

# FAA Composite Safety Awareness Course Developments

## Outline

- Overall strategies
- Structural engineering safety awareness course
- Manufacturing safety awareness course

Presented to: Fall 2012 AMTAS Meeting

By: Larry Ilcewicz, FAA

Date: October 31, 2012



Federal Aviation  
Administration



# Composite Educational Initiatives

## FAA AVS Composite Training

- **FAA composite training strategy using existing courses, FAA COE & industry support [Sept., 2009]**

- Courses to support airframe engineering, manufacturing and maintenance functional disciplines

- **Incl. three levels of competency:**

### I) **Introduction** (common to all functional disciplines)

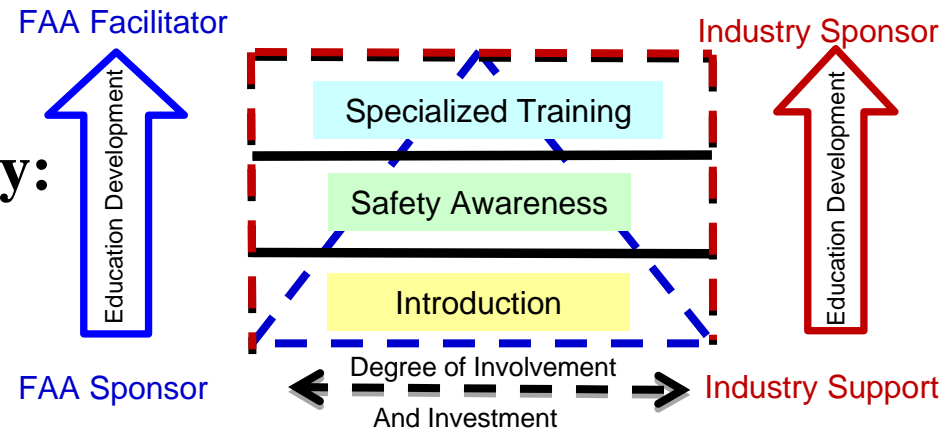
- Self-study intro content for composite basics/terminology
- CMH-17 Tutorial for composite certification & compliance [Aug, 2008]

### II) **Safety Awareness** (courses for each functional discipline)

- Skills needed for FAA workforce supporting composite applications
- FAA development status summarized on the following charts

### III) **Specific Skills Building** (most courses developed by the industry)

- Specialized skills needed in the industry and some FAA experts



# Status - Level II Courses Development

- **Maintenance Safety Awareness (CMT)**

- [International Standard: CACRC AIR5719]**

- FAA-led course development completed by Edmonds CC [9/2008]
    - AFS-500 class-room version available to FAA [Since 2009]
      - ~ 350+ AFS Inspectors trained to date through FAA contract with ABARIS
    - Future review cycles to update for currency [starting 2012]
    - On-line version available to the industry

- **Structural Engineering Safety Awareness (CSET)**

- [In Work - Sponsored by FAA R&D, AIR-520]**

- FAA “M&P Control” Workshop and Module [2010]
    - Content development (90%) [4/2012]
    - Beta Course Workshop [6/2012]
    - Completion of content, teaching points and assessments [9/2012]
    - Course (on-line and lab) offered through WSU [2/2013]

# Status - Level II Course Development (cont.)

- **Manufacturing Safety Awareness (CMfgT)**  
**[In Work - Sponsored by FAA R&D, AIR-520]**
  - Detail outline [12/2011]
  - Content development started [9/2012]
  - Beta Course [6/2013]
  - Content completion, teaching points and assessments [9/2013]
  - Course (on-line and lab) offered through WSU [2/2014]
- CMT – Target Audience: FAA Flight Safety Inspectors  
[Content: 64 Hours]
- CSET – Target Audience: FAA Airframe Engineers & Delegations [Content: 80 Hours]
- CMfgT – Target Audience: FAA Manufacturing Inspectors  
[Content: 64 Hours]

