# Quantifying Future Return on Investment of Live, Virtual, Constructive Training

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## ABSTRACT

The United States Marine Corps future shift from predominately live training towards the increased use of Live, Virtual, Constructive (LVC) training will require a significant investment. A capital infusion of this nature demands a quantifiable return on investment (ROI) that justifies increasing LVC training costs. Prior research provides insights into determining the ROI of focused simulation-based training, such as gunnery training, flight training, and medical procedure training. Minimal research has been performed to develop methods for quantifying how the application of LVC in small and large unit collective training can provide cost savings and, more importantly, improved readiness. This paper reports on a study that was performed to quantify the potential ROI of the future Marine Corps Live, Virtual, Constructive Training Environment (LVC-TE). The methodology to determine the ROI metrics used in the study is discussed. Both quantitative ROI metrics, and the data that is required to calculate those metrics, as well as qualitative metrics were used. Examples of qualitative metrics include: training & readiness events that can only be conducted in a synthetic environment, training against a higher end threat, and the ability to train where training and readiness standards do not yet exist (e.g., training in a contested space environment). The results of quantifying the ROI of the LVC-TE are provided and compared against the status quo training. Finally, the paper presents recommendations for developing an LVC-TE training and operations data strategy that outlines the metrics that should be tracked prior to and post LVC-TE fielding to measure the ROI that is being achieved by the LVC-TE.

## ABOUT THE AUTHORS

**Jeff Bergenthal** is a Program Manager at the Johns Hopkins University Applied Physics Laboratory (JHU/APL) providing leadership for a portfolio of studies and analyses focused on the Marine Corps. Prior to joining JHU/APL in 2013, he spent 26 years with the Lockheed Martin Corporation, most recently as the Director of Advanced Programs. He holds a M.S. in Operations Research from the University of California, Los Angeles, and a B.S. in Management Science from the Massachusetts Institute of Technology.

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## BACKGROUND

The 38th Commandant of the Marine Corps has highlighted that "Training must be focused on winning in combat in the most challenging conditions and operating environments - from the thin air and high altitudes of the mountains, to the sweltering heat of triple canopy jungles, and including the sprawling self-organized chaos of dense urban terrain" (CMC, 2019). His guidance noted that training should be progressive, with units maximizing their home station training opportunities before deploying to the field. Executing this guidance will require the Marine Corps to shift from mainly live training toward the increased use of live, virtual, and constructive training; however, this shift will require a significant investment. Force Design 2030 (CMC, 2020) further emphasizes the Marine Corps' need for training modernization that spans operational domains to enable training and readiness in the 21st century operating environment. Achieving operational readiness in emerging distributed maritime operational concepts requires a Live, Virtual, and Constructive Training Environment (LVC-TE) built on modern technologies that support immersive, realistic, multi-domain training for geographically dispersed units.

The objective of LVC-TE is to provide greater combat readiness and enhanced operational execution by supporting a training continuum that features planning, preparation, execution, and assessment capabilities for the Marine Air Ground Task Force (MAGTF) commander in both Joint and Service venues. An analysis of alternatives (AoA) was completed in late 2018 to assess potential material solutions that address the 23 validated capability gaps identified in the LVC-TE Initial Capabilities Document and to identify a recommended alternative (JHU/APL, 2019). The AoA results were briefed to the Commanding Generals (CGs) of the Training and Education Command (TECOM) and the Marine Corps Systems Command (MCSC) in December 2018. The CGs selected a hybrid alternative in proceeding:

- LVC-TE Increment 1 will focus upon a government–owned, government-operated federation of existing Marine Corps training systems using the U.S. Army Live, Virtual, and Constructive Integrating Architecture (LVC-IA) to provide an interim solution of limited training improvement over the status quo.
- LVC-TE Increment 2 will provide new integrated training capabilities using a training as a service approach. LVC-TE Increment 1 will be retired when the new development is at full operational capability (FOC). Most legacy Increment 1 USMC training solutions will also be retired when the new development is at FOC.

Training as a service is a strategy that is designed to provide ready and relevant performance improvement at the point of need. This implies training that is supported and enabled by training devices that maintain technological modernization at the pace of innovation and not the pace of acquisition. Furthermore, this necessitates the identification of training needs and the tailoring of programs of instruction to serve a distinct primary and secondary training audience. By addressing specific learning objectives at the optimized level of complexity, trainers can focus an environment's strengths on improving the proficiency of participants. This type of progressive, right-sized approach requires dedicated instructor/operator cadre that do not change annually but are managed externally. Additionally, as training device integration becomes more important to properly execute training, a training as a service model places the responsibility on the contractor to ensure devices are properly set up and integrated. This concept allows Marines to focus on training Mission Essential Tasks. While this strategy ensures the right solution is developed quickly and delivered efficiently at the point of need, the added risk borne by the contractor comes at a premium price.

