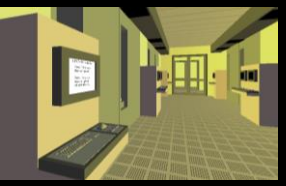


Engaging Engineering Students at Scale:
Technological Innovation and Organizational Change

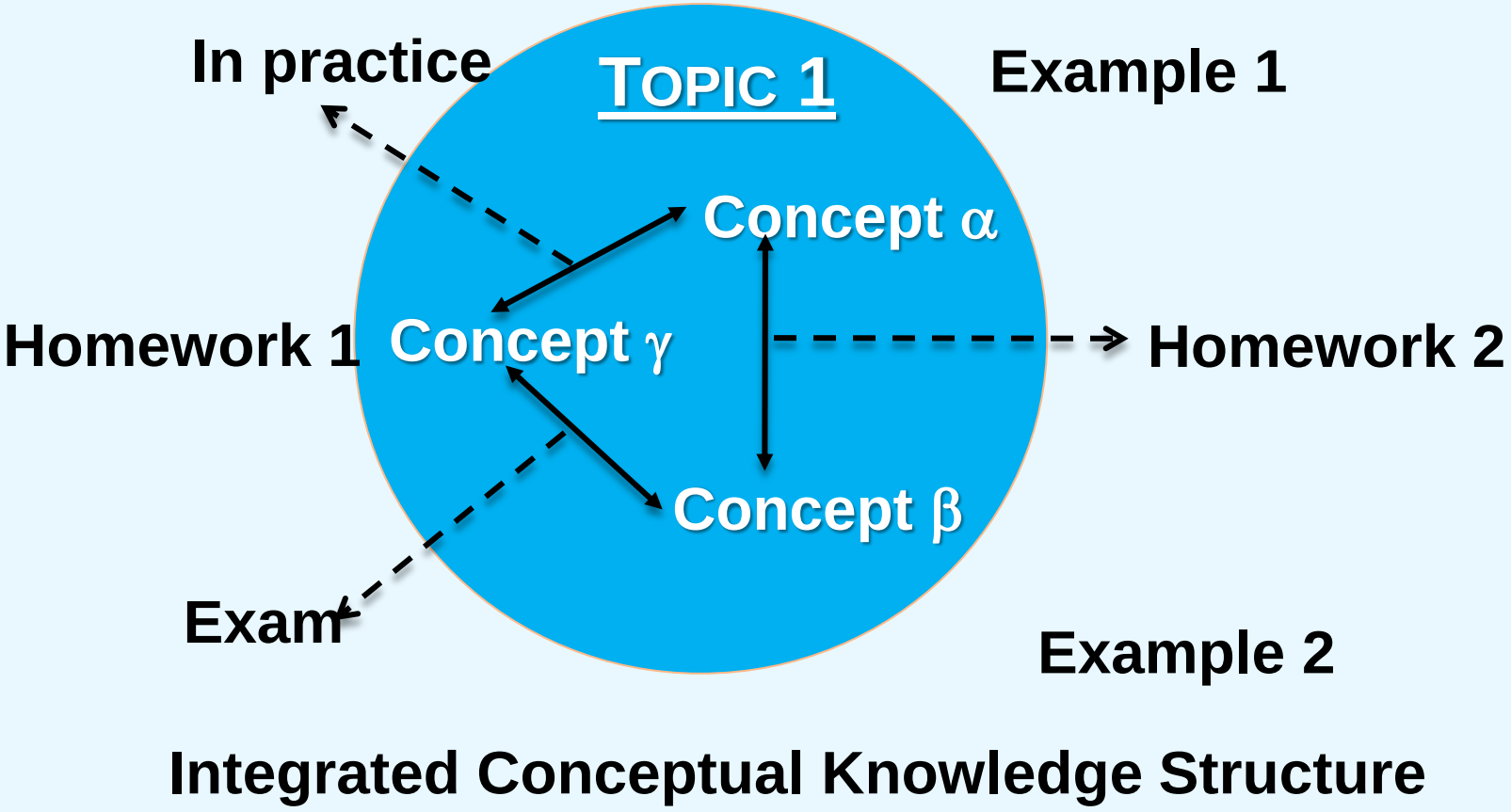
Milo Koretsky

School of Chemical, Biological and Environmental Engineering

Problem Solving: Procedural Approach

Example	Homework	Exam
Given *T*	Given *T*	Given *P*
Step 1	Step 1	Step 4
Step 2	Step 2	Step 3
Step 3	Step 3	Step 2
Step 4	Step 4	Step 1
