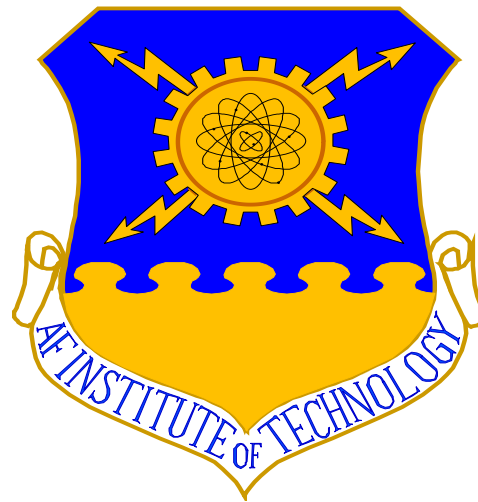


# *The Intellectual and Leadership Center of the Air Force*

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## **AFIT and its Academic Involvement in Test and Evaluation**

*We make a difference...*

*one student at a time*



# Educational Challenges



*Develop America's Airmen Today ... for Tomorrow*

- The challenge here is to improve the overall knowledge associated with the application of experimental design and statistical analyses in DoD applications particularly test and evaluation
  - Use of statistical methods and understanding of risk and uncertainty
  - Use of not only conventional but “state-of-the-art” experimental designs and understanding their use
  - Use of advanced statistical analysis methods for analyzing large data sets
  - Deep understanding of the statistical principles employed in any T&E event



# COE and REL Courses



*Develop America's Airmen Today ... for Tomorrow*

SOT 210 Introduction to Science of Test:  
Experimental Design and Analysis  
(2 Days, Prerequisite: None)

SOT 310 Science of Test:  
Experimental Design and  
Analysis I  
(4.5 Days, Prerequisite: None)



SOT 410 Science of Test:  
Experimental Design and  
Analysis II  
(4.5 Days, Prerequisite: SOT 310)

REL 210: Introduction to Reliability and  
Reliability Growth  
(2 Days, Prerequisite: None)

REL 310: Reliability and Reliability  
Growth Foundations  
(4 Days, Prerequisite: None)



# SOT and REL Enrollment



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Course	FY2011	FY2012	FY2013	FY2014	Total
SOT 210	173 <sup>a</sup> (10 <sup>b</sup> )	123 (8)	220 (17)	352 (18)	868 (53)
SOT 310	64 (5)	113 (9)	206 (16)	350 (18)	733 (48)
SOT 410	43 (2)	23 (5)	28 (4)	95 (8)	189 (19)
REL 210		48 (3)	134 (13)	117 (8)	299 (24)
REL 310		70 (5)	142 (10)	74 (6)	286 (21)
<b>Total</b>	<b>280</b> <b>(17)</b>	<b>377</b> <b>(30)</b>	<b>730</b> <b>(60)</b>	<b>988</b> <b>(58)</b>	<b>2375</b> <b>(165)</b>

<sup>a</sup> Number of Students, <sup>b</sup> Number of Offerings

## T&E Workforce Development—Do Not Forget Education

Raymond R. Hill, Ph.D.

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*The Department of Defense is pushing hard to include statistical rigor as part of defense test and evaluation. Workforce development is a component of this initiative. An overreliance on training avenues of workforce development has the potential to leave the overall workforce lacking in the deep knowledge needed for statistical rigor. These training avenues should be augmented with graduate-level educational avenues to help the test-and-evaluation workforce achieve the deeper level of statistical knowledge needed for the statistical-rigor initiative. This article discusses the levels of learning associated with training, argues for considering concepts from statistical engineering, and lays out an existing example of a graduate certificate course focused on the deeper statistical knowledge the Department of Defense is likely to need for the test-and-evaluation workforce.*

**Key words:** Education; statistical engineering; statistical thinking; training; workforce development.

All tests are experiments, and all experiments are planned (Montgomery 2011). Not all experiments are planned using statistical thinking. Tests include demonstrations, envelope expansions, full factorial experiments, and various other types of tests. These may not be classical examples of experimental design (see the nice summary in Johnson et al. 2012). However, statistical thinking and statistical rigor should be a component supporting the planning, execution, analysis, and evaluation of every type of test.

Past articles in this journal have more than adequately discussed the recent emphasis by the Department of Defense (DoD) on improving the statistical rigor associated with test and evaluation (T&E). Dr. Gilmore's update (2011) and Greer's overview (2010) well summarize these initiatives. Dr. Warner (2011), in addressing the need for statistical rigor to meet T&E challenges, even states, "We must use statistical tools." (Such tools are not necessarily computer based.) The statistical-rigor initiatives are essential, but eventual success in these endeavors requires a T&E workforce that is ready and well prepared to make the initiatives work. Clearly, workforce development must play a key role in the DoD's goal to improve the statistical rigor across the range of T&E efforts. Training will be an important element in workforce development, since training programs focus on personnel knowing how to

do things. However, education, which focuses on the "why" of the things that need to be done, must be part of the workforce-development solution as well.

