Composite Materials Course Development Using Problem-Based Case Learning Techniques

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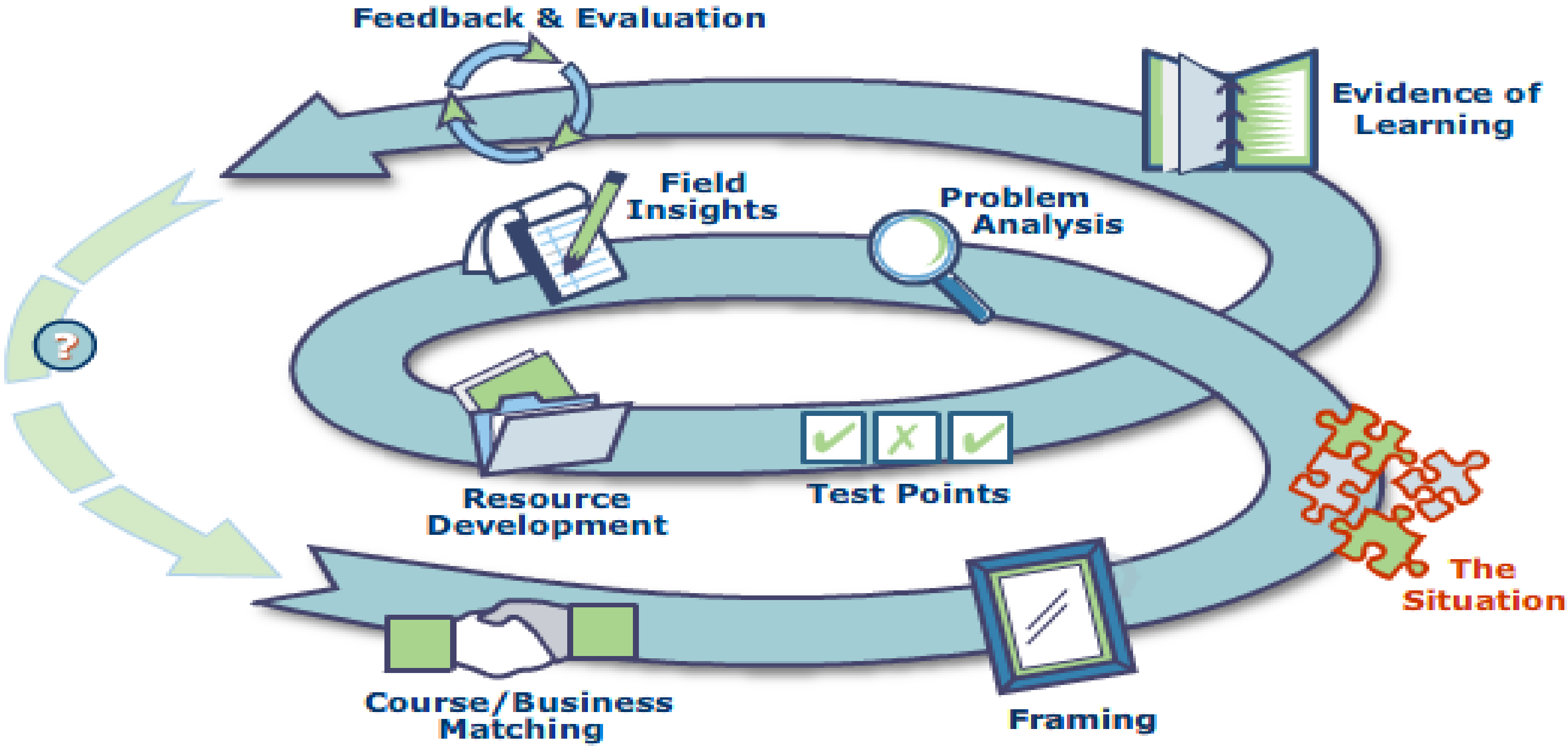
The PBCL Cycle



Roll over a stage in the PBCL cycle to see a description; click to view related video.

The Situation
The instructor, often together with the business partner, introduces the students to the business, the problematic situation and the PBCL Cycle. The students begin their quest to uncover the messy problem within the situation.

view video

Download a more detailed description of the stages of the PBCL Cycle (PDF).

