DT&E Using Scientific T&E Design

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Scientific T&E Design

Goal: *Understand process factors and their interaction with each other, so that their results produce an accurate prediction of the outcome.*

- Responses: Desired/Expected Outcomes
- Factors: Important Measures
  [FACTORS are "broad categories of conditions that affect responses, " factors + levels = operational envelope," wrt scientific method: responses = dependent variables, factors = independent variables, the MEASURES should be chosen before identifying factors and levels]
- Levels: Possible Ranges/Extents for Factors

Benefits for testers…

- Plan based on statistical confidence

All Services use such methodologies for various reasons. OSD's emphasis is on planning for robust Integrated T&E

Deputy Undersecretary of Defense for Developmental T&E's Position

- **"Integrated Testing is important to institute in order to attain test data that can be used across the acquisition processes… Early Planning for Integrated Testing sets up complementary individual [DT & OT] evaluation"**

- **STED puts discipline into T&E planning…through structured processes such as "Design of Experiments". STED is part of the T&E tool-bag for OSD Integrated Testing efforts"**

DDT&E: *Integrated Testing and Evaluation Can be Aided by Applying STED Methods Across Entire Acquisition Development Cycle*

STED in DT&E Planning

- **Determine Optimum Test Runs, Test Points & Resources**
  - Based on Factors, Levels & Interactions
  - Utilize Statistical Tools
  - Forms the basis of Integrated T&E

- **Helps Allocate Test Requirements to Test Sequence**
  - Contractor Test, DT, OT
  - Component—Subsystem—System
  - Informs what is likely to be learned at key decision points

- **Iterative Process**
  - Can help re-vector test plan based on emerging results
  - Supports better use of Modeling and Simulation

Reduce test time and statistically consider interactions better than traditional one-factor-at-a-time methods

STED in the Acquisition Process

- **To MS B**
  - Determine what functions and influences are most important to T&E design and are worth close monitoring
  - Develop the T&E test space
  - Identify the likely T&E resources needs
  - Supports the time-phasing of CT-DT-OT

- **At MS C [and to FRP]**
  - Assess adequacy of T&E, compared to data accumulated
  - Determine future T&E priorities
  - Identify where T&E trades can be made given results

The wise investigator expends his effort not in one grand design (necessarily conceived at a time when he knows least about unfolding reality), but in a series of smaller designs, analyzing, modifying, and getting new ideas as he goes.

— *G. E. P. Box*

STED Benefits in an Integrated T&E Environment

- **Everyone Understands the Test Problem, the Test Environment and How the System is Tested**

- **Statistical Tools Identify Optimum Factors, Test Points and Conditions to be Tested**

- **Performance being Assessed is Allocated to Specific Tests in Sequence**

- **Allows Comprehensive Body of Data to be Accumulated to Support Findings**

- **Facilitates Coordination of Test Events**

DT Results Better Support OT Findings, Helping Scope OT

STED in Use

- ## TEMP – DT&E Expectations
  - Part III – Discuss the analytical methodology used to develop the DT/IT test program
  - Part III - Show the Test and Evaluation framework in chart form
  - Part IV – Ensure test resources are mapped to the T&E framework

- ## Program examples:
  - SDB-II, JAGM, AIM-9X, JASSM
    - Examine the power of contractor test plans
    - Develop a robust (power/confidence) integrated test approach CT/DT/OT with the minimum number of tests
    - Recognize scope of viable testing to support MS C
  - P-8, AWACS, JSTARS, F-35, MQ-9

Back-up Slides

DoD Policy on Integrated T&E

DoDD 5000.01:

- "**Test and evaluation shall be integrated** throughout the defense acquisition process"

DoDI 5000.02:

- "**Integrate**, . . . successive periods of DT&E, LFT&E, and IOT&E

DoDI 5000.02, Enclosure 2:

- "Developmental and operational test activities **shall be integrated and seamless** throughout the phase"

- "Evaluations shall **take into account all available and relevant data and information** from contractor and Government sources"

DOE Resources for Testers

- **USAF DoE Community of Practice**
  - Web-ex Mondays 1400 CT
  - Contact: https://connect.dco.dod.mil/eglindoe
    Gregory T. Hutto: Gregory.Hutto@Eglin.af.mil
- *Design and Analysis Of Experiments*, 6th Ed., 2004
  - Douglas C. Montgomery, ISBN 0-471-15746-5
- *Design of Experiments*, 2nd Ed., 1957
  - Cochran and Cox, Wiley and Sons
- *Response Surface Methodology*, Process and Product Optimization Using Designed Experiments, 3rd Ed., 2009
  - Raymond H. Myers and Douglas C. Montgomery
- *Joint Test and Evaluation Program Handbook*
  - DOT&E, December 2008
- *Efficient Simulation Using DOE Methods*
  - Dr. Tom Donnelly, SAS Institute: Tom.Donnelly@jmp.com
- **Sample Size, Confidence and Designed Experiments**
  - Dr. Mark Kiemele, President, Air Academy Associates: aaa@airacad.com

- **ATEC**
  - DoE used for planning system evaluations and individual data-collection events
  - Single table depicts how the individual test events will manage each factor
  - Be able to reconfigure for unforeseen events
  - Manage tradeoffs between operational realism and sufficient data
  - Requires detailed front-end planning

- **COMOPTEVFOR**
  - DOE part of Mission-based Test Design (MBTD)
  - A shift functional-based to mission-based OT.
  - OT team provides detailed OT input earlier in program schedule.
  - OT designed around factorial design
  - Sharing of T&E responsibility, resources, and data throughout system development.
  - IOT&E as mission capability confirmation.

- **53RD Test Wing**

  – With digital simulations, screen 15-20 variables with fractional factorials and predict performance

  – In HWIL, confirm digital prediction (validate model) and further screen 8-12 factors; predict

  – In live fly, confirm prediction (validate) & test 3-5 most vital variables

  – Prediction Discrepancies provide opportunity to improve simulations