Based on the significant resourcing requirements training as a service requires, the CGs requested that a follow-on study be performed to deepen and expand on the AoA results and define the potential return on investment (ROI) that LVC-TE can deliver. The broad scope and constrained timeline of the AoA allowed some initial estimates of LVC-

TE training demand and capacity but precluded an in-depth analysis. In addition, the AoA was limited by the availability and quality of Marine Corps training and readiness data. The ROI study was envisioned to more precisely define the training demand that operational units will generate for the LVC-TE in future years and the training capacity that the LVC-TE can enable once fielded. The Johns Hopkins University Applied Physics Laboratory (JHU/APL) began working in July 2019 to perform this ROI study.

## REVIEW OF SIMULATION AND LVC ROI LITERATURE AND LIMITATIONS

The study team performed background research to identify metrics that will most accurately reflect the ROI the Marine Corps can achieve with LVC-TE. The background research initially focused on past efforts to determine the ROI of training and simulation. A set of studies, analyses, and reports on the ROI of simulation in military training, LVC, and contractor-owned, contractor-operated defense capabilities were identified and reviewed, including:

- Government Accounting Office (GAO) reports (GAO, 2006, 2013, 2016, 2017, 2019, 2020)
- Federally Funded Research and Development Center and not-for-profit organization reports (RAND, 2006; McArdle, 2019; Potomac Institute for Policy Studies, 2016; JHU/APL, 2018)
- Academic organization papers and reports (Wells II, 2012; Kuan, 2009; Loeffelman, 2019; Blow, 2012)
- Journal articles and conference papers (Wesolek, 2009; Oswalt, 2009; Yates, 2019; Jones, 2015; Dunne, 2014; Haney, 2014)
- The LVC-IA Integrated Training Environment Pre-Fielding User Assessment (ATSC, 2019)
- Industry studies and papers (GlobalSim, 2017; Calytrix, 2012; Cermak, 2010)

The study used the seven AoA training scenarios which address afloat and ashore MAGTF operations. Four scenarios cover company and battalion level missions, and three scenarios cover Marine Expeditionary Brigade and Marine Expeditionary Force staff operations. Each scenario has a defined set of current and future operational modes (OMs), and each OM has a specified set of live and/or simulation training systems. Because of the breadth of the scenarios, metrics were needed for assessing the ROI of training from the individual Marine and small unit level up through training at the collective staff level. Consequently, the literature review considered the scale of training audiences. The review showed that while documents highlighted one (or more) potential metric for assessing potential ROI, no document identified a comprehensive set of metrics for assessment. Therefore, the study team compiled a series of potential metrics from across the range of documentation and grouped them into three broad categories, one addressing optimization of the training process, one on providing enhanced training opportunities, and one on optimization of the training product. An assessment strategy and a data collection plan were developed for each potential metric. Some potential metrics, such as those focused at the strategic level, were rejected from future consideration because they were assessed to be difficult to objectively measure.

Overarching Marine Corps guidance and new operating concepts, including the Commandant's Planning Guidance (CMC, 2019), briefings and documentation on Expeditionary Advanced Base Operations (DoN, 2019), and Littoral Operations in a Contested Environment (DoN, 2017), were also reviewed by the study team to ensure that the ROI metrics would accurately reflect the future operations and needs of the Marine Corps.

## DATA COLLECTION

Understanding that the ROI for an enterprise level training capability would have both financial and non-financial benefits, the study team employed two separate strategies for collecting the data necessary: a cost analysis and subject matter expert (SME) sentiment analysis. A cost estimate related to the upfront and sustainment costs of LVC-TE for Increment 1 and 2 was completed as a part of the previously mentioned AoA. This provided the information to populate the investment basis for each alternative. Separately, the cost analysis sought to build an understanding of what resources were required to train the seven scenarios and their operational modes currently. By comparing the alternatives, researchers could analyze efficiencies to determine how an added capability might mitigate current training costs. The SME sentiment analysis required that a large representative sample of Marines be interviewed to determine how much utility each alternative provided. For this portion of the study, researchers visited every major training location in the Marine Corps to survey and interview Marines from Lance Corporal to Colonel for a total of 120 participants. These interviews provided the insight necessary to build utility curves that related the system

attributes of each alternative to a non-financial benefit in Tier 1 (see next section). These interviews provided additional opportunities to ascertain cost, schedule, and other training data from the audience.

For assessing potential financial benefits, the study team gathered and reviewed existing cost data and metrics. An exhaustive cost analysis was conducted during the AoA. The study team supplemented its data with additional cost information from the government, other studies, and SMEs. One of the additional sources was the Cost to Run a Marine Expeditionary Force (C2RAM) program.

