National Shipbuilding Research Program

Guidance on Characterizing Project Benefits / Return On Investment (ROI)

April 2022

1. Objective: The National Shipbuilding Research Program (NSRP) Executive Control Board (ECB) committed to working with NAVSEA to improve characterization of program benefits and return on Navy investment, striving for a common solution that strengthens the case for Navy investment, without introducing undue contractual / business risk nor administrative burden to the members, or negatively impacting the portfolio.
2. Applicability
    a. This guidance applies to NSRP-funded and Navy-directed Research Announcement (RA) projects. The objective of this guidance is to characterize the projects' benefits to the Navy. This guidance does not require information on how projects benefit commercial shipbuilding and repair; however, project teams may choose to separately estimate the benefits for commercial shipbuilding and repair.
    b. This guidance might not be applicable to the unique circumstances of every project. When that is the case, project teams may adjust the calculation method while providing the necessary information for the reader to understand the expected benefits of the project.
    c. Future project solicitations shall have ROI Guidance included as part of the solicitation.
3. General Information
    a. Project benefits may be in terms of cost reduction (including both cost savings and cost avoidance), schedule reduction, or both.
    b. NSRP will provide engineering rough order of magnitude (EROM) estimates only. Industry participants (hereafter referred to generically as "shipyards") may use and define the particular EROM that they typically use with their clients.

    The GAO description of a rough order of magnitude estimate helps define the intent of EROM development:

    > "Developed when a quick estimate is needed and few details are available. Usually based on historical ratio information, it is typically developed to support what-if analyses and can be developed for a particular phase or portion of an estimate to the entire cost estimate, depending on available data. It is helpful for examining differences in high-level alternatives to see which are the most feasible. Because it is developed from limited data and in a short time, a rough order of magnitude analysis should never be considered a budget-quality cost estimate."[1]

[1] United States Government Accountability Office, "GAO-09-3SP: GAO Cost Estimating and Assessment Guide," March 2009, page 35.

Engineering rough order of magnitude estimates are defined by the Project Management Body of Knowledge to be in the accuracy range of -25% to +75%.[2] For example, if the project team published an EROM savings of $1M per ship, the actual savings are likely to be between $0.75M and $1.75M per ship.

c. The Navy recognizes that not all projects will lend themselves to estimating the benefits. One hallmark of the program has been NSRP's ability to undertake projects that mutually "de-risk" research and development across the member shipyards and the industry as a whole.

d. RA projects having an estimated final Technology Readiness Level (TRL)[3] of TRL 4 or below do not require an ROI.

e. Providing information on project benefits does not make a commitment with regard to those benefits.

f. EROMs shall be considered the proprietary information of each reporting organization (so marked by the originator) and provided solely for the benefit of the Program Administrator and the Navy. Proprietary information from team member shipyards may be submitted directly to the Program Administrator The NAVSEA Program Manager (PM) will ensure that the proprietary information is treated as such while it is being shared with others in the Navy.

g. Project teams may choose to include a statement along with benefit information to remind readers of the expected use of the information. For example, "All estimates of project benefits contained within this document are provided for technical decision-making only and are not to be considered formal quotes or commitments. These are engineering rough order of magnitude estimates only and are not suitable for use in discussions related to cost or price. Contact the shipbuilder's contracts or pricing department for formal pricing or cost estimates."

h. NSRP does not expect the project team to estimate the benefits that would be realized at shipyards that are not project team members. Estimated benefits from the project team for any shipyard that is not a member of the project team cannot be used as a part of the ROI calculation unless specifically provided in writing by that shipyard's NSRP Shipyard Delegate (NSD).

i. This guidance might not be applicable to the unique circumstances of every individual project. When that occurs, project teams may adjust the calculation method while providing the necessary information for the reader to understand the expected Navy benefits of the project.

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[2] Project Management Institute, "A guide to the project management body of knowledge (PMBOK guide), Sixth Edition" 2017, Section 7.2 page 241.

[3] DoD Deskbook 5000.2-R, Appx 6, "Technology Readiness Levels and Their Definitions" (https://www.dau.edu/cop/pqm/DAU%20Sponsored%20Documents/TRL50002R.doc)

4. Potential Uses of Project Benefit Information

    a. Navy sponsors will use this information to understand the benefits to their programs that will result from their investments in NSRP. Thus, they will be able to prioritize NSRP funding within their budgets.

    b. Navy Program Managers may use information about expected benefits to determine if they will provide financial support for implementation.

    c. Shipyard Program Managers are encouraged to discuss NSRP project accomplishments and benefits with their Navy Program Managers to encourage their continued support for NSRP.

    d. The Executive Control Board will continue to use information on project benefits in RA proposals and PP white papers as part of the project selection criteria.

    e. Any EROM projections contained herein are provided for technical decision making only and are not to be considered formal platform savings by a shipyard, nor should they be used for permanent planning. Any potential cost savings resulting from this project, along with other unrelated cost increases, will be addressed separately as part of the contracting process of the impacted program or project.

