Course Development Maintenance of Composite Aircraft Structures

A Center of Excellence
AMTAS
Advanced Materials in Transport Aircraft Structures

EDMONDS COMMUNITY COLLEGE

CECAM
Center of excellence for composites and advanced materials

The Joint Advanced Materials and Structures Center of Excellence

Course Development: Maintenance of Composite Aircraft Structures

- Motivation and Key Issues
  - Practical, introductory-level course for engineers, technicians and inspectors
- Objective
  - Develop framework, content and assessment criteria as a basis for curriculum training
  - Online course, with ‘hands-on’ laboratory, which will increase awareness of critical safety issues in composites’ maintenance
- Approach
  - Series of workshops and ‘beta’ class with experienced practitioners
  - Industry, regulatory and academic collaboration

FAA Sponsored Project Information

- Principal Investigators & Researchers
  - Charles Seaton, PI, Edmonds Community College
  - Cyndi Schaeffer, Executive Director, EdCC
- FAA Technical Monitor
  - Curt Davies, Acting
- Other FAA Personnel Involved
  - Larry Ilcewicz, Curt Davies
- Industry Participation
  - Boeing, Airbus, EASA, Hexcel, Heatcon, Abaris and others

Motivation and Key Issues

Build Awareness: Critical Composite Maintenance and Repair Issues

- Understand roles & responsibilities (importance of teamwork)
- Recognize composite damage types & sources (proper team reaction to possible service damage)
- Understand the inspection methods & procedures needed for detection, characterization and disposition of damage
- Understand regulations and importance of approved source documentation
- Realize the unique processing issues and quality controls needed for bonded composite repairs
- Realize the unique processing issues and quality controls needed for bolted composite repairs
- Realize need for more training to acquire technician, inspector or engineering skills (avoid working beyond skill limits)