For assessing potential non-financial benefits, the study team used the results from the literature review to establish an initial set of potential metrics to provide context for subsequent study data collection and analysis. The metrics were then refined in a series of discussions with Fleet Marine Force (FMF) trainers (both Marines and civilians), trainees (a range of unit personnel, from senior leaders to junior enlisted), and training cost experts. Each participant completed the interview by providing survey feedback that indicated the level of utility various system attributes would contribute to the alternative's non-financial benefit. The interview further provided researchers the opportunity to ascertain documents such as Training Exercise Employment Plans (TEEPs), cost schedules, and planning conference schedules. These documents were critical in separating participants' perception of constraints from reality to better understand how an LVC-TE capability might optimize training schedules, time, and ultimately, readiness.

## NON-FINANCIAL ROI METRICS HIERARCHY

Based on the combined data collection feedback and comments, the study team refined the metrics into a final hierarchy consisting of three "Tier 1" categories of non-financial metrics. This hierarchy provides the framework for quantifying the potential non-financial ROI of LVC-TE. The FMF trainers and trainees were asked to provide their prioritization of the categories and the individual metrics. The priorities are shown in Table 1. The local weights in the table sum to 100 percent across the metrics within a Tier 1 category, and the global weights sum to 100 percent across all metrics.

1. Increased effectiveness on the operational battlefield: These metrics focus on the perspective of the training audience that eventually will use what they learned in real combat situations. These metrics look at the ability to have the LVC-TE training improve the combat effectiveness of MAGTFs. The metrics within this tier are:
    - Increase combat readiness and effectiveness by offering additional training opportunities (i.e., increased repetitions and sets). Enhance/sustain MAGTF collective proficiency
    - Major combat operations readiness. Increase readiness for advanced combat operations by training for a higher end fight
    - Increase mission-capable forces by improving training realism, allowing for training broader/more realistic conditions
    - Increase proficiency when executing a task. Develop/maintain operational proficiency
2. High-risk/low-opportunity training: These metrics focus on the perspective of training for skills where readiness is impacted by the safety, cost, or other attributes of live training. These metrics measure the types of training that are a challenge to train without an LVC-TE solution and give insights for the completeness of training that can be enabled with LVC-TE. The metrics within this tier are:
    - Ability to train missions that cannot be trained live
    - Decreased risk of accidents, etc. Repetitions via simulation before live fire and playback of live-fire events to reverse unsafe habits
    - Adapt to new capabilities/missions where standards do not yet exist
    - Increase the training value of exercises by improving the ability to execute tasks that live training physically cannot support (large training area, larger forces)
    - Ability to conduct experiments
3. Improved effectiveness/efficiency of training events: These metrics focus on the perspective of the instructors or trainers. These metrics look at the conduct of the specific training event across the plan, prepare, execute, and assess phases. The metrics within this tier are:
    - Standardized training opportunities
    - Ability to "pause" training and emphasize learning points. Debrief and after-action review (AAR)

- Reduce total time to train. Decrease time to first success rate. Ability to support adaptive and progressive practice that focuses training on the audience's needs
- "Experience on demand"

**Table 1. Non-Financial Metrics and Prioritization**

| Criteria | Metric | Local Weights | Global Weights | Ranking |
|---|---|---|---|---|
| Increased effectiveness on the operational battlefield **43.9%** | Increase combat readiness and effectiveness through additional training opportunities (i.e. increased reps and sets) | 28.0% | 12.3% | 1 |
| | Increase readiness for advanced combat operations by training for a high-end fight | 21.8% | 9.6% | 4 |
| | Increase mission capable forces by improving training realism - allowing for training broader / more realistic conditions | 25.7% | 11.3% | 2 |
| | Increase proficiency when executing a task. Develop/maintain operational proficiency. Enhance/sustain MAGTF collective proficiency | 24.4% | 10.7% | 3 |
| High-risk/Low-opportunity training **30.8%** | Ability to train missions that cannot be trained live | 22.9% | 7.1% | 6 |
| | Decrease risk of accidents, etc. (reps via simulation before live fire) | 19.5% | 6.0% | 10 |
| | Adapt to new capabilities/missions where standards do not yet exist | 19.3% | 5.9% | 11 |
| | Increase the training value of exercises by improving the ability to do things that live training physically can't support (larger training areas, larger forces) | 24.4% | 7.5% | 5 |
| | Ability to conduct experiments | 14.0% | 4.3% | 13 |
| Improved effectiveness/efficiency of training events **25.3%** | Standardize training opportunities | 22.4% | 5.7% | 12 |
| | Ability to "pause" training and emphasize learning points. Debrief and AAR. | 26.5% | 6.7% | 8 |
| | Reduce total time to train. Decrease time to first success rate | 27.1% | 6.9% | 7 |
| | Generate "experience on demand" and tailor training | 24.0% | 6.1% | 9 |