Find *P*	Find *P*	Find *T*

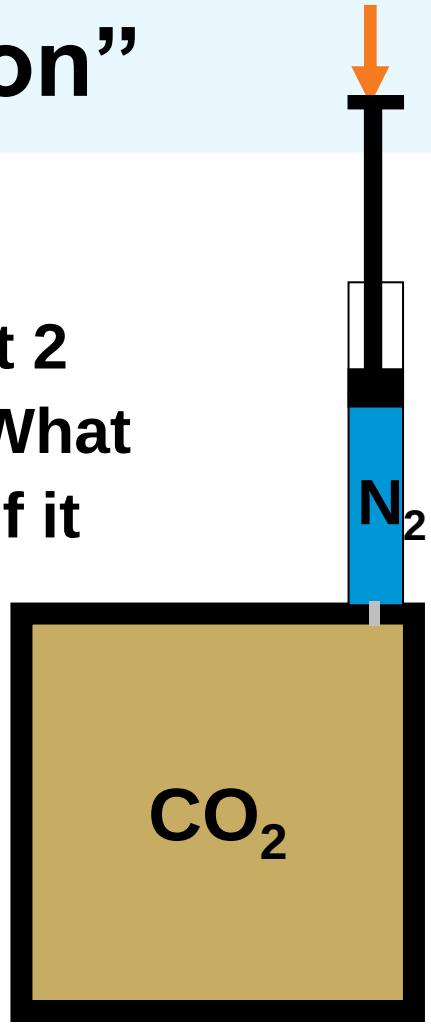
Problem Solving: Conceptual Approach



Objective: To develop conceptual understanding by removing the "calculation procedure" from the question

Example "Concept Question"

A constant-volume tank contains CO_2 at 2 atm. Nitrogen is injected into the tank. What happens to the partial pressure of CO_2 if it all remains in the tank? Assume ideal gases and an isothermal system.