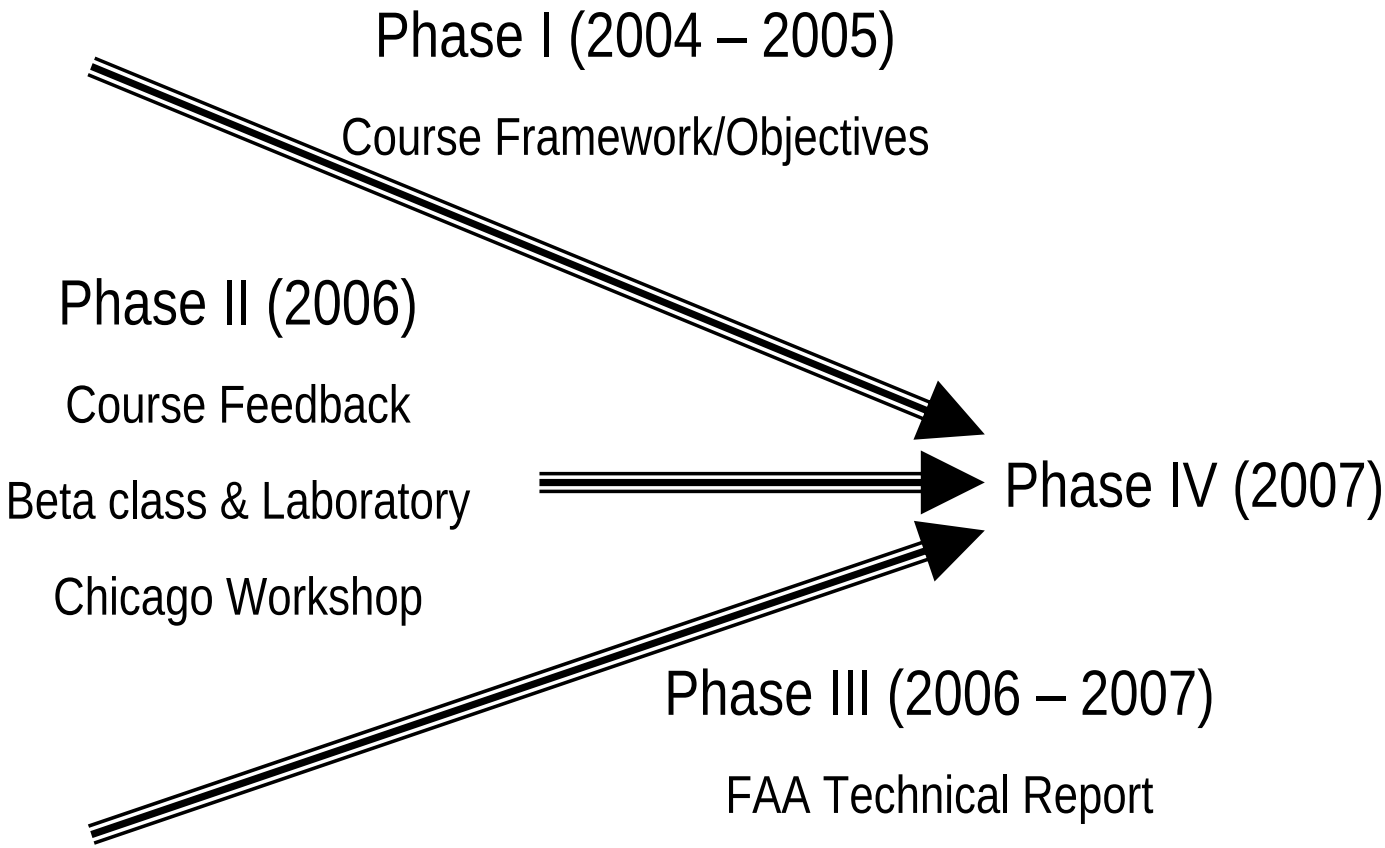
Objectives

- Develop awareness course through industry consensus for a practical, introductory-level course for engineers, technicians and inspectors (Phases I – III)
  - Applicable for other decision-makers, such as production planners, purchasing agents and executive management
  - Short course (7 days, traditional classroom), including labs, worth 4 credits
  - Technical Center Report
    - Terminal Course Objectives (TCOs)
    - Safety messages
    - Narrative description of critical issues
    - Instructor's guide
    - Class design guidance
- Adapt content in technical center report to a web-based, distance learning format during Phase IV
- Develop generic structural repair manual for teaching documentation during Phase IV