5. When to Report

    Project primes and other project participants, sponsors, shipyards and other stakeholders will use information on project benefits as they consider implementing the results of the project. Therefore, project teams will provide information on project benefits, including projected or realized cost and schedule reductions, in the following project documents:

    a. RA "End of Phase" Technology Transfer and Implementation Plan update

    b. RA Project Final Report

6. Financial Benefit Expectations

    a. NSRP will pursue a balanced portfolio that provides return on investment while still conducting projects that do not lend themselves to return on investment calculations.

    b. NSRP will continue to fund projects to explore technologies with low technology readiness levels that will not be expected to show a Navy return on investment.

    c. NSRP will also continue to fund projects where the primary benefit will be for commercial shipbuilding and/or ship repair.

    d. The Navy's desired ROI for the NSRP project portfolio as a whole, for individual Navy funding sponsors, and for individual projects is 2:1.

    e. The project's prime contractor (i.e. proposal offeror, and intended recipient of the project award from the Program Administrator) will provide the overall project ROI information to the Program Administrator. At a minimum, this information will consist of the basic values shown in 7.c below; namely, the Cost Reduction and Navy Investment values for each implementing shipyard participating in the project.

        i. If deemed appropriate, the detailed information and assumptions provided by the participating shipyards for ROI calculations may be properly marked as the proprietary information of any such shipyard, and shall be handled as such.

ii. If the project prime is the sole implementing shipyard for the project, then the full ROI information and assumptions detailed in Sections 7 and 8, and illustrated in Appendix A, will be provided to the Program Administrator.

iii. A project implementing shipyard (that is a team member, and not the project prime) shall deliver, at a minimum, the basic ROI values shown in 7.c regarding their own implementation to the project prime, with the additional ROI details and assumptions of sections 7 and 8, and illustrated in Appendix A, provided separately to the Program Administrator.

iv. If basic ROI information in 7.c of a project team member is also determined to be proprietary by that member, then that information will be provided to the Program Administrator only, and the project prime is relieved of including this information in its ROI reporting.

f. In calculating project ROI, the Program Administrator will make every effort to prevent any specific shipyard source of ROI from being revealed. In cases where multiple shipyards build or repair a ship class, the ROI calculations from the multiple shipyards will be combined and reported as a single result to the Navy. If a reporting shipyard is the only builder/repairer of a ship class, the ROI information can be considered the shipyard's proprietary information and provided solely for the benefit of the Program Administrator and the Navy. The NAVSEA PM will ensure that the proprietary information is treated as such while it is being shared with others in the Navy.

7. Estimates of Financial Benefits

a. EROM estimates can be based on simple metrics that are normally part of the project team's metrics, such as the estimated time the project results will save or the estimated reduction in materials. The Program Administrator will use the participating members' savings estimated by each team member to calculate the project ROI. Estimates received from member shipyards identified as proprietary shall not be shared with other shipyards or program participants.

b. Assumptions made in developing EROM estimates shall be provided to the Program Administrator, with proprietary assumptions being appropriately marked.

c. Use the generalized formula shown below:

$$ROI = \frac{Cost\ Reduction - Navy\ Investment}{Navy\ Investment}$$

d. Cost Reduction

The term cost reduction comprises both savings and cost avoidance.

ROI calculations should be based on the predicted cost reduction for a 5-year period that starts at initial implementation at the first project site or one year after the project concludes, whichever is earlier. If this timeframe differs from the particular EROM method typically used with the shipyard's client (see 3.b above), then utilize the typical EROM method. In either case, document the timeframe utilized in the assumptions.

Shipyards that participate in or implement a project will estimate the cost reduction per ship for each of the ship classes that will be impacted by implementing the project results.

When converting from hours to dollars, use notional rates such as $75/hour for "touch" labor and $100/hour for engineering labor to protect proprietary information. State as an assumption the notional rates used.

The total cost reduction resulting from the project's solution will applied to the appropriate number of hulls identified in the 5-year period selected.

