

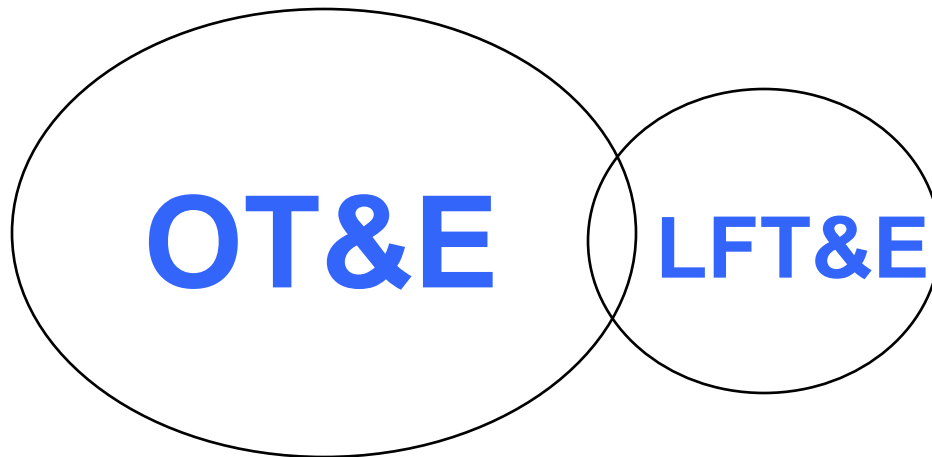
***An LFT&E Perspective on Making
M&S and T&E Better Partners***

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DOT&E Assessments

- Operational Effectiveness
- Operational Suitability
- Survivability



Lethality -- weapons systems and munitions

Vulnerability --manned systems



What Makes LFT&E Different?

- **Operational Tests**
 - Force-on-force
 - Systems operated by typical users
 - Users protected from live fire
- **Live Fire Tests**
 - One-on-one
 - Destructive tests
 - User not on board



Legislative Emphasis on User Casualties

LFT&E

The term 'realistic survivability testing' means...

testing for vulnerability of the system in combat by firing munitions likely to be encountered in combat...

with the primary emphasis on testing vulnerability with respect to potential user casualties....

10 USC 2366

Basic Principles

- It is possible to craft an LFT&E program that does not include modeling and simulation, but probably not wise
- M&S is a tool in support of both test and evaluation, not an alternative to testing

Test & Evaluation

M & S

- Shot selection
- Test sequencing
- Pre-test prediction

- Integration of test results
- Extension to untested conditions
- System-level analyses
- Validation & model improvement

