze. The other model noticeably twists. The Golden Gate Bridge has been extensively studied analytically and in wind tunnel testing to evaluate its wind performance.



Bridge Deck Torsional Resistance Retrofit

Completed in 1937, the design of the Golden Gate Bridge did not benefit from knowledge about the collapse of the Tacoma Narrows Bridge in 1940, which twisted itself to collapse in a moderate breeze. The Golden Gate Bridge was retrofitted in 1954 with horizontal diagonal bracing between the bottom edges of the vertical deck trusses. This makes the deck much harder to twist, which is felt by the visitor in this comparison of pre- and post-retrofit bridge decks.

LOCATED AT THE EXPLORATORIUM



Tracking Daily Movements of the Bridge

In a normal day, the Bridge deck rises up a few feet at night when it gets colder, the steel in the cables shrinks, and there is less traffic weight on it. It goes down in the daytime with the rise in temperature and increased traffic load. It sways to the east when the wind comes off the ocean from the west. This exhibit displays actual measured movements of the bridge, which can be "played" forward and backward.

FUTURE / PLANNED EXHIBITS

In an effort to reach the commuting public, an exhibit will be installed on one of the commuter ferryboats that feature a piece of Bridge suspender rope. The exhibit will educate the commuting public about suspender rope load strength as compared to the weight of a ferry vessel.

Plans are in process to proceed with the remodeling of the visitor area at the south end of the Bridge, which will allow the addition of other planned exhibits. On the base of the 1:80 scale model of the bridge will be information on the geology of the Bridge foundations. Once completed space will be available to include exhibits that illustrate the full size of one of the tower legs through the outline of a tower leg in the walkway. A newly constructed concrete wall will allow space for a planned 80 foot long mural that will feature large, historic photos of the bridges history and construction; and the workers, designers, planners, and dreamers who made the Bridge a reality.



Once the new space is completed, the interim exhibits will be installed in their permanent location.