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The World's Largest Modeling, Simulation & Training Conference

Establishing the Value of Simulation (VoS): Methodology and Case Study

VoS Study Team

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Learning Objectives

- **On Completion of This Tutorial, Students Should Be Able To:**
  - Explain why Return on Investment (ROI) is challenging for training
  - Enumerate some primary considerations in setting Value of Simulation
  - Explain how the value of simulators has been evaluated
  - Describe why assessing the value of simulation is challenging for staff training
  - Explain what two principal elements are used in assessing the value of simulation
  - Name one tool that can be used to compare the cost of live and simulation-aided exercises
  - Explain two of the issues that made the test case difficult to execute
  - Describe one way trial survey responses can be used to test validity of the survey
  - Explain what tasks, standards and metrics are and how they fit into evaluations

VoS Tutorial Team

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Outline

- Why be concerned about ROI or Value of Simulation (VoS)?
- M&S ROI: Prior Work
- Design of Evaluations

  Use Case: Value of Simulation (VoS) Study
- The Proof of Concept Study
- Methodology
  - Performance Evaluation
  - Cost Evaluation
- Roadblocks
  - Challenge of Evaluating Simulation-Based Staff Training
  - Data Acquisition
- Results

Return on Investment (ROI)

- **Classic Definition (from financial industry)**

$$\frac{\textit{Value of result} - \textit{Cost of investment}}{\textit{Cost of investment}}$$

  - Requires some form of measurement of the result, often interest
  - Requires statement of cost
  - Presumes that both are measured in the same type of units

- **Converting Results into the Same Units as Cost – a Problem**
  - Return for M&S in training is non-materiel, not readily = $$
  - Return for training ≈ enhanced operational effectiveness

Why is ROI Important?

- **ROI: A Means of Comparing Investments**
  - Given limited resources – where do I get most out of them?
  - Are the new capabilities producing measurably better results
- **Today's Environment**
  - Strategic guidance is changing
  - Training is changing in response
  - Resources are going down
  - Is simulation-based training a better buy than health care or facilities or equipment?

Why Value of Simulation?

- **ROI: Assumes That All Units Are Fiscal**
  - Benefits in training are not fiscal
  - Equating operational effectiveness to $$ can be done, but results are always subject to doubt
- **Value of Simulation**
  - Allows a more flexible approach
  - Recognizes that benefits are not all fiscal
    - Improvements in performance are primary benefits
  - Includes different types of cost terms
    - Personnel costs (running simulation facilities)
    - Investments in and sustainment of simulations and facilities
    - Cost avoidances – what is saved by not having to do this live
- **All Methods Require**
  - Some differential in benefits or performance
  - Some differential in cost

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Prior Studies: Degnan (1)

- **Degnan: Award-winning I/ITSEC Tutorial**
  - Presents 9 areas for ROI (one fiscal and 8 performance-related)