## DETERMINATION OF NON-FINANCIAL ROI

The study team calculated non-financial benefits using multi-criteria decision analysis (MCDA) techniques. A defining feature of MCDA is the transformation from measure space to value space that enables mathematical representation of a composite value score across multiple measures. Real-world measurements and the results of modeling and analysis are used to populate rating scales. The scales are in turn translated to scoring contributions via utility curves. An example of how this is done for a single metric is shown in Figure 1. The determination of ROI for two of the metrics is presented below. The other qualitative metrics were analyzed with a similar methodology.

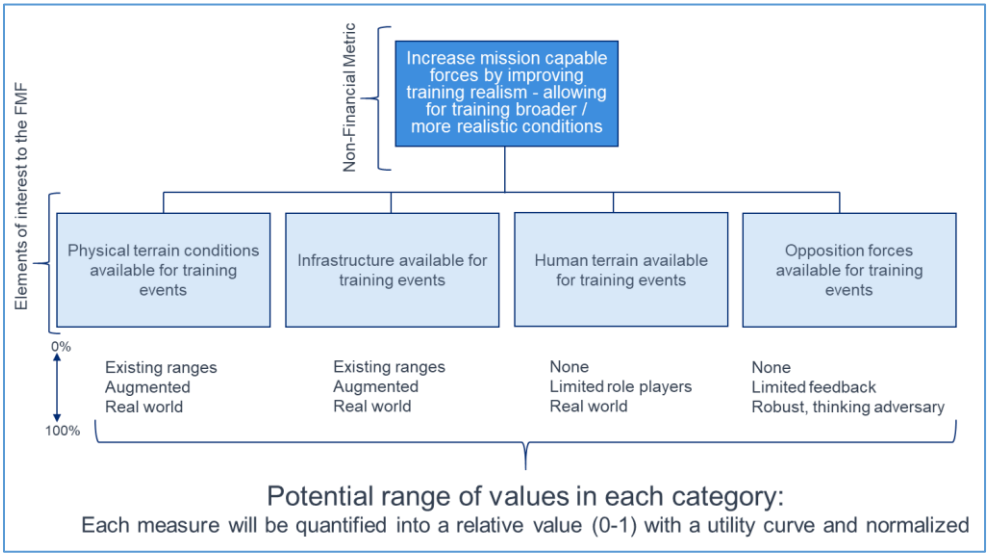


**Figure 1. Example of Non-Financial ROI Determination for a Metric**

**Increase Combat Readiness and Effectiveness through Additional Training Opportunities**

This metric provides a comparison of readiness in terms of the number of training events, by scenario that are executed in the status quo, and could be executed in the LVC-TE increments. The TEEP data informed the status quo repetitions and sets. Future mode calculations were based on the projected execution time for a future operational mode training event, unit training time available, and the simulator/range capacity for each training scenario at each site.

The utility curve is a concave down, increasing curve - there is greater marginal utility from participating in an additional training exercise when the total number of repetitions and sets is low. The maximum possible utility is defined as the number of training events possible based solely on unit training time available and the length of an individual event's execution. Summing these events across sites and scenarios resulted in 182 training events.

We found that the status quo totaled 73 training events, or a utility score of 0.59. In comparison, Increment 1 could support 81 training events, for a utility score of 0.63, and Increment 2 could support 123 training events, for a utility score of 0.84. In analyzing training potential under Increment 2, the study team took full advantage of the training system capacity defined within the AoA and full advantage of units' stated available training times. This approach yielded increased numbers of annual training events (combined live and simulation) for a given unit over the status quo. The study team also considered an alternate approach, Increment 2 Excursion, with a slightly less robust increase in numbers of training events per unit (i.e., typically the increase in number was reduced by a single training event per unit per year, the minimum reduction possible). The Increment 2 Excursion could support 110 training events, for a utility score of 0.79.

**Increase Readiness for Advanced Combat Operations by Training for a High-End Fight**

This metric provides a comparison of readiness in terms of how well the status quo and the Increments support training for a high-end fight. A review of emerging Marine Corps operating concepts identified 23 elements of a high-end fight that were grouped into six categories: integration with other Services and partners; multi-domain/all domain; operate in a contested environment; operate under adversary persistent intelligence, surveillance, and reconnaissance; conduct fast maneuver, distributed maneuver, and dispersed operations; and conduct expeditionary logistics within contested environments. Each operational mode was evaluated by the authors against each high-end fight element and scored as: fully supports the high-end fight element, partially supports the high-end fight element, or does not support the high-end fight element. The scores were combined across the operational modes to arrive at a score from zero to four for each of the six high-end fight categories. This scoring was performed for the status quo, LVC-TE Increment 1, and LVC-TE Increment 2 and Increment 2 Excursion. The utility curve, shown in Figure 2, was constructed as a concave up, increasing curve with the operational modes supporting all high-end fight elements across all high-end fight categories corresponding to the highest value and decreasing value as the support for high-end fight elements lessens. An increasing curve was selected to reflect SME sentiment that including more high-end fight elements provides a more effective training environment.

