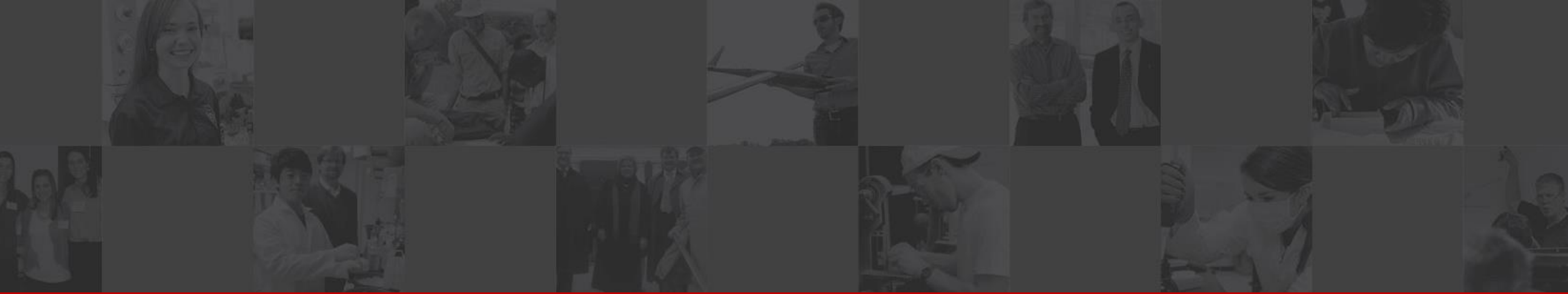

THE OHIO STATE UNIVERSITY
COLLEGE OF ENGINEERING

Utilizing student-led experiments to encourage creativity, critical thinking, and engagement with concrete sustainability initiatives

Lisa Burris

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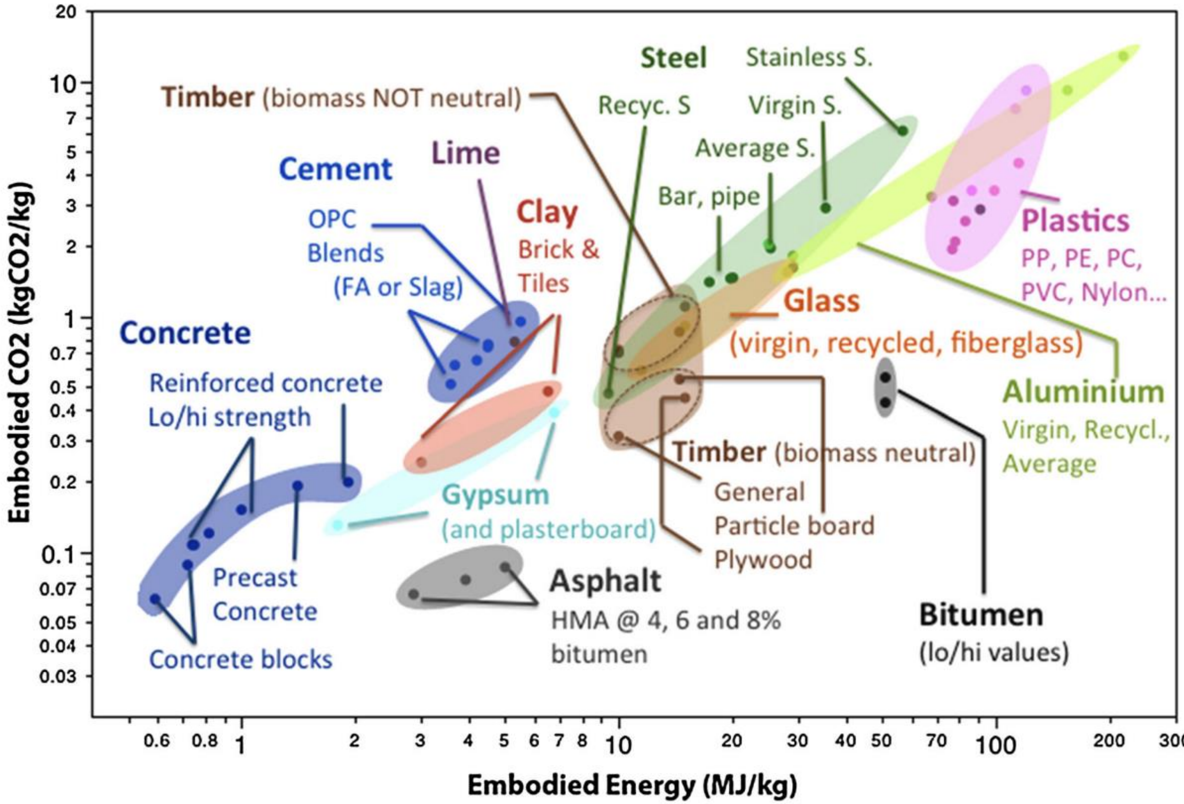
***The* Ohio State University**