Money

Time

Risk

Reuse

Efficiency

Environment

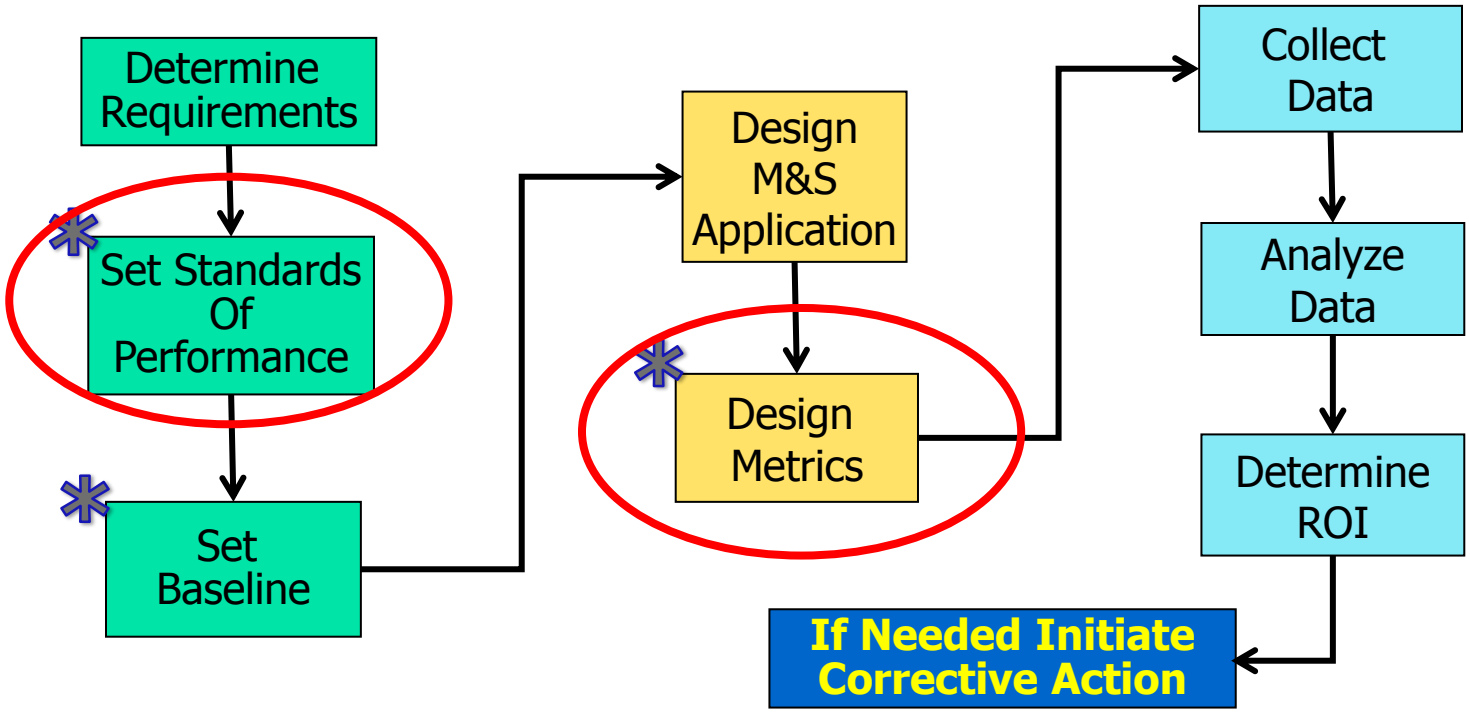
Lives

Readiness

Effectiveness

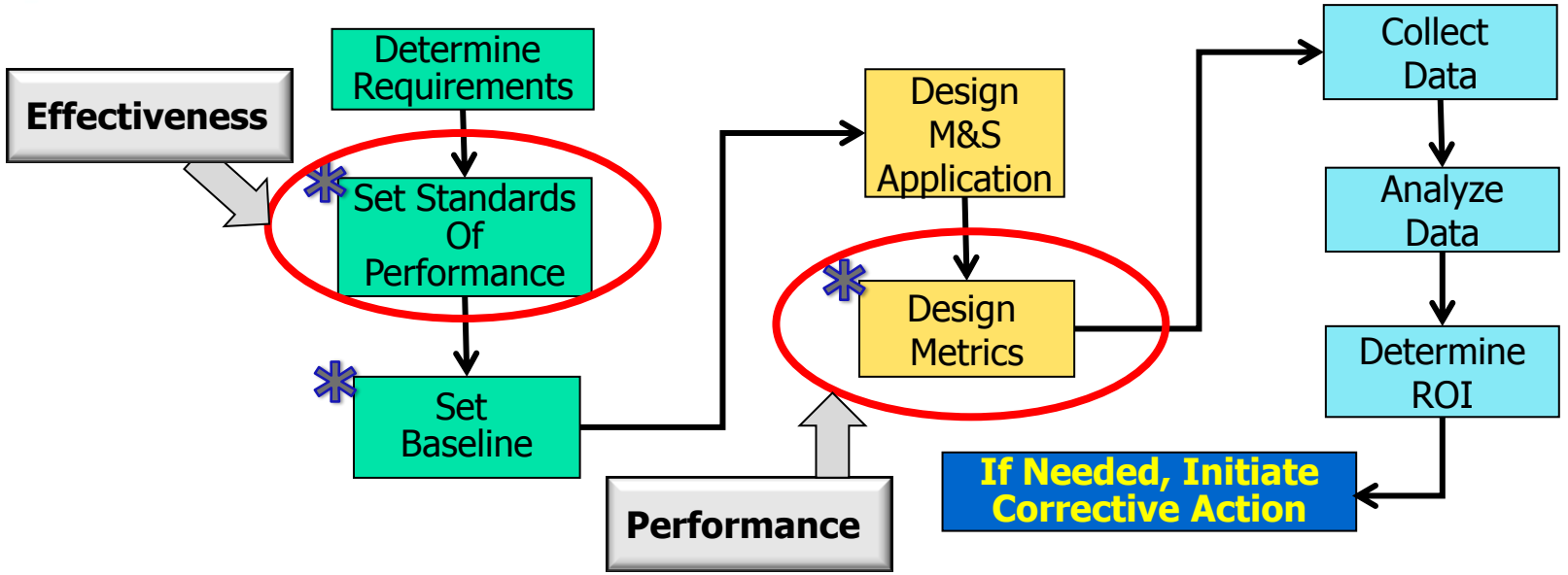
Prior Studies: Degnan (2)

- **Process to Evaluate ROI**



- **Critical Elements for Assessment**
  - Standards of Performance, Baseline, Metrics
  - Individuals Involved: End User, Designer, Sponsor, (Trainer)
- **Evaluations along some or all of the 9 areas of evaluation**

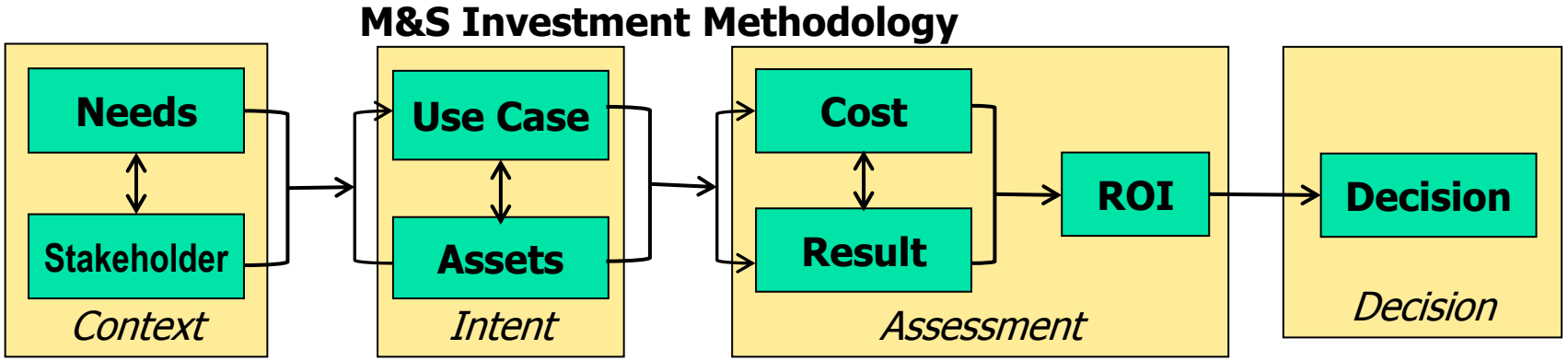
ROI of What?



- **What Value Is Important**
  - If metrics are set for the M&S application during the design process, it is possible that they will be directed toward the **effective performance of the application**
  - If the question to be addressed is how much **improvement in mission effectiveness** results from the use of the M&S application, then the metrics have to be established in conjunction with the performance standards of the mission
  - Both questions are valid – what do you want to address?

Prior Studies: Aegis + (1)

- **Analysis Team:**
  - Oswalt, Waite, Cooley, Feinberg, Gordon, Lightner, Severinghaus*



  - **Focus:** frames the problem in terms of the overall ENTERPRISE while allowing for the development and additional ROI computations to exist at the COMPONENT level
    - **Context:** Establishes needs and requirements taking into consideration the perspectives of the critical stakeholders including other members of the Enterprise
    - **Intent:** Use Cases (scenarios) to review needs of all stakeholders, costs and benefits, and available data as well as the assets needed and already available
    - **Assessment : ROI** can be computed in a number of ways, but method focuses on tiers of generalized metrics for use across the enterprise

* "Calculating Return on Investment for U.S. Department of Defense Modeling and Simulation", Acquisition Review Journal, Vol 18, No 2, Issue 58, April 2011, (accessible via http://www.dau.mil)

Prior Studies: Aegis + (2)

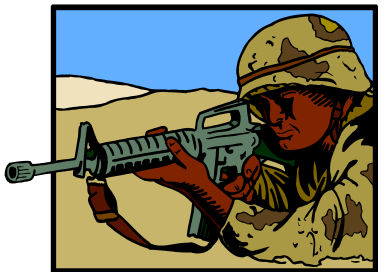
- **Sample Enterprise-level Metrics** (from same source)
  - Not what is generally thought of at the individual program level
  - Essential to have if DoD or a Service or Domain is looking to establish the value of M&S for its purposes

Enterprises Perspective		Sample Metrics	
Characteristic	**Definition**	**Quality (Performance)**	**Monetary (Cost)**
Leadership (class / category			
Leadership	vision / timely actions for an effective enterprise	# of documents supporting vision *(adoption of vision by senior leadership)*	% funding aligned to vision (savings from reduced unused sunk costs)
Empowerment	Engaged all stakeholders -- all able to contribute	# of innovative ideas % of M&S decision makers at key meetings	Reduced cost to get new M&S concepts Savings from innovative M&S use
Situational Awareness	Understanding of M&S standards, tools, etc.	# of meeting, conferences, repositories, web portals % evidence of critical information exchange	Reduced cost to get good M&S information Cost savings from reduced duplication
Management	Capability for recruiting, asigning, career development for M&S workforce	% M&S billeds staffed with M&S-qualified persons %M&S persons retained/ promoted	No unnecessary training / retraining costs Cost-effective M&S deciison
Process	Adoption of relelvant standards, certifications, policies, tools, workforce	# promulgated processes adopted (decreased product generation time)	Reduced labor, travel, and software reworks Savings from error-rate reduction

Prior Studies: Cohn & Fletcher (1)

Purpose: ***suggest ways to develop objective cost analyses as a basis for deciding among alternative investments for enhancing operational effectiveness****

- **Design Decision Aids:** **design for operational effectiveness**
  - **OSBATS**: Army's Optimization of Simulation-Based Training Systems uses historical data to analyze tradeoffs in design features to optimize design for specific cost thresholds.
  - **ASTAR / RELATE**: Air Force's Automated simulator Test and Assessment Routine and Relating Effective Learning to Attributes of the Training Environment
    - Link training design to achieving training objective and human performance levels



- **Cost Not Included:**
  - Design Aids: guidance that could result in cost-effectiveness
  - Cost is not an explicit variable

*Cohn, J., Fletcher, D., "What is a Pound of Training Worth? Frameworks and Practical Examples for Assessing Return on Investment in Training," I/ITSEC 2010, (accessible via http://www.iitsec.org)

Prior Studies: Cohn & Fletcher (2)