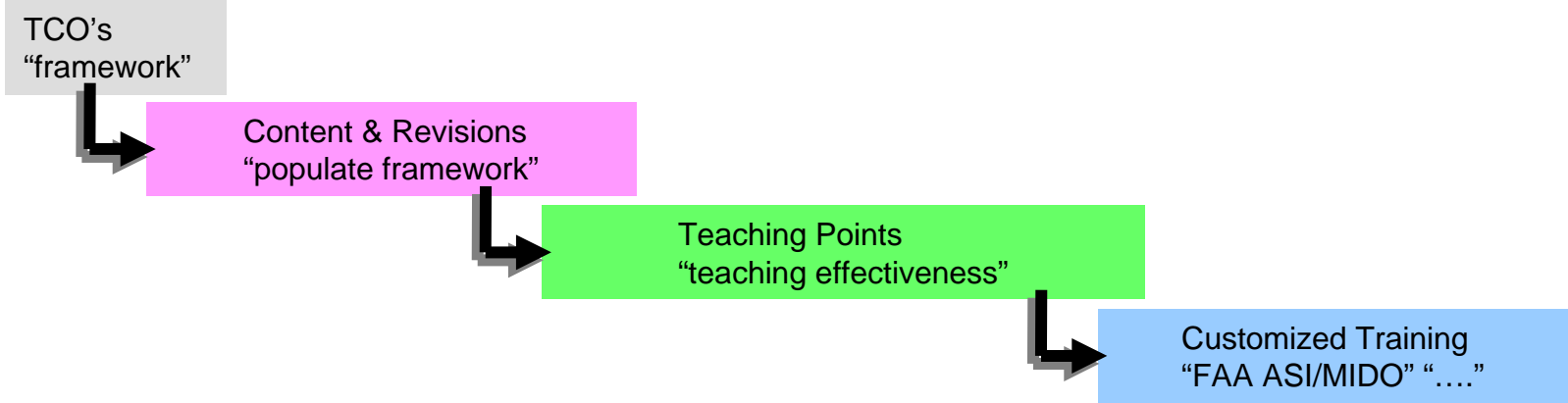


# Composites Maintenance and Repair Curriculum

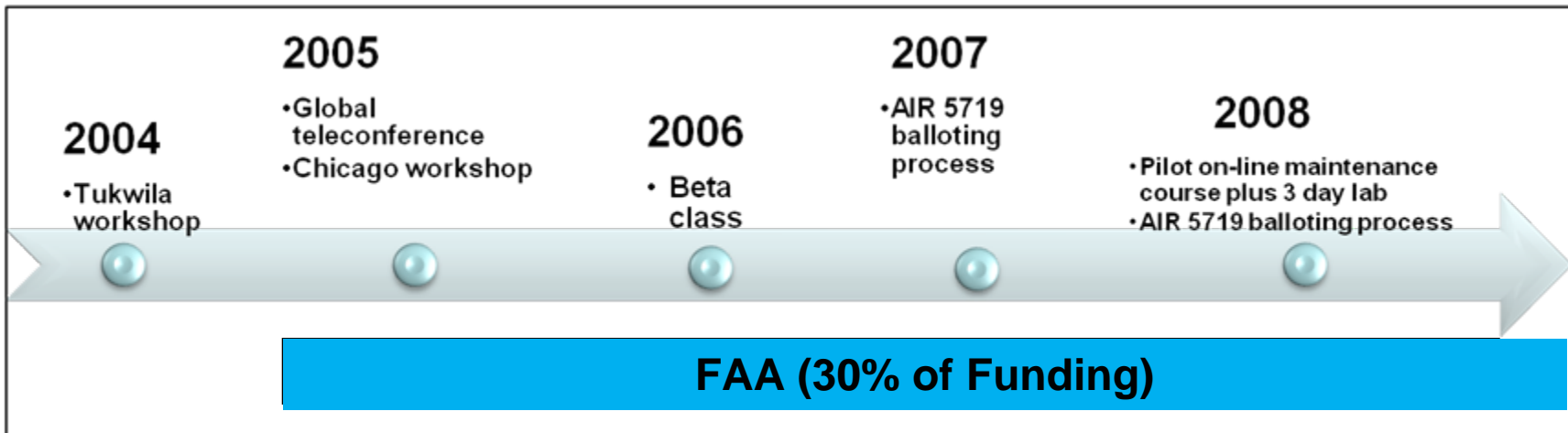
Total Cost at \$1.7 mm

Development

2004	2005	2006	2007	2008
------	------	------	------	------



Industry Feedback



# Curriculum Philosophy Applied to All Level II Safety Awareness Courses

- **Objective:**
  - Present content and provide learning retention through a combination of format, teaching materials, and multiple student experiences.
    - The most effective approach establishes “meaning before content” for students through learning enhancements.
      - **Goal: long term retention**
    - Assessments, including discussion of applications, assure students understand teaching points



# Curriculum Philosophy, *continued*

## Examples of Learning Enhancements

<b>Tactile Learning</b>	➤ Hands-On Laboratory
<b>Contextual Learning</b>	➤ Practical Application <ul style="list-style-type: none"><li>○ Field Repair Examples</li><li>○ Case Studies</li><li>○ Testimonials from Experts</li></ul>
<b>Audio-Visual Learning</b>	➤ Examples: <ul style="list-style-type: none"><li>○ Pulse Echo/TTU/Wedge Test</li></ul>

- **Teaching points enable a consistent teaching experience regardless of instructor or learning environment**
- **Learning Enhancements increase long-term retention**



# Composite Structural Engineering Technology (CSET) Course

- **Top-level Course Objectives**

- Students will describe essential safety awareness issues associated with composite structural engineering important to safe composite aircraft product applications
- Students will describe engineering principles of composite airframe substantiation during all stages of aircraft product certification

- **Top-level Course Outline**

- 1.0 Introduction
- 2.0 Challenges of Composite Applications
- 3.0 Design, Material and Fabrication Development
- 4.0 Proof of Structure