13 A. Decreases

32 B. Increases

6 C. Stays the same (chance is 17)

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Learning Landscape

Knowledge Structures

Technology Development

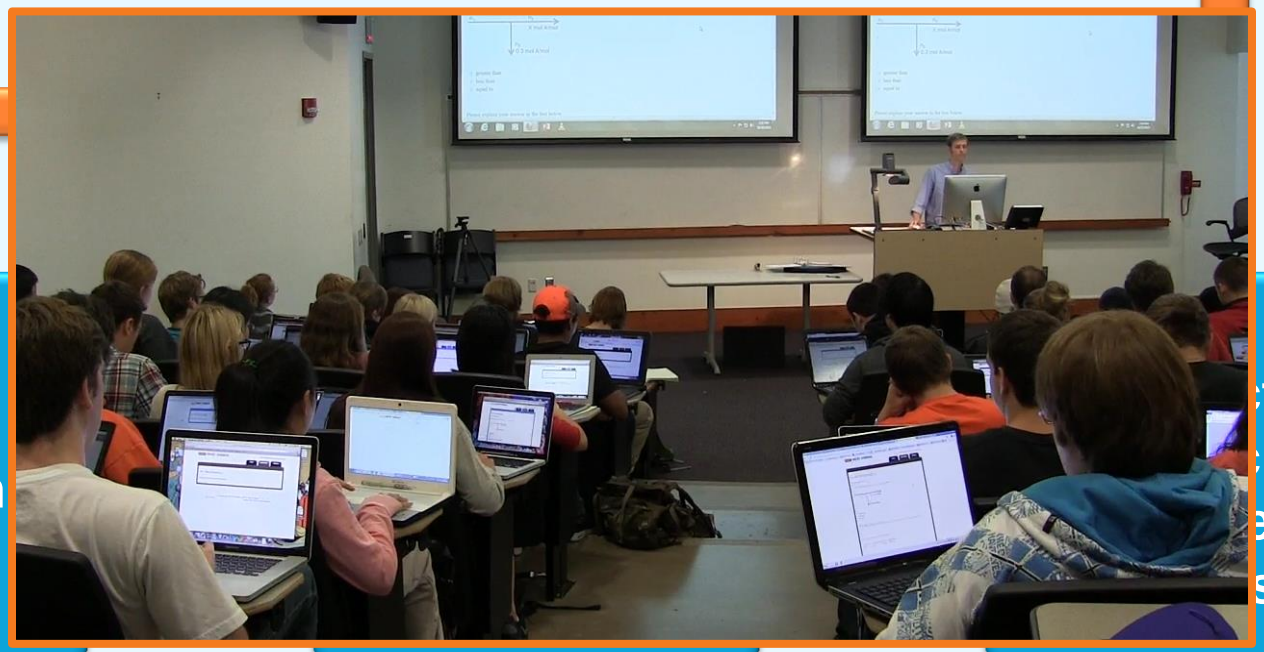
The AIChE Concept Warehouse

Peer Instruction

Instructor assigns a conceptual question

Students answer individually

Students discuss in groups



Instructor reassigns th question

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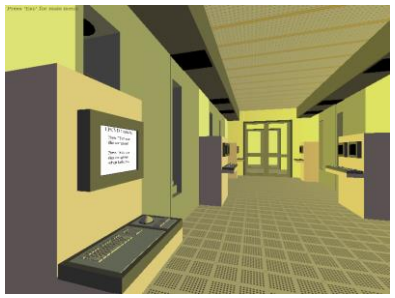
Learning Landscape