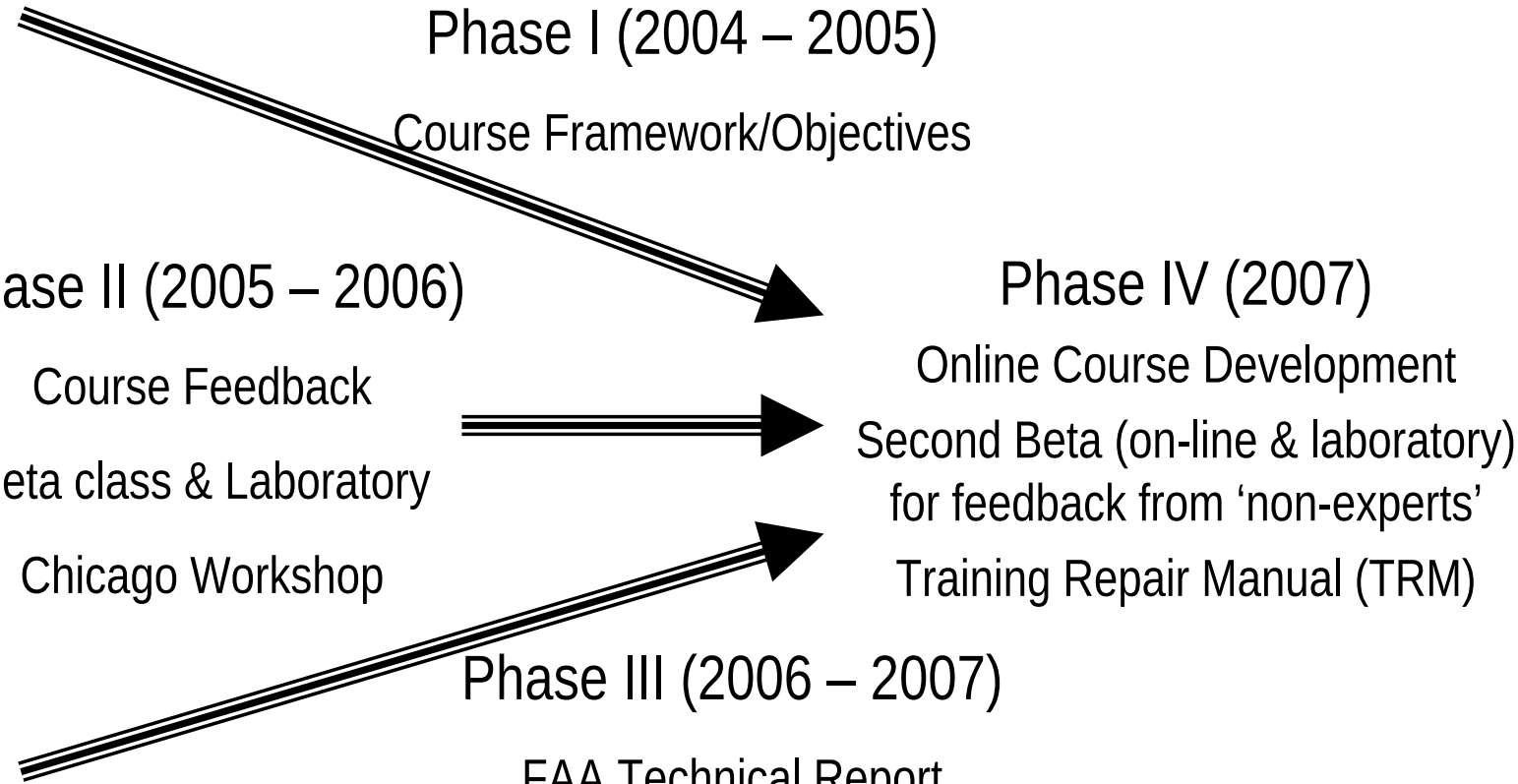
Approach

- Series of workshops to bring regulators and industry together on technical issues
  - FAA/NRC Workshop in Wash. DC (May 18 & 19, 2004)
    Executive review of systematic, repair, NDI & training issues
  - 2004 Kickoff for FAA research to evaluate training needs
  - 2005 and 2006 FAA Workshops to review progress in establishing training needs
- Industry & government experts recruited to support the development of training *standards*
  - 2004 Seattle workshop defined terminal course objectives (TCO)
  - 2005 Chicago workshop used to review draft modules that will be released with the TCO as *industry standards*
  - Boeing/Airbus/EASA WG review – recommend updates
  - Phases I through III: 350+ page technical center report with *industry standard modules*
  - CACRC document (AIR) has been approved for distribution including *course objectives and teaching points,* to be released during 2007
- Phase IV (to be completed in 2007)
  - Training Repair Manual – generic repair manual for teaching organizations
  - Distance learning development – applying online concepts to increase availability of awareness course on a global level, cost-effectively

