

# Composite Safety and Certification Initiatives



Federal Aviation  
Administration

## Objectives

- 1) Work with industry, other govt. agencies and academia to ensure safe and efficient deployment of composite technologies used in existing & future aircraft
- 2) Update policies, advisory circulars, training, and detailed background used to support standardized composite industry practices

Presented to: European Bonded Structure Meeting  
(EASA, Koln Germany)

By: Larry Ilcewicz, FAA

Date: June 13, 2013

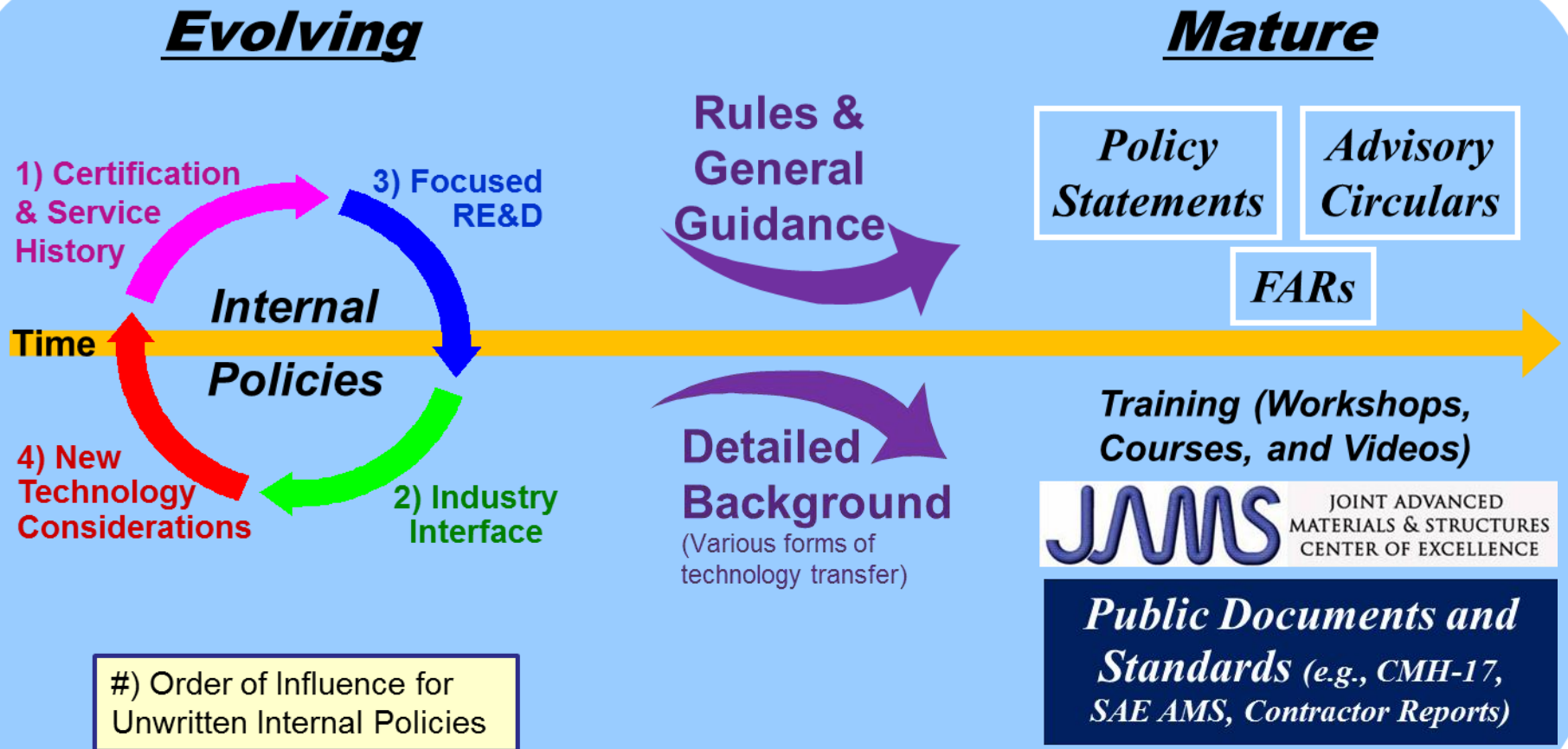


# Outline

- **Background**
- **FAA Aviation Safety Composite Plan**
- **Ongoing initiatives for composite guidance/standards**
  - Bonded repair initiatives (policy and related plans)
  - Future bonded structures initiatives
- **FAA composite educational initiatives**
  - Overall strategies
  - Structural engineering safety awareness course
  - Manufacturing safety awareness course



# FAA Approach to Composite Safety & Certification Initiatives



# Composite Technical Thrust Areas

*Advancements depend on close integration between areas*

Material Control, Standardization  
and Shared Databases

## Structural Substantiation

- Advances in analysis & test building blocks
- Statistical significance
- Environmental effects
- Manufacturing integration

## Progress to Date

- AC 20-107B (9/09)
- 2 other Advisory Circulars
- 7 Policy Memos
- 16 Workshops
- 4 Training Initiatives
- 2 Technical Documents
- CMH-17 Updates
- SAE CACRC Standards
- ~60 FAA R&D Reports

## Damage Tolerance and Maintenance Practices

- Critical defects (impact & mfg.)
- Bonded structure & repair issues
- Fatigue & damage considerations
- Life assessment (tests & analyses)
- Structural test & analysis protocol
- Accelerated testing
- Structural tear-down aging studies
- NDI damage metrics
- Equivalent levels of safety
- Training standards

Bonded Joint  
Processing Issues

Advanced Material  
Forms and  
Processes