Knowledge Structures

Disciplinary Practice

Industrially-Situated Labs

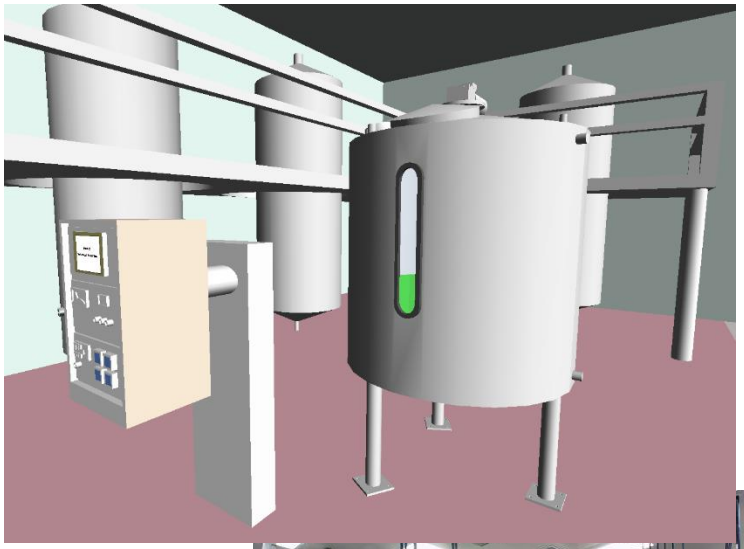


Technology Development

Virtual Process Development Tasks

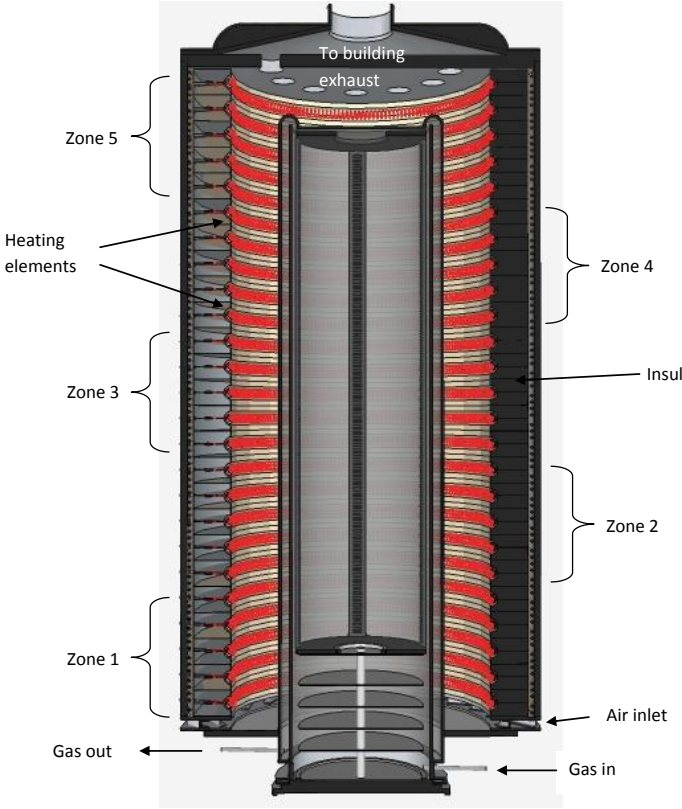
Chemical Vapor Deposition Reactor

Bio Reactor



Virtual CVD Process Development Task

Students must develop a "recipe" to grow Si_3N_4 film with uniform thickness, by:



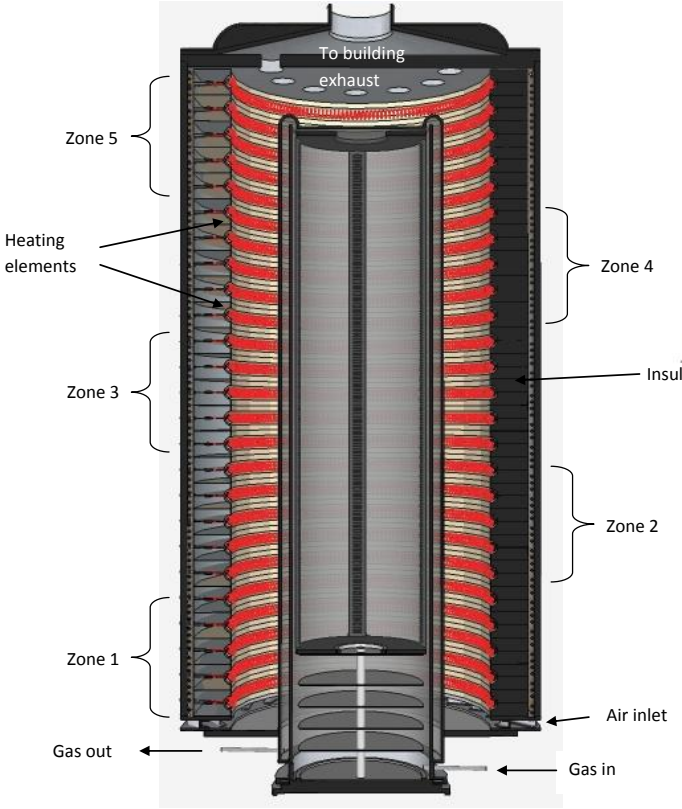
Pressure:		mTorr
NH_3 Flow:		sccm
DCS Flow:		sccm
Reaction time:		min