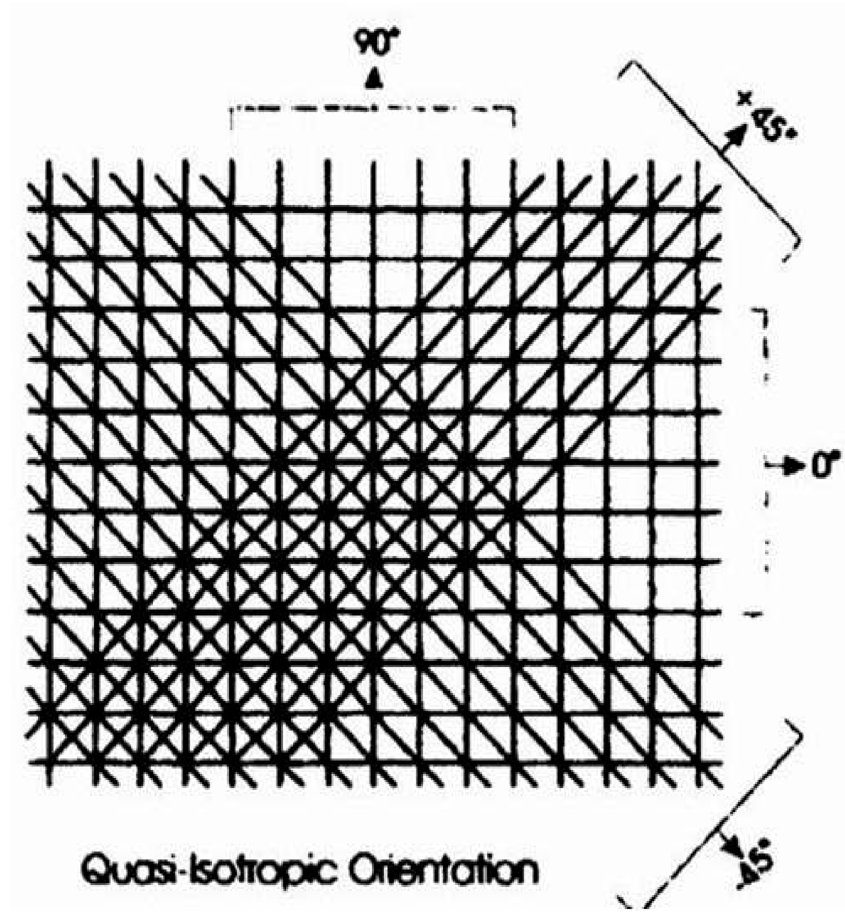
Course/Business Matching

- Goal-Training new employees on the use of composites
- Cessna – ramp up to build their 4 seat composite aircraft in an ‘assembly line’ application.
- Course concepts and skills: basic skills-math, comparison of other materials to composite materials, working with tools and the materials, inspection techniques.

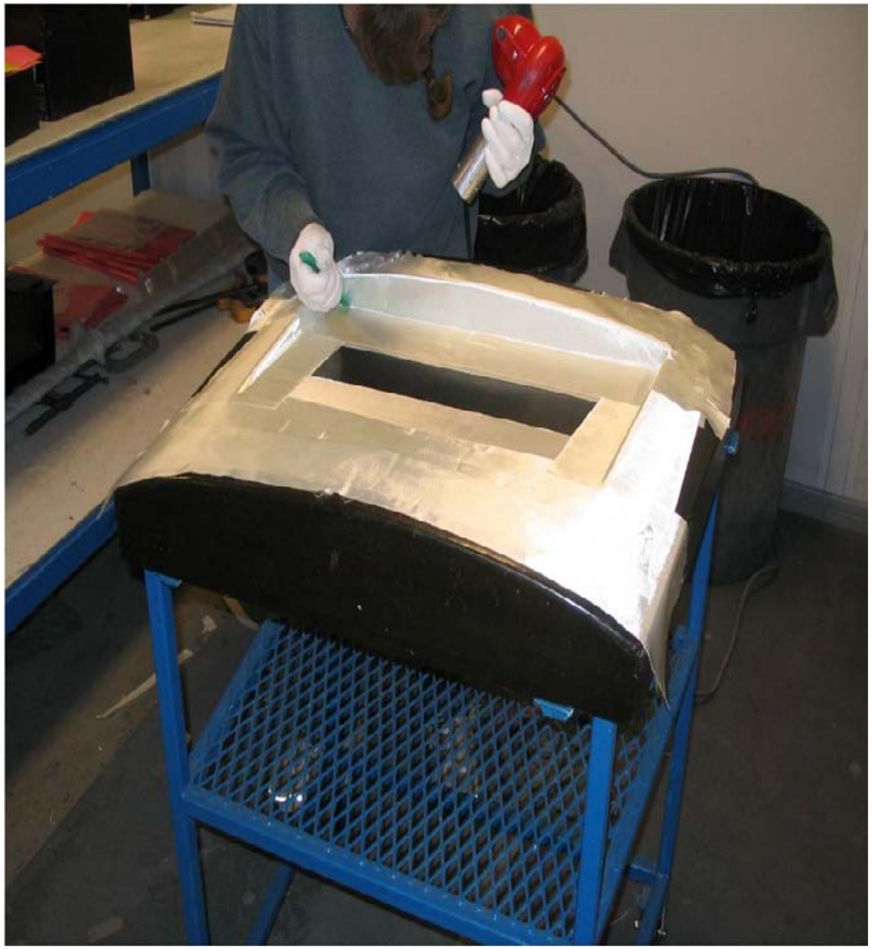
Framing

Student deliverables:

- math proficiency- ratios, angles, fractions, basic calculator work-assess with exercises and quiz.
- Comparison- of metals to composites, wood to composites and cloth to composite materials- assess with quiz and homework piece
- Blueprint reading-review of composite blueprints and application on shop floor- assess with oral discussion



Framing with business partner



- Include professionals from business where possible- classroom discussions, lab, videos, documents (blue prints, work orders, operations procedures) to reinforce learning process

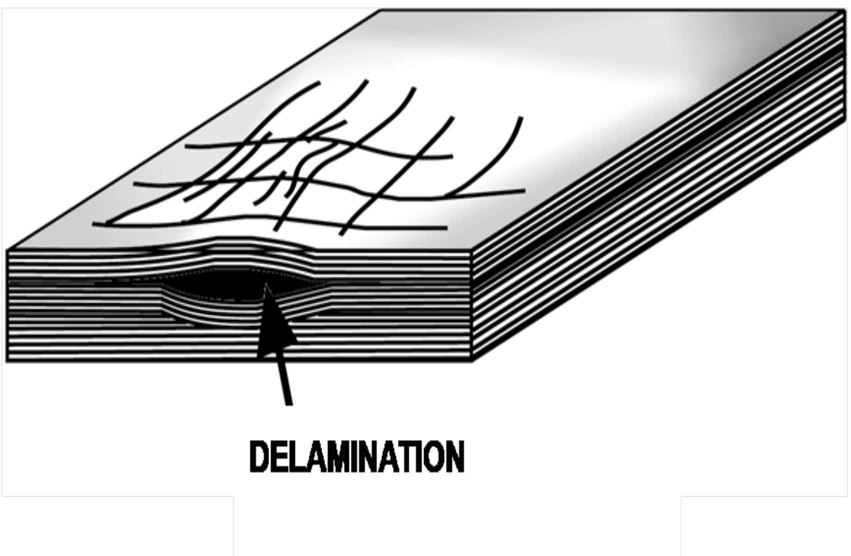
- ID Tools and support to complete project- composite materials and small molds for lab work, blueprint documents, sample pieces for inspection, photographs

The Situation

Instructor then:

- Creates student TEAMS
- Have teams define ‘the problem’
- ‘The Situation’-the teams are introduced to the problematic situation and the PBCL cycle using media and different perspectives (good to have business partner involved)
- Students are invited to ask questions and extend their thinking about the problematic situation

Problem Analysis



Each team of students:

- Form a hypothesis to uncover the problem behind the situation.
- Use questioning techniques to identify facts, assumptions, questions and resources needed to research options.
- Begin building skills in collaborative teamwork and reflective learning.

Field Insights

Each team has identified a problem to address- goal now is to gain a deep understanding of it by:

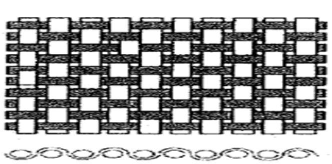
- Research-source docs, internet, periodicals and books.
- Interview business partners & industry experts.
- Organize information, share insights, and integrate analysis of data.

WEAVE PATTERNS/FORMS

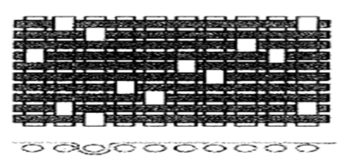
Plain: The plain weave consists of yarns interlaced in an alternating fashion one over and one under every other yarn. The plain weave provides stability, but is generally the least pliable, and least strong, due to a high number of crimps. Plain weave also tends to have gaps at the yarn intersections, which have to be filled with resin.

8-Harness Satin (8-HS): This is a very pliable weave, with good drape, and especially adaptable for forming over compound curved surfaces. Typically, more expensive to produce

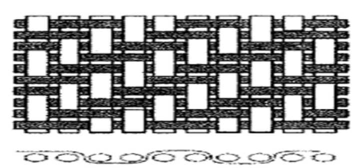
Twill: The basic twill weave is more pliable than the plain weave has better drapeability while maintaining more fabric stability than a four or eight harness weave. The weave pattern is characterized by a diagonal rib caused by one warp yarn floating over at least two filling yards.