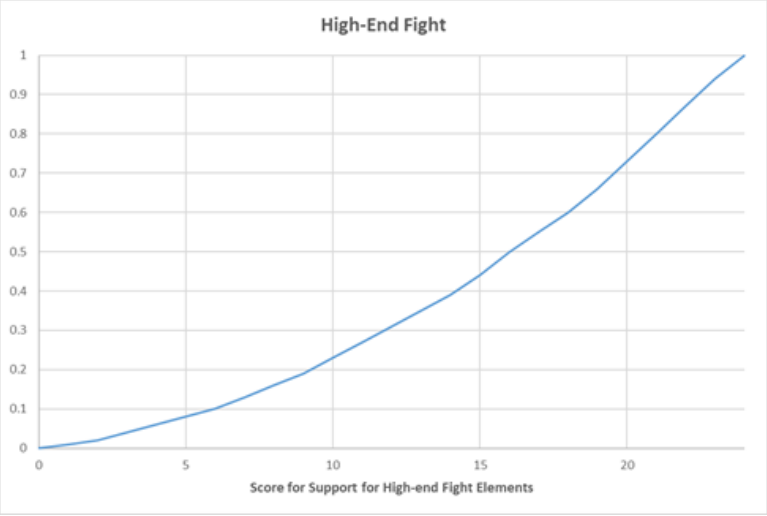


**Figure 2. High-End Fight Utility Curve**

The status quo and LVC-TE Increment 1 both received a raw score of 10, with most high-end fight categories having partial support. This low score is due to the limited number of high-end fight elements that can be provided in the existing training devices. The raw score of 10 maps to a utility curve value of 0.23. The LVC-TE Increment 2 and Increment 2 Excursion raw scores are both 22, with four high-end fight categories being fully supported and the remaining two categories partially supported. Carefully identifying and specifying the high-end fight requirements in

the training as a service contract can enable LVC-TE to provide the high-end fight elements during training exercises. The raw score of 22 maps to a utility curve value of 0.87.

**Combining the Individual Metrics**

The weights for the metrics were applied to the non-financial metric scores to arrive at an overall benefit score for each Tier 1 category for the status quo, Increment 1, Increment 2, and Increment 2 Excursion. Table 2 provides the combined scores for the Increased Effectiveness on the Operational Battlefield category.

**Table 2. Increased Effectiveness on the Operational Battlefield Scores**

| Alternatives | Non-Financial | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Tier 1 Benefit | Tier 1 Non-Financial Benefit Breakdown Increased Effectiveness Score | | | | | | | |
| | | High-End Fight (0-4 scale over 6 categories) | | Additional Training Opportunities (Total Operational Modes / unit across the sites) | | Increased Realistic Conditions (0-4 scale over 7 conditions) | | Increase Proficiency (over 6 elements) | |
| Status Quo | 0.42 | 10/24 | 0.23 | 73/182 | 0.59 | 7/28 | 0.45 | 0.35/1 | 0.35 |
| Increment 1 | 0.48 | 10/24 | 0.23 | 81/182 | 0.63 | 9/28 | 0.48 | 0.54/1 | 0.54 |
| Increment 2 | 0.77 | 22/24 | 0.88 | 123/182 | 0.84 | 10/28 | 0.62 | 0.75/1 | 0.75 |
| Increment 2 Excursion | 0.74 | 22/24 | 0.88 | 110/182 | 0.79 | 10/28 | 0.62 | 0.67/1 | 0.67 |

**DETERMINATION OF FINANCIAL ROI**

Financial metrics were calculated by comparing costs between the status quo and LVC-TE Increments 1 and 2. The results of existing cost analysis, to include the LVC-TE AoA and other relevant data sets, were used to develop each alternative's life-cycle cost estimate (LCCE). The LCCEs account for USMC enterprise-wide costs within the LVC-TE domain as bounded by the ground rules, constraints, and assumptions detailed below, and are not limited to training device program of record costs. When not available, independent cost estimates were made using engineering build-up, parametric, and/or analogous cost estimating methodologies that are commensurate with the current state of technical understanding of the alternatives, available data, and other relevant constraints.