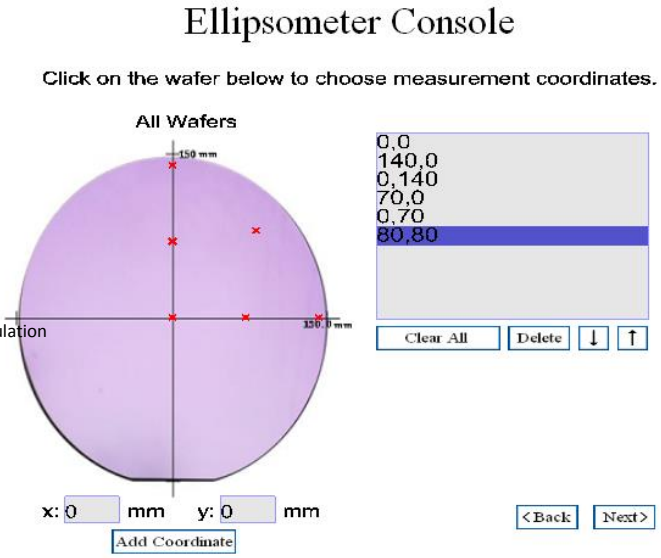
Zone 1:		°C
Zone 2:		°C
Zone 3:		°C
Zone 4:		°C
Zone 5:		°C

Choosing the 9 *Virtual* CVD Reactor parameters, and then

Virtual CVD Process Development Task

Students must develop a "recipe" to grow Si_3N_4 film with uniform thickness, by:





Choosing the locations on the wafer to measure

Each run and each measurement costs $

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Instructional Design

Deliverables

Begin Experiments

Design Memo
- Initial parameters
- Budget
- Experimental strategy

Update Memo
- Progress to date

- Final Report
- Final Oral Presentation
- Final Recipe
- Laboratory Notebook

Student-Coach Interaction

Faculty Present
- Background info
- Intro to software

Design Meeting
- Discuss strategy
- Students get authorization for VL

Update Meeting
- Discuss progress & strategy

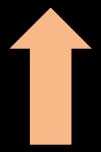
Final Presentations
- 10-15 min present
- 10-15 min questions from students, coach, 2 other faculty

Task Intro | End of Wk 1 | End of Wk 2 | End of Wk 3

Conceptions of Learning

"Students need to understand the concepts so they have the foundation to do engineering"

Doing

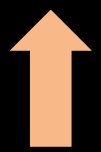


Understanding

or

"By doing engineering students can recognize the salient concepts they need to learn"

Understanding



Doing

Co-construction and Co-production

- Co-construction: cognitive talk directed at **making meaning**, trying to build connections between ideas and understanding, and answering how and why questions related to the knowledge underlying the task
- Co-production: cognitive talk orientated at the **completion of the set work** that was prescribed by the instructor (in School World) or develop the process recipe and meet engineering objectives of the project (in Engineering World).

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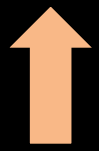
Conceptions of Learning

"Students need to understand the concepts so they have the foundation to do engineering"