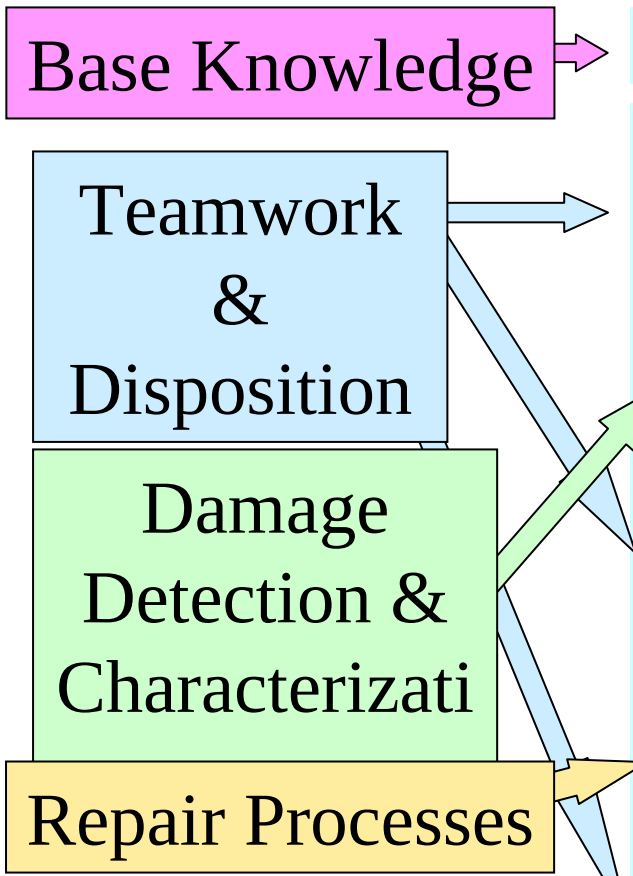
Awareness Course Process



Awareness Course Process



Awareness Course Content



Prerequisite: Students take assessment prior to main course

Main Course

Understand the roles & responsibilities of key teammates

Recognize composite damage types and sources and describe composite damage and repair inspection procedures (2 labs)

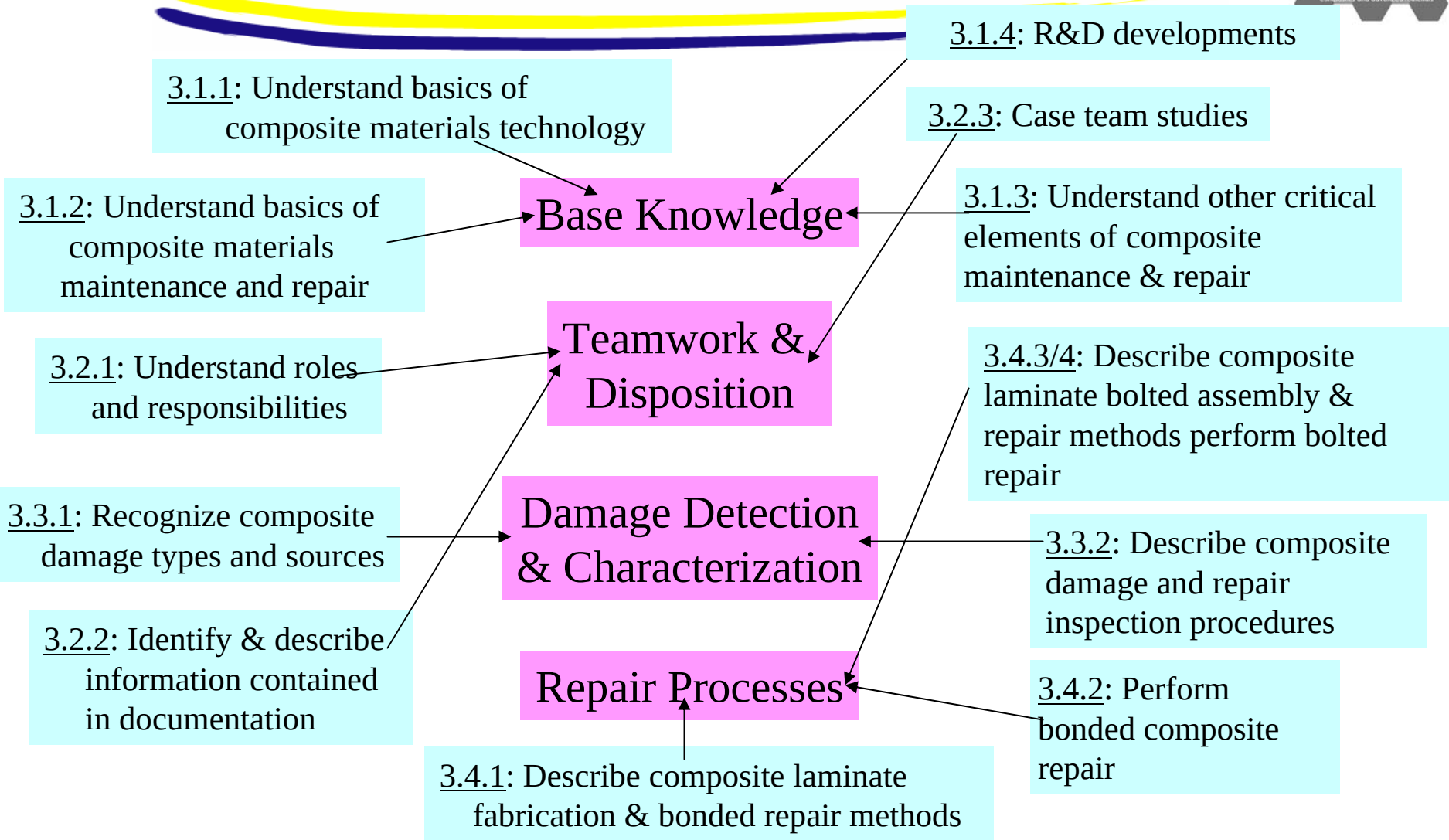
Identify & describe information contained in documentation for approved maintenance & repair