Flammability &  
Crashworthiness

*Support to future  
cabin safety initiatives*

*Significant progress, which has relevance to all aircraft products, has been gained to date*

# Recent/Future Milestones for Composite Safety & Certification Guidance & Training

Implement Composite Maintenance Awareness Course

High Energy Blunt Impact Awareness

Release AC 20-107B (Composite Aircraft Structure)

Release CMH-17 Revision G

- *Advances in statistics, test methods and data reduction protocol*
- *Major Volume 3 re-organization*
- *New Volume 6 (Sandwich)*
- *New certification & compliance chapter*
- *New crashworthiness chapter*
- *New safety management chapter*
- *Updates to damage tolerance & maintenance*

**6 Hour Tutorial  
developed in 2008**

NCAMP shared databases and specifications (CMH-17, SAE AMS)

Sandwich disbond growth initiatives (CMH-17 Disbond & Delamination TG)

Additional FAA/Industry WG initiatives (bonded repair, hybrid structure)

FAA/Industry composite education initiatives

Metal bond durability standards & guidance

Composite damage tolerance guidance

Crashworthiness guidance

2010

2011

2012

2013

2014

2015

# Aviation Safety Composite Plan

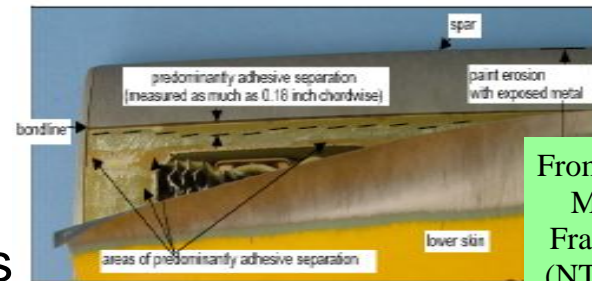
Continuous Operational Safety (COS)	Certification Efficiency (CE)	Workforce Education (WE)
COS 1: Bonded Repair	CE 1: Hybrid F&DT Substantiation	WE 1: Composite Manufacturing Technology
COS 2: Metal Bond Quality Control	CE 2: Bolted Repair	WE 2: Composite Structures Technology
COS 3: Sandwich Bond Growth	CE 3: Transport Crashworthiness	WE 3: Composite Maintenance Technology
COS 4: HEWABI	CE 4: Composite QC	WE 4: Composite Basics
COS 5: Aging Composite Aircraft Teardown	CE 5: Lightning Protection	WE 5: Composite DER
COS 6: Failure Analysis of Composites Subjected to Fire	CE 6: Advanced Composite Maintenance	WE 6: Composite Training Budget
	CE 7: Bonded Structure Guidance	
	CE 8: General Composite Structure Guidance	
	CE 9: CMH-17 Revision H	





