Locking in Value: An Early Value Study Combined with Economic Reevaluation of the Redundant Poe Size Lock Project

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Abstract

The U. S. Army Corps of Engineers is charged with delivering solutions to the Nation's toughest engineering challenges. As our infrastructure ages and resources decline, the Corps must make the most effective and efficient use of taxpayers' dollars. Projects must achieve a benefit to cost ratio (BCR) above 1.0 in order to compete for national funding. Since value is represented in equation format as being equivalent to the ratio of function to resources and is directly parallel the ratio of benefit to cost or BCR ratio, it is fitting that an early value study was performed in conjunction with the reassessment of the BCR for the Soo Locks redundant Poe Size Lock Project. The Soo Locks are the lynch pin of the Great Lakes Navigation System. Eighty five percent of the commercial commodities are carried by ships transiting the Soo Locks and are limited by size to the Poe Lock. Due to aging and deteriorating infrastructure, unscheduled outages are increasing. The economic impact of a 30-day unscheduled closure of the Soo Locks is $160,000,000. This paper explores the utilization of the Value Methodology concurrently with the reassessment of the BCR for the Redundant Poe Size Lock Project.

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The Project

The Soo Locks are located in Sault St. Marie, MI. in Chippewa County. Construction of a second, Poe-sized (110' by 1200') lock on the site of the existing Davis and Sabin Locks will provide for more efficient movement of waterborne commerce and redundancy for the Poe Lock. The Corps is currently preparing a Limited Re-evaluation Report (LRR) to update all of the benefit categories and costs of the remaining construction efforts of the new lock to generate a new benefit to cost ratio (BCR). The Detroit District initiated an Economic Reevaluation in January 2016 to reassess the BCR with updated assumptions on reliability and alternate transportation modes. The reevaluation will also include updated failure probabilities based on reliability of major components. The report is scheduled to be complete in December 2017, contingent upon funding. If the BCR is above 1.0, the District will compete for funds nationally to resume the final design of the lock chamber, upstream channel excavation, construction of upstream and downstream guide walls, and new lock chamber construction. The project was authorized by Congress in 1986 but has not yet been funded.

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Some important factoids about the Soo Locks that express its importance to the nation:

- $500.4 billion in iron ore is shipped through the Soo Locks each year
- 80 million tons of cargo annually is shipped through the Soo Locks each year
- Poe Lock accommodates vessels up to just over 1000' long and 105 feet wide with a capacity of 80,000 tons
- Soo Locks accommodates a 10 month shipping season
- It takes 9 hours to navigate the St Marys between Lakes Superior and Huron
- Performs 10,000 lockages per year

The Timing and Combination of Efforts

The Soo New Redundant Poe-Size Lock Project Delivery Team (PDT) proposed a value study in conjunction with the LRR cost certification and revision of the BCR. Preliminary designs are complete; however, it is early enough in the design to maximize impact with a value study.

Realizing that the BCR and the value index are synonymous terms utilized to express a similar ratio: benefit / cost in cost terminology is equivalent to function worth / function cost in value analysis terminology, the timing for a value study seemed optimal.

BCR responsibility lies within Civil Works Cost Engineering and Agency Technical Review Mandatory Center of Expertise (MCX) with Technical Expertise (TCX) duties, located at the Walla Walla District Cost Engineering Branch. Roles include items within a TCX that are structured to provide technical support and assistance, various cost tools, and resources to Headquarters (HQ) U.S. Army Corps of Engineers (USACE); division command or Major Subordinate Command (MSC) and/or district command or operating MSC; and MSC elements on cost engineering issues. The MCX is structured to provide a mandatory agency technical review (ATR) center and Support for Others Program for Civil Works Projects.

Another important factor within the Corps that influenced the optimum timing for the value study is the evolution of the Inland Navigation Design Center (INDC) Mandatory Center of Expertise established in 2013. The purpose of the new organization was to use in-house technical expertise in both the Mississippi Valley Division (MVD) and the Great Lakes and Ohio River Division (LRD) to deliver inland navigation projects. Expert resources from across the Corps could then be engaged if the workload demanded or specialization in specific areas were needed. Prior efforts on the design of the new Poe Lock predate the existence of the INDC. The INDC will become the designer of record for the New

Redundant Poe Lock Project. This was a perfect time to get the INDC up to speed on the design and challenges faced by the project.