Plain Weave



8 Harness Satin Weave



2/2 Twill Weave

Resource Development

Each team now:

- Complete research and begin proposing solutions
- ID gaps and plan to address them.
- Execute revisions for accuracy and relevance
- Form hypothesis about solutions

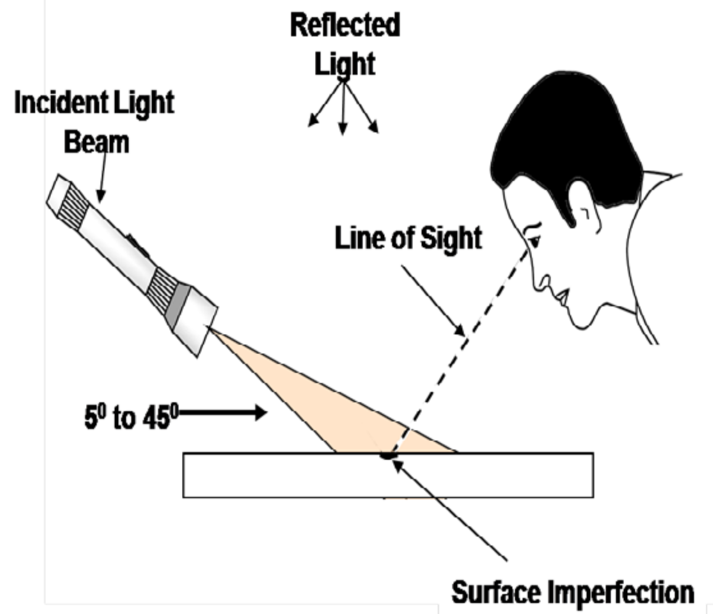
Test Points

Teams decide:

- Significance & validity of info and sources
- What solutions to propose.
- An evaluation of the process by which they reached their solution(s).
- Strategies for presenting solutions
- Create presentation and support materials
- Considers how the approach to identifying a problem and developing solution(s) demonstrates the significance of course-related concepts and skills

Evidence of Learning

- With business partner, instructor, and peers as their audience, each team:
- Presents the problem they've identified and the related solution(s)
- Explains the reasoning behind their identified problem and solution(s)
- Encourages audience inquiry and invites feedback



Feedback and Evaluation

The instructor facilitates a discussion during which all the participants:

- Determine if revisions are necessary to each team's problem description and proposed solution(s)
- Evaluate individual and team performance
- Reflect on the learning achieved by all

  and on the PBCL process
- Celebrate successes

Implementation

Instructors and business partners consider:

- If any of the proposed solutions might be implemented by the business partner to address the problematic situation
- Determine how the instructor and students might be involved in the

  solution's implementation
- Recommend changes to course content and instructional approaches
- Plan their ongoing partnership and prepare for the selection of future

  problematic situations
- Reflect on the value contributed by the students, instructor, and business partner

PBCL Similarities and Differences (to other instructional methodologies)

Similar		Different
Inquiry-based approach	+	Structural framework
Contextual learning	+	Real-time problematic business situation

Similarities:

- **Students are actively engaged in creating their own collaborative learning experiences.**
- **Concepts and skills are learned within the context of their real-world applications**

Differences:

- ***PBCL includes a structural framework, the PBCL Cycle, upon which instructors can build their curricula.***
- ***PBCL requires that a current business situation be used to place the learning in context.***