Describe composite laminate fabrication, bonding, & bolted assembly methods and perform bonded & bolted repairs (2 labs)

Participate in case team studies (lab)

Modified from presentations and seminars by L. Ilcewicz

Awareness Course Content
Terminal Course Modules



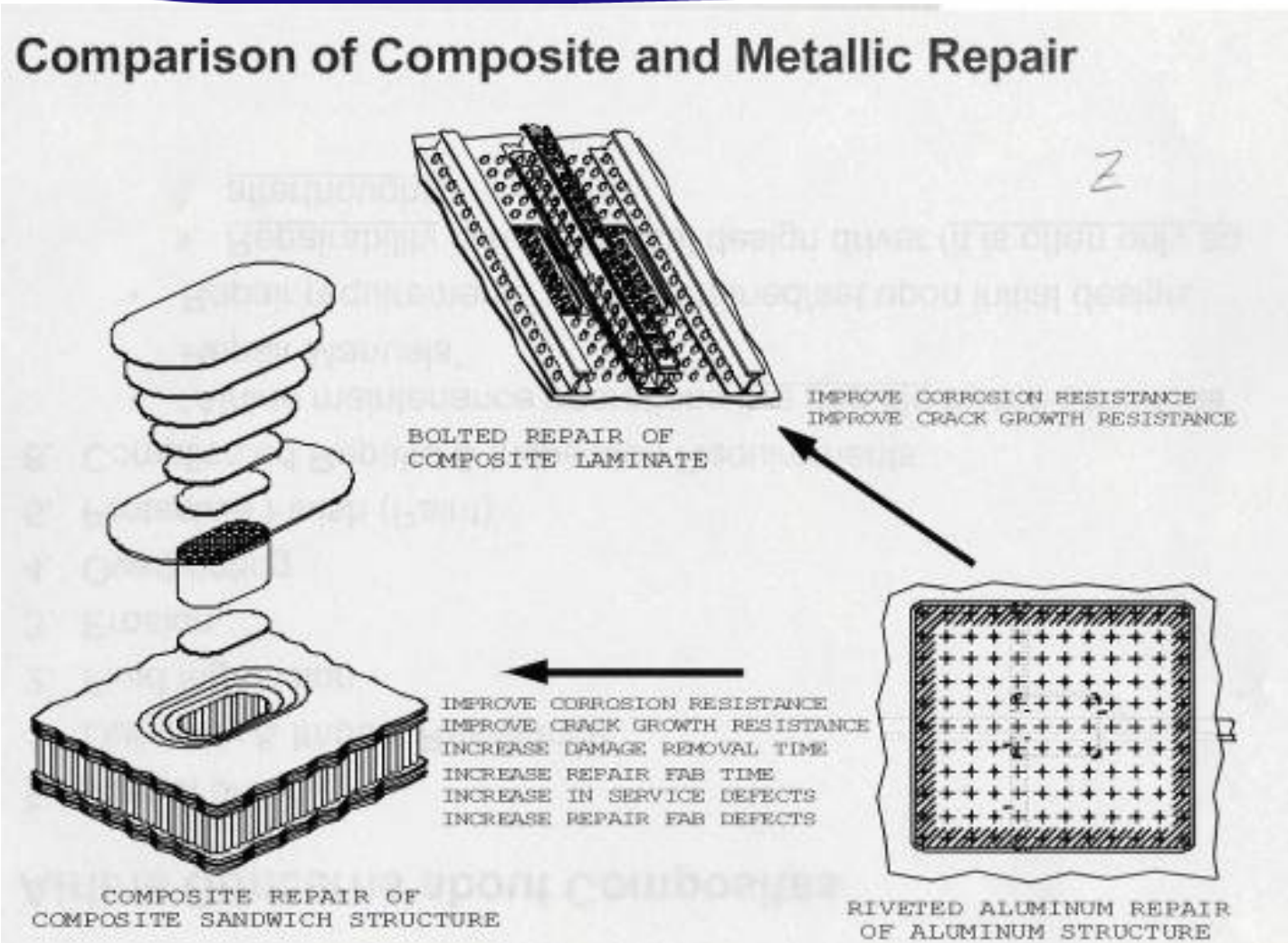
From presentations and seminars by L. Ilcewicz