Estimators will use the current Navy 30-year Shipbuilding Plan to estimate the number of hulls that will be affected.

For projects that impact more than one ship class, the total cost reduction will include the cost reduction resulting from the application of the project's solution to all hulls impacted. Where multiple platforms are involved, the cost reduction must be segregated by platform.

For platforms that have multiple hulls being built annually, determine whether the project solution applies to all hulls.

If other assumptions make more sense for a specific project, state the assumptions and explain why they are being used.

e. Navy Investment

Include NSRP program funding approved for the project. Do not include industry cost share.

Include implementation costs chargeable to the Navy (e.g., additional testing, process certification, training). Include such costs at all assumed implementation sites.

f. Implementation Costs

The cost of implementing project results in order to realize the anticipated cost or schedule reductions may be part of the Navy Investment, part of the Industry Investment (over and above project cost share), or a combination of both.

As noted above, where implementation costs are assumed to be chargeable to the Navy, they should be included in the Navy Investment.

Implementation costs that will be borne solely by the shipyards should <u>not</u> be included in the calculated ROI.

g. Example

A detailed example of an ROI calculation is provided in Appendix A to this document.

The method of calculating financial benefits in the Appendix does not apply in all circumstances. In those cases, project teams may adjust the calculations appropriately and show the supporting information.

8. Estimates of Schedule Benefits

a. Some projects may be able to estimate a schedule reduction. Where the associated costs associated with schedule reduction can be estimated, they should be reported, but it can be acceptable for projects to show schedule reduction (in days) without cost information. Schedule reduction shall be proprietary and shared only with the Program Administrator for calculating any potential schedule savings.

b. Estimated schedule benefits should be specific in identifying which schedule will benefit. For example, a project may shorten the lead time for a certain type of component, may shorten the time to execute a specific phase of ship construction or repair, or may shorten the time to upgrade a specified major system. However, when considering a project's overall schedule, the preceding schedule reductions may not reduce the overall schedule.

9. Information Management and Retention

a. The Program Administrator will track project benefit information and provide periodic updates to the NAVSEA NSRP Program Manager and to the ECB.

b. The NAVSEA NSRP Program Office will provide these estimates to the affected Navy Program Managers, Program Executive Officers and other Navy leaders to support their investment decisions, employing necessary safeguards for the shipyards' proprietary information.

Sample ROI Calculation

1. Background

a. This is an example of a NSRP project team ROI calculation.
b. The values for weld speed and typical length of weld are taken from an actual project reported in the May 2009 *Journal of Ship Production*. Ship displacements are from historical data. All other values used are fictitious; any resemblance to actual values is purely coincidental.

2. Assumptions for This Example

a. Shipyard A and Shipyard B are participating in an NSRP Research Announcement project entitled "HLAW for Manufacture of Thin-walled T-beams."
b. The project is funded by $1.25M of program funds.
c. Shipyard A builds South Dakota class battleships (35,000 tons displacement).
d. The Navy's 30-year Shipbuilding Plan shows construction of 5 South Dakota class battleships in the 5-year ROI period.
e. Shipyard B builds Iowa class battleships (45,000 tons displacement)
f. The Navy's 30-year Shipbuilding Plan shows construction of 3 Iowa class battleships during the 5-year ROI period.
g. A typical ship would require 164,000 feet of welding using the new process.
h. The notional "touch" labor rate is $75/hour.
i. The EROM cost reduction is rounded to the first three digits. For this example, they are rounded to the nearest $10,000.

3. Equation

a. $$\text{Navy ROI} = \frac{\text{Cost Reduction} - \text{Navy Investment}}{\text{Navy Investment}}$$

4. Investment

a. The investment is the cost to perform the project. Navy investment is the funding provided by the Navy.

b. No implementation costs are assumed to be chargeable to the Navy and are not included in the Navy Investment.

c. Implementation costs that will be borne solely by the shipyards are not included in the calculated ROI.

5. The EROM in the Research Announcement Summary Proposal

a. The proposal team estimates that the current process welds at 18 inches per minute with 2 hours of arc time per shift. This results in 180 feet of welding in a shift.
b. The proposal team estimated that the new process would weld at 100 inches per minute with 7 hours of arc time per shift, resulting in 3500 feet of welding in a shift.
c. The calculations (shown in the ROI Calculations workbook, at the end of this Appendix) result in an EROM cost reduction of $4.15M for the ROI period.

d. Using the equation in section 3,

i. $\text{Navy ROI} = \frac{\text{Cost Reduction} - \text{Navy Investment}}{\text{Navy Investment}} = \frac{\$4.15\text{M} - \$1.25\text{M}}{\$1.25\text{M}} = 2.3$

e. The project team uses the results of this calculation whenever discussing ROI.