aci VIRTUAL CONCRETE CONVENTION
always advancing

Approaching teaching about concrete sustainability…



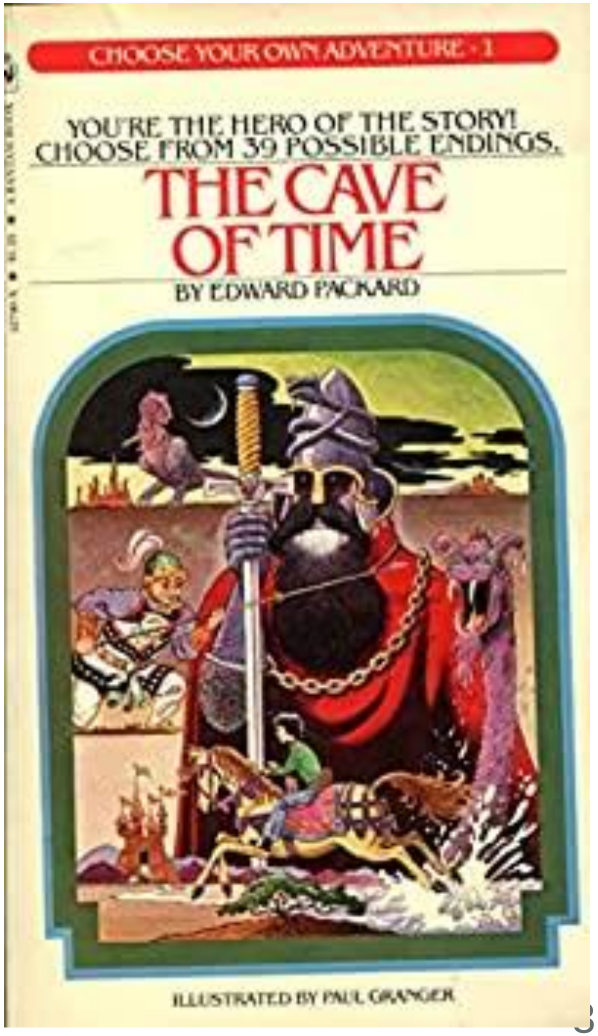
Barcelo, Laurent, John Kline, Gunther Walenta, and Ellis Gartner. "Cement and carbon emissions." *Materials and structures* 47, no. 6 (2014): 1055-1065.

Student-Led Experiments

Course projects allowing students control of topic selection and experimental processes

Talk Agenda – SLE:

- Benefits
- Requirements
- Challenges
- Examples



ABET Criteria 6: an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions

How can we do that with prescriptive lab modules?

ASTM C231/138 – Pressure Method Air Content Test and Unit Weight

Materials & Equipment

- Pressure Meter (Fig C)
- Mallet
- Bulb syringe
- 5/8” tamping rod
- Strike-off Plate or Bar
- Scoop
- Spray Tube
- Safety Glasses
- Paper towel
-