The Highly Diverse, High Functioning Team and the Concurrent Mission

Seeing that all the right players were converging for a meeting of the minds made it the perfect timing for a value study. The team composition was ideal, the dream team included:

- Deputy Director and two Technical Directors from INDC
- A cost engineer from the Civil Works Cost Engineering and Agency Technical Review Mandatory Center of Expertise (MCX) with Technical Expertise (TCX), located at the Walla Walla District Cost Engineering Branch serving as the cost certifier.
- A cost engineer from the Chicago District serving as the Cost Agency Technical Review (ATR) team member.
- PDT members from Detroit District (structural engineer Regional Technical Specialist, cost engineer, Soo Area Office Engineer and Construction Engineer) and Huntington District (project manager, cost and risk analyst); and the Dam Safety Production Center (civil engineer).
- Extended management team members from Detroit District (Commander; Deputy District Engineer; Chief, Operations Engineering and Construction; Chief, Engineering and Construction; Chief Cost Engineering; Soo Area Chief of Construction, Chief, Operations;
- Stakeholder and boat captain, Director of Vessel Operations and Security, Interlake Steamship Company

The team was a brilliant mix of long term hands-on PDT members, those in management not as closely integrated into the design, as well as new eyes from the INDC, Cost MCX, and cost ATR, plus one very important stakeholder. Typically this level of upper management participation does not occur throughout a value study at the Corps; however, due to the criticality of this BCR that will determine if the project receives funding leadership actively participated throughout the entire value methodology six step process.

The Methodology

Pre-Workshop Information Phase (26-28 Sept 2017). Two weeks prior to the actual value study, the team met for three days to go over project materials and set a scope for the value study and cost certification during the Soo Locks Design Charrette Information Phase and Scoping Meeting. Fifteen features of work were identified as the scope for the value study.

Individual Function Analysis (2-4 Oct 2017). Pre-study work was assigned for the project. The team was provided with instructional materials from the Value Methodology – A Pocket Guide to Reduce Cost and Improve Value Through Function Analysis by Lawrence D. Miles Foundation. Each team member was tasked to identify the functions of each of the fifteen features of work on their own. The facilitator complied all of the responses into a table.

Value Study (10-12 Oct 2017). The formal Value study followed the prescribed Value Methodology following the six phases: Information, Function Analysis, Creative, Evaluation, Development, and Presentation.

Function Analysis Wins

This particular project was demonstrative of the value of performing Function Analysis (FA). Not only did FA prove to be very effective as a tool for brainstorming ideas, it also proved extremely effective in the evaluation phase. The team performed the FA, Creative, and Evaluation phases of the methodology on each of the fifteen features sequentially. Prime example is the vertical lift gate functions shown in the figure below.

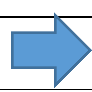
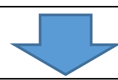
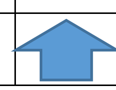
Figure 1. Vertical Lift Gate Function Analysis

Feature of Work	Function	
	Active Verb	Measurable Noun
Vertical Lift Gate	Provide	Closure
	Allow	Lock De-watering
	Facilitate	ice passage
	Control	Flow
	Reduce	Lockage Time
	Block	Flow
	Release	Flow
	Respond	Emergency
	Sluice	Ice
	Reduce	Risk

Through the normal design process, the designer becomes concerned about risk and safety. As a result, the vertical lift gate is added to "provide closure" and "reduce risk". However, when you look back to the highest order function you see that it is to "create lock", more specifically "create redundant lock". When going through the evaluation phase, the discussion led to the fact that the existing Poe Lock does not have a vertical lift gate. This leads to the conclusion that the vertical lift gate is an unnecessary feature, thus through FA we have identified scope creep.

Furthermore, upon initial look at the title of the proposal "Eliminate Vertical Lift Gate" one might think that this is not value engineering, but merely cost cutting. Looking more closely you can see that the function of the overall project does not increase. Eliminating the vertical lift gate holds function worth at the same level but reduces function cost thereby improving value demonstrated by the graphics in the figure below. This proposal was accepted.

Figure 2. Graphical Depiction of the Value Analysis for the Eliminate Vertical Lift Gate Proposal

Proposal Number	Description	Function	Resources	Value	PDT Recommendation	Potential Cost Savings
1	Eliminate Vertical Lift Gate				Accepted	Yes

Conversely the Eliminate the Second Fender Boom proposal does reduce the function as demonstrated in the figure below. The proposal was rejected as the second fender boom did add value to the project.

