

AFFTC-PA-11251



STATISTICALLY DEFENSIBLE TEST & EVALUATION: CURRENT APPROACHES AND FUTURE RESEARCH AT THE AFFTC

EILEEN BJORKMAN

**AIR FORCE FLIGHT TEST CENTER
EDWARDS AFB, CA**

21 July 2011

**A
F
F
T
C**

Approved for public release A: distribution is unlimited.

**AIR FORCE FLIGHT TEST CENTER
EDWARDS AIR FORCE BASE, CALIFORNIA
AIR FORCE MATERIEL COMMAND
UNITED STATES AIR FORCE**

Air Force Flight Test Center (AFFTC)

War-Winning Capabilities ... On Time, On Cost

Statistically Defensible Test & Evaluation: Current Approaches and Future Research at the AFFTC



U.S. AIR FORCE

Eileen Bjorkman, AFFTC/CZ

21 Jul 11

(661) 275-2074

eileen.bjorkman@edwards.af.mil

Integrity - Service - Excellence

Approved for public release; distribution is unlimited, AFFTC-PA-No: 11251



Overview



- **AFFTC Mission**
- **Test Approaches**
- **AFFTC Application Examples**
- **AFFTC Way Forward**
- **Potential Research Areas**



AFFTC Mission



AFFTC



- The Air Force's center of excellence for airframe propulsion, avionics and electronic warfare research developmental test & evaluation
- Leverage our location, weather, partnerships & personnel to conduct independent, objective assessments on behalf of the United States Air Force





Test Approaches



- **Statistical**
 - **Designed Experiments**
 - **Observational Studies (may have limited scope of inference based on test design)**
- **Demonstrations**
- **SME/Opinion-Based**

- **Primary difference is in the outcome of each approach:**
 - **Validity of the result, and**
 - **Scope of inference that can be made for that test**



AFFTC Application: Target Detection and Recognition



AFFTC



Test Objective:

- Demonstrate the ranges at which a pilot can recognize and identify certain ground targets using imaging sensors in a targeting pod

Test Approach:

- DOE with four factors and four response variables
- Augmented flight tests with post-flight video review

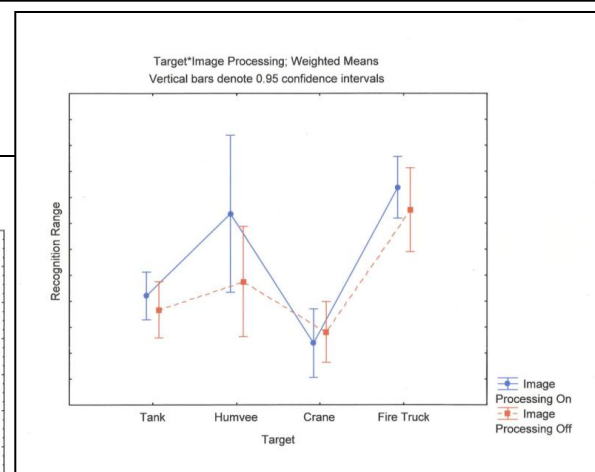
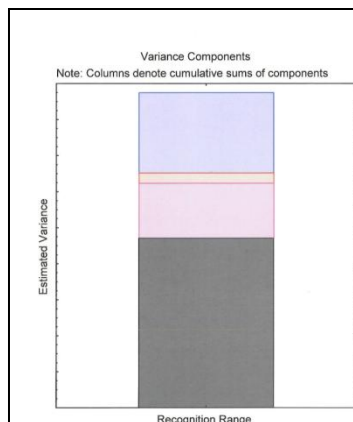
Analysis Approach:

- Paired t-test to compare in-flight data to post-flight data
- ANOVA to determine significant factors, recognition ranges, and identification ranges

	Recognition	Identification
p-value	0.46	0.078

No statistical difference, but close!

Results:





AFFTC Application: Endurance Verification



Test Objective:

- Determine if an aircraft, in mission capable configuration, has a minimum total endurance of **X** hours plus appropriate fuel reserves IAW AF instructions

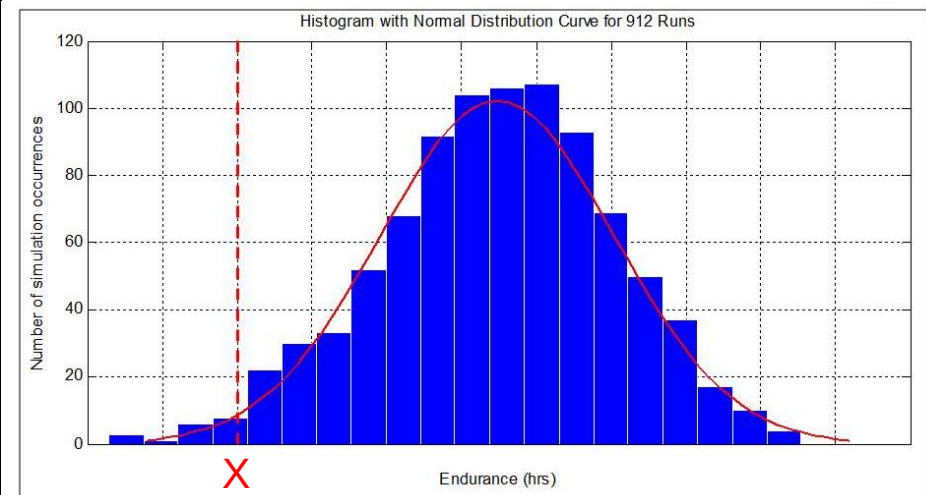
Test Approach:

- Collect flight data regarding drag and lift coefficients, fuel flow, and static pressure error

Analysis Approach:

- Estimate uncertainties associated with weight, outside air temperature, thrust, fuel, flow, drag coefficient, and calibrated airspeed
- Use Monte-Carlo analysis to generate expected range and endurance

Results:





AFFTC Way Forward



- **Developing handbook to include overview of statistics and AFFTC best practices**
- **Adding statistics input and review to our test planning and reporting processes**
- **Working potential research projects with Air Force Institute of Technology and USAF Test Pilot School**
- **Planning pathfinder projects in each flight test technical discipline**

Flight controls
Collision avoidance
Performance
Human Systems Integration
Radar Systems
Electronic Attack

Modeling & Simulation
Guidance, Nav, ID
Communications
C4ISR
Weapons Systems
Anechoic Facility

R&M
Avionics
Threat Signals
Propulsion
Structures
Subsystems



Potential Research Topics



- **Flight test techniques that take advantage of advanced computing & statistical methods**
- **Analysis of time series data**
 - Tends to be highly correlated
 - Often violates independence assumptions required for analyzing normal data
- **Quantifying aleatory and epistemic measurement uncertainties associated with:**
 - Digital data buses
 - Data models
- **Bayesian techniques**
 - Combining prior information with flight test data
 - Combining multiple models