| EM-5.22 Lessons Learned Bulletin | **February 2017** |
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# Oakland East Span Bay Bridge Lessons Learned


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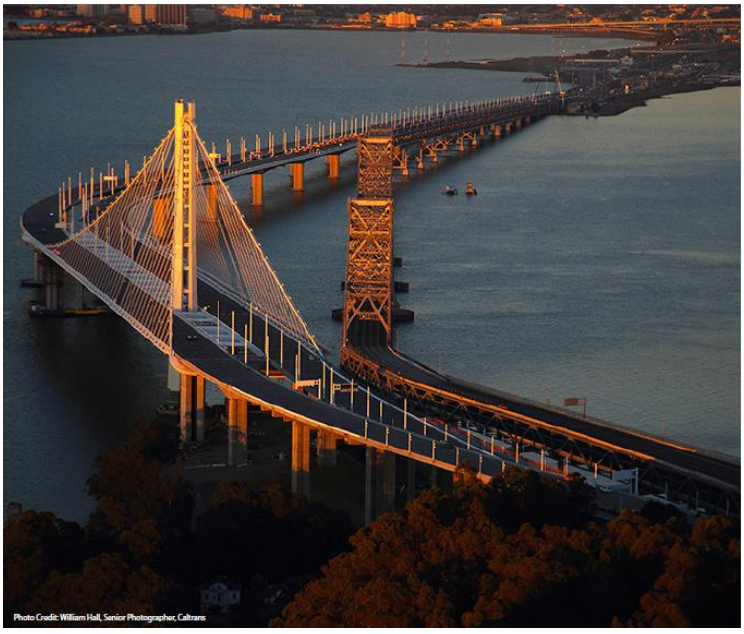
**Statement:**

Management of Mega-Projects can be tricky for even the most experienced companies. The challenges introduced through the sheer size in budget, long duration schedules, management of contracts and projects, internal and external communications, and the involvement of regulators and the public should be closely reviewed when considering or executing a Mega-Project. In the increasing need for larger and more complicated projects, a valuable amount of data is available in lessons learned from prior projects to support the execution of existing and planned projects.

The 1989 Loma Prieta earthquake initiated the California Department of Transportation (Caltrans) replacement or retrofitting of more than 2,000 bridges in the state. One of those bridges was the San Francisco Bay Bridge. The western span, Golden Gate portion, of the bridge was seismically upgraded while the eastern span was deemed in need of replacement. The project experienced both a 246% cost overrun and 63% schedule overrun in which the state passed Assembly Bill 144 establishing additional funding, instating a governing body, and provided operating requirements for the project. The project provided a lessons learned identifying areas of positive performance and recovery from poor activities.

**Discussion:**

The Loma Prieta earthquake struck on October 17, 1989 impacting more than 2,000 bridges in the state of California. One of those bridges, the East Span Oakland Bay Bridge, experienced seismic failure in which a 250 ton portion of the bridge collapsed. From 1989 to 1997 the California Department of Transportation (Caltrans) through the Toll Bridge Seismic Retrofit Program (TBSRP) performed studies to determine the best approach for correcting the failed bridge and how to ensure the safe passageway from Yerba Buena Island to Oakland. The final determination came in 1996 to replace the bridge. From 1997 to mid-2001 Caltrans collaborated with Metropolitan Transportation Commission (MTC) developing a design and having it receive environmental clearance through the San Francisco Oakland Bay Bridge East Span Replacement Project. From 2001 to 2005 the TBSRP experienced a number of setbacks from the terror attack of 2001 to the Recall of Governor Davis in 2003. These events cause fluctuations in material pricing and political uncertainty. In 2005 Governor Schwarzenegger passed Assembly Bill 144 providing additional funding to complete the project, establishing a new governing body, and setting operational requirements for the project. The project was originally estimated at $2.6 Billion dollars with a completion date in 2007. The project completed at a cost of $6.4 Billion on September 2, 2013.




The project team provided a Lessons Learned report as part of their final project report. The lesson learned portion was structured in seven sections which have been identified below with the section summaries included. These summary statements provide the overall take-away from the project's perspective.

**GOVERNING BODY –**

The appropriate governance structure of a mega-project should be broadly assessed in the context of the needs of the program rather than in the context of an existing owner organizational structure. Mature organizations have developed systems, processes, and an organizational structure to deliver well on their core functions. While an organization can sometimes be pushed beyond the intended levels of its management structure and be successful, delivery of a mega-project (once in a generation for most professionals) is typically well beyond the standards and management approach for which an organization has been developed, particularly where there may be significant stakeholders external to the organization.