Essential Elements in Cost Effectiveness Analyses

Element	Comment
Identify Objectives	What system is meant to achieve -- could be expressed as what students are to achieve
Identify Requirements for Scale	Student throughput or integration with other systems, accessibility, etc.
Indentify Cost Model	Which costs are to be included explicitly, direct and indirect, actuals preferred to estimated
Identify Alternatives	Set should be both realistic and comprehensive
Design Analysis	May involve experiments or use existing empirical data but should incorporate rigorous experimental design principles
Establishing Metrics	adequate measures must include concerns of those making the investment and those benefiting from its returns
Metrics Pitfalls	Mis-scaling the cost, assumption that relationships are linear and monotonic, neglecting synergies with other system
Analysis	Sufficient sample sizes, designes appropriate for experimental, quasi-experimental or analytic approaches, long and short term effects included
Sensitivity Analysis	Allows decision makers insight into robustness of the analysis to variations in assumptions
Reporting Results	Include both strengths and limitations of the analysis.

$$ROI = \frac{\text{Value of the Result} - \text{Cost of the Investment}}{\text{Cost of the Investment}}$$

*Cohn, J., Fletcher, D., "What is a Pound of Training Worth? Frameworks and Practical Examples for Assessing Return on Investment in Training," I/ITSEC 2010, (accessible via http://www.iitsec.org)

Prior Studies: Cohn & Fletcher (3)

Example: ROI for Technology-Based Specialized Skill Training*

Investment		Return	
Develop and produce 320 hours of instruction	320 x $14,000.00 = $4.48M	total hours saved by 40% of learners	143,080 students x 136 hours = 19,459 hours
Deliver 320 hours of instruction to 40% of learners	143,080 x 320 x $4 = $183.14M	composite pay and Reimbursement per hour x hours saved	$42 x 19.459M = $217,273M
Total Investment	**$187.62M**	**Total Return**	**$817.27M**

Assumes:

- 30% time reduction to train 40% of 357,700 learners
- Average course of 456 hours replaced by 320 hours of technology-based training
- 136 hours saved per learner
- $13000/hour to produce and $4/hour to deliver technology-based training
- $42 average hourly cost (pay and reimbursement) per learner

$$ROI = \frac{\$817.27M - \$187.62M}{\$187.62M} = 3.36$$

If you are doing an ROI

Don't leave home without reading this!

*Cohn, J., Fletcher, D., "What is a Pound of Training Worth? Frameworks and Practical Examples for Assessing Return on Investment in Training," I/ITSEC 2010, (accessible via http://www.iitsec.org)

Brief Summary

- **All assessments require two elements**
  - Benefits: easiest if computed in monetary terms
  - Costs: model may not need to include all types of costs, but needs to specify which are included and which are not
- **Benefits and Costs**
  - ROI assumes a differential: 'with and without' or 'before and after'
  - Generally benefits and costs use different models
  - Are tied together normally by using common measurement units
  - Life gets REALLY hard when benefit cannot be computed in $$
- **Coming Next**
  - Evaluation Methodologies
  - Cost-Benefit Analyses

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Evaluation Methodologies: GAO (1)

- **Yes, that's Government Accountability Office (GAO)**
  - "Designing Evaluations" is excellent, academically grounded, and realistic
- **Key Components of an Evaluation Design**
  - Evaluation questions, objectives, and scope (what are you trying to assess)
  - Information sources and measures (what information you need for measuring)
  - Data collection methods, sampling procedures (how to get the information)
  - Analysis plan, evaluative criteria or comparisons (basis to judge performance)
  - Assessment of study limitations
- **Evaluation Criteria** (UJTLs, METLs, etc., tests, trainer evaluations)

Set by law or regulation	Agency policies or procedures
Professional standards or norms	Expert opinions
Prior period's performance	Performance of other entities as benchmarks

Designs for Different Types of Programs: GAO (2)

Typical Design	Comparison on controlling for alternative explanations	Best suited for
Process, outcome monitoring or evaluation	Performance and pre-existing goals such as • Productivity, efficiency standards • Customer expectations, industry standards	• Where coverage is national, complete • Few alternatives explain observed outcomes
Quasi-experiment: Single group	Outcomes before and after intervention • Data collected at multiple points in time • Controls for alternative causal explanations	• Clearly defined start, intervention • Coverage national and complete • Random assignment of participants is NOT possible, ethical, practical, etc.
Quasi-experiment: Comparison groups	Participants and comparison group closely matched on key characteristics • Key characteristics are plausible explanation for difference • Ideally measures outcome before and after intervention (pretest, posttest)	Service and other programs where • Clearly defined interventions exist, controls exist (control populations) • Coverage is limited • Randomly assigning participants is NOT possible, ethical, or practical
Randomized experiments: control groups	Outcomes for randomly assigned participant group and non-participating control group • Measures outcomes (pretest, posttest)	Service and other programs where • Clearly defined interventions exist • Coverage is limited • Randomly assigning participants is feasible and ethical.

*U.S. Government Accountability Office, "Designing Evalutions," 2012 Revision, Applied Research and Methods, GAO-12-208G (http://www.gao.gov/assets/590/588146.pdf)

Challenges to Designs: GAO (3)

In many federal programs, it can be difficult to assess the program's effectiveness in achieving its ultimate objective because it is difficult to obtain data on those goals.*

- ***Lack of Common Outcome Measures***
- ***Desired Outcomes are Infrequently Observed***
  - *Measure intermediate goals*
  - *Conduct critical-incident review of any incidents that occur*
- ***Benefits of Research Programs Are Difficult to Predict***
  - *External expert review*
- ***Isolating Impact When Several Programs Are Aimed at the Same Outcome***
  - *Narrow scope of outcome measure*
  - *Measure additional outcomes*

If your ROI is 'official'

Don't leave home without reading this!

*U.S. Government Accountability Office, "Designing Evalutions," 2012 Revision, Applied Research and Methods, GAO-12-208G (http://www.gao.gov/assets/590/588146.pdf)

Alternative Method: Cost-Benefit Analysis

- **Meeting the Challenge of Different 'Value' units**
  - Issue: how to convert benefits into monetary units when they are largely intangible
  - Recall: Cohn & Fletcher used time differences and converted time into money
- **Cost-Benefit Analysis**
  - Can readily employ non-quantitative evaluations for both cost and benefits
  - Suggested areas for exploring benefits (Sciarretta, et al.)
    - Capability enhancements: degree to which capability is enhanced (operational eval?)
    - Cost avoidance: can be measured in $$ and then rated on a Likert scale
    - Productivity: can be measured in units/time if applicable
    - Risk reduction: operational evaluations can often address this point
    - Stakeholder confidence: often used with technological maturity or operational experience
  - Categories of questions can and should address institutional values
  - Hard (numbers, $$) and Soft (surveys, expert judgments) can be mixed

Army Cost Benefit Analysis Process

COSTS

The total of quantifiable and non-quantifiable costs

Quantifiable costs

- Direct
- Indirect
- Initial/Start up
- Sustainment
- Procurement
- Salary and Benefits

Non Quantifiable costs

- Life/Safety/Health
- Perception/Image
- Opportunity
- Risk/Uncertainty

BENEFITS

The total of quantifiable and non-quantifiable benefits

Quantifiable benefits

- ❑ Cost savings and avoidances
- ❑ Increased productivity
- ❑ Reduced processing time
- ❑ Reduced error rates
- ❑ Increase in capacity

Non-quantifiable benefits

- ❑ Better Information for decision making
- ❑ Easier to use or access
- ❑ Increase in choice or options
- ❑ Reduced redundancy
- ❑ Political
- ❑ Achievement of organizational goals/objectives

BENEFITS MUST BALANCE OR OUTWEIGH COSTS AND REQUIRED TRADE-OFFS

Office of the Deputy Assistant Secretary of the Army (cost and Economics), "U.S. Army Cost Benefit Analysis Guide, 2nd Edition," April 2011

