

Engineering Design for the Texas Four-by-Four



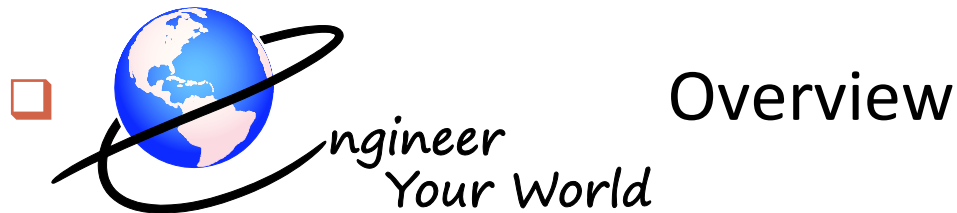
Rich Crawford, Mechanical Engineer

Cheryl Farmer, Project Director

Todd Head, Physics Teacher

Presentation Overview

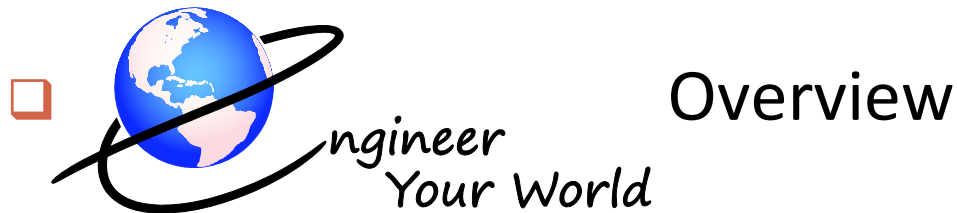
- ❑ What is engineering? Form or function?



- ❑ Texas Pilot and Early Results
- ❑ Pilot Phase Two and Beyond

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Features

- ❑ Engages students in authentic engineering practices
- ❑ Project-based environment
 - 80% hands-on activity
 - 20% documenting and reflecting on work, preparing presentations and reports, participating in direct instruction
- ❑ Student learning scaffolded over six design challenges
 - Standardized engineering design process
 - Requires purposeful application of engineering principles and relevant science and math concepts
- ❑ Aligned with Texas state standards and emerging Next Generation Science Standards