The level of success of a governance structure is dependent on the individuals assigned to key responsible roles. These roles and responsibilities must be clearly defined and lines of communication established and followed. All of the key managers must instill discipline and transparency into the team and processes, as well as bring an open and collaborative approach to the governing team to bring about a high level of trust and support timely decision making.

**TOLL BRIDGE SEISMIC RETROFIT PROGRAM ORGANIZATION –**

A mega-project requires an organization structure with a full-time dedicated team with clearly defined roles and responsibilities. The program manager needs to be empowered to make decisions and have access to top leadership in the oversight organization. The team needs to have strong resources, systems, and tools throughout the project and team co-location is highly recommended. The people who work on the project need the drive, commitment, expertise, and ability to adjust to change. One of the biggest drivers for success of a project is the people who work on it — people matter.

**RISK MANAGEMENT –**

After the passage of Assembly Bill 144, the TBSRP was required to implement a robust and integrated risk management process. The risk management analysis developed was thorough enough to support management decisions on the project relating to schedule and costs. The corridor schedule developed, after Assembly Bill 144 passed, used the schedule risk analysis to set when the bridge would open. That schedule was met. Although the TBSRP risk management program was considered a success, the new East Span project did not get the full benefits during the early phases of the program because the risk management program was implemented mid-way through the program after construction had started. By the construction phase, the project benefited from cost estimating that included program contingencies derived by the risk management analysis.

**MANAGING EXPECTATIONS –**

To manage expectations on a mega-project, qualified and dedicated professionals, respected outside expertise, robust communication, and risk management teams are needed from beginning to end to deliver the project. An open executive decision-making process is necessary to improve transparency. Readily available project documents can help maintain public trust. When they cannot be produced suspicion sets in. Top-level project decision-making meetings should be open to the public. Critical project information must be communicated in a clear, concise, and timely manner internally to ensure good decision making and externally to provide clarity and transparency. Mega-project owners should also consider innovative delivery methods to communicate critical information such as project status and public safety. Making an extra effort beyond mandated or legislated reporting to keep elected officials up to date with current and projected status of the project is critical to decision making that affects project delivery. Managing expectations on a mega-project is best accomplished when the communications team is empowered to speak with one voice from the project site representing the direction of the governing body throughout the entire life of the project.

**PROJECT DELIVERY METHOD –**

The TBSRP delivered the multiple construction contracts of the East Span project using Design-Bid-Build (DBB) procurement method for each of the contracts. There were benefits and challenges using the DBB method for a complex mega-project such as the East Span project. Because the project was being delivered by DBB, the design was developed

by the owner for each of the contracts and the contractor chosen was the lowest responsible bidder on each of the contracts. While a DBB delivery approach provided Caltrans control of the design details, having more in-house construction-related expertise during the design development could have benefited the project by minimizing potential design revisions during the construction phase as well as potential schedule risks. Although not available when Caltrans began contracting for the East Span project, future mega-projects should consider and evaluate alternative project delivery methods that best fits the project needs.

**QUALITY MANAGEMENT –**

The implementation of quality for all parties on a mega-project requires management commitment, adequate resources, and good working relationships amongst the owner, contractor, and fabricator throughout the life of a project. Mega-project owners should have QA and testing staff involved throughout the life of a project to assist during design and construction phases. Third-party expert panels that advise on global issues such as the SSPRP or specific subject matter such as the QA/QC Expert Panel that provide guidance on complex technical issues and demonstrate to stakeholders that particular methods being employed on the project are appropriate and consistent with the current state of the practice are important to establish early on and maintain throughout the project.

Mega-project owners should incorporate detailed fabrication processes in the contract documents to further define quality best practices if there is a potential for overseas fabrication. If any element of the mega-project is being fabricated in a foreign country, management attention, resources, and schedule time should be allocated to developing cultural awareness for expat staff of the local people in the country where the materials are being fabricated.