The following ground rules, constraints, and assumptions were used to frame the analysis while reflecting Marine Corps guidance and ensuring analytical consistency across alternatives:

- Costs are documented in a cost model and a cost estimating methodology matrix that adhere to Department of Defense (DoD) and Service instructions and guidance (DoD, 2017; DoN, 2013; DoD CIO, 2014; Secretary of the Navy, 2012; US Air Force Office of Aerospace Studies, 2016; MCSC, 2017).
- Costs are estimated in base-year 2020 constant dollars (BY20$) and presented in then-year dollars.
- The cost analysis includes the research and development (R&D), production and deployment (P&D), and operations and support (O&S) life-cycle phases. The disposal phase was excluded from the analysis.
- The cost estimate period of performance is a start date of fiscal year (FY) 2021 to FOC + 15 years of O&S. Fifteen years is based on the O&S life cycle of legacy DoD training systems. To ensure apples-to-apples comparisons, the analysis end date was set at FY2043, which coincides with FOC + 15 years for Increment 2.

- Sunk costs for legacy systems participating in the LVC-TE are not included. Sunk costs include costs incurred in prior FYs, as well as planned and program costs included in the program acquisition baseline.
- Life-cycle phases do not imply funding appropriations.

The LCCEs by phase are shown in Table 3. The costs shown reflect the representative life cycle costs within the analysis timeframe due to acquisition sensitivity constraints. Increment 1 and Increment 2 Excursion show an overall cost reduction from the status quo baseline, whereas Increment 2 reflects an overall cost increase. Because these cost deltas from the status quo primarily occur in the O&S phase, which accumulate year to year, it is beneficial to also display the annual average O&S cost for each alternative.

**Table 3. Life Cycle Cost Estimates**

| BY20 ($M) | R&D | Investment | O&S | Total | Annual Average O&S Cost (BY20 $M) |
|---|---|---|---|---|---|
| Status Quo | $ - | $ - | $ 75,845 | $ 75,845 | $ 3,298 |
| Increment 1 | $ 15.6 | $ 24.7 | $ 72,096 | $ 72,136 | $ 3,135 |
| Increment 2 | $ 465.9 | $ 85.6 | $ 83,438 | $ 83,990 | $ 3,628 |
| Increment 2 Excursion | $ 465.9 | $ 85.6 | $ 72,890 | $ 73,441 | $ 3,169 |

The primary driver of the cost decrease of Increment 1 compared to the status quo are the estimated reductions in time and effort for plan, prepare, execute, and assess (PPEA) activities. The primary driver of cost increase of Increment 2 compared to the status quo is the increase in exercise frequency to maximize capacity, which is more than offsetting the estimated reductions in PPEA activities per exercise. These PPEA effort reductions result in a cost decrease for the Increment 2 Excursion, considering that there is no coinciding increase to exercise frequency.

Calculation of economic viability metrics involves a comparison of each alternative to the status quo, requiring an application of discounting the change in net cost increase or savings for each year with a factor representing the time value of money. The current 20-year nominal discount rate is 2.3% as per Office of Management and Budget Circular A-94. The following economic viability metrics were calculated and are shown in Table 4:

- Net Present Value (NPV) = Discounted Benefits – Discounted Costs. Benefits and costs represent the year-to-year differences in financial value between an alternative and the status quo. Benefits are captured when the delta between an alternative and the status quo results in a savings (i.e., the alternative is less expensive than the status quo for a specific year). Cost are captured when the delta between an alternative and the status quo results in an expense (i.e., the alternative is more expensive than the status quo for a specific year).
- Return on Investment = (Discounted Benefits – Discounted Costs) / Discounted Investment Costs. Investment costs include the R&D and investment phase costs incurred for an alternative.
- Break Even Point = the point (number of years or projected year) at which the cumulative costs (investment plus sustainment) of an alternative and the status quo are equal. At this point, the savings in current dollars from the comparison will equal the investment in current dollars. Past this point, net savings will accumulate.

**Table 4. Financial Return on Investment Metrics**

| Alternative Economic Viability Comparison | | | | | | |
|---|---|---|---|---|---|---|
| Increment 1 | NPV = | **$3,701 M** | Break Even (Discounted) = | **Start + 1 yr** | ROI = | **89%** |
| Increment 2 | NPV = | **<0** | Break Even (Discounted) = | **NONE** | ROI = | **<1** |
| Increment 2 Excursion | NPV = | **$2,367 M** | Break Even (Discounted) = | **Start + 8 yrs** | ROI = | **5%** |

## OVERALL COMPARISON OF ROI RESULTS

Combining the results from the analysis of the financial metrics with those from the analysis of the non-financial metrics provides a more integrated comparison of the increment training environments as shown in Table 5.