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Course Framework

Engineering
Design
Process

High School Engineering Design and Problem Solving Course Framework		Fall Semester		Spring Semester	
		1	2	1	2
Engineering Practices					
<p>Engineering Practice 1: Define the Problem - Students learn about engineering's societal responsibilities, applications of engineering, and the engineering process and how it relates to their challenges and the necessity for engineering design, innovation, and problem-solving.</p> <p>Engineering Practice 2: Analyze a Problem and Design a Solution - Students learn about the engineering design process, including the importance of defining the problem, identifying constraints and challenges, brainstorming solutions, and evaluating and testing solutions.</p> <p>Engineering Practice 3: Construct, Test, and Refine a Design - Students learn about the engineering design process, including the importance of defining the problem, identifying constraints and challenges, brainstorming solutions, and evaluating and testing solutions.</p> <p>Engineering Practice 4: Communicate Solutions - Students learn about the engineering design process, including the importance of defining the problem, identifying constraints and challenges, brainstorming solutions, and evaluating and testing solutions.</p> <p>Engineering Practice 5: Work with Others - Students learn about the engineering design process, including the importance of defining the problem, identifying constraints and challenges, brainstorming solutions, and evaluating and testing solutions.</p> <p>Engineering Practice 6: Seek, Evaluate, and Communicate Information - Students learn about the engineering design process, including the importance of defining the problem, identifying constraints and challenges, brainstorming solutions, and evaluating and testing solutions.</p> <p>Engineering Practice 7: Engage in Critical Thinking - Students learn about the engineering design process, including the importance of defining the problem, identifying constraints and challenges, brainstorming solutions, and evaluating and testing solutions.</p> <p>Engineering Practice 8: Engage in Creative Thinking - Students learn about the engineering design process, including the importance of defining the problem, identifying constraints and challenges, brainstorming solutions, and evaluating and testing solutions.</p> <p>Engineering Practice 9: Engage in Systems Thinking - Students learn about the engineering design process, including the importance of defining the problem, identifying constraints and challenges, brainstorming solutions, and evaluating and testing solutions.</p>					
Engineering Design Process					
<p>The Engineering Design Process - Students learn about the engineering design process, including the importance of defining the problem, identifying constraints and challenges, brainstorming solutions, and evaluating and testing solutions.</p>					
Engineering Skills and Abilities of 12th					
<p>Systems Thinking - Students identify and analyze a system or process based on the idea that the parts of a system can be understood in the context of relationships with other parts and that those parts affect those relationships. Students are asked to identify components, their interactions, and critical variables.</p> <p>System Analysis and Synthesis - Students learn about the engineering design process, including the importance of defining the problem, identifying constraints and challenges, brainstorming solutions, and evaluating and testing solutions.</p> <p>Communication - Students learn about the engineering design process, including the importance of defining the problem, identifying constraints and challenges, brainstorming solutions, and evaluating and testing solutions.</p> <p>Problem Solving and Decision Making - Students learn about the engineering design process, including the importance of defining the problem, identifying constraints and challenges, brainstorming solutions, and evaluating and testing solutions.</p> <p>Teamwork - Students learn about the engineering design process, including the importance of defining the problem, identifying constraints and challenges, brainstorming solutions, and evaluating and testing solutions.</p> <p>Research and Innovation - Students learn about the engineering design process, including the importance of defining the problem, identifying constraints and challenges, brainstorming solutions, and evaluating and testing solutions.</p> <p>Design and Problem Solving - Students learn about the engineering design process, including the importance of defining the problem, identifying constraints and challenges, brainstorming solutions, and evaluating and testing solutions.</p> <p>Technical Communication - Students learn about the engineering design process, including the importance of defining the problem, identifying constraints and challenges, brainstorming solutions, and evaluating and testing solutions.</p> <p>Mathematical Proficiency - Students learn about the engineering design process, including the importance of defining the problem, identifying constraints and challenges, brainstorming solutions, and evaluating and testing solutions.</p> <p>Science Practices - Students learn about the engineering design process, including the importance of defining the problem, identifying constraints and challenges, brainstorming solutions, and evaluating and testing solutions.</p> <p>Engineering Practices - Students learn about the engineering design process, including the importance of defining the problem, identifying constraints and challenges, brainstorming solutions, and evaluating and testing solutions.</p> <p>Engineering Design Process - Students learn about the engineering design process, including the importance of defining the problem, identifying constraints and challenges, brainstorming solutions, and evaluating and testing solutions.</p> <p>Engineering Skills and Abilities of 12th - Students learn about the engineering design process, including the importance of defining the problem, identifying constraints and challenges, brainstorming solutions, and evaluating and testing solutions.</p>					
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Unit 1: What Is Engineering? & Class Norms

Engineers rely on teamwork and communication.

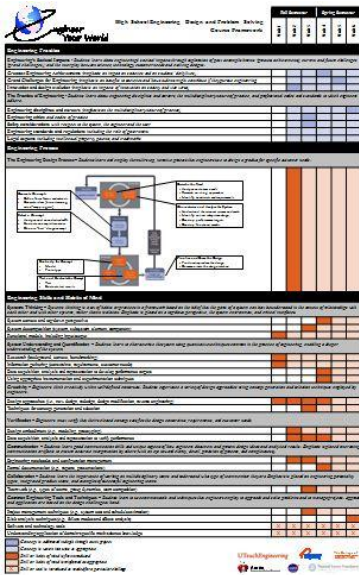
High School Engineering Design and Problem Solving Course Framework	1	2	3	4	5	6
Engineering Overview						
Engineering Process						
Engineering Skills and Skills of the 21st Century						

Documentation
Collaboration

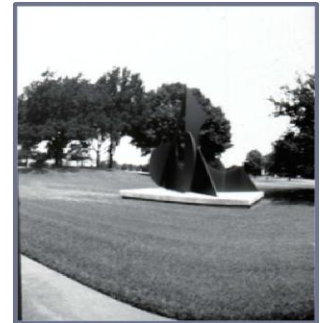


Unit 2: The Evolution of Imagery

Engineers design products to satisfy customer wants and needs.



