

**TITLE: Information Fusion Systems Evaluation**

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**DURATION: Half-Day**

**KEYWORDS:** Fusion Evaluation, Performance Assessment, Metrics, Scenarios, Tracking, Object Identification, Situational Awareness

**OBJECTIVE:** Information fusion, like other research areas, needs to standardize methods of evaluation for design and operational testing, validation, and verification. The tutorial presents methods and approaches gathered and used to show the usefulness and contribution of information fusion methods to complex systems designs.

**ABSTRACT:**

This course provides attendees with a basic working knowledge of assessing the performance of integrating Data, Sensor, and Information. The course concentrates on information fusion architectures, algorithmic designs, testing methods, and comparison techniques of multi-sensory systems. Many practical and useful examples are included throughout with metrics, experiments, and evaluation considerations. You will become knowledgeable with how to effectively design, test, and evaluate Fusion systems for varied applications and users. The course price includes the documentation presented by the instructor.

**This course will enable you to:**

- Integrate an Fusion Evaluation techniques into an information fusion design
- Identify metrics and evaluation standards for Fusion systems
- Describe various operating conditions for Fusion testing
- Demonstrate fusion performance modeling for information fusion systems

**Intended audience:**

This material is intended for anyone who needs to learn how to integrate, test, and verify information fusion designs as part of a complex system utilizing multi-information inputs. Those who design their own Fusion subsystems, need to validate their architectures to users, or work with information fusion designers will find this course valuable.

Course level: Intermediate

**Instructor:**

**Erik Blasch** is a Fusion Evaluation engineer at Air Force Research Lab, co-founder of the International Society of Information Fusion (ISIF), adjunct professor in the Electrical Engineering at Wright State University, and has been involved in information fusion design

and engineering for over 15 years. He has authored over 200 papers and been associated with many fusion programs within DoD. He is a SPIE Fellow.

**Detailed outline:** A detailed outline of the tutorial addressing the following issues: references to past tutorials or teaching materials, why the topic is of interest for Fusion 2008 attendees and the expected benefit to participant, depth and scope of the exposed topics, exercises, software demonstrations, etc.

#### **OUTLINE:**

**Lesson 1:** Introduction - Importance of Sensor Fusion (advantages and disadvantages)

**Lesson 2:** Sensors and Architectures - JDL Levels 1 - 5, Decision making Metrics

**Lesson 3:** Reducing the error /uncertainty analysis, compensating for unknown

**Lesson 4:** Fusion System Evaluation - Fusion Gain, ROC Curve, and Design of Experiments

**REFERENCES:** Past tutorials in Fusion Evaluation by Dr. Blasch include Fusion07 and Fusion05. Teaching material includes class material from EE718 Target Tracking, ENG501 Automatic Target Recognition, EE717 Data Fusion, and a host of standard EE classes in stochastic methods, communications, and linear systems where I emphasize comparative methods in learning and projects.

**INTEREST/BENEFIT to ATTENDEES:** Based on the feedback from FusionNN students and people who attended the tutorial, they are always excited (and thankful) about the importance and methodology presented to verify and validate their approaches of information fusion in a complex system. Such information as metrics, evaluation, and scenario design over sensors, targets, and environmental operating conditions allow them to effectively demonstrate their techniques and "manage expectations" to users. The scope and depth vary as I can accommodate a variety of topics and tailor the examples to the audience: from tracking, object identification, small-to-large scale systems, cyber systems, etc. Software demonstrations and routines (MATLAB) are available to the student. While I have yet to formally package them, I have produced CDS of the course material and stand-alone routines to hand out, as well as provided DVDs with exemplar code and data for the specific audience (as needed). Due to the job affiliation, I have tried for years to deliver data to the practitioners. Examples of successful things include tracking routines of synthesized data, image fusion evaluation routines using the ([www.imagefusion.org](http://www.imagefusion.org)) data from the UK and the Swedish CARABASS data, as well as the AFRL/MSTAR SAR data. Other proposed techniques include an ISIF working group on cyber data and standard image processing data (VIVID). I usually follow up with the attendees to make their attendance rewarding.

The tutorial is intended to cover the general topics concerning data and information fusion use with emphasis on pragmatic fusion techniques. By highlighting the advantages and disadvantages of fusion, one can assess the gain of using multiple sources of information. Many users are excited about the prospects of the concept called "fusion"; however, if applied inappropriately, could result in detrimental effects. To mitigate the embellished opportunities of fusion, it is important to correctly evaluate fusion systems and appropriately quantify the "fusion gain".

By introducing fusionists to metrics and evaluation techniques, one can determine if combining multiple sources of information is justifiable. The first session introduces the importance of fusion, as in using different sensors to capture observable quantities about the environment. The second session details the larger organization of fusion systems as machines that process large quantities of data and reduce the dimensionality for a user to reason and make decisions over. The third topic highlights the fact that any information uncertainty must be reduced for the user. In the third session explains the mathematical techniques to reduce uncertainty. If the user is better able to make decisions with appropriate mathematical models for information fusion, data collection, and timeliness of results; the fusion system is doing its job.

The final session details the process by which a fusionist can determine a "fusion gain" for user decision making and verifiable situational awareness. A fusion evaluation process will be explained which includes

- (1) metrics for testing,
- (2) design of experiments analysis over operating variables, and
- (3) examples of successful fusion evaluation techniques.

After attending the tutorial, the student would better appreciate the complexity surrounding defending a realistic efficacy in fusion system performance.

**Presenter**

Dr. Blasch has been a long standing member of the ISIF community and currently leads a Fusion Evaluation Team.

Ongoing work includes performance evaluation of

- (1) image fusion systems,
- (2) tracking techniques, and
- (3) simultaneous target tracking and identification systems for which he was the first to publish a mathematical technique of integrating image fusion and target tracking techniques.

The performance evaluation studies also include end users and field tests of such systems in complex environments.