**What Worked:**

1. The Toll Bridge Program Oversight Committee (TBPOC) was an effective governing body concept because it enhanced accountability, oversight to program finances, and resolution of critical issues relating to cost and schedule impacts, and regular reporting to the California State Legislature for the TBSRP.
2. Three agencies joining together added credibility to a unified oversight of the TBSRP. One agency alone may bring a narrower perspective in decision making.
3. The TBSRP co-located all parties. This central location created a campus environment that fostered team work, accountability, and communication.
4. Leadership communicated effectively during the construction phase with various fabricators
5. Leadership engaged various external permitting agencies throughout the project, which positively impacted the project towards completion.
6. The TBSRP established formal and informal partnering activities with prime contractors on a regular basis that helped develop relationships for efficiently addressing challenges.
7. Project established a robust risk management program that informed major decisions on the project after 2005.
8. Multidisciplinary task forces were created to assess and resolve specific high risk project issues that were identified on the risk register.
9. The project team found innovative ways of delivering project information such as creating an online media bar, using Google Earth, and developing mobile applications to reach out to the public.
10. Caltrans engaged potential contractors through contractor outreach processes to get their input before each of the contracts went out to bid.
11. Increased participation of small businesses through various outreaches and business-related training workshops.
12. The project Materials Engineering and Testing Services (METS) team provided input from past bridge projects during the design process. This was instrumental in ensuring quality on Bay Bridge contracts during construction.
13. Caltrans devoted management attention and resources to cultural awareness during the fabrication of the Self-Anchored Suspension (SAS) system in China
14. The Seismic Safety Peer Review Panel (SSPRP) provided expert advice to the project team from the beginning of design through construction
15. The TBSRP created the Quality Assurance / Quality Control Expert Panel comprised of subject matter experts

**What Did Not Work:**

1. A review of best practices for mega-project delivery was not formally performed to determine key processes required to support the program.
2. Clear lines of responsibility, accountability, and communication were not established between the Program Manager, Project Management Team (PMT), and TBPOC. Consideration should be given to have one program manager reporting directly to the decision-making body.
3. Regular public meetings or conduct business through a public process were not held.
4. A dedicated full-time core team that was augmented with team members who were not exclusively working on the project. At times, this challenged these non-full-time team members with balancing workload and supervision outside of the East Span project.
5. The formal program management plan was not regularly updated. This plan should have clearly and formally defined roles responsibilities.
6. A formalized database for maintaining project records at the beginning of the program that was capable of adapting to the growing needs of the program was not established.
7. The formal risk management program was implemented mid-way through the program during the construction phase of the project and did not provide benefits during the early phases of the project.
8. At times the project struggled to keep elected officials, stakeholders, the media, and the public up to date.
9. Contractor and fabricator input during the design process would have benefited the design phase and minimized costs impacts during construction.
10. Following common practice in the U.S., the SAS contract specifications did not completely define fabrication processes which created challenges in overseas fabrication requiring additional oversight.
11. The Quality Assurance / Quality Control Expert Panel was formally assembled after China fabrication had started, and as a result, the SAS project did not receive the benefits earlier in the project development.

## Summary of Lessons Learned Recommendations for Consideration:

These recommendations are provided from the project's perspective and relate to DOE project management practices as defined in DOE Order 413.3B as well as other practical considerations that reinforce sound project management principles that lead to success. EM FPDs and Site Managers may want to consider some of the approaches identified in the lessons learned as applicable to their projects and activities.

**Governing Body:**

1. Managers should research and assess processes that will be applied during the development lifecycle to ensure that management systems can be put in place to drive the team to the required outcomes in a timely manner.
2. Assess and confirm development level and timing for processes required to support the project and develop project-specific procedures and reporting that meet requirements of the applicable program. Identify stakeholders with responsibility for project functionality, cost, and schedule, for consideration as part of a governance structure for project delivery.
3. Maintain clear lines of responsibility and accountability between the oversight organization and the Program Manager, Site Manager, or FPD.
4. Evaluate the benefits of an independent delivery governance structure of a project following a public process, particularly where there are political requirements or influences that can adversely affect the functionality, cost, or schedule of the program

**Project Organization:**

1. The size and complexity of a project determines the organizational structure. Projects should be adequately resourced and work towards the goal of project delivery through a common reporting line structure.
2. It is recommended that FPDs have direct reporting and access to the highest pertinent levels of leadership within the organization

3. From the onset, projects should formally define clear roles and responsibilities for all levels of the project in a formal project management plan that is reviewed and updated regularly or as needed when changes arise. In EM projects, the FPD updates the Project Execution Plan (PEP).
4. A fully integrated information management system needs to be established and implemented at the start of the project and managed by a document control team. This system should support future requirements of project maintenance and operation information systems as part of the records retention practices.
5. Co-locating all parties is effective in fostering working relationships, collaboration, cooperation, and communication.
6. It is important to establish relationships with key contractors and suppliers (e.g., detailers, fabricators, suppliers, and others) that are critical to the overall completion of a project.
7. People and talent matter at all levels of project organization. Staff with commitment, expertise, and ability to adjust to the changing environment of project are vital to its on-going and overall delivery.