2006 Beta Class
Excerpts from Instructor's Guide

In-service damage

Courtesy of Abaris Training Resources, Inc.

2006 Beta Class
Excerpts from Instructor's Guide



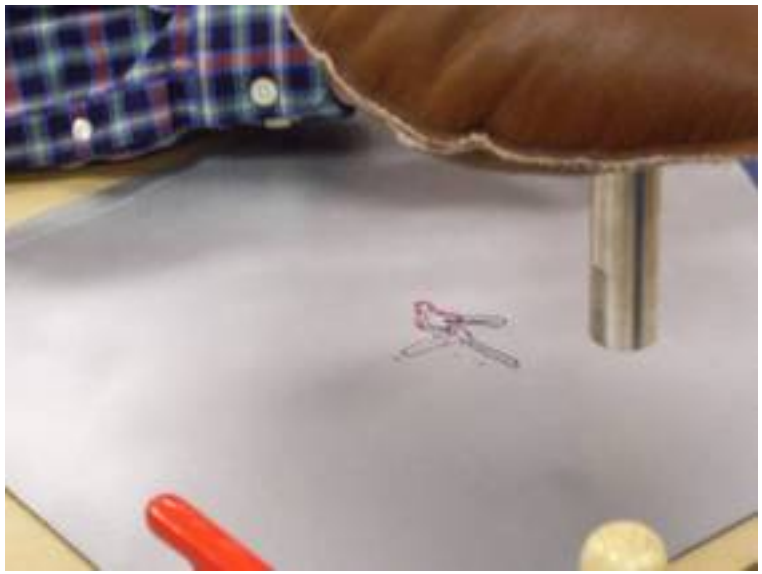
2006 Beta Class
Excerpts from Instructor's Guide

TABLE 8.3.1 *Common non-destructive test methods.*

METHOD	STRUCTURE	DAMAGE DETECTED	RELIABILITY
Visual	All	Surface damage	Good
Tap test	Thin laminate	Delaminations near surface	Good
	Thin face sheet	Lack of bond	Good
		Disbond near surface	Good
		Voids	Poor
		Blown core (core damage)	Poor
		Lack of tie-in at closure	Good
		Lack of tie-in at core splice	Poor
Ultrasonics	All	Delaminations	Good
		Lack of bond	Good
	Sandwich	Crushed core	Poor
		Blown core (core damage)	Poor
		Water in core	Poor
Radiography	All	Disbonds/delaminations	Poor
		Delaminations in corners	Good
	Sandwich	Node separation	Good
		Crushed core	Good
		Blown core (core damage)	Good
		Water in core	Good
Shearography	All	Disbonds/delaminations	Good
Thermography	All	Disbonds/delaminations	Good
	Sandwich	Water in core	Good