Example of a CBA

- **5 Major Selection Categories of Institutional Value**
  - Case-Related sub-categories
  - Assessments on scale of 0 – 3 for each sub-category
- **Issues**
  - Categories must be viable for all options
  - Evaluations can involve hard and soft data
  - Weighting categories does bias results – may be desirable
- **Data**
  - Completeness and Sufficiency remain important
  - Expert evaluation easily used

			Raw Scoring				
		Wgt	A	B	C	D	E
General Operational Efficiencies:		1.5					
	Mission Alignment		3	2	2	2	2
	Service Needs		2	3	3	2	2
	Interoperability		3	3	3	0	0
	Compliance with Standards		3	2	2	1	2
Strengthens Operational Effectiveness:		3					
	Agility		3	3	3	2	2
	Engineering Support		3	3	3	2	2
	Help Desk Response		3	3	3	0	0
	Prioritization		3	3	3	1	1
	Multi-modal Capability		3	3	3	3	3
	Timeliness		3	3	3	3	3
	Capacity		3	3	3	3	3
	Availability		3	3	3	3	3
Promotes Cost Efficiencies:		2					
	Funding Availability		2	3	3	2	2
	Investment Cost		0	2	1	2	1
	Sustainment Cost Risk		2	2	2	2	2
Complies with DoD Governance:		2.5					
	Authorities		3	1	1	0	0
	Governing Regulations		3	2	2	1	1
	Governing Boards		3	2	2	1	1
	Control		3	3	3	2	2
	Information Assurance		3	2	2	2	2
Meets Strategic Vision:		1					
	Congress		2	3	3	0	1
	Stake-holders		3	3	3	0	2
	Intra-departmental		3	1	1	0	0
	Inter-agency		2	2	2	1	1

How to Evaluate Cost (Knapp and Orlansky, 1983, comprehensive model)

Major Categories

- Research and Development
  - Products: designs, testing, prototypes
  - Data: managerial, technical
  - Labor: direct and indirect – fully loaded
- Initial Investment
  - Production: recurring and non-recurring
  - Data: managerial, technical, infrastructure
  - Labor: direct and indirect
  - Training and Transportation (train instructors)
- Operating and Support
  - Infrastructure
  - Data: for maintenance and required for routine use
  - Labor: direct and indirect

Challenges

- **Different Organizational Budgets**
  - Development Organization
  - Organization responsible for readiness
  - Training Location
- **Different Accounting Schemes**
- **Availability**
  - Institutional sensitivities

Which Costs Are Meaningful

- For some comparisons, sunk costs are excluded (base infrastructure, research)
- The question to be addressed determines how much of the comprehensive model is used

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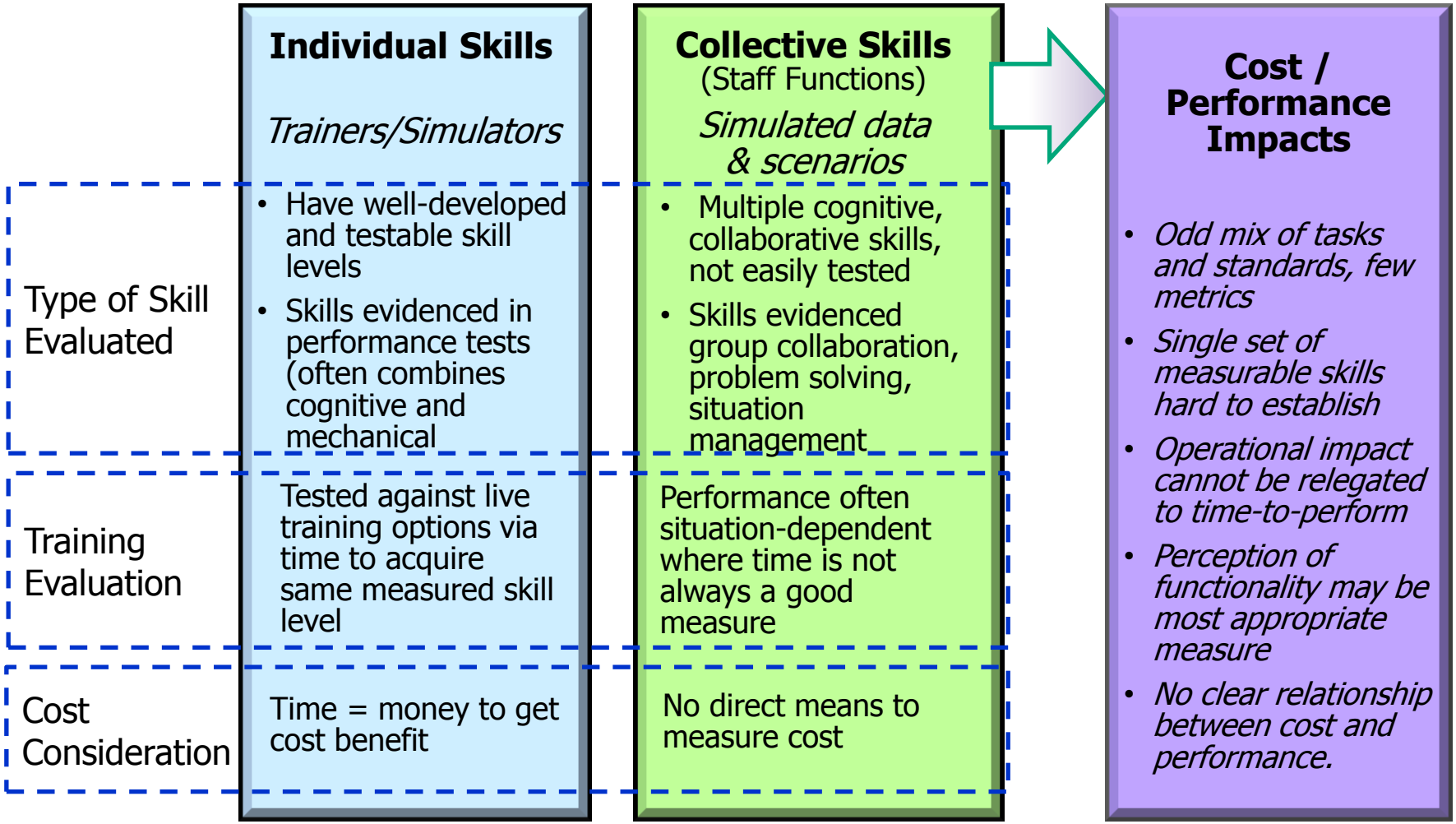
Why the VoS Study

- **M&S offers the promise of big value-added to military training**
  - Dollars saved, e.g. cost avoidance by training in a virtual world vs the real world
  - Effectiveness increased, e.g. higher performance mastered in a given period of training
  - Costs avoided, e.g. savings by foregoing the next best training alternative
- **Senior leaders – Hill, OSD/JS, Army – are inclined to believe it, but want evidence before they commit new and more dollars to M&S for training**
- **Unfortunately, the evidence is not consistently available**
  - Lots for the value of training individual skills
  - Some for the value of operational unit training
  - Almost none for command staff training in the military decision-making process and mission command

Individual vs Collective Skills



Brief Summary of VoS

- **Problem Statement:**
  - "What is the Value of Simulation to the Army as it trains its BCT commanders and staffs to execute the Operations Process and Mission Command throughout the ARFORGEN cycle?"
- **Determining the *Effectiveness* and *Insight* components of Value**
  - Evaluation data do not exist or are essentially inaccessible
  - Therefore, we are using survey instruments as a primary data source (Note: surveys are the primary data collection instrument for operational effectiveness)
- **Our survey instruments examine value from two different perspectives, using two established methodologies**
  - A Comparison of Alternate Approaches, reference Army Cost Benefit Analysis (CBA) Guide
  - Performance of command staffs, reference the GAO's Designing Evaluations
- **Determining the *Accounting* component of Value**
  - *Calytrix Technologies* LVC Cost Counter
  - Authoritative Army cost data
  - Return on Investment (ROI) spreadsheet tool