Vulnerability and Lethality

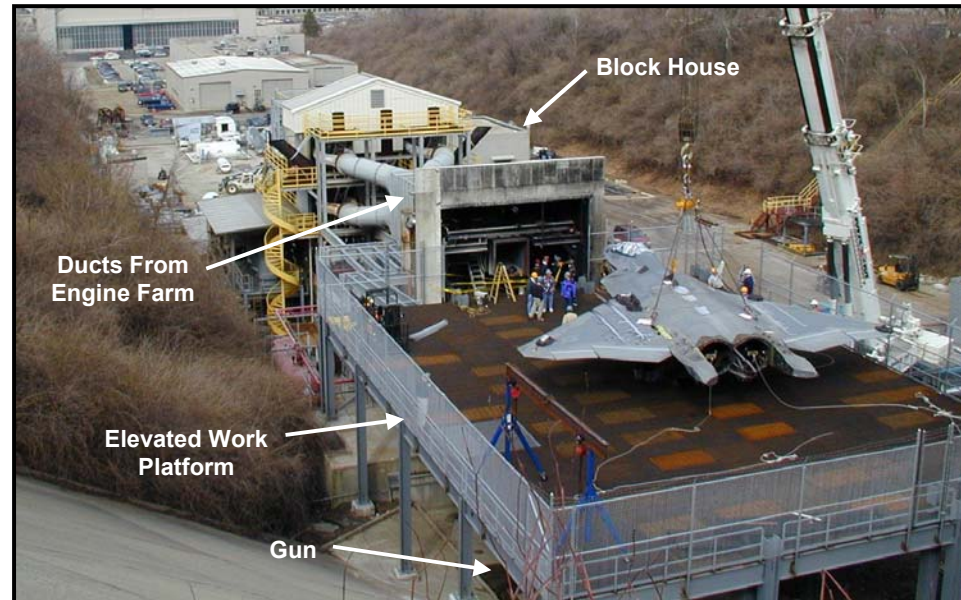
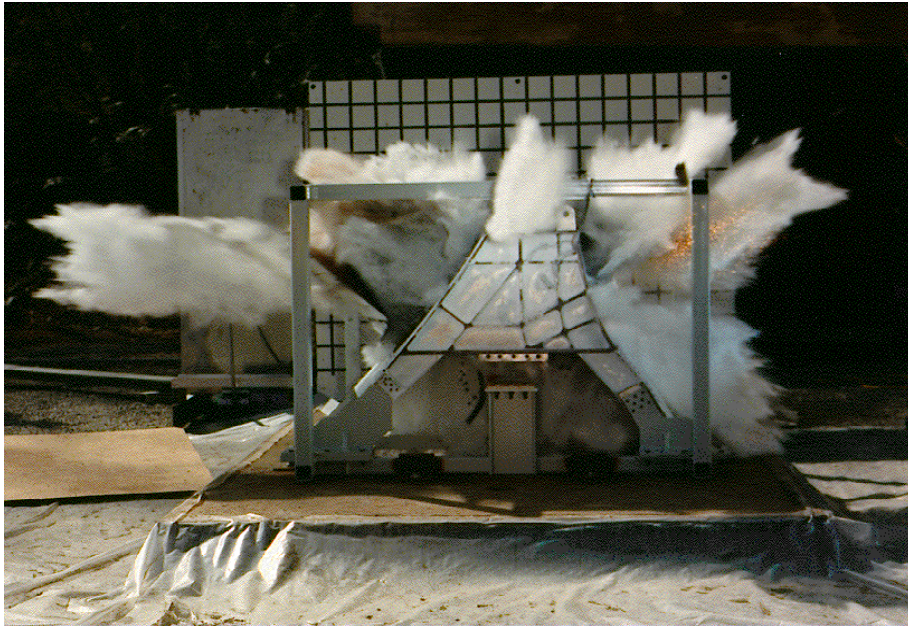
- **Unexpected vulnerabilities, personnel casualties**
- **M&S tends to underestimate lethality, overestimate survivability**
- **Operational lethality vs. parametric lethality**

Validity

We test in order to validate system performance. We simulate because we cannot afford to test everywhere

"If we don't test, the model is always right." (Jim O'Bryon)

F-22 Wing Section Test



Benefits of M&S?

"Modeling and simulation offers the F-22 program another benefit," Air Force sources said. "Because the Service would control the inputs into the model, the outcome -- proving the aircraft's effectiveness -- is much easier to shape than the outcome of an open air test with any number of unanticipated variables."

Inside the Pentagon, September 1, 1995

- **All sources of data are not equal**
- **A number of laws require testing; few laws require M&S**

Learning and Evaluation

- **M&S is of undoubted benefit in designing more survivable, or more lethal, systems**