**Risk Management:**

1. Projects should have a robust risk management program supported at the highest levels of the project that covers all aspects and phases of the project. The risk management process will help the program articulate the risks and, therefore, set realistic expectations.
2. The risk management team should be part of the overall management team, and the risk management analysis has to be thorough enough to be able to inform management decisions on the project relating to schedule and costs.
3. The development and management of project cost contingencies need to be tied to the risk management process. The size of a project contingency should be determined by the risk assessment documented in the risk register and should be based on the defined quantified costs in the risk register.
4. Use schedule risk analysis practices based on the Monte Carlo method — a standard statistical algorithm for probability ranges of the scheduled task — to create and manage the overall project schedule during the planning, design, and construction phases of the project.
5. Create task forces, as needed, to address a particular issue identified in the risk register. Task force teams should be multidisciplinary groups that can bring a multifaceted approach to developing risk mitigation solutions.
6. If possible, when addressing an identified risk, do so in a manner that does not change the parameters defined in the contract documents. Once the scope is changed by DOE to mitigate a risk, the risk is transferred from the contractor to DOE. Even though a risk may be mitigated, once the contractor's responsibility to the contract has been reduced, the potential for increased costs or the emergence of other unanticipated risks increases.

**Management Expectations:**

1. To manage expectations on a project, qualified and dedicated professionals as well as respected outside expertise and robust communication and risk management teams are needed from beginning to end to deliver the project.
2. Projects should establish an open executive decision-making process to successfully manage expectations and to provide transparency to the public and stakeholders. DOE specifies the Project Management Executive in DOE Order 413.3B.
3. Critical project information must be communicated in a clear, concise, and timely manner internally to ensure good decision making and externally to provide clarity and transparency. FPD's may want to consider best approaches to communicate critical information such as project status and public safety to the various stakeholders.
4. Project Managers should make an extra effort beyond legislatively required reporting to keep elected officials up to date with the status of the project. Keeping this audience continually updated is critical to decision making that affects project delivery.
5. Managing expectations of a project is best accomplished when the communications team is empowered to speak with one voice from the project site representing the direction of the governing body throughout the entire life of the project.

**Project Delivery method:**

1. During the planning phase of a project, the project management team should assess the merits of the various project delivery methods. ). A critical success factor is assessing the balance of the key project values of schedule, risk, cost, and design definition, and the selection of the appropriate project delivery method or combination of methods that best meets the specific needs of the project.
2. On projects with multiple construction contracts, the scope of each of the construction packages must be vetted through a risk management process prior to starting substantial design efforts. There can be significant benefit to a project by engaging contractor and fabricator expertise early in the project development process.
3. Due to the complexity of some projects, designs should be developed in 3D as applicable using building information modeling (BIM) design software. The project can be virtually constructed through the use of 4D models (3D model plus construction schedule) to identify design and construction conflicts during the design phase instead of the construction phase.
4. It is important to engage small businesses, to the extent practical, to strengthen the ties of the project to local community and further enhance the economic development of the area.

**Quality Management:**

1. The implementation of quality for all parties on a project requires management commitment, adequate resources, and good working relationships amongst DOE, contractor, and vendor throughout the entire life of the project.
2. Project owners should have quality assurance (QA) and testing staff involved throughout the life of a project to assist during design and construction phases.
3. Third-party expert panels (such as a Seismic Safety Peer Review Panel (SSPRP) or a QA/QC Expert Panel) that provide guidance on complex technical issues and demonstrate particular methods being employed on the project are appropriate and consistent with the current state of the practice are important to establish early on and maintain throughout the project.
4. Project owners should consider incorporating detailed fabrication processes in the contract documents to further define quality best practices if there is a potential for overseas fabrication.
5. If any element of a project is being fabricated in a foreign country, management attention, resources, and time should be allocated to developing cultural awareness practices for expat staff.

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| Critical Decision(s): | CD-0 to CD-4 |
| Facility Type(s): | All |
| Work Functions(s): | Contract/Program Management |
| Technical Discipline(s): | Contracting, Management, Planning |

References:

1. Caltrans, “Lessons Learned Report – Final Report May 2014”, http://baybridgeinfo.org/lessons-learned-report (Feb, 2017).