# Bonding Field Difficulties

- Helicopter main rotor blade metal bonding problems
  - 2008 NTSB Safety Recommendations
  - Possible metal bond processing problems  
(*FAA R&D to help update wedge test standards & training*)
- Rudder debonding
  - NDI to control current field problems
  - OEM shared technical solutions & design concerns with industry in FAA 2009 Tokyo Workshop (*standards to be adopted by CMH-17*)
- Extensive repair deficiencies
  - DER-approved *repair design and processes* without supporting data
  - Inappropriate material substitutions, poor workmanship & inadequate tooling
  - Discovered when rigging on aircraft  
(*case studies documented with CACRC*)

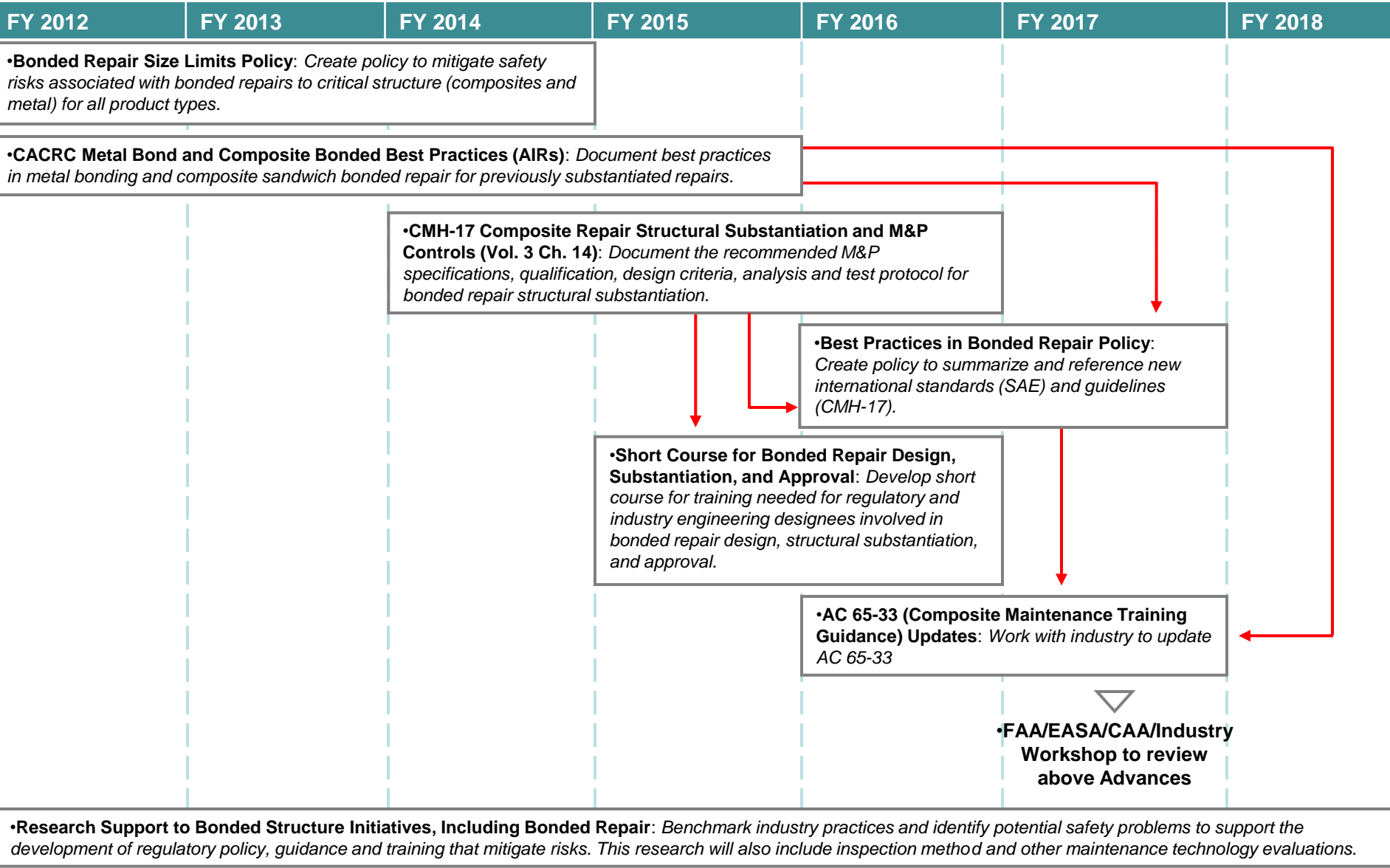


From Air Force  
MP3 Mtg.  
Frank Zankar  
(NTSB, 2008)

In-flight Rudder Failure  
(Large damage causing flutter)  
Air Transat Flight 961 [3/6/05]



# Bonded Repair Initiatives





# Policy Content: *Bonded Repair Size Limits*

- *The size and extent of a bonded repair is first constrained by the limits of substantiating data* used to meet appropriate rules
  - Repair processes must produce consistently sound structure (performed using approved/qualified materials and processes)
  - Repair design must have structural substantiation needed for the structure (tests or analyses supported by tests)