CAM Course 1: Introduction to Composites Schedule

22-Feb-10

Module	Group Work	Meta-Cognitive ✓	Recitation (Big Idea)	Lab Demo (Big Idea)	Lab Work
UNIT 1: COURSE INTRODUCTION, SAFETY AND MATH MODULE COMPONENTS					
1-1	Teaming Exercise	PBCL Intro & Example	Course, Syllabus & Resources	Orientation & Tour	Lab Project 1 Assignment
1-2	Chapter 1 / 2	PBCL Orientation	Safety, Math & Design	Materials, Tools & Safety	Materials ID Checklist
1-3	Chapter 1 / 2	PBCL Orientation	Composites	Materials Handling & Storage	Lab Project 1 Work
1-4	Chapter 22	PBCL Orientation	Molds, Tools & Processes	Molds vs. Tools	Lab Project 1 Work
1-5	Chapter 10 / 20	PBCL Orientation	QC, Testing and Repair	Repair Techniques	Tools ID Checklist
1-6	Chapter 11	One-minute Paper	PBCL Review	Weight / Volume / Measuring	Present Lab Project 1
UNIT 2: COMPOSITES MODULE COMPONENTS					
2-1	Chapter 1 / 2	PBCL 1 Assignment	Composites & Matrices	Crosslinking & Curing	Lab Project 2 Assignment
2-2	Chapter 8 / 9	Think - Pair - Share	Polymers & Plastics	Design & Blueprints	Blueprint Reading
2-3	Present PBCL 1	One-minute Paper	Resins	Honeycomb & Clocking	Lab Project 2 Work
2-4	Chapter 8 / 9	PBCL 2 Assignment	Fiber - Resin Interface	Tensile Strength	Lab Project 2 Work
2-5	Chapter 5 / 6 / 12	Think - Pair - Share	Core Structures	Flexibility	Measure Tensile Strength
2-6	Present PBCL 2	One-minute Paper	Thermosets & Thermoplastics	Toughness	Present Lab Project 2
UNIT 3: MOLDS, TOOLS & PROCESSES MODULE COMPONENTS					
3-1	Chapter 13	PBCL 3 Assignment	Molds & Tools	Wet Layup	Lab Project 3 Assignment
3-2	Chapter 13 / 16	Think - Pair - Share	Wet Layup & Pre-Preg	Wet Layup	Wet Layup Procedure
3-3	Present PBCL 3	One-minute Paper	Resin Transfer Molding	Vacuum Bagging	Lab Project 3 Work
3-4	Chapter 17	PBCL 4 Assignment	Geometry & Filaments	Vacuum Bagging	Lab Project 3 Work
3-5	Chapter 15 / 18	Think - Pair - Share	Compression Molding	Pre-Preg Materials	Pre-Preg Handling
3-6	Present PBCL 4	One-minute Paper	Pultrusion	Pre-Preg Materials	Present Lab Project 3
UNIT 4: QUALITY CONTROL, TESTING & REPAIR MODULE COMPONENTS					
4-1	Chapter 10	PBCL 5 Assignment	Quality Control	QC Procedures	Lab Project 4 Assignment
4-2	Chapter 20	Think - Pair - Share	Stress & Fatigue	Testing	NDI Testing
4-3	Present PBCL 5	One-minute Paper	Types of Damage	Damage Examples	Lab Project 4 Work
4-4	Chapter 10	PBCL 6 Assignment	Inspection Techniques	Repair Techniques	Lab Project 4 Work
4-5	Chapter 20	Think - Pair - Share	Repair Techniques	Repair Techniques	Repair Procedure
4-6	Present PBCL 6	One-minute Paper	Repair Procedures	Repair Techniques	Present Lab Project 4

24 1.5 hr. Class Meetings (36 clock hrs.) + 24 1.5 hour Lab Sessions (36 clock hrs.) = 54 credit hrs. (approximately) or 5 quarter hrs. academic credit

PBCL 1 - 6: Topics to be developed with business partners

Lab Project 1 - Build a "Keychain" using exisitng tool (individual student)

Lab Project 2 - Reverse engineer Documenation Package from existing item (pair of students)

Lab Project 3 - Build a "Clipboard" from existing Documentation Package using existing tool (group of students)

Lab Project 4 - Choose and build a (unique) project from existing Documentation Package using exisiting tool (group of students)