Dropping “Tupp” to damage laminate specimen

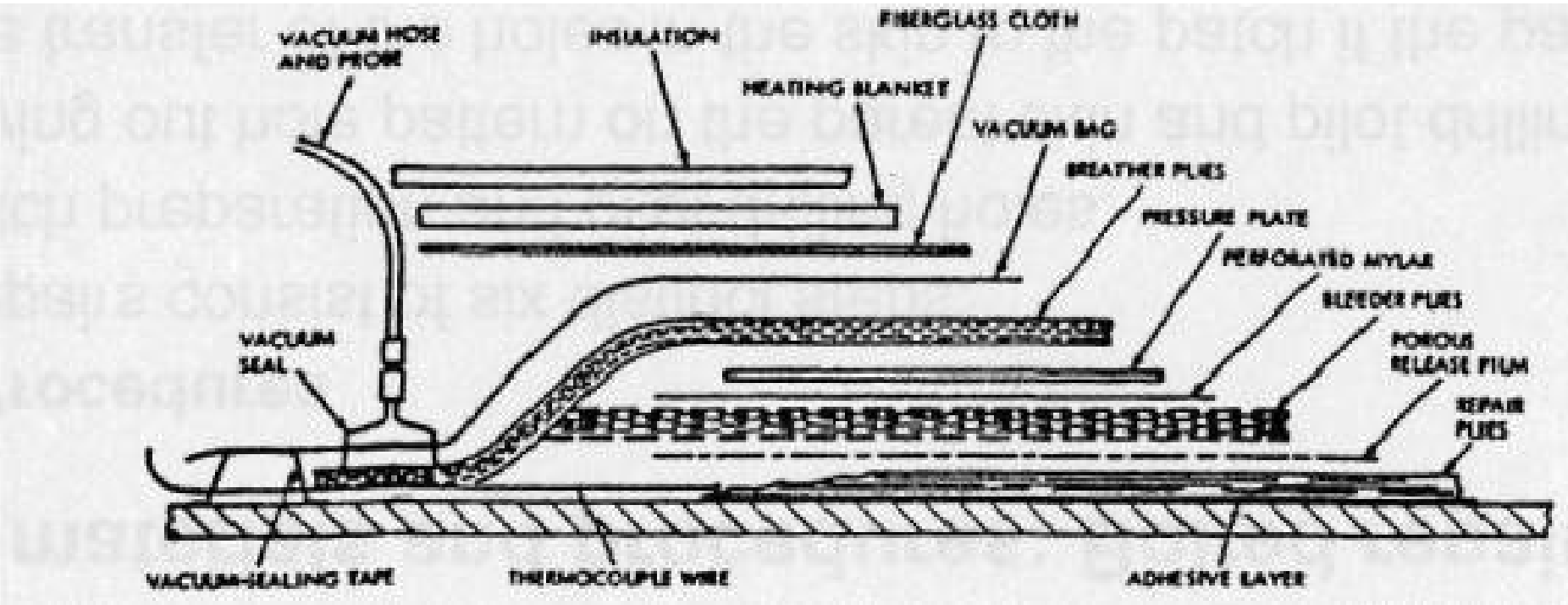
2006 Beta Class
Excerpts from Instructor's Guide