6. The EROM in the "End of Phase 1" Report

a. During Phase 1, the project team reduces their estimate for the new process to 80 inches per minute, resulting in 2800 feet of welding in a shift. The EROM cost reduction becomes $4,091,767, which is rounded to $4.090M.

b. Using the equation in section 3,

i. $\text{Navy ROI} = \frac{\text{Cost Reduction} - \text{Navy Investment}}{\text{Navy Investment}} = \frac{\$4.09\text{M} - \$1.25\text{M}}{\$1.25\text{M}} = 2.3$

c. The project team uses the results of this calculation whenever discussing ROI after the Phase 1 report.

7. The EROM in the Final Report

a. During the second and final phase of the RA project, the project team further reduces its estimate for the new process to 60 inches per minute, resulting in 2100 feet of welding in a shift. The EROM cost reduction becomes $3,997,992, rounded to $4.00M.

b. Using the equation in section 3,

i. $\text{Navy ROI} = \frac{\text{Cost Reduction} - \text{Navy Investment}}{\text{Navy Investment}} = \frac{\$4.00\text{M} - \$1.25\text{M}}{\$1.25\text{M}} = 2.2$

c. PThe project team uses the results of this calculation for the project's Final Report.

8. Discussion

a. The only variable that changes during the course of this example project is the weld speed for the new process.

b. The project team is reporting based on a typical ship and a rough estimate of how much welding will be done using the new process.

c. .

9. Proprietary EROM Information

a. The project team used an approximate length of welding required for a typical ship in the proposal. Each shipyard will base their EROM cost reduction on the approximate length of weld for the class(es) of ship they are building.

b. Shipyard A

i. Shipyard A builds the South Dakota class battleship and plans to use the new process on 120,000 feet of welding.

ii. At the end of Phase 1, Shipyard A reports to the Program Administrator, as proprietary information, an EROM cost reduction of $370,000 per South Dakota class battleship. The calculations are shown in the "Sample SY Calcs" worksheet in the ROI Calculations workbook at the end of this Appendix.

iii. At the end of the project, Shipyard A repeats the estimate and reports the EROM cost reduction of $370,000 per South Dakota class battleship.

c. Shipyard B

i. Shipyard B builds the larger Iowa class battleship and plans to the use the new process on 200,000 feet of welding.

ii. At the end of Phase 1, Shipyard B reports to the Program Administrator, as proprietary information, an EROM cost reduction of $620,000 per Iowa class battleship. The calculations are shown in the "Sample SY Calcs" worksheet in the ROI Calculations workbook at the end of this Appendix.

iii. At the end of the project, Shipyard B reports to the Program Administrator, as proprietary information, an EROM cost reduction of $610,000 per Iowa class battleship. The calculations are shown in the "Sample SY Calcs" worksheet in the ROI Calculations workbook at the end of this Appendix.

d. The Program Administrator reports the proprietary EROM cost reduction to the Navy NSRP Program Manager. The EROM cost reduction report after Phase 1 concludes would be similar to:

Project	Shipyard	Class	EROM stage	EROM Cost Reduction per Hull
HLAW for Manufacture of Thin-walled T-beams	A	South Dakota	End of Phase 1	$370,000
HLAW for Manufacture of Thin-walled T-beams	B	Iowa	End of Phase 1	$620,000

Accompanying ROI Calculations Workbook for Appendix A

"Basis for Cost Reduction"

Example is based on data from "Economics of Hybrid Laser Arc Welding for Manufacturing Weight-Optimized T-beams" by Oller, Blomquist and Ludwig. *Journal of Ship Production* , May 2009.					
Mechanized GMAW	HLAW				
18	80	inches per minute			
120	420	minutes of arc time per shift			
2160	33600	inches per shift			
180	2800	feet per shift			
0.044444444	0.002857	man-hours per foot			
82,000 ft of manufactured thin-walled T-beams per DDG-51					
164,000 ft of welding required per DDG-51					
at 100 ipm weld speed			0.002286	man-hours per foot	
at 80 ipm weld speed			0.002857	man-hours per foot	
at 60 ipm weld speed			0.00381	man-hours per foot	

"Reported ROI"