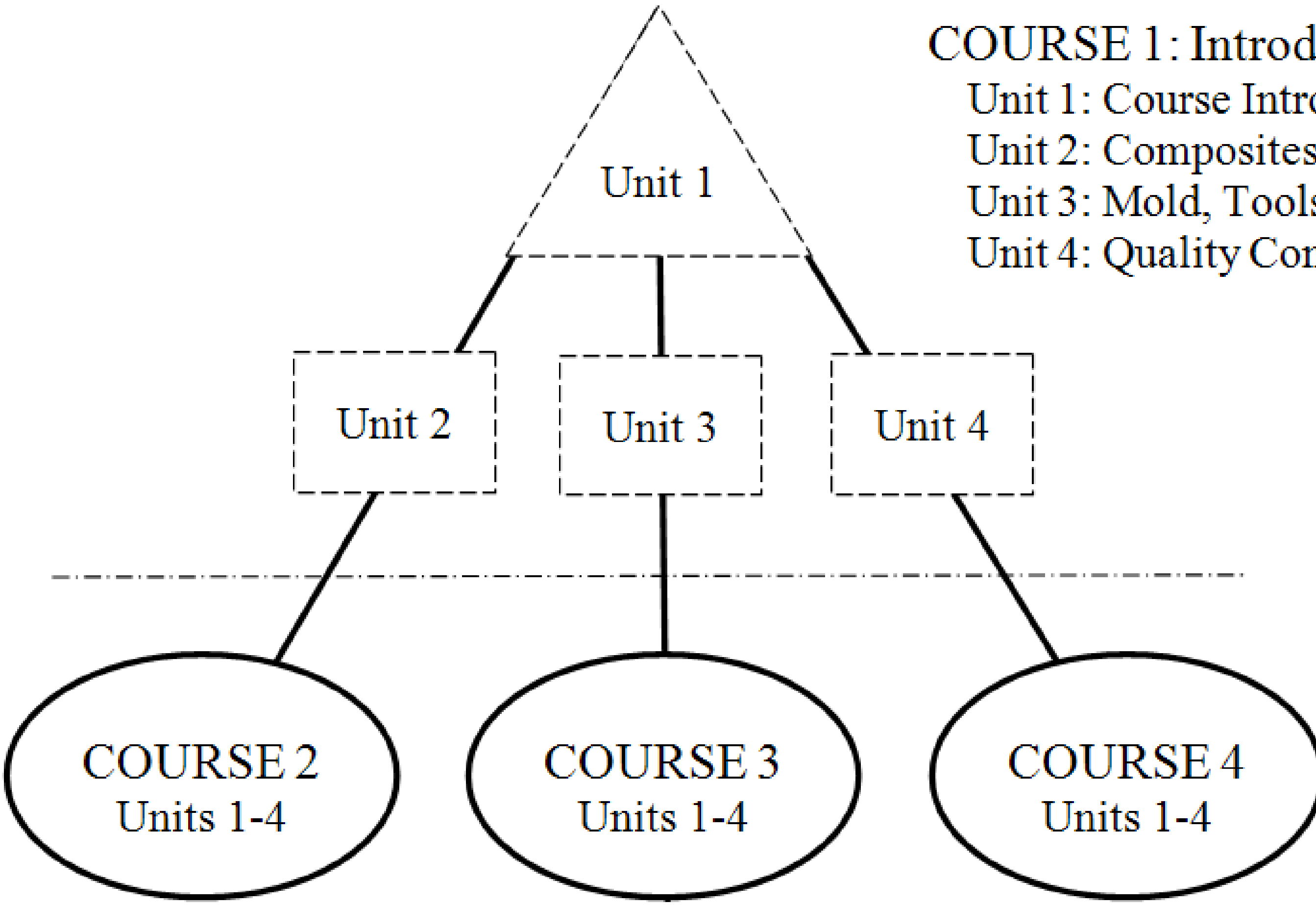
COURSE 1: Introduction to Composites

Unit 1: Course Introduction, Safety and Math

Unit 2: Composites

Unit 3: Mold, Tools and Processes

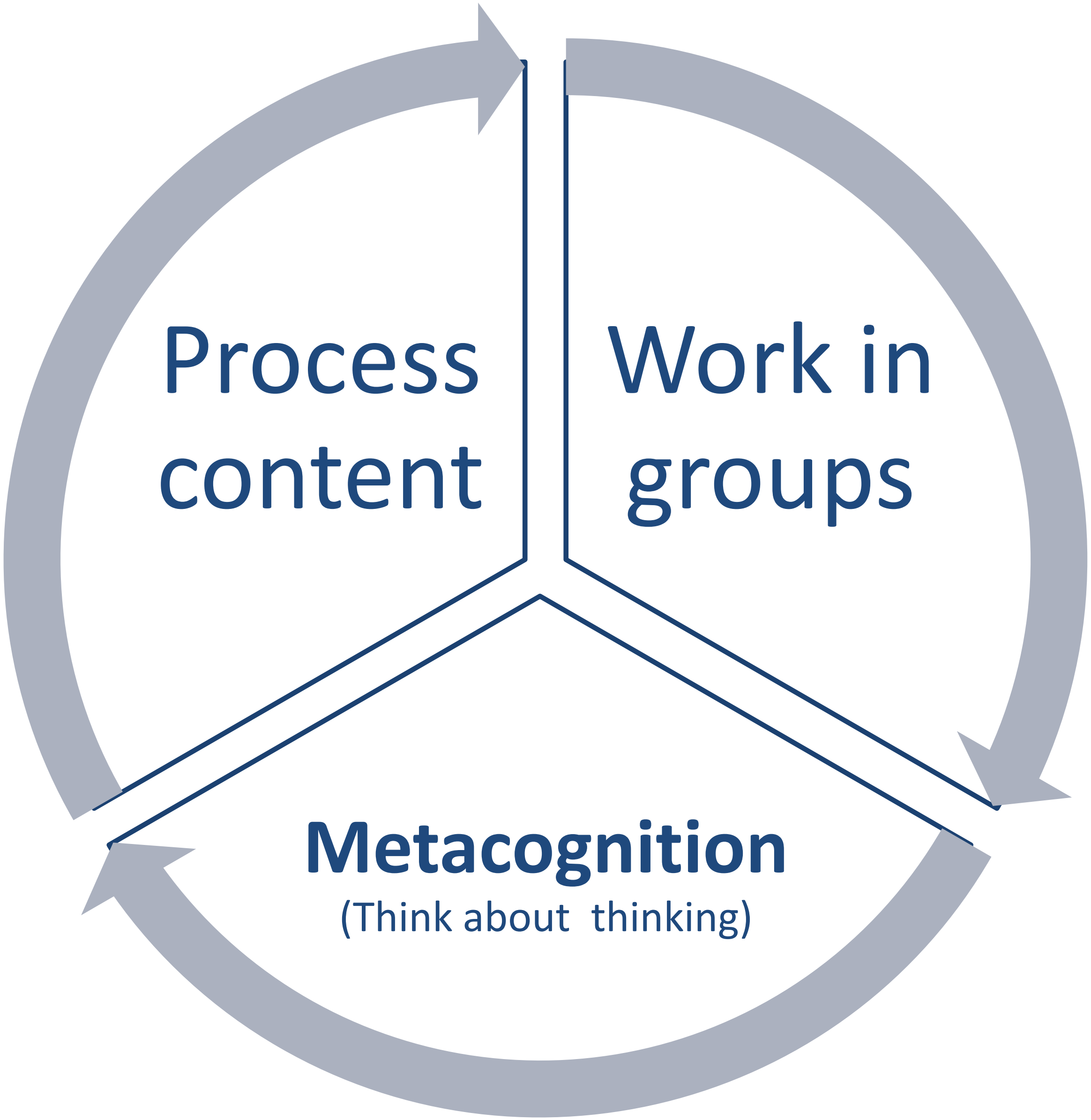
Unit 4: Quality Control, Testing and Repair



COURSE 2: Composites

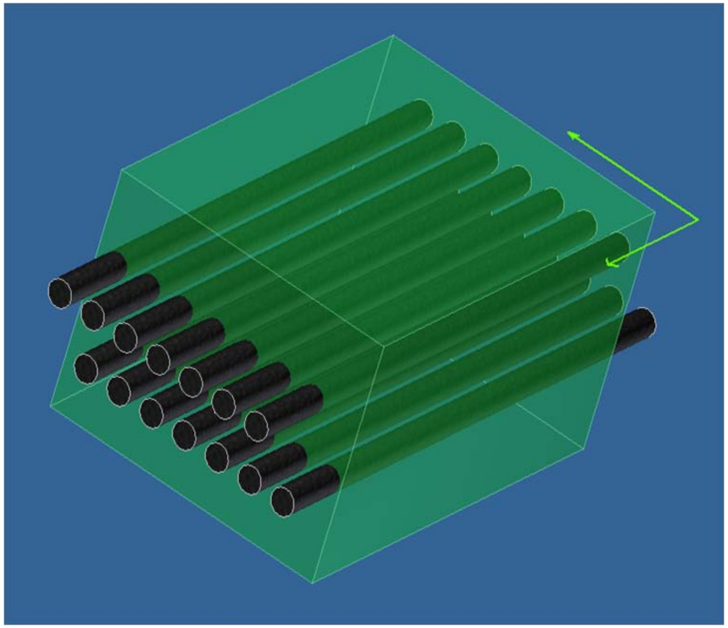
COURSE 3: Mold, Tools and Processes

COURSE 4: Quality Control, Testing and Repair


Process content
Work in groups
Metacognition
(Think about thinking)

Tools for Using PBCL:

- Think/Pair/Share
- Need to know board
- One minute paper (reflection)



Think/Pair/Share

- Individual=>Learning Pair=>Coop Team
- Your thoughts=>Pair thoughts=>Team thoughts
- Reflect on questions that pair now has
- Groups now to generate new ideas and promote careful listening
- Analyses individual ideas & broadens personal perspectives

Exercise: Explain a composite material and why use it?