- 5.0 Quality Control of Composite Manufacturing Process
- 6.0 Maintenance Interface Issues
- 7.0 Additional Considerations

**70% of  
Course**





# Contributors - Level II CSET Course

- **FAA Composite Team** (led by Larry Ilcewicz, Lester Cheng & Charlie Seaton)
  - Structures Specialists: Dave Walen (Lightning Protection CSTA), Mark Freisthler (Transport Directorate Standards), Cindy Ashforth (Transport Directorate International Branch), Angie Kostopoulos (Chicago ACO), Allen Rauschendorfer, Melanie Violette and Nathan Weigand (Seattle ACO)
  - Cabin Safety Experts: Joseph Pelletiere (Crash Dynamics CSTA), Dick Hill, Robert Ochs & Alan Abramowitz (FAA Technical Center), Jeff Gardlin (Transport Directorate Standards),
- **Key subject matter experts (SME)**
  - Peter Smith (retired Boeing)
  - Keith Kedward & Steve Keifer, UCSB (incl. composite design/analysis textbook)
  - Steve Ward (M&P control, design/analysis and proof of structure)
  - Tom Walker and D.M. Hoyt, NSE Composites (fatigue & damage tolerance)
  - Wichita State University (Yeow Ng, Waruna Senevertine, Beth Clarkson, lab development)
  - Delft University (Christos Kassapoglou)
  - Other SME (contractors and volunteers)
    - Michael Niu (UCLA, composite design)
    - Max Davis (Adhesion Associates, metal-bonding)
    - Michael Borgman (Spirit Aero, repair substantiation)
    - FAA JAMS (Paolo Feraboli, Hyonny Kim, Dan Adams)
    - Convergent Manufacturing Technologies (Univ. of British Columbia composite manufacturing experts)
    - Heatcon (Field and Production repairs, including those performed on-airplane)
    - Workshop participants: presentations, discussions, testimonials (M&P control, fatigue & damage tolerance, crashworthiness)
    - John Halpin (retired Air Force)
    - Will McCarvill (retired Hexcel)
    - John Adelman (retired Sikorsky)
    - Dan Ruffner (Boeing, Mesa)