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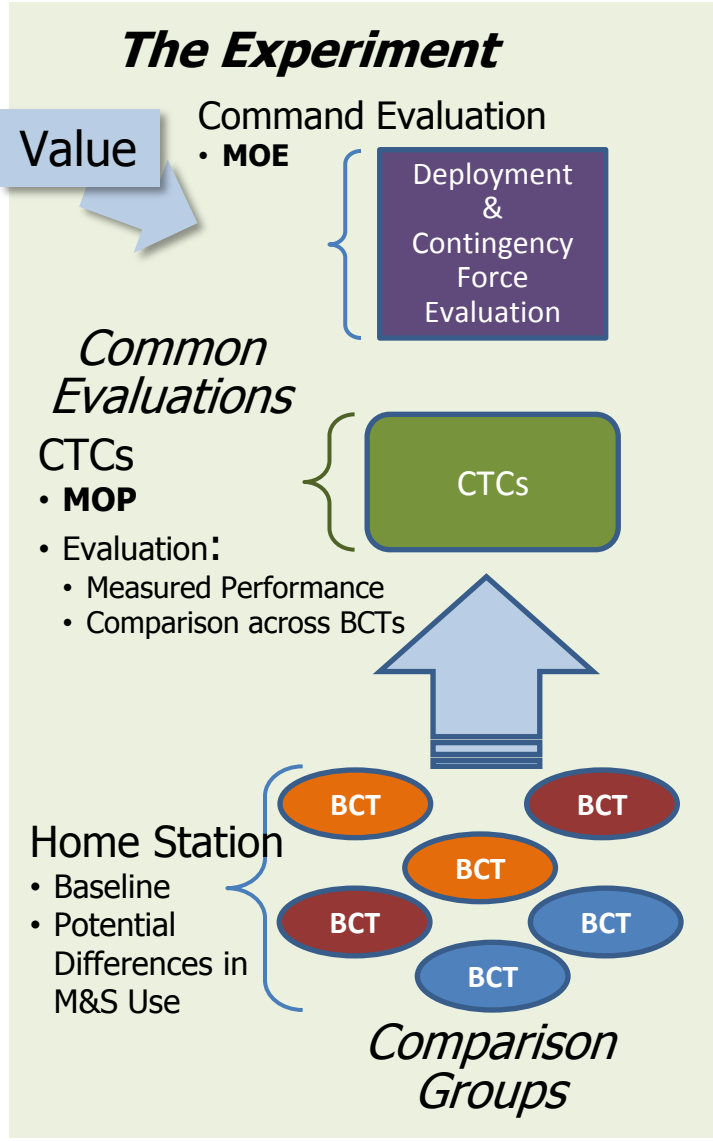
Methodology: Approach for Performance Assessment

- **Problem: Assess the value of simulation in Command and Staff Training (collective training) – emphasis on Military Decision Making Process(MDMP) and Execution (staff must do both)**
  - Not a closely knit team where 'specialized small team' performance is readily measurable
  - Use of simulation is a reasonably clear intervention
  - Coverage is limited and random selection is not feasible (commanders and staffs are not randomly selected – sometimes they are hand-picked)
- **Points to Use of A *Quasi-Experiment*** **(remember the green block in GAO examples)**
  - Comparison group? -- differing experiences with simulations at various home stations
  - Need assessment of infrastructure as companion to performance – are home stations measurably different **(need to test the hypothesis)**
  - Can provide Measures of Performance **(not Measures of Effectiveness)**
- **Cost-Benefit Analysis** **(can we get Measure of Effectiveness?)**
  - Select among viable training methods (Live, Simulation-Based, Instructional)
  - Use MDMP and execution with the same areas used in the Quasi-Experiment
  - Add perceived cost-effectiveness to provide both performance and cost

Assessing Performance

Quasi-Experiment Using Comparison Groups Explanation of Terms

- **An experiment usually has control conditions or factors that define different 'experimental runs'**
  - **Quasi-experiment**: is one in which the evaluator does not have control over the variables or factors or control conditions
- **In the case of ARFORGEN, the training (classically called the 'intervention') is done largely at home stations, which are not identical**
  - Differences cannot be controlled, but they can be assessed
  - Differences include simulation capabilities (sims, facilities, support personnel – **the variables**) and they way they are used
- **Comparison Groups**
  - Closely matched in key characteristics (like BCT staffs – individuals with comparable experience in specified roles working with a commander)
  - All groups go through the ARFORGEN process
- **Experiment Runs**
  - Several BCTs from each of several home stations
  - Measures: self-evaluation
  - Added Comparative measures: at CTCs where evaluators/trainers/coaches have a perspective across many BCTs from all the home stations considered



Anticipated Outcome: Performance of BCTs will differ based on their differing use experiences with constructive simulation–based training

Data Collection Instruments

Linked Surveys/ Three Target Groups / Two Analysis Methods

Methodology
Quasi-experiment Using Comparison Groups

Survey 1: Infrastructure

Facilities
……
Resources
……..
Patterns of Use
……
Utility for Sims
……..
Group Performance

Research Focus

Does constructive simulation experience correlate with higher self-evaluations of performance, given differences in facilities?

What is the degree of correlation in perceptions between simulation facility staff and command staff?

Target Group

Staff from the simulation facilities at unit home stations to include OTCs as well as technical support staff

Survey 2: Performance Evals

Facilities
……
Resources
……..
Patterns of Use
……
Utility for Sims
……..
Group Performance

Methodology
Comparison of Alternatives

Research Focus

What is the degree of correlation between self-evaluation and expectations of constructive simulation applicability?

For what command staff skill areas are constructive simulations most advantageous?

Target Group

Commanders and senior command staff personnel that have recently completed an ARFORGEN process through, at least, CTC deployment

Survey 3: CBA

Utility and Cost for Sims
……..
Group Performance
……..
Utility and Cost for Alt 1
……..
Utility and Cost for Alt 2

Target Group

Senior commanders, and command staff with multiple training cycle experiences (from war colleges…)
OTCs at mixed training sites

Skill Areas Used in Surveys 2 and 3

- **Skill Areas**
  - Selected from Army Doctrine and included numerous subordinate skills
  - Tested on Army trainers (and SIMCI members) from Ft. Leavenworth and elsewhere before using
  - Attempted NOT to favor skills best acquired via simulation
- **Differential in Self-evaluation**
  - Rate skill of staff as a staff at mid-point and end-point of ARFORGEN cycle

Question	Skill Areas
16	Ability to develop viable plans in a timely manner
19	Ability to perform good course of action analyses
22	Ability to synchronize forces and resources
25	Ability to manage information to achieve situation awareness
28	Ability to integrate other service and allied assets (forces, ISR, etc.)
31	Ability to adapt plans, actions, processes, rapidly in response to external factors
34	Ability to understand the adversary's capability and intent
37	Ability to understand and anticipate the response of the indigenous population
40	Ability to work under stress
43	Ability to identify, assess, accept, and mitigate risk
46	Ability to conduct execution processes effectively

Determining Cost

Initial Assertions

- Costs would be based on current operating costs or recurrent costs
- Sunk costs would not be included
  - Would require sunk costs for live training facilities and simulation facilities, some of which might be amortized
  - Such costs would be very difficult to substantiate with accurate data
- Costs for military personnel not included on the basis that they would be paid for that time regardless of how it was used
- All costs are in current dollars with no factors to include value of money

Current Operating Costs

- Total Operating Cost Fragmented across multiple Organizations and budgets
- MTC staff
  - If only normal operating hours required, costs funded by IMCOM
  - If additional operating hours required, added hours funded by FORSCOM
- MTCs and MCTPs are largely government owned – contractor operated: adds complexity
- TRMIS database for costing major items often updates only when items are used
- Cost to home station for running BCT training: estimated weekly $ from one site