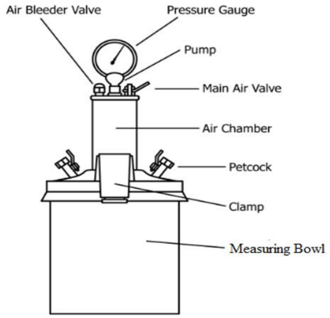


Fig. B – Air Pressure Meter

Testing Procedure

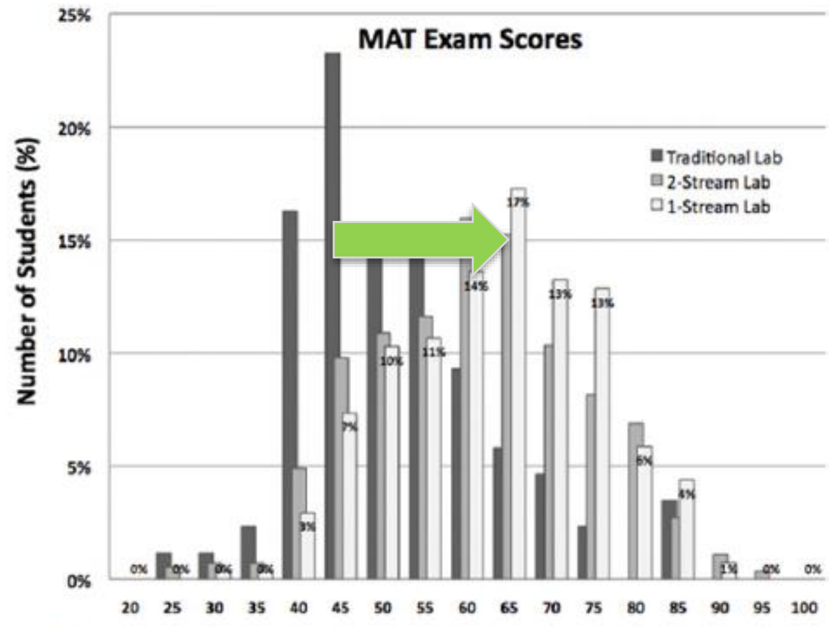
— Weigh the empty air pot and record.

— Dampen the inside of the measuring bowl.

— Using the scoop, place concrete in the measuring bowl in 3 equal layers, rodding each 25 times

SLE Benefits: What the literature tells us

- Increases student engagement with the course material and overall learning
- Boosts student confidence
- Teaches autonomous learning and problem solving
- Increases student interest in experiential learning
- Increases student satisfaction and can increase course SEIs
- Integrates creativity back into engineering!



Great place to integrate sustainability concepts

"The papers, as much of a pain as they were–helped me master the material because they forcer me to think a step further than basic lab protocols."

"I have learned more from this lab than any other lab because of the freedom of experimental design."

"Feel confident I could leave this lab and lab work and do the things I did here somewhere else."

Luckie et al. "Less teaching, more learning"

Project Elements

Pre-experiment Prep

- Teach about experimental elements: theory and analysis

Proposal

- Students perform literature search
- Formulate hypothesis and experimental plan in writing

Proposal Review

- Students present plan and discuss elements with instructor

Conduct Experiment, Analyze and Present Data

- Report/Presentation/Video

Peer Review

- Students practice giving and receiving feedback
- Peer review lessens instructor grading effort

First half of the semester is more traditional laboratory setup

Second half begins student-led work

Week	Mon. Date	Lecture Numbers	Suggested Text Reading	Lab Topics and Additional Notes	Assignment Su **Labs due 11: your lab s
1	1/10	Introduction Materials Basics 1-2	Ch. 1	No lab this week	
2	1/17	Materials Basics 3	Ch. 2	Note – no class or office hours on 1/17 due to MLK Day Intro, Lab Safety, Group Assignments	DQ: M
3	1/24	Metals 1-2	Ch. 3: 3.1-3.2, 3.4-3.8	Metals 1	DQ: MB2 & Carmen Lab Sa
4	1/31	Metals 3-4	Ch. 3: 3.3, 3.10-3.12, Ch. 4	Metals 2	DQ: M1 & Metals 1 La
5	2/7	Wood 1-2	Ch. 10: through 10.8, 10.12-10.14	Wood	DQ: M3 & Metals 2 La
6	2/14	Agg 1 Midterm Review	Ch. 5: Through 5.5.7	Aggregates 1	DQ: W1 & Wood Lab
7	2/21	Agg 2	Ch. 5: 5.5.8, 5.7	Aggregates 2	No DQ Agg 1 Lab
		Midterm – Materials Basics, Metals, Wood			
8	2/28	Agg 3 Concrete 1	Ch. 6: through 6.2, 6.9	Concrete 1: Concrete Mix Design	DQ: Ag1 & Agg Lab 2
9	3/7	Concrete 2 & 3	Ch. 6: 6.5-6.8	Concrete 2: Workability and Strength & Concrete Experiment Intro	DQ: Ag3 Concrete Mix D written assignme @ lab; Carm completed
	3/14	Spring Break			
10	3/21	Concrete 4 & 5	Ch. 6: 6.11	Concrete Experiment Discussion with Dr. Burris or Ms. Ammari (over zoom)	DQ: C2 & Workability Concrete Exper due
11	3/28	Concrete 6 & 7	Ch. 7: 7.6-7.7	No lab – use this time to write your experiment report Introduction, finalize your mix design	DQ: C4 &