Nearly all new initiatives involve a quick infusion of training. Some individuals may fondly recall the quality initiatives from 20 years ago and the various courses in topics ranging from continuous process improvement to Taguchi robust-design methods. I recall that some common metrics of the time were courses offered, personnel trained, and improvement teams chartered. The lean and Six Sigma initiatives are now in full stride, and there is no shortage of training and certification opportunities. However, there are problems with reliance on training alone, a topic succinctly brought out by Goh (2010). Among these problems are trained (and sometimes fully expert) personnel's unawareness of the limitations of what they know and their rigid application of methods and tools even when the applicability of those methods and tools may be tenuous. Many statistical methods beneficial to test are beyond the scope of training programs. Such limitations in the breadth of expertise among personnel are often inherent in a reliance on training and should not be repeated in the statistical-rigor initiatives for DoD test.

### Training versus education

Training focuses on familiarization of concepts while emphasizing processes to complete tasks or





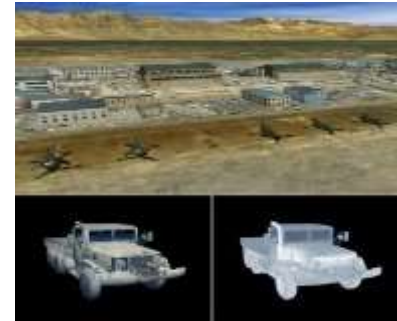
# AFIT OR Degree



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## Operations Research

- Deterministic & Probabilistic OR
- Simulation & Combat Modeling
- Information Operations
- Applied Statistics
  
- 3-year PhD in Operations Research
- 18-month MS w/ Thesis
- 12-month IDE MS program w/ project
- T&E Certificate Program



Theses/GRPs/Dissertations address  
real-world, real-time problems  
Military uses AAD/IDE process,  
civilians use education process  
LT/FT and CDE





# T&E Certificate Program



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- Certificate program approved in Dec '08
  - Graduate Courses include: Prob/Stat, Empirical Modeling, DOE, RM&A, Advanced DOE (or capstone)
  - Math/Stat and OR Dept – Distance Learning
  - DL format, taped lectures, Collaborative environment
  - We work to accommodate student busy schedule
- Broad AF interest from T&E organizations
  - Support across T&E for fundamental education
  - HQ AFMC (workforce development), ACC (53<sup>rd</sup> at Eglin), AFMC (46<sup>th</sup> at Eglin), AEDC, AFFTC, AFOTEC
- Purpose is to provide advanced statistical knowledge to the T&E enterprise



# T&E Certificate Program



*Develop America's Airmen Today ... for Tomorrow*

- Our students:
  - 804 MXS/MXM, 780 TS/OGMAT, 782 TS/TSWH, 411 FLTS , 40th FTS/DOP, 46 TS/OGEC, 46TS/TSDE, AFOTEC Det 1, AFOTEC Det 2, HQ AFOTEC, 746 TS (the first cohort)
  - Cohort #1 – #3 – Total of 31 of 40 enrollees have finished
  - Cohort #4-6 – SAF/AQ funding programmed for 25; 26 started
    - Graduated 42 of 50 in Cohort 4 & 5 have finished
    - Cohort 6 is in progress; Cohort 7 being assembled
- T&E Workforce Development driving req'ts
  - T&E Workforce applicants are the priority
- Feedback to date has been outstanding





# Science of Test Consortium



*Develop America's Airmen Today ... for Tomorrow*



Ray Hill  
Doug Hodson  
Brian Stone  
Jason Freels  
Brent Russell  
Darryl Ahner

Rachel Silvestrini

Douglas Montgomery  
Edgar Hassler  
Sarah Burke



Alyson Wilson



Geoff Vining  
Rebecca Dickinson



Edward Pohl  
Kelly Sullivan  
Alex Wong



# Brief History



*Develop America's Airmen Today ... for Tomorrow*

- Consortium initiated with FY11 Funding
  - Kickoff meeting March 4, 2011
  - Focus on experimental design and applied statistics
  - Realized reliability should be a component as well
- University of Arkansas added in early 2013
- University of North Carolina added in late 2013
- Full consortium support with FY14 funding
- Three main focii
  - Experimental design and applied statistics
  - Reliability and reliability growth
  - Live, virtual and constructive simulation



# Accomplishments



*Develop America's Airmen Today ... for Tomorrow*

- 24 Journal papers accepted/published
  - 6 additional papers submitted
- 9 Conference papers
- 20 Masters theses produced
- 5 PhD completions, 2-5 in-progress
- Over 20 professional presentations
- Re-write of the DAU statistical curriculum
- Various tutorial videos created and will becoming available