  - Service inspections of bonded repair should be capable of finding complete or partial failure of the bondline. Inspection intervals must consider criticality of the structure and residual strength with the repair failed.
- *Critical structure will have an additional repair size limit to be no larger than able to yield Limit Load residual strength capability with the repair failed* within arresting design features
  - Note that this requirement may not control depending on the repair size limit coming from the first constraint
  - Residual strength with the repair failed should be shown by tests or analysis supported by tests

# Schedule for Development, Approval and Release of Initial Policy for Bonded Repair Size Limits

Essential Content &

▼ Top-Level Outline

▼ Detailed Outline

▼ 1<sup>st</sup> draft of Policy

▼ WG Update of Policy

Final draft of Policy ▼

4 <sup>th</sup> Quarter 2011	1 <sup>st</sup> Quarter 2012	2 <sup>nd</sup> Quarter 2012	3 <sup>rd</sup> Quarter 2012	4 <sup>th</sup> Quarter 2012	1 <sup>st</sup> Quarter 2013	2 <sup>nd</sup> Quarter 2013
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Subsequent Tasks

- FAA/EASA Internal Reviews
- US & Europe Public Commenting
- Final FAA/EASA Issuance

# Progress for Bonded Structures

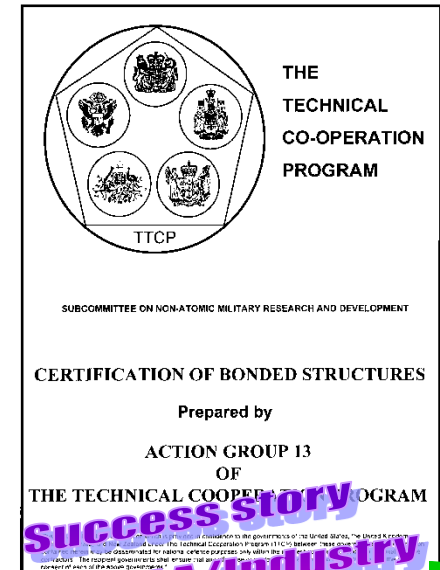
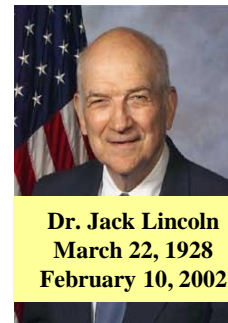
## *Action Groups for Detailed Documentation*