Calculations for the ROI Example							
This page is for the ROI the project team reports at various stages of the project.							
Program Funds	$ 1,250,000						
Cost Share	$ 1,250,000						
Total	$ 2,500,000						
Notional Rate	$75	per hour					
Estimated quantity of weld	164,000	ft					
	8	ships in the Navy 30-year Shipbuilding Plan					
EROM Cost Reduction							
In the Proposal	**The values for man-hours/ft are calculated on the "Basis for Cost Reduction" worksheet.**						
Current process	0.04444	man-hours/ft			180 feet in a shift		
New process	0.002286	man-hours/ft			100 ipm, 3500 feet in a shift		
Labor Reduction	0.042154	man-hours/ft					
Total labor reduction	6913.256	man-hours					
Cost Reduction	$518,494	per typical ship					
	$4,147,953.60	cost reduction for the 5-year ROI period					
	$4,150,000	EROM cost reduction for the 5-year ROI period					
In the Phase 1 Report							
Current process	0.04444	man-hours/ft			180 feet in a shift		
New process	0.002857	man-hours/ft			80 ipm, 2800 feet in a shift		
Labor Reduction	0.041583	man-hours/ft					
Total labor reduction	6819.612	man-hours					
Cost Reduction	$511,471	per typical ship					
	$4,091,767.20	cost reduction for the 5-year ROI period					
	$4,090,000	EROM cost reduction for the 5-year ROI period					
In the Phase 2 Report							
Current process	0.04444	man-hours/ft			180 feet in a shift		
New process	0.00381	man-hours/ft			60 ipm, 2100 feet in a shift		
Labor Reduction	0.04063	man-hours/ft					
Total labor reduction	6663.32	man-hours					
Total labor reduction	$499,749	per typical ship					
Cost Reduction	$3,997,992	cost reduction for the 5-year ROI period					
	$4,000,000	EROM cost reduction for the 5-year ROI period					

Sample SY Calculations

Calculations for the ROI Example							
This worksheet is for the proprietary calculation of cost savings for each hull in the affected classes of ships.							
Shipyard A					**Shipyard B**		
Labor Rate	$75	per hour			Labor Rate	$75	per hour	
Estimated quantity of weld	120,000	ft			Estimated quantity of weld	200,000	ft	
Cost Reduction					Cost Reduction			
Proposal					Proposal			
Current process	0.04444	man-hours/ft	180 feet in a shift		Current process	0.04444	man-hours/ft	180 feet in a shift
New process	0.002286	man-hours/ft	3500 feet in a shift		New process	0.002286	man-hours/ft	3500 feet in a shift
Labor Reduction	0.042154	man-hours/ft			Labor Reduction	0.042154	man-hours/ft	
Total labor reduction	5058.48	man-hours			Total labor reduction	8430.8	man-hours	
Cost reduction	$379,386	per South Dakota class ship			Cost reduction	$632,310.00	per Iowa class battleship	
Cost reduction	$380,000	Proprietary EROM cost reduction			Cost reduction	$630,000	Proprietary EROM cost reduction	
At the end of Phase 1					At the end of Phase 1			
Current process	0.04444	man-hours/ft	180 feet in a shift		Current process	0.04444	man-hours/ft	180 feet in a shift
New process	0.002857	man-hours/ft	2800 feet in a shift		New process	0.002857	man-hours/ft	2800 feet in a shift
Labor Reduction	0.041583	man-hours/ft			Labor Reduction	0.041583	man-hours/ft	
Total labor reduction	4989.96	man-hours			Total labor reduction	8316.6	man-hours	
Cost reduction	$374,247	per South Dakota class ship			Cost reduction	$623,745.00	per Iowa class battleship	
Cost reduction	$370,000	Proprietary EROM cost reduction			Cost reduction	$620,000	Proprietary EROM cost reduction	
At the end of the project					At the end of the project			
Current process	0.04444	man-hours/ft	180 feet in a shift		Current process	0.04444	man-hours/ft	180 feet in a shift
New process	0.00381	man-hours/ft	2100 feet in a shift		New process	0.00381	man-hours/ft	2100 feet in a shift
Labor Reduction	0.04063	man-hours/ft			Labor Reduction	0.04063	man-hours/ft	
Total labor reduction	4875.6	man-hours			Total labor reduction	8126	man-hours	
Cost reduction	$365,670	per South Dakota class ship			Cost reduction	$609,450	per Iowa class battleship	
Cost reduction	$370,000	Proprietary EROM cost reduction			Cost reduction	$610,000	Proprietary EROM cost reduction	