Figure 3. Graphical Depiction of the Eliminate the Second Fender Boom Proposal

Proposal Number	Description	Function	Resources	Value	PDT Recommendation	Potential Cost Savings
2	Eliminate Second Fender Boom	↓	↓	↓	Not Accepted (Does not meet the basic function of the project)	Yes

Graphical depiction of the value analysis on each of the proposals can be seen below.

Figure 4. Graphical Depiction of all Fifteen Proposals

Proposal Number	Description	Function	Resources	Value	PDT Recommendation	Potential Cost Savings
1	Eliminate Vertical Lift Gate	→	↓	↑	Accepted	Yes
2	Eliminate Second Fender Boom	↓	↓	↓	Not Accepted (Does not meet the basic function of the project)	Yes
3	Eliminate Large Operations Building and Replace with Two Smaller Control Shelters	→	↓	↑	Accepted	Yes
4	Remove Sluiceway and Replace it with SSP Cell Structure	→	↓	↑	Accepted	Yes
5	Reduce the Size of the Bridgeway on top of Miter Gate	↓	↓	↑	Accepted	Yes
6	Eliminate Pump Well and Provide Dewatering via the Davis Lock	-	-	-	Not Accepted (Revisit at 35% Design VE Study)	Yes
8	Reduce Miter Gate Sill Geometry	-	-	-	Not accepted (Mutually exclusive with Proposal 14)	N/A
9	Reduce Fill Material in Davis Lock Chamber	→	↓	↑	Accepted	Yes

10	Rubbilize Davis Lock Floor Instead of Placing Flowable Fill in Davis Lock Culverts	⬇	⬇	⬇	Not Accepted (stability concerns)	Yes
14	Change to a Bottom Lateral Filling System is the existing Davis Lock Chamber as a Flume way	➡	⬇	⬆	Accepted	Yes
15	Reduce Length of Approach Wall Upstream of the Bascule Railroad Bridge	➡	⬇	⬆	Accepted	Yes
16	Reduce the Number of SSP Cells for the Upstream and Downstream Nose Piers	⬆	⬇	⬆	Accepted	Yes

After Action Review (AAR)

An AAR was performed after the study was complete. The AAR provides performance-oriented evaluation and feedback used to identify successes and shortcomings.

What went well?

- Team selection. Team was diverse (4 Districts and the INDC) and extremely technically competent.
- Industry Involvement. Capt. Paul Cristensen's navigation and safety insights were invaluable.
- Team member participation. 100% active participation.
- The Information Phase was held two weeks prior to the value study session. This allowed the team time to review design documentation, discuss, and digest for a while before going through the function analysis phase and remainder of the process. The team was well prepared coming into the session and had already gone through the form, norm, and storm phases of team development and was at the perform phase. This was instrumental to accommodate the condensed schedule for the event and allow for more productive discussions during the session 10-12 Oct.
- Combination of the Charrette, Cost Risk, Cost ATR and VE Study efforts.

What didn't go well?

- VE facilitator was too hands off during the 10-12 Oct session and was not as up to speed on the project as the rest of the team. Fortunately, this issue was attenuated by situational leadership within the group who who were stakeholders in the concurrent activities (cost risk and design charrette); it became a team effort.

Lessons Learned or Areas for Improvement:

Lesson 1: Holding VE Information Phase in a prior separate session, CVS facilitator should attend.

The Information Phase was held two weeks prior to the charrette / VE session. This allowed the team time to review design documentation, discuss, and digest for a while before going through the function analysis phase and remainder of the process. This was instrumental in getting the team up to speed and ready to move into more productive discussions during the follow on session 10-12 Oct. As a VE Facilitator, I will try to incorporate this “pre-workshop” information phase into future studies.

Conclusions

The overall success of this value study can be attributed to all of the factors previously discussed. The timing of the study was perfectly coordinated with the reevaluation of the BCR. The team was top notch and all were vested in the outcome of the project. INDC involvement in the value study was paramount to its success and assisted with the transition to INDC ownership of the design. Utilization of a pre-work period as the kickoff information phase increased the understanding of the team and maximized the efficiency of working through the remainder of the value methodology steps. The Lesson Learned from the AAR is where possible to incorporate a pre-workshop information phase.

REFERENCES

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