**Table 5. Combined Return on Investment Metrics**

| Overall Comparison of Alternatives | Financial | | | | Non-Financial | | |
|---|---|---|---|---|---|---|---|
| | ROI | NPV | Break Even | Lifecycle Costs (Start year – Start + 23 years) | Tier 1 Non-Financial Benefit Breakdown | | |
| | | | | | Increased Effectiveness on the Battlefield | High Risk / Low Opportunity Training | Effectiveness / Efficiency of Training Events |
| Status Quo | N/A | N/A | N/A | $75,845 M | 0.42 | 0.45 | 0.23 |
| Increment 1 | 89% | $3,701 M | Start + 1 yr | $72,136 M | 0.48 | 0.53 | 0.39 |
| Increment 2 | <1 | <0 | NONE | $83,990 M | 0.77 | 0.67 | 0.54 |
| Increment 2 Excursion | 5% | $2,367 M | Start + 8 yrs | $73,441 M | 0.74 | 0.67 | 0.54 |

Analysis of the combined metrics shows that Increment 1 offers:

- Roughly a similar number of training events per unit per year as the status quo.
- Non-financial benefit only about 24% above the status quo training environment.
- Financial ROI of about 89% due to expected reduction in exercise plan, prepare, and assess phases required personnel and time.

In contrast, the analysis showed that Increment 2 and the excursion provide:

- An increased number of training events per unit per year for companies, battalions, MEUs, and MEB staffs, if taking full advantage of available simulation and live training capacity.
- A more robust non-financial benefit, about 79% above the status quo training environment. The excursion maintains the majority of the robust non-financial benefit at 76% above the status quo training environment.
- A non-favorable financial ROI impacted by the additional training events from the status quo, particularly live events. However, the excursion analysis showed that a modest reduction in additional live training events benefits the financial ROI (now about 5%).

## FINDINGS AND RECOMMENDATIONS

Over the course of the study a number of gaps in the status quo training data were identified. Filling the gaps to address the study questions was a challenge for the study team and for the government. Optimizing the available training data would support more readily and accurately quantifying the status quo and the benefits of LVC-TE in future analyses.

- There are issues with current training cost data availability, accuracy, and completeness. A recent GAO study stated that "the Marine Corps cannot fully track all unit-level training funds for ground combat forces through the budget cycle" (GAO, 2019). For example, we found issues with:
  - The holistic cost of an exercise. The study team encountered a range of training cost reporting, typically accounting for one or more elements of a training event. An event has a number of participants (exercise force, opposition force, instructors, and support personnel) and a number of funding sources. The study team did not find sources that rolled up the entirety of cost data across an event. Having a holistic view of training event costs would facilitate analysis of LVC-TE benefits.
  - The quality of C2RAM data. The study team relied heavily on the available C2RAM data. Some cost elements, such as ammunition and aviation (i.e., Navy funding), are outside its scope. Because the data are entered manually, there are issues with the accuracy, standardization, and completeness of entries for a training event.
  - Training manpower data and costs. The study team found that reporting of training manpower, the numbers of individuals involved in a training event, from C2RAM and discussions with Fleet units and instructors, typically only considered the execution phase of the event. Reporting on manpower employed during the plan, prepare, and assess phases was sparse.
  - Range maintenance costs. Some data on unit sustainment and maintenance were available for some training events within the C2RAM database. However, again, the entries were sparse and often appeared to be round numbers suggesting rough estimates, rather than actual expenditures.
  - Travel costs for training. The C2RAM database includes fields for transport of personnel and temporary additional duty costs. Beyond the issues already raised with accuracy and completeness, the study team found gaps in accounting for all travel for an event. With a focus on collective, MAGTF training, entries for all participating units had to be identified and assessed. In addition, travel costs for event instructors and support personnel often were not available.
  - Ammunition and aviation costs. The study team received and used a series of event and concept cards, providing recommended quantities for an event, but not the actual expenditures for each event.
- Simulation and live training range data is currently not linked to units, T&R events, and training results. Limited quantitative information is available on how simulations are used within training events. The study team found that aggregate reporting of hours used by system and by site are available. Discussions with instructors and support personnel in some cases led to additional detail. However, the study team did not find consistent records of detailed training conducted across the sites. Future analyses of LVC-TE benefits and unit readiness could be more effective if simulation and live training usage were consistently tracked and reported in detail. That reporting needs to include identification of the unit, the training event, its duration, relevant T&R codes, and event results.
- There is considerable variation in stated time available and time needed to train. Each unit work-up is unique, and its timing and sequencing of training events depend on a number of variables. The study team found considerable variation in reporting on unit time available for training and the time needed to conduct a training event in discussions with Fleet units and instructors. Units need to maintain a reasonable operating tempo while developing readiness for deployment, and time available and time needed are key elements of training capacity. The reported availability for training from participants was significantly less than the actual availability, which suggested a reporting artifact.
- There is a perceived under-utilization of available simulation/range time. Data collected during the site visits indicate that the existing suite of simulations and ranges are not currently used to their full capacity.

Additionally, we found that LVC-TE Increment 2 and Increment 2 Excursion provide significant advantages in situations where training is currently limited:

- LVC-TE Increment 2 will provide benefits at sites with constrained live training. Based on site-visit data collection and discussions, the study team noted that the current training environments at each site varied significantly. For example, live training opportunities, and in particular live fire training opportunities, are severely constrained in both Hawaii and Okinawa. Given political, resource, and environmental limitations, optimizing live training at those locations is improbable. However, the increase in simulation training opportunities under LVC-TE will provide additional synthetic training opportunities to prepare for scarce live training and support training for the conditions that are not possible in live training.
- MEU sustainment training is enabled under Increment 2. During the analysis of the status quo versus future operational modes, the team found that one scenario, the MEU Afloat scenario, has a dramatic shift in

capability for Increment 2. During status quo and Increment 1, the MEU operational modes are solely executed during the MEU work-up training time. Once the MEU deploys, there is no linkage to the enterprise training capabilities. However, Increment 2 connects the Marines aboard ships to the enterprise training capabilities via the LVC-TE. Therefore, Increment 2 is the only option that enables simulation supported sustainment training for the MEU while on deployment. The current capacity assumptions within the ROI study allows for up to three iterations of the MEU Afloat operational mode 2B. Each base that supports MEUs (Camp Lejeune, Camp Pendleton, and Okinawa) will have a capacity of three operational modes.

The study team offers the following recommendations to enable the Marine Corps to achieve the potential ROI from LVC-TE:

- Rapidly field the LVC-TE Increment 1 capability to begin reaping the financial savings over the status quo that result from improved training efficiency, while implementing the business actions necessary to achieve the improved readiness benefits that will result from fielding Increment 2 Excursion FOC.
- Update the capabilities baseline descriptions and life cycle cost estimates for LVC-TE Increment 1 and Increment 2 to reflect the new force design.
- Develop and implement a data strategy to measure training ROI and provide fiscal justification for annual training budgets. Several gaps in training and cost data collection and reporting, identified in the Findings section of this report, hinder determining training ROI. These gaps must be closed. Additionally, a better means of articulating and tracking unit and MAGTF proficiency is needed.
- Establish policy or guidance to maximize the use of training devices. The improved ease of use of virtual and constructive training simulations offered by LVC-TE, combined with policy, can enable units to maximize their home-station training opportunities.
- Establish policy or guidance to enable more effective MAGTF training. Linkages between the training events of individual MAGTF elements must be identified and documented across the Training and Readiness (T&R) manuals of the individual MAGTF elements. Additionally, extensions to the current MAGTF T&R manual are necessary to provide guidance and examples of MAGTF collective training.

In April 2020, the study results were briefed to CGs of TECOM and MCSC. The CGs concurred with the analysis and are moving forward with program actions to begin work on LVC-TE Increment 1. TECOM has also begun to take initial actions on the data strategy and policy recommendations.

## SUMMARY

This paper has presented a robust and repeatable methodology for quantifying the future ROI of LVC training. The ROI determination includes both traditional economic viability metrics that quantify ROI in financial terms, and non-financial metrics that quantify the ROI in terms of improved readiness and training efficiency. The non-financial metrics used in this study add to the current body of knowledge and practice in determining the ROI of simulation and training by considering a broad range of training audiences, emerging operational concepts, and a number of ways in which the use of LVC in training can impact readiness. Using both types of metrics to determine ROI can provide senior leaders with a more complete view of the impact of LVC training and support decisions involving cost and readiness tradeoffs.

The methodology was used to quantify the potential ROI of the future Marine Corps LVC-TE to support senior leader decision making and justify resourcing. The analysis showed that both Increment 1 and the Increment 2 Excursion are economically viable in that they have positive NPVs and ROIs greater than one. The interim LVC-TE Increment 1 will rapidly pay for itself through efficiencies it creates in planning, preparing, and assessing training events, but will provide limited readiness improvements. LVC-TE Increment 2 Excursion will provide significant readiness improvements and achieves a small financial ROI over its life cycle. This financial ROI is smaller than Increment 1's financial benefit primarily due to the longer payback period resulting from the investment required to build a more robust capability. Several findings were identified during the study, and the analysis led to five recommendations. The Marine Corps has begun to take initial actions on the three near-term recommendations and is moving forward with R&D activities on LVC-TE Increment 1.

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