- Some guidance for bonded structures, which comes from military and commercial aircraft experiences, was documented in a TTCP report
  - Chairman: Jack Lincoln, WPAFB
  - Composite and metal bonding
  - Starting point for FAA bonding initiatives
- FAA policy for bonded joints and structures was released in Sept., 2005

### Purpose

1. To review the critical safety/technical issues
2. To highlight some of the successful engineering practices employed in the industry
3. To present regulatory requirements and certification considerations pertinent to bonded structures

- Part 21 AC planned for FY16 to FY20



*Success story  
of DOD/FAA/Industry  
collaboration*



U.S. Department  
of Transportation  
Federal Aviation  
Administration

### Memorandum

Subject: **INFORMATION:** Bonded Joints and Structures -  
Technical Issues and Certification Considerations;  
PS-ACE100-2005-10038

Date: **DRAFT**

From: Acting Manager, Small Airplane Directorate,  
ACE-100

Reply to  
Attn. of: Lester Cheng; 316-946-4111

To: See Distribution



# 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)

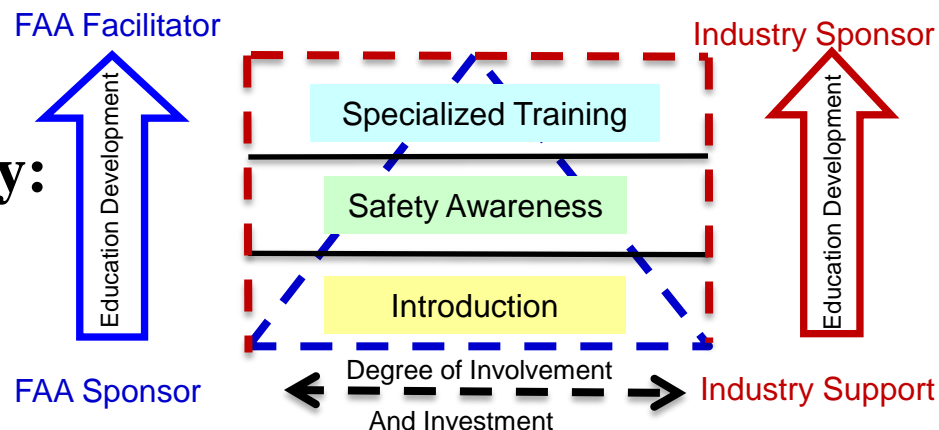
- Self-study intro content for composite basics/terminology
- CMH-17 Tutorial for composite certification & compliance [Aug, 2008]

**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 & some FAA experts



# Status - Level II Courses Development

- **Maintenance Safety Awareness (CMT)**  
**[International Standard: CACRC AIR5719]**
  - FAA-led course development completed [9/2008]
  - AFS-500 class-room version available to FAA [Since 2009]
    - ~ 350+ AFS Inspectors trained to date through FAA contract with ABARIS
  - On-line version available to the industry
- **Structural Engineering Safety Awareness (CSET)**  
**[In Work - Sponsored by FAA R&D, AIR-520]**
  - FAA “M&PC” Workshop and Module [2010]
  - Content Development (90%) [4/2012]
  - Beta Course [6/2012]
  - Content Completion [8/2012]
  - Teaching points & Assessments [9/2012]
  - First course offering through Wichita State Univ. [4/2013]



# 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 (50%) [12/2012]
  - Beta Course [11/2013]
  - Content Completion, Teaching points & Assessments [4/2014]

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]



# Composite Structural Engineering Technology (CSET) Course *(currently in-development)*

- **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

- **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
  - 7.1 Proof of Structure – Flutter +
  - 7.2 Crashworthiness
  - 7.3 Fire safety and fuel tank issues
  - 7.4 Lightning protection