- The engineering design process
- New design
- Design evolution
- Analyzing/interpreting requirements
- Concept generation
- Design embodiment
- Performance verification
- Engineering notebooks

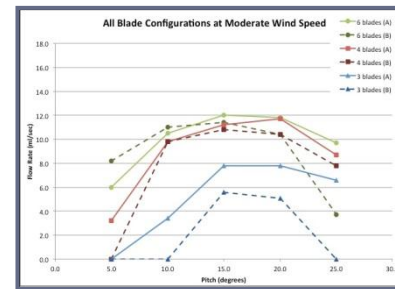


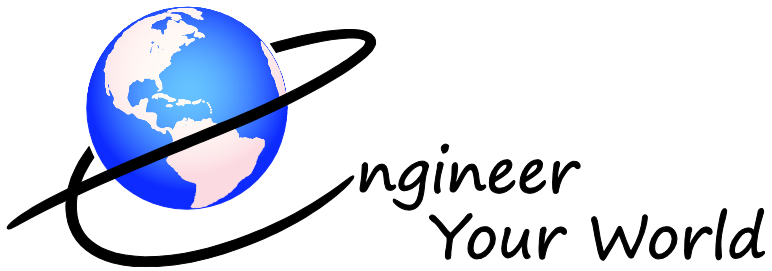
Unit 3: Green Energy for Clean Water

Engineers improve lives.

The screenshot shows a project management tool with a Gantt chart on the left and a task list on the right. The task list includes various engineering tasks such as 'Design Modification', 'Instrumentation', and 'Data Acquisition'. The Gantt chart shows the timeline of these tasks, with some tasks overlapping or occurring in sequence.

Design modification
Appropriate instrumentation and experimentation
Data acquisition, analysis and representation
Engineering standards and regulations





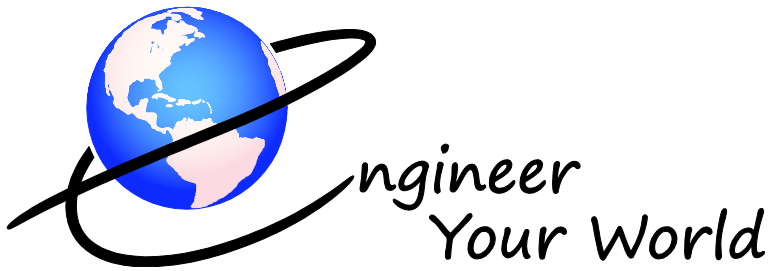
Unit 4: Aerial Imaging

Engineers work in teams to solve complex design challenges.

Task	Week 1	Week 2	Week 3	Week 4	Week 5
Task 1	█				
Task 2		█			
Task 3			█		
Task 4				█	
Task 5					█

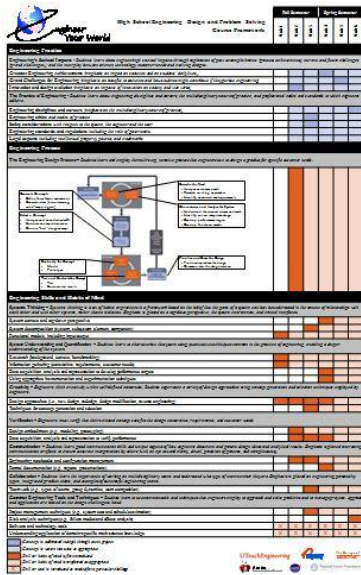
Systems thinking
Design at the subsystem level
Complex teams
Project management
Concept selection
Risk analysis
Ethics and safety



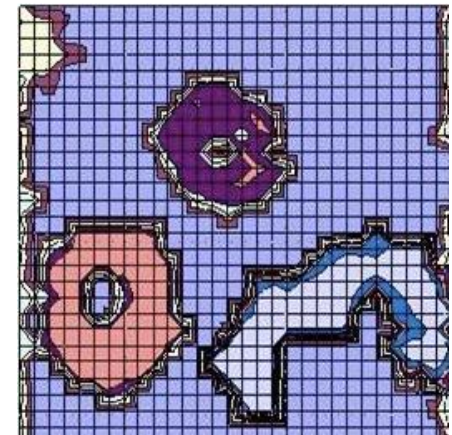
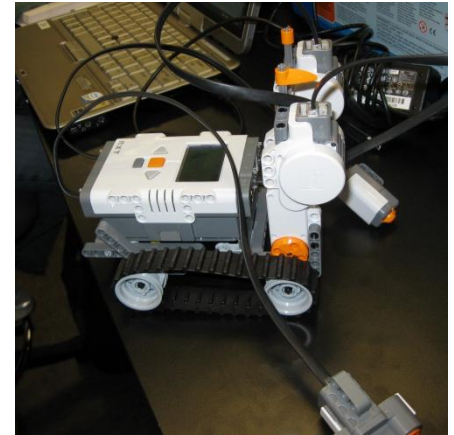