MTC: Mission Training Center

MCTP: Mission Command Training Program

TRMIS: Training Resource Model Information System database maintained by HQDA and FORSCOM

BCT: Brigade Combat Team

IMCOM: US Army Installation Management Command

FORSCOM: US Army Forces Command

Cost Estimates

- **Gold Standard: BCT rotation at Combat Training Center (CTC)**
  - Total Cost for most BCT rotations: $15M - $20M
  - Total Cost for armored BCT rotation: $25M - $30M
  - Variations according to type of unit and its distance from the CTC
- **Using LVC Cost Counter (Calytrix)**
  - Pulls data from an HLA federation to estimate the cost of fuel and material expended should the scenario have been done live
  - Use an armored BCT arrayed against enemy Brigade for 90 minute combat
  - Cost including live missiles ~ $3M , without missiles ~ $1.6M, without enemy ~ $1M
- **Creating a Comparison**
  - BCT rotation of 21 days includes 7-10 days 'in the maneuver box', 1 scenario/day
  - Cost range ($1M x 7 days) to ($1.6M x 10 days) or $7M to $16M (from cost counter)
- **Other Training Cost Estimates from Sites**
  - $.6M to $.9M per event for major simulation-driven event
  - $ .675M per training event (type of training not specified)
  - Issue: What is included in the cost of rotation that is not included in the event cost

Final Thoughts on Cost

- **Establishing the Baseline Is Critical**
  - Exactly what is included in the cost estimated provided by the sites
  - What types of scenarios are included and what types of weapons/systems are excluded?
  - Are there OPFOR?
  - Are any of these events done totally without simulation? So many are live-virtual-constructive computer-assisted exercises
- **Using the LVC Cost Counter**
  - There is some learning curve before it can be used easily
  - Ideally, the scenario would match that done live – creates problem in capturing and running each scenario
  - Could run a range of scenarios to establish a typical cost for typical scenarios
- **Establishing Individual Cost Figures**
  - Is not easy even when everyone is trying to cooperate
  - Determine how critical exact figures are before undertaking the task

Outline

- Why be concerned about ROI or Value of Simulation (VoS)?
- M&S ROI: Prior Work
- Design of Evaluations

  Use Case: Value of Simulation (VoS) Study
- The Proof of Concept Study
- Methodology
  - Performance Evaluation
  - Cost Evaluation
- Roadblocks
  - Challenge of Evaluating Simulation-Based Staff Training
  - Data Acquisition
- Results

Data Collection

- **Cost and Performance Data Are Sensitive**
  - Performance data may impact promotion
  - Performance data may impact reports on readiness
  - Cost is always an issue as part of operations and maintenance (O&M) for home stations, training expenses and total cost of products
  - Different organizational budgets are involved: PEO STRI for development and installation, home station for O&M, FORSCOM for unit's operational training
- **Accessibility?**
  - Always a problem, but command and staff training presented a special issue
    - There are no proficiency exams
    - Observer/Trainers/Controller are now Coaches and their reports are held closely – more so than exam results
    - Commander's monthly TPU reports are so heavily redacted that comparisons across home stations and units are not possible – hence, they were useless to us
  - Cost data, always sensitive, was especially so in today's fiscal climate

Requirements and Availability

- **Co-location for Survey 1 and Survey 2**
  - Survey 1 and Survey 2 should capture the infrastructure at the time the unit was training in that location **(get multiple perspectives on infrastructure for clarity)**
- **Samples after months of 'contact and cajole'**

  - Survey 1: 3 Home Stations
  - Survey 2: One recently deployed BCT (not from one of the three home stations interviewed)
- **But Miracles Do Happen**

  - 50% of the respondents from the test site indicated they DID NOT USE simulation-based training for staff at their pre-deployment training locations **(two comparison groups!)**
- **Survey 3**
  - Very much under-sampled – too few volunteers -- but results promising

Outline

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Caveats

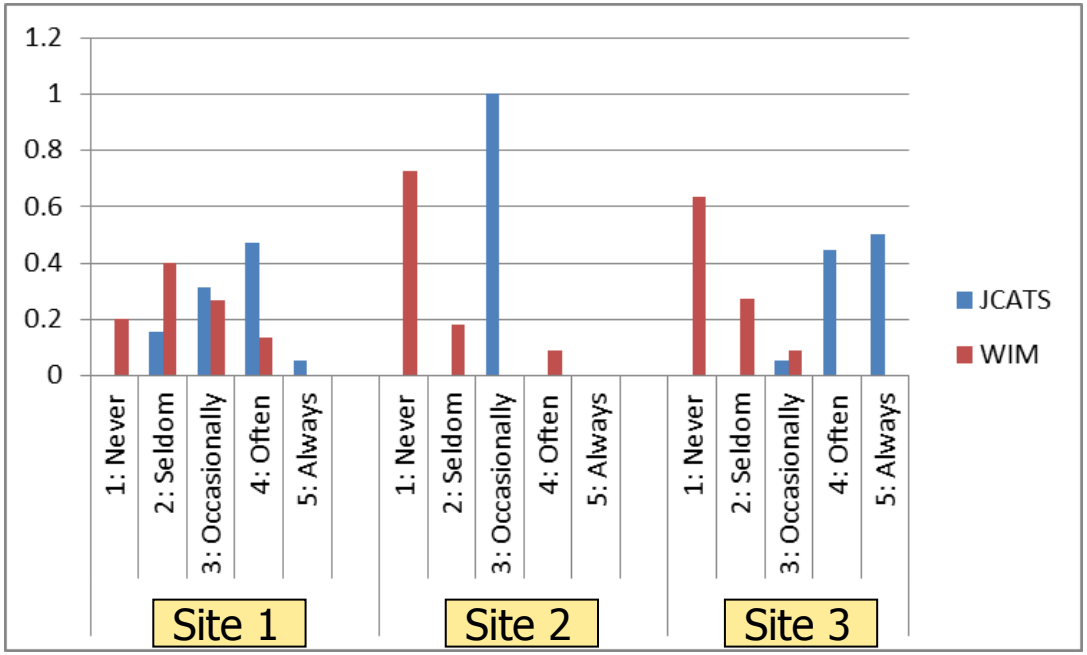
- **Remember: VoS Is A Proof of Concept Test**
  - Develop and test a methodology
  - Preferably a methodology that can be transitioned to other areas of application for simulation
- **Results**
  - Are test results and not answers to the ultimate question of the value of simulation
- **Returns and Sampling**
  - No attempt was made to develop a representative sample
  - Returns included both Army and Marines (not by design)
  - Results were too few for meaningful statistical analyses
- **BUT Results Were Sufficient to Test Key Hypotheses**

Hypothesis: Simulation Environments Differ Among Home Stations

- **Comparison of Simulation Usage**
  - JCATS: Joint Conflict and Tactical Simulation, part of JLCCTC-ERF (Joint Land Component constructive Training Capability – Entity Resolution Federation)
  - WIM: WARSIM Intelligence Module (WIM), part of JLCCTC-MRF (Multi-Resolution Federation)
  - Patterns of use differ significantly when comparing 3 different home stations

- All three locations seem to use JCATS more than WIM
- Site 3 appear to use JCATS nearly all the time
- Site 1 shows a much more distributed use of both JCATS and WIM