Need to know board

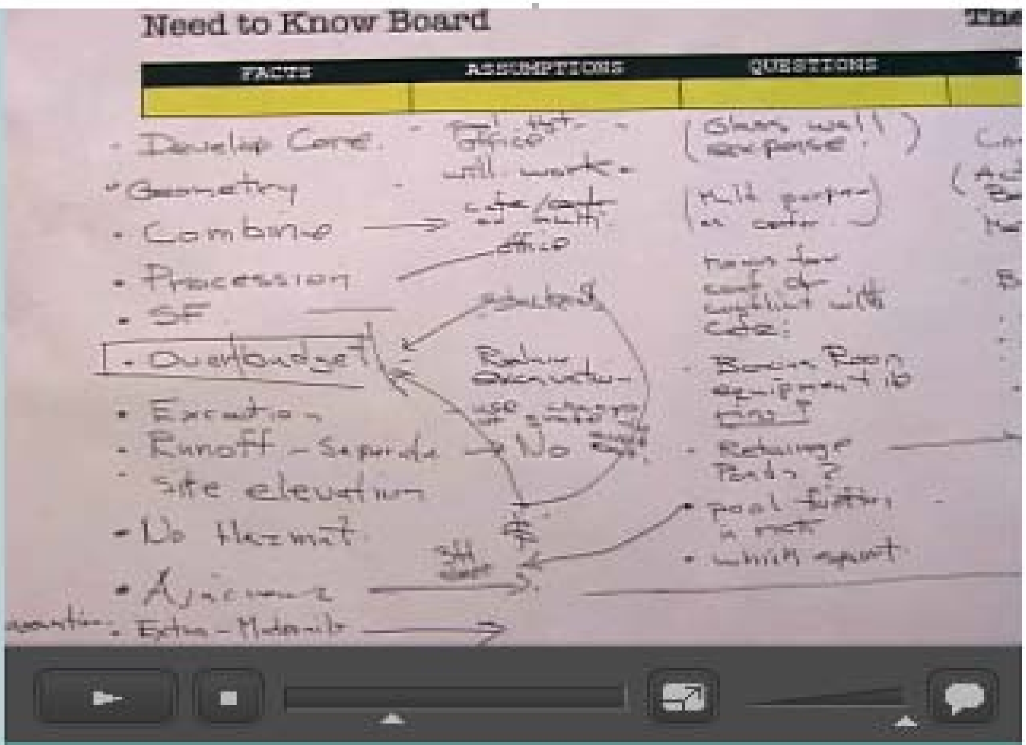
Exercise: How do I design a light military container that will stack easily and not slide

Facts	Assumptions	Questions	Resources
What do I know? List only facts with identified sources. NOTE: Students often want to equate "knowledge" with "facts." This is only valid when the knowledge can be supported by available sources or references	What am I assuming to be true? List conjectures based on unproven information, inferences based upon prior knowledge or experience, and/or beliefs based on intuition, emotion, or opinion.	What do I need to research? List all of the questions or ideas that you need to investigate in order to prove or disprove assumptions or to uncover missing information.	Where, how, and/or from whom can I find answers to my questions that will result in new facts? List documents or other media with information that can be verified, locations or activities to investigate, and/or people with relevant knowledge.

Select a video to watch:

Problem Analysis/Field Insights
(03:10)
Using the Need to Know Board, Jack Wallace's students develop research questions, identify potential resources, and document findings from a construction site visit.

How does the Need to Know Board make systematic analysis of the problematic situation visible to the whole team?



Problem Analysis/ Field Insights

Field Insights

Resource Development

View the PBCL Cycle

Download a more detailed description of the stages of the PBCL Cycle (PDF).

Exercise: Discuss inspection of composite materials then do this Reflection: ONE MINUTE PAPER

<u>Successful "prompts" used in a one minute paper in a one minute paper –</u>

1. <u>Build on what students have contributed to the discussion</u>
2. <u>Can be completed in one minute</u>
3. <u>Directs attention to key points</u>

BASIC Template for One-minute paper - Called "basic" because variation from this template is expected. Example prompts:

Three questions for a one-minute paper:

1. What did I learn that surprised me?
2. What did I learn about myself?
3. What questions do I have?

What did I learn about ______________________________?

OR

What was the main idea of the lesson today?

OR

What do you now know about ___________?

OR

A word that describes what we did today is ___________

References/Credits

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- ‘Materials Engineering, Science, Processing and Design’ Ashby, Shercliff and Cebon
- ‘Mechanics of Composite Materials’ 2nd ed., Autar Kaw
- Ruth M. Loring, Ph.D.- Senior Project Leader and Professional Development Designer for PBCL
- Edward Webster-Partner, Institute for Professional Training and Education
- Frank Cox- Edmonds Community College – CAM Project Administrator
- Joe Stuart- Professor- Oregon Institute of Technology