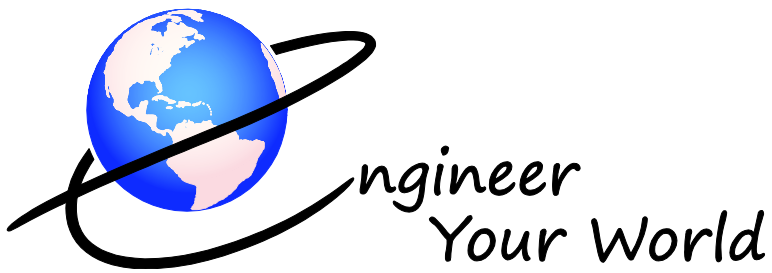
Unit 5: The Search for Lunar Ice

Engineering opens frontiers.



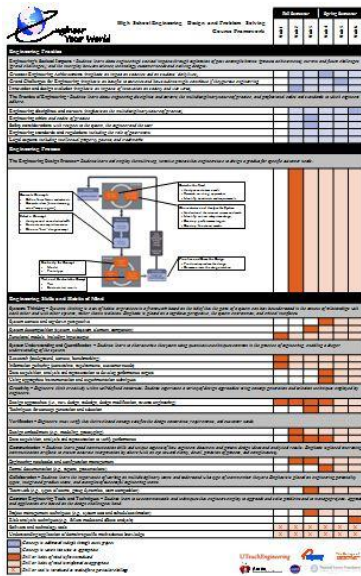
Automation and control
Programming basics
Operations planning
Greatest engineering achievements



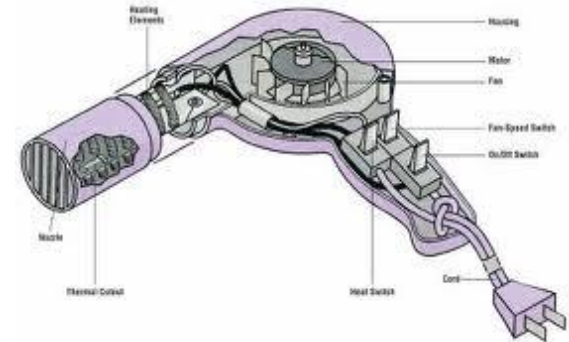


Unit 6: Reverse Engineer Your World

Engineering impacts our everyday lives.

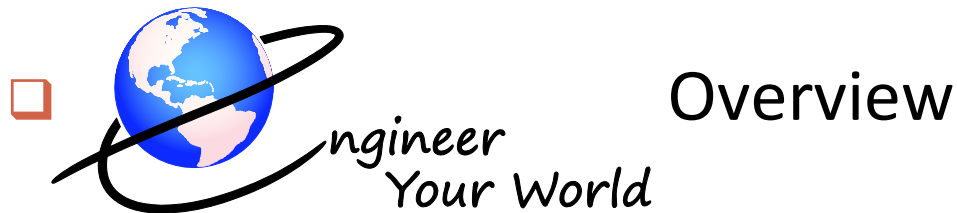


Reverse engineering
and redesign
Functional modeling
Gathering/analyzing
customer needs
Information gathering
Grand challenges for
engineering
Safety and legal aspects



Presentation Overview

- ❑ What is engineering? Form or function?