**70% of  
Course**

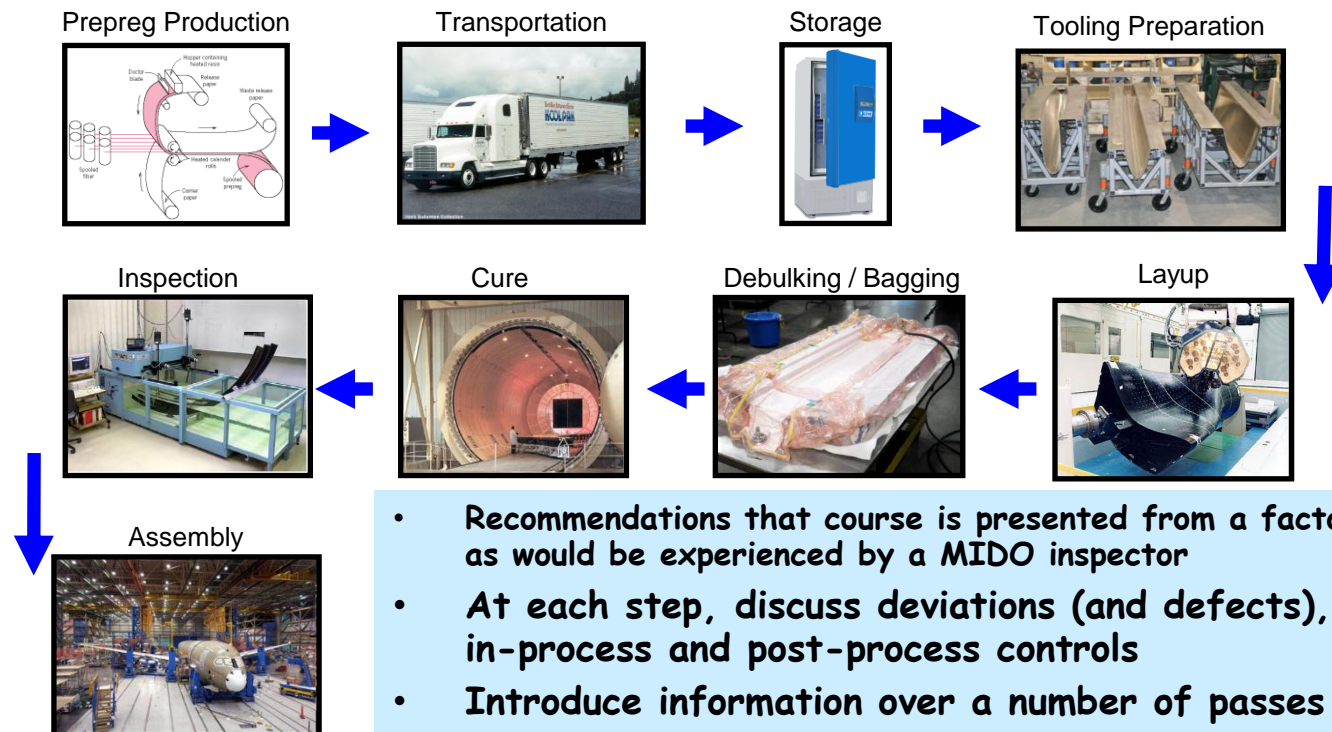
# Contributors - Level II CSET Course

- **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 Pellettiere (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 Adelmann (retired Sikorsky)
    - Dan Ruffner (Boeing, Mesa)

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

- **Top-level Course Objectives**

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



# Summary

- **Several active initiatives for composite and metal bonding guidance/standards**
  - Bonded repair size limits policy has safety priority  
*(related bonded repair initiatives with help of CACRC & CMH-17)*
  - Development of industry best practices, guidelines and standards to benchmark bonded structures technology
  - Long-term plans for Advisory Circular updating existing *Bonded Structures Policy*
- **Two active composite training initiatives**
  - Composite Structural Engineering Technology (CSET) is currently available through WSU continuous education
  - Composite Manufacturing Technology (CMfgT) is on schedule, involving MIDO reps, to be completed in 2014