# Composite Structural Engineering Technology

## Selected Course Outline Details

Prerequisite self-study modules for basic understanding/terminology and synopsis  
(using an outline that follows that of the main course)

1. Introduction
2. Practical appreciation for the challenges of composite applications
3. Design, Material and Fabrication Development Module
  - 3.1 Integrated product team needs (emphasis on composite specialists)
  - 3.2 Material & Process Control (roughly 1/3 of this section)  
*Qualification, test methods, test matrices, material & process specifications, quality control, statistical process control, and roles & responsibilities*
  - 3.3 Composite Structural Design (roughly 1/2 of this section)  
*Structural details, lamination theory, failure modes, environmental considerations, design criteria & objectives, analysis methods, finite element considerations, material allowables/properties, design values, structural bonded & bolted joints other considerations in design (crashworthiness, fire safety, lightning), protection of structure*
  - 3.4 Manufacturing Interface Section  
*Composite manufacturing methods, manufacturing documentation, production considerations*
  - 3.5 Maintenance Interface Section  
*Composite maintenance practices (repair & inspection), maintenance documentation*
  - 3.6 Statistical methods



# Composite Structural Engineering Technology

## Selected Course Outline Details, *cont.*

4. Proof of Structure Module  
[integrated for static strength, fatigue & damage tolerance]
  - 4.1 to 4.9 General  
*Rules/guidance, key concepts, compliance approaches, program development plan, damage & defects and related design considerations*
  - 4.10 Damage Threat Assessment
  - 4.11 to 4.13 Structural substantiation  
*Building block approach (structural details, design values, typical test matrices), repeated load reliability (load enhancement factor) and full scale test considerations*
  - 4.14 Inspection Program Definition and Substantiation
5. Quality Control of Composite Manufacturing Processes
6. Maintenance Interface issues
7. Additional Considerations
  - 7.1 Proof of Structure - Flutter
  - 7.2 Crashworthiness
  - 7.3 Fire Safety and Fuel tank Issues
  - 7.4 Lightning Protection



# Composite Manufacturing Technology (CMfgT) Course *(currently in-development)*

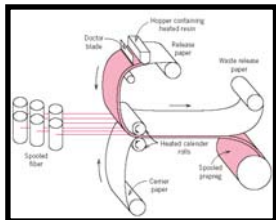
## Top-Level Course Objectives

- **Students will describe the essential safety awareness issues associated with composite manufacturing technologies & processes important for conformity to type design.**
- **Students will describe deficiencies on the factory floor that have safety implications.**



# Composite Manufacturing Technology (CMfgT) Course Outline

Prepreg Production



Transportation



Storage



Tooling Preparation



Inspection



Cure



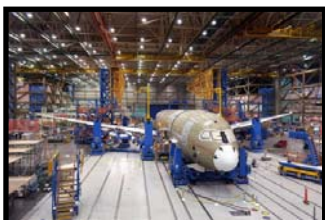
Debulking / Bagging



Layup



Assembly



- Recommendations that course is presented from a factory perspective as experienced by a Manufacturing Inspection District Office (MIDO) Inspector
- At each step, discuss deviations (and defects), root causes, in-process and post-process controls
- Introduce information over a number of passes

# Summary

- **FAA composite training developments are focused on safety awareness (Level II)**
  - Industry has supported the efforts since 2005
  - Separate courses for maintenance, structural engineering and manufacturing functional disciplines
  - Learning enhancements include labs, testimonials, case studies and application discussion threads with experts
  - Composite maintenance course first taught in 2009
- **Two active composite training initiatives**
  - Composite Structural Engineering Technology (CSET) is nearly completed and scheduled to be available in 2013
  - Composite Manufacturing Technology (CMfgT) is under development and scheduled to be available in 2014