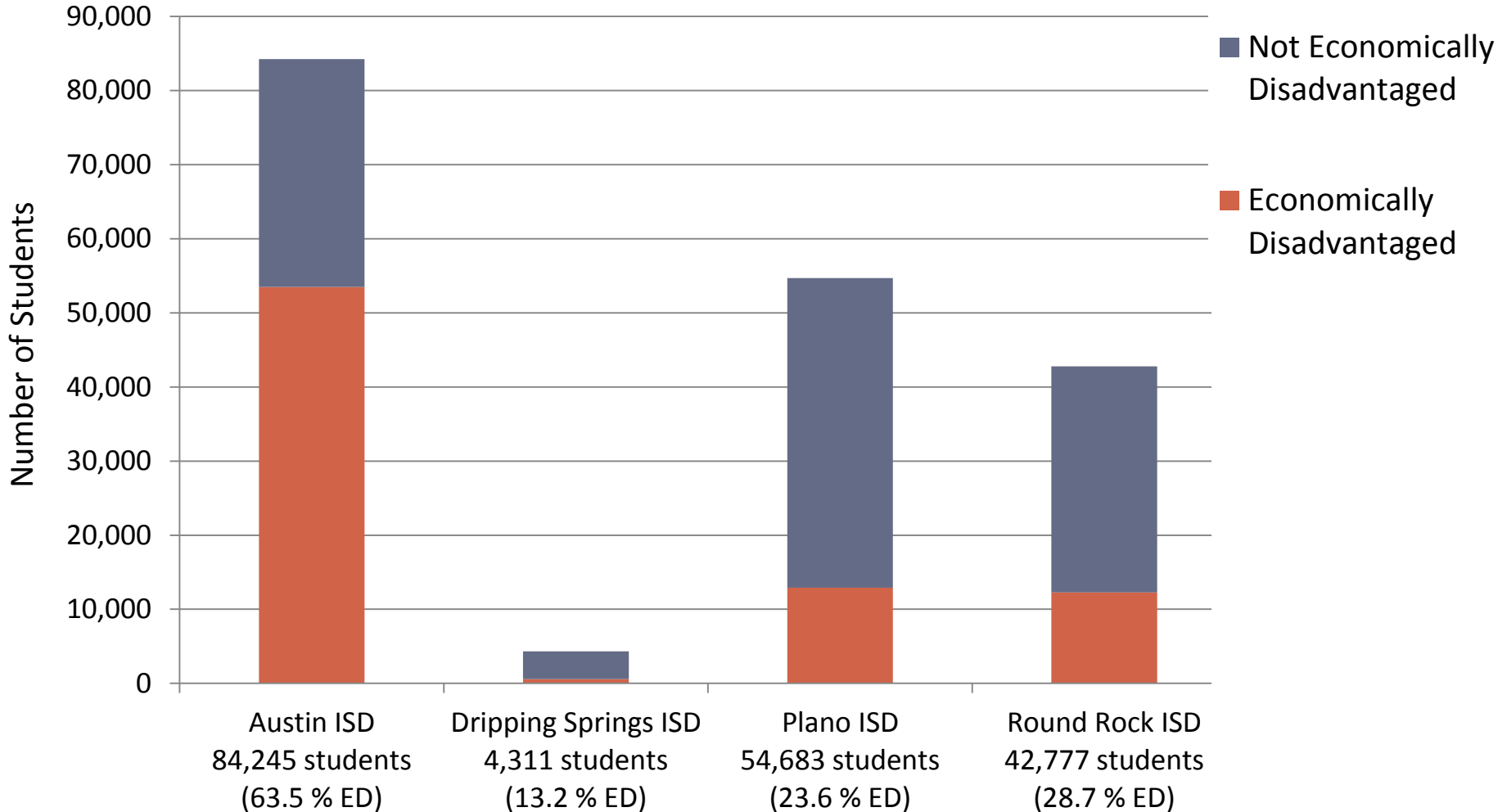
- ❑ **Texas Pilot and Early Results**

- ❑ Pilot Phase Two and Beyond



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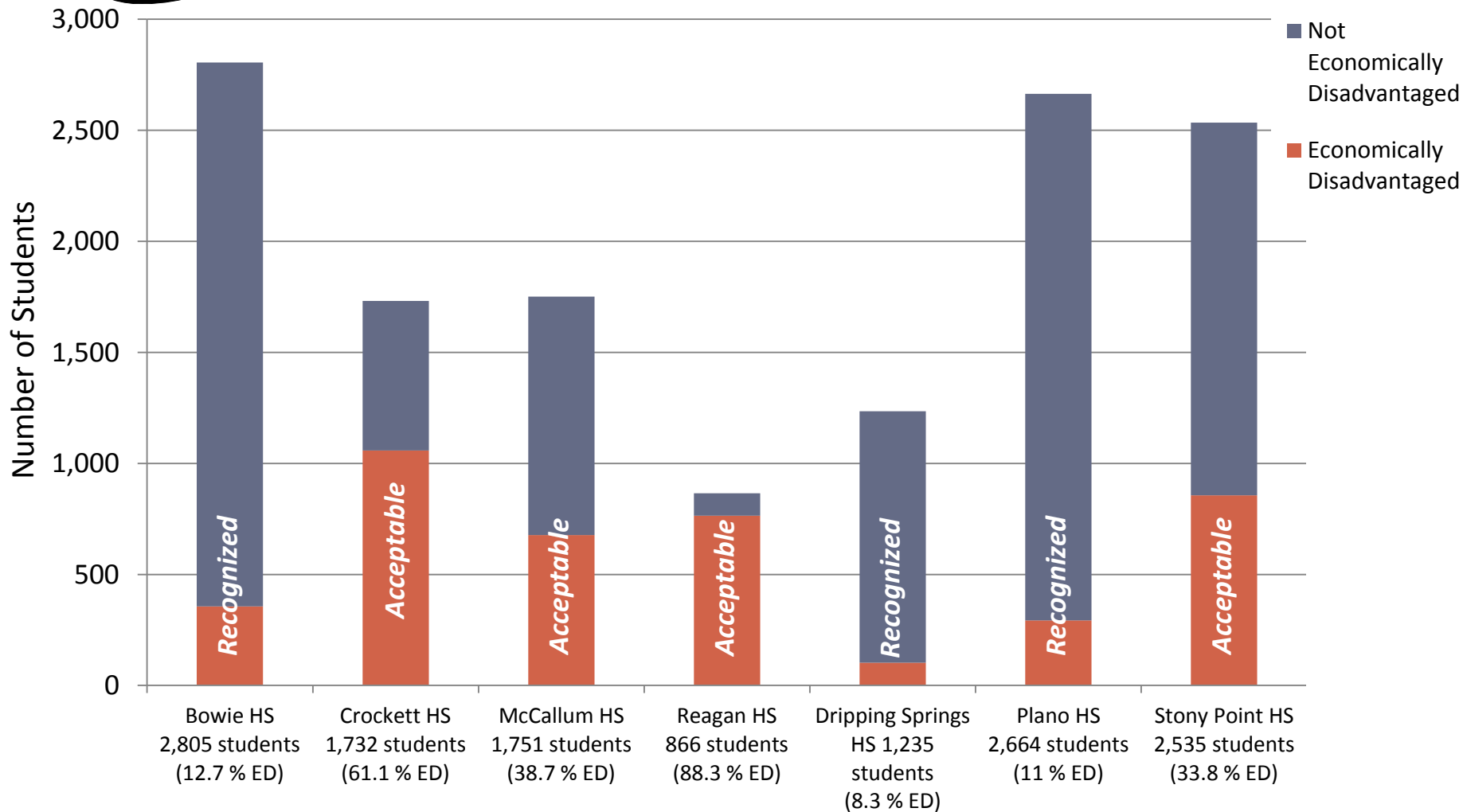
2011-12 Pilot Districts





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2011-12 Pilot Schools





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Pilot Teachers

Campus (Rating)	# Sections Offered	# Students in 2011-12 Pilot Course	Other Courses Taught	Years Teaching Experience	Engineering Degree or Experience
Bowie HS (R)	1	24	Physics	20	No
Crockett HS (A)	1	9	Physics	15	No
McCallum HS (A)	1	10	CAD	10	No
Reagan HS (A)	1	7	Physics	4	
Dripping Springs HS (R)	1	22	Statistics	10	