Learning and Evaluation

- Much can be learned from a single realistic event



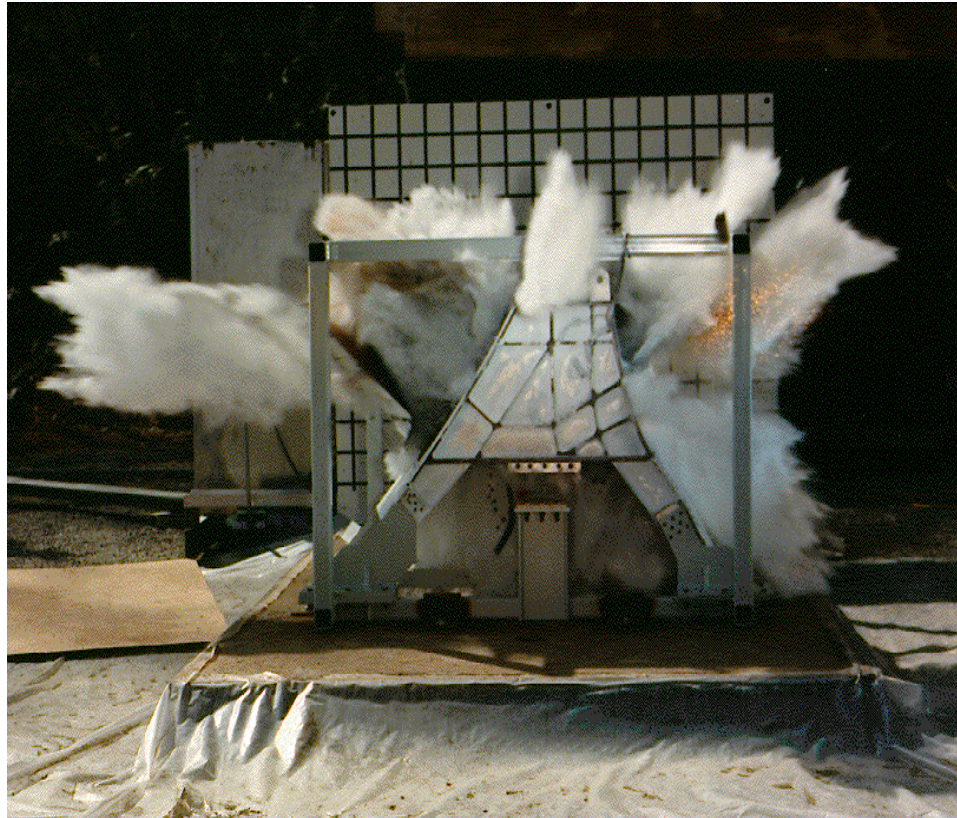
Learning and Evaluation

- **Much can be learned from a single realistic event**



Learning and Evaluation

- Much can be learned from a single realistic event



- **It is misleading to compare relative numbers of test shots and simulated shots**
- **Beware the appeal of “statistically significant” sample sizes based on M&S**
- **“Does the model give 1000 shots worth of information, or the information from one shot 1000 times over?”**

Learning and Evaluation

- **Live Fire Testing is limited to a small number of tests, but each one provides the opportunity for surprises**
- **Surprises occur regularly**
- **The level of test realism determines the kinds of surprises that are possible**



Learning and Evaluation

- **If M&S results are to affect design, the information must be credible at the component level**
- **OSD's M1A1 Abrams Tank LFT&E report noted that the model "...in its current state, would be inadequate for evaluating the effectiveness reduction of design changes. Over half of the critical components damaged leading to a loss of function were either not predicted ... or were assessed as rare events...."**

Pretest Predictions

- **“We’ll know we’re successful in live fire testing when the modeling tools we use are so successful that there are no surprises in LFT.” (Gen Larry Welch)**
- **Surprises are only meaningful in terms of expectations, and expectations are defined by pretest predictions.**

Pretest Predictions

- **Pretest predictions do not have to employ computer models**
- **Predictions should contribute to the planned evaluation**
- **The prediction should be capable of being compared with the test damage assessment**

“In assessing the value of computer models, the “golden rule” applies: a model must predict with higher accuracy than the consensus process (engineering judgment).”

Challenges -- Personnel Casualties

- **Assessment of personnel casualties is increasingly relevant, and presents a major challenge for M&S**
- **Personnel casualties are important in their own right, and not just as a contributor to mission kill**
- **If we expect to make progress towards reducing casualties, we need a means to track that progress**

Challenges -- Ships

- **Ship programs are looking for alternatives to full ship shock trials**
- **M&S will need to be developed to support these alternatives**



Other M&S Challenges

- **Proprietary M&S**
- **Integrated survivability M&S (detectability, hit avoidance, vulnerability, recoverability)**
- **Timely correction of M&S-based estimates to account for test results**
- **Ballistic M&S**

- **LFT&E needs M&S to properly evaluate system vulnerability or lethality**
- **Improvement is needed in several areas**
- **These include the assessment of personnel casualties, and the integration of vulnerability M&S into an integrated survivability assessment**