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Assignment Setup:

Project Objective: This semester you are tasked with **coming up with a concrete research question and developing an experiment to answer that question.**

What are you doing?

Here are some possible ideas to get you started, you are more than welcome to come up with something more creative.

- Explore the effect of varying quantities of an SCM or fiber reinforcement on a property of concrete (compressive strength, flexural strength, durability, etc).
- Determine the effect of curing technique on concrete strength gain.
- Determine the influence of load application rate on concrete strength.
- Track the effect of an admixture (superplasticizer, air entrainer, retarder, etc) on a concrete property (workability, strength, durability, etc).
- Determine the performance of an alternative to steel reinforcement or compare different reinforcement configurations.
- Investigate use of a 'novel' SCM or admixture in concrete (something you create or bring in).

What could this look like?

Assignment Setup:

Lists of available materials:

Cement and SCMs: Portland cement (SG = 3.15), Class F fly ash (SG = 2.5), Silica Fume (SG = 2.5), Ground granulated blast furnace slag (SG = 2.5)

Admixtures: Superplasticizer, Air entraining agent, Calcium chloride accelerator
For mix design, assume the admixtures take up zero volume in your mix.

Aggregates: #57 Pea gravel, Concrete sand.

Fibers: Plastic fibers, Steel fibers

Equipment:

Slump cones and mini slump cones
Concrete pressure air test setup
Compressive strength actuator (similar setup to the wood compression samples)
Concrete split tensile setup
Flexural test setup (similar to setup for the wood lab)
Concrete modulus of elasticity setup
Concrete electrical resistivity meter
Ultrasonic pulse velocity meter
Schmidt hammer
Oven – up to 120C
Scales and Calipers
Fog room for curing
5 gal buckets
6x6x22” beam molds
4” diameter x 8” tall concrete cylinder molds

Example Projects:

Fun Past Ideas:

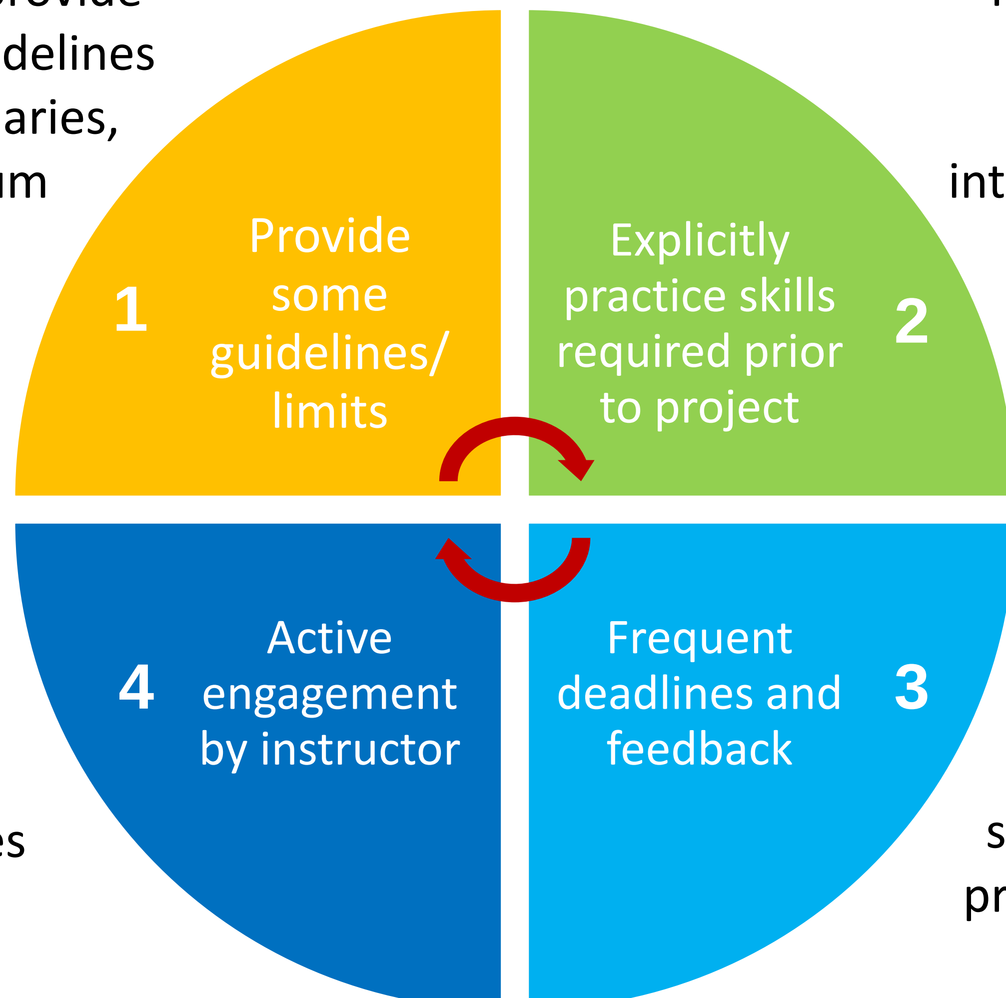
- Effect of sea shells at varying particles sizes on strength and resistivity
- Use of anti-freeze as a freeze-thaw damage prevention agent
- Plastics in concrete
- Iron filings – use to induce horizontal flow in fresh concrete and levels of magnetic potential in hardened concrete
- Effect of milk on setting time and strength development
- Pervious concrete flow rate: effect of aggregate proportions

Extra credit is **amazing** for encouraging creativity and pushing the students towards topics you want to see exploration in

Keys to Success

Instructor must provide structure and guidelines for choice-boundaries, including minimum requirements

Try to limit amount of 'new' in the project where possible and introduce experimental basics in chunks



Instructor must actively engage with students – teaching style massively changes from traditional labs.

Provide 'check in' points to keep students on track and provide early feedback

Questions?


AW, MAN. THIS JOB JUST KEEPS GETTING HARDER AND HARDER.
CONCRETE INC.
CONCRETE INC.
PABLO STANLEY

Utilize Peer Reviews:

2 goals with peer review:

Provide practice reviewing others' work, and have help catching major omissions

Get students thinking critically about their own work

Introduction section:

1. Is enough background information provided to give you a sense of what we currently know about the group's project focus? If not, give a suggestion for at least one thing that would help you understand the topic a bit more.
2. Does the group state their hypothesis? Is it a testable hypothesis? (i.e. it must make a prediction "We believe plastic will increase concrete's modulus of rupture."

Materials and Methods section:

1. Is it clear what concrete mixes the group used and what the difference was between each mix that was created?
2. What samples were created for the experiment (aka 4x8" cylinders, beams etc)? Dimensions and numbers of samples should be provided.
3. What tests were performed during the experiment?

Discussion:

1. What are the findings of the experiment? Can you determine if the report's hypothesis was correct or not from the data provided?
2. Did the report provide generalizable results or only specific results for these mixtures in particular?
3. What were the limitations of this experiment and/or what would the authors do differently next time?

Lessons Learned:

- Must provide minimums requirements
- Allowing time for iteration furthers learning gains
- Point out process challenges and basic steps
- Increase your availability but also force engagement
- Give expectation for how it feels to take on engineering judgement