Plano HS (R)	4 (2 teachers)	> 120	Physics	5 and 2	 
Stony Point HS (A)	2	60	Physics	16	No

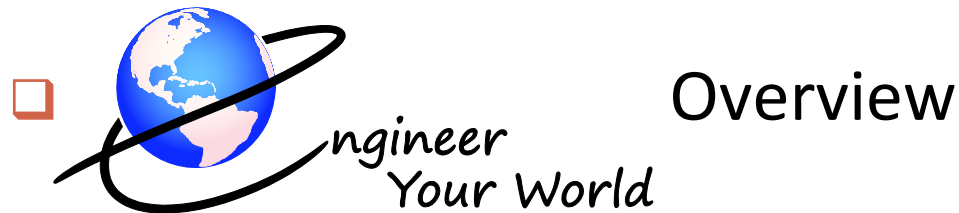
Early Results from 2011-12 Pilot

- ❑ Teachers struggled to complete the course in their first year (to be expected)
- ❑ Need to establish classroom norms early in the course
- ❑ Need to modify and strengthen scaffolding
- ❑ What do you want to know?

Q&A with a pilot teacher

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What's New in 2012-2013?

❑ Teacher PD

- Two-week workshop to enhance participants' engineering content knowledge and pedagogical content knowledge

❑ Mentorship

- Developing and testing a mentorship model for scale