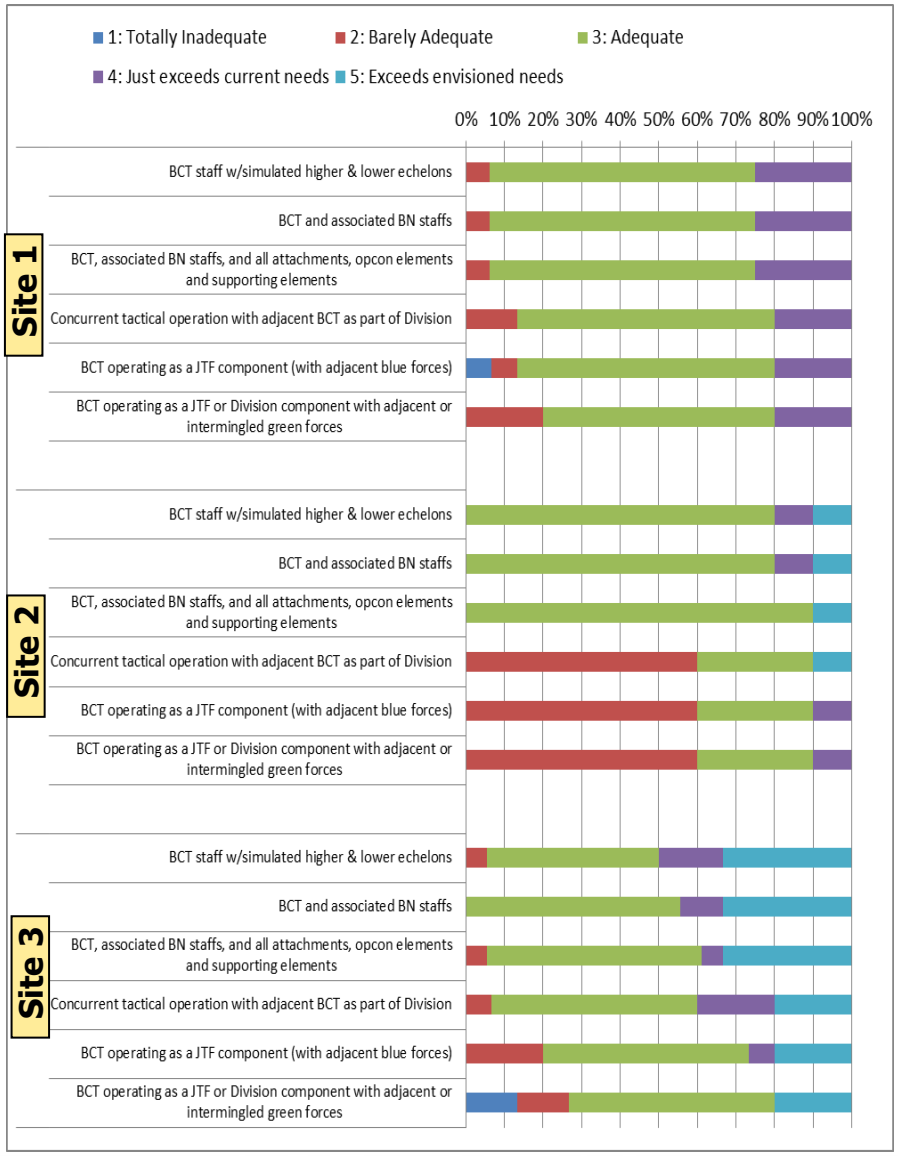
Results suggest that usage distributions can be used to distinguish among installations



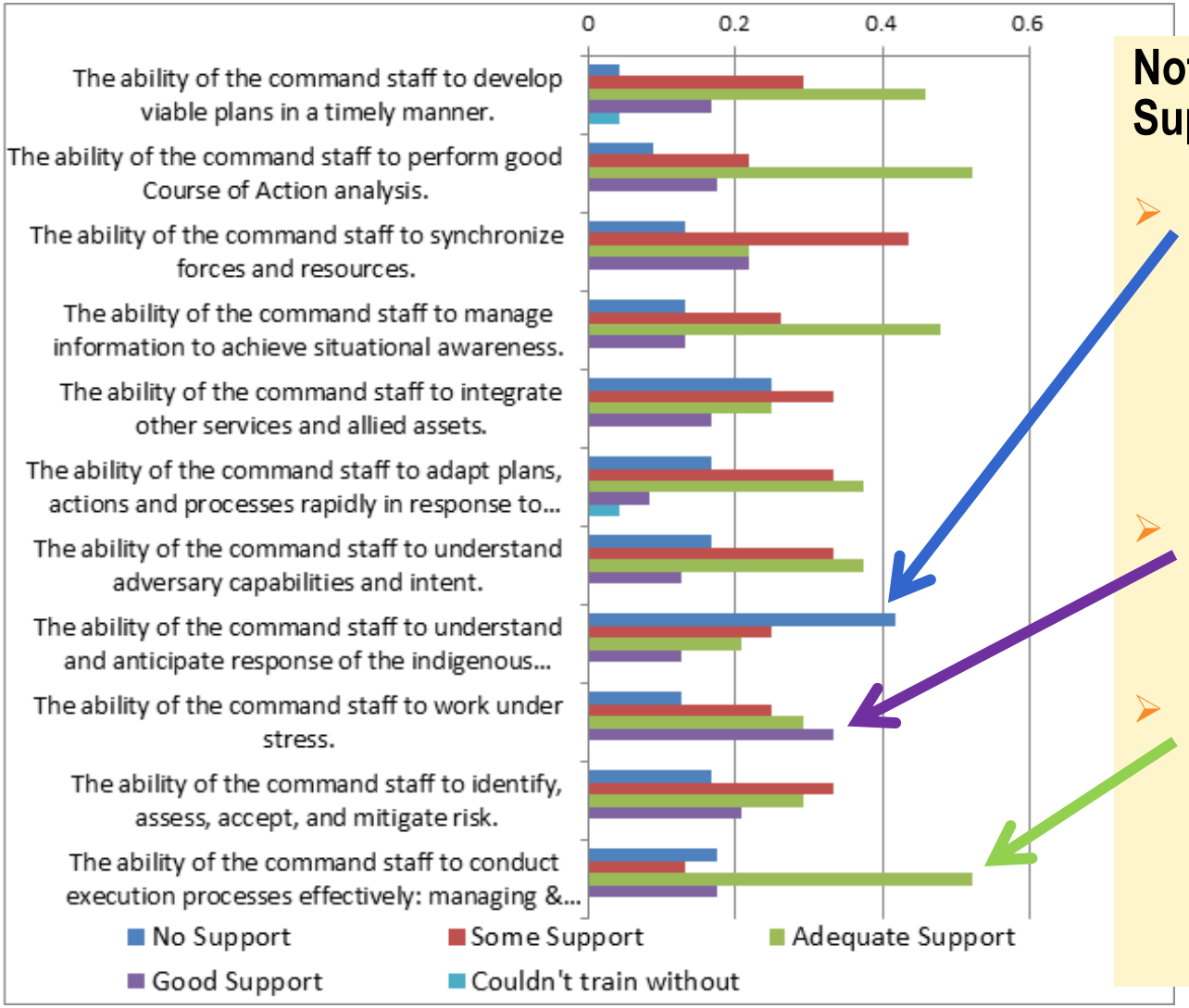
Additional Support for Hypothesis

Graph Compares Ability to Represent Various Echelons – Differ Among Sites

- **Echelon Scales on left**
  - BCT with simulated higher and lower echelons
  - BCT and associated BN staffs
  - BCT, BN and all supporting elements
  - Concurrent ops with adjacent BCT as part of Division
  - BCT operating as a JTF component with adjacent blue forces
  - BCT operating as JTF or Division component with adjacent or intermingled GREEN forces
- **Color Scales from Low to High Support**
  - Totally inadequate
  - Barely Adequate
  - Adequate
  - Just exceeds current needs
  - Exceeds envisioned needs