Production

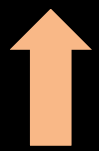


Construction

or

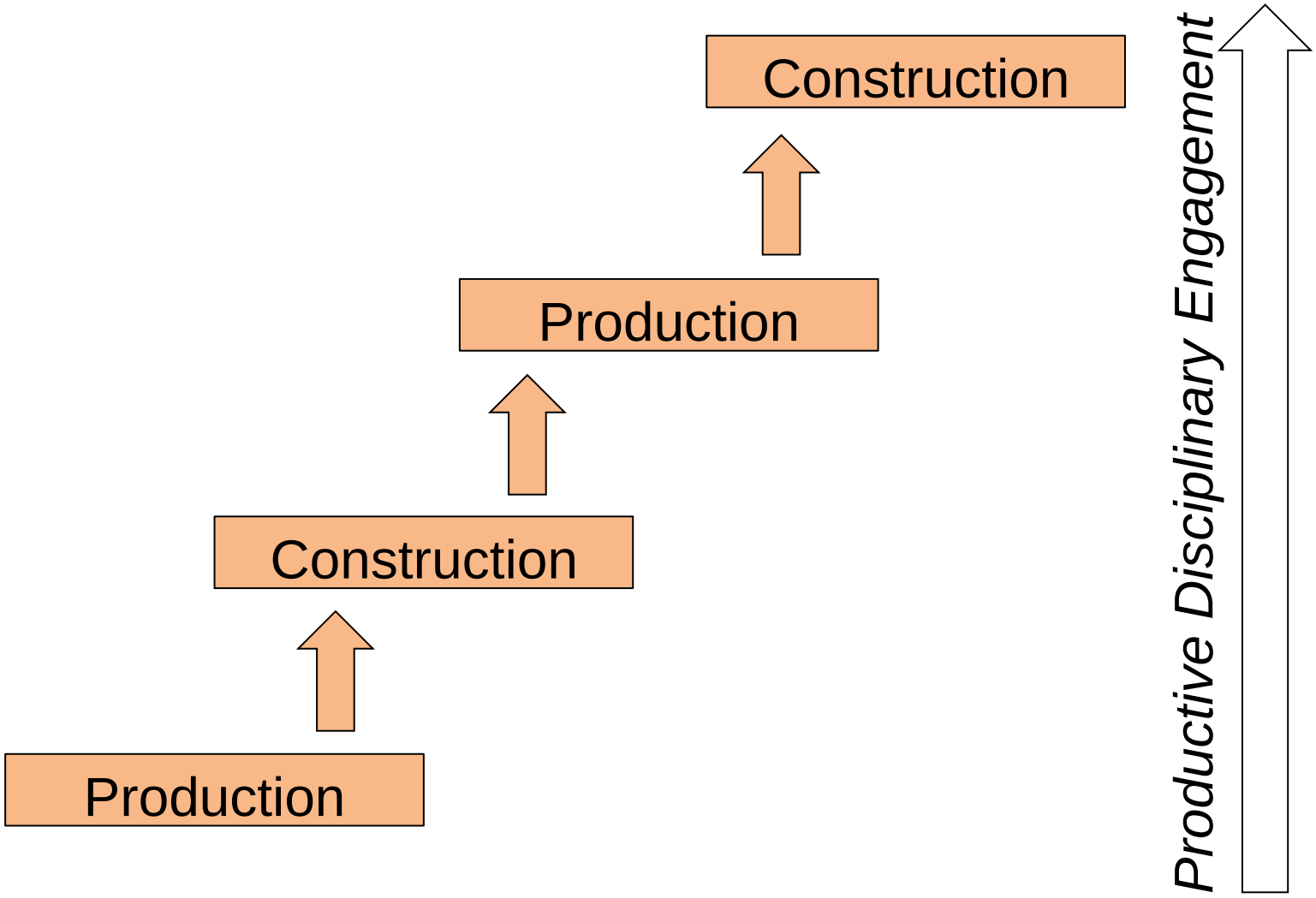
"By doing engineering students can recognize the salient concepts they need to learn"

Construction



Production

Doing and Understanding in Authentic Engineering Projects



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Learning Landscape

Knowledge Structures ⟷ Disciplinary Practice

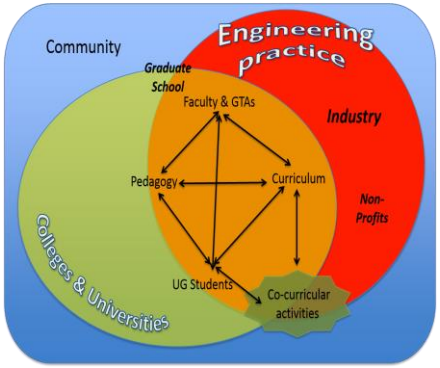
Technology Development ↕ Organizational Change

Industrially-Situated Labs

ESTEME@OSU

Enhancing STEM Education at Oregon State University

Revolutionizing Engineering Dpts



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