Mapping periphery of damage

Mapping results utilizing pulse echo, tap test, and visual inspection

2006 Beta Class
Excerpts from Instructor's Guide



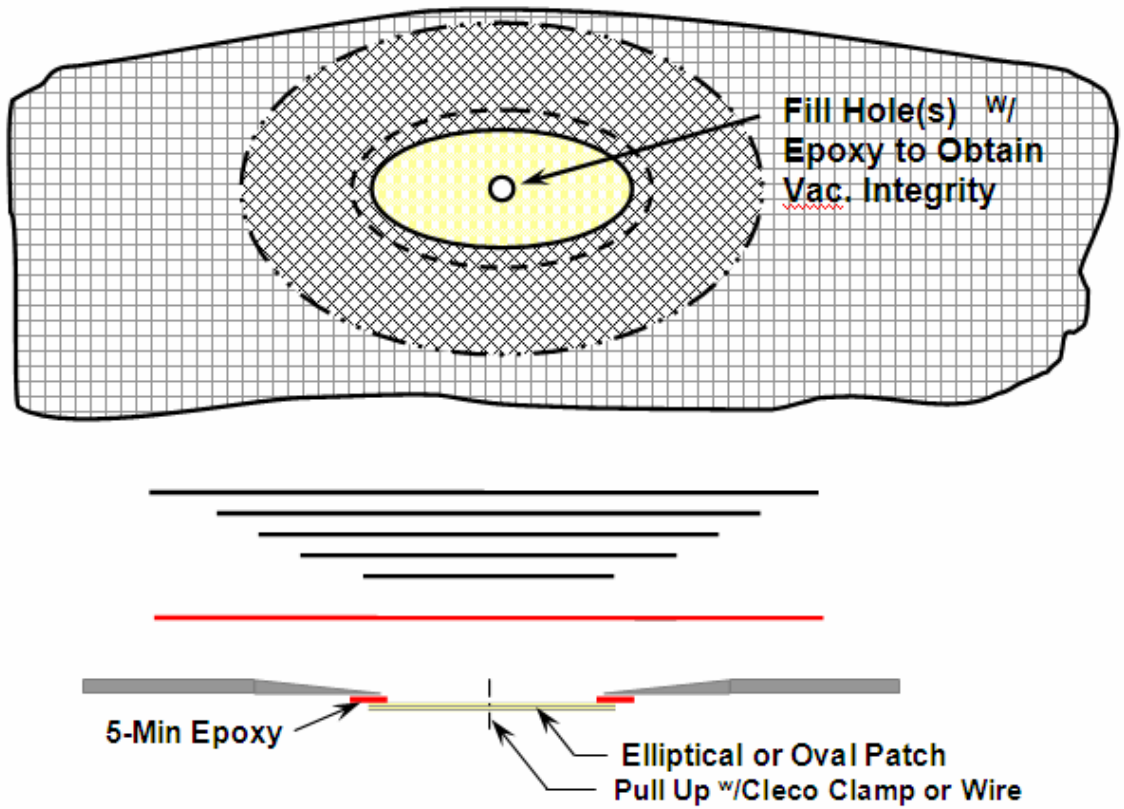
Courtesy of Heatcon Composite Systems

2006 Beta Class
Excerpts from Instructor's Guide

Graphic display from heat bonder controller

2006 Beta Class
Excerpts from Instructor's Guide

Repair of composite with no backside access



Courtesy of Abaris Training Resources, Inc.

What we have Learned

- Creating a standard course framework from diverse experts is possible!
  - Process of consensus
  - Feedback mechanisms
- Creating a standard course framework from diverse experts requires patience and considerable funding
- Synergy among dedicated industry, academia and regulatory organizations and people is high with sufficient interest
  - Must meet needs of organizations and individuals
  - Must fit with business interests of contributing organizations

Course Development Integration Role

- Terminal Course Objective development
  - Disciplined approach
  - Reveals gaps in content and balance
  - Can be applied to a variety of circumstances as an integration agent
- Curriculum development becomes a guide for establishing priorities
  - Provides a framework for achieving consensus

A Look Forward

- Benefit to Aviation
  - This development relates to a FAA goal for outlining ***what*** needs to be considered for aircraft safety. It is intended to help industry develop guidelines, standards and other training
  - Increasing composite materials content in aircraft requires awareness of maintenance related to composite materials – asking the right questions, and 'knowing what you don't know'
- Future needs
  - Identify additional training development needs
  - Provide directions for future research and development