Command & Staff Discriminate Among Skill Areas

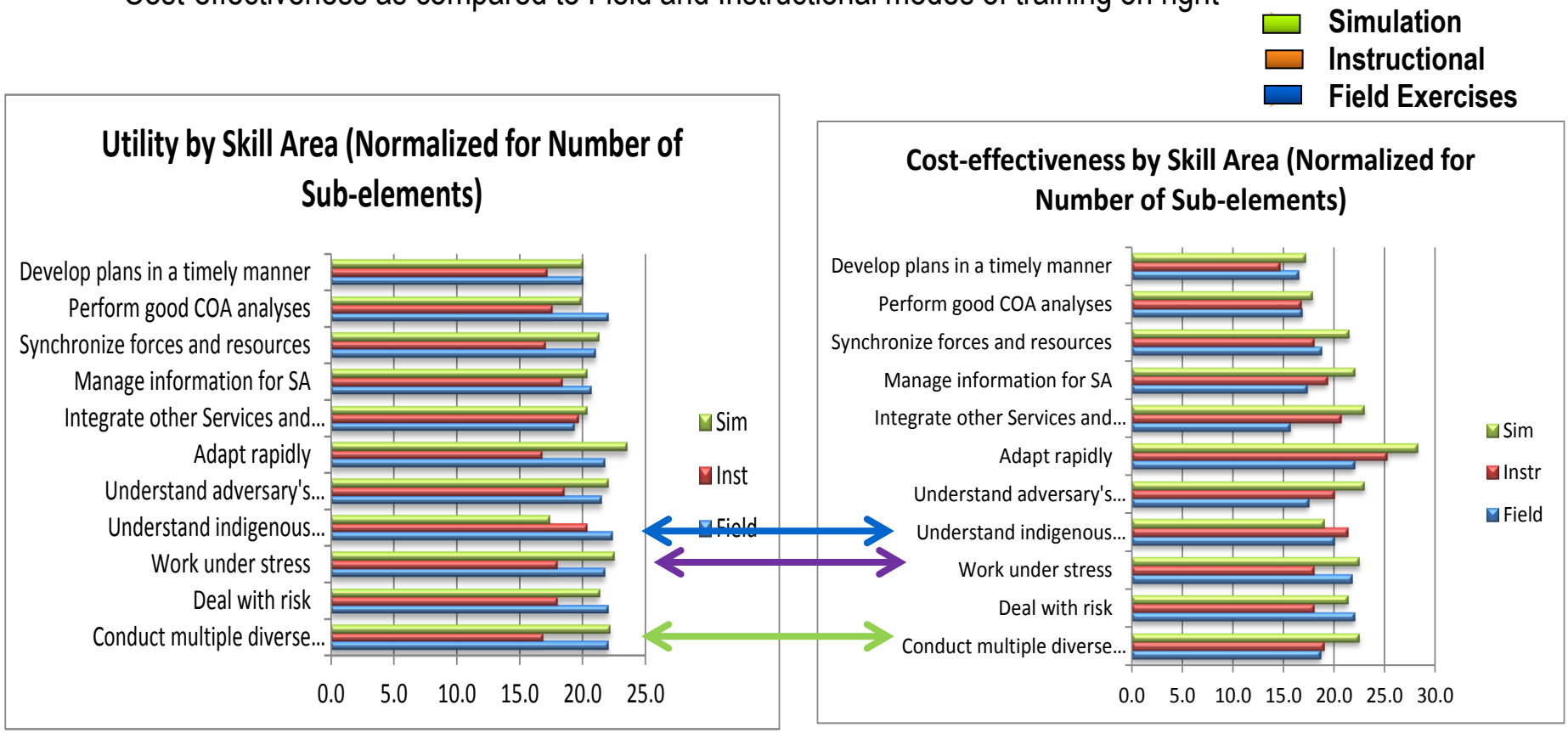


Not All Skills are Equally Supported by Simulation

- Blue arrow pointing to the high blue bar shows a large number of respondents feel that simulation provides NO support for understanding the indigenous population
- Over 30% felt that simulation supported their training to work under stress
- Simulation scored reasonably well in training staff to execute multiple threads

Correspondence Between Survey 2 and 3

- **Survey 3 had very few responses, but correspondence with Survey 2 on salient skills give credibility to Survey 3**
  - Same skill areas as indicated in the prior graph, now shown for Survey 3
  - Utility of Simulation as compared to Field and Instructional modes of training on left
  - Cost-effectiveness as compared to Field and Instructional modes of training on right



Perceived Capability of Simulations

Correlation of Perceived Contribution of Simulations and Availability of Simulations

Number	Text of questions used to differentiate populations with and without us of simulation
49	Were constructive simulation capabilities made available for your training as a staff?
50	As a staff, were you directed to use simulation as part of your staff training?
60	Did the available CONSTRUCTIVE simulations provide capability to support the commander and staff in developing proficiency in their tasks (provide insight, allow for COA evaluation, opportunity to repeat activities with assessment and refinement, try things not available in the field, etc.)?

Answers to Question 60

Yes: Sims did support acquiring skills

No: Sims did not support acquiring skills

Let full population be **Full**

Let population that experiences sims be **Q49Y**

Let population that did **not** experience sims be **Q49N**

Average scores of Q60 should range as

Q49Y > Full >Q49N

With Q49Y as highest and Q49N as Lowest

	Full Population	Q49: Yes			Q49: No		
Question[11]	Full	Q60: Y or N (Grp A) Q49Y	Q60: Y	Q60: N	Q60: Yor N Q49N	Q60: Y (Grp B)	Q60: N (Grp C)
16	2.87	3.22	3.25	3	2.50	2.83	2.17
19	2.78	3.22	3.12	4	2.27	2.60	2.00
22	2.52	2.78	2.62	4	2.5	3.00	2.00
25	2.61	2.89	2.87	3	2.6	2.80	2.40
28	2.33	2.67	2.62	3	2.09	2.67	1.40
31	2.50	2.67	2.62	3	2.36	2.67	2.00
34	2.46	2.78	2.87	2	2.36	3.00	1.60
37	2.04	2.67	2.75	2	1.81	2.17	1.40
40	2.83	3.33	3.25	4	2.73	3.00	2.40
43	2.54	3.33	3.37	3	2.18	2.67	1.60
46	2.70	3.33	3.37	3	2.54	3.00	2.00
	Middle	Highest			Lowest		

What We Learned

- **Cost**
  - Complicated and difficult to acquire
  - Requires many good organizational relationships and considerable time
  - Definition of what to include and exclude is critically important
- **Cost Perceptions**
  - Experienced commanders and staff can estimate the relative costs in a reasonable fashion
  - Cost-Benefit Analysis (CBA) approach is a viable alternative evaluation method
- **Performance**
  - Differentials between using and not using simulations is hard because simulation is so pervasive
  - Different installations provide different simulation experiences and commanders and staffs understand enough of those differences to give a good comparison
  - While the full range of tests for the Quasi-experimental, comparison groups could not be done with the data available; Survey 2 alone could suffice
  - Self-evaluations at midpoint and end of training provided appropriate differential for assessing individual units based on examining all returns
- **Linking Cost and Performance**
  - Use CBA-like approach, establish cost 'bands', equate them to Likert scale values

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BACKUP SLIDES

Focus of VoS

- **VoS is focused on quickly getting evidence on the value of Army command staff training**
  - By surveying the recent literature, to capture the evidence in it (unfortunately, there's not much there)
  - By developing and using a methodology that can assess value of M&S initially in Constructive domains
    - For Army BCT and BN command staff training (currently focusing on the ARFORGEN Process)
- **Results of this task will be useful in the near and longer-term**
  - Credible evidence on the value of simulation in the near-term for the current budget cycle; and
  - A credible methodology to be used over the longer term to get more comprehensive evidence.
- **To Evaluate the Methodology – Not to Perform the Final Analysis**
  - Examine one or more methodologies
  - Test them and the instruments for gathering the data
  - Note the issues in data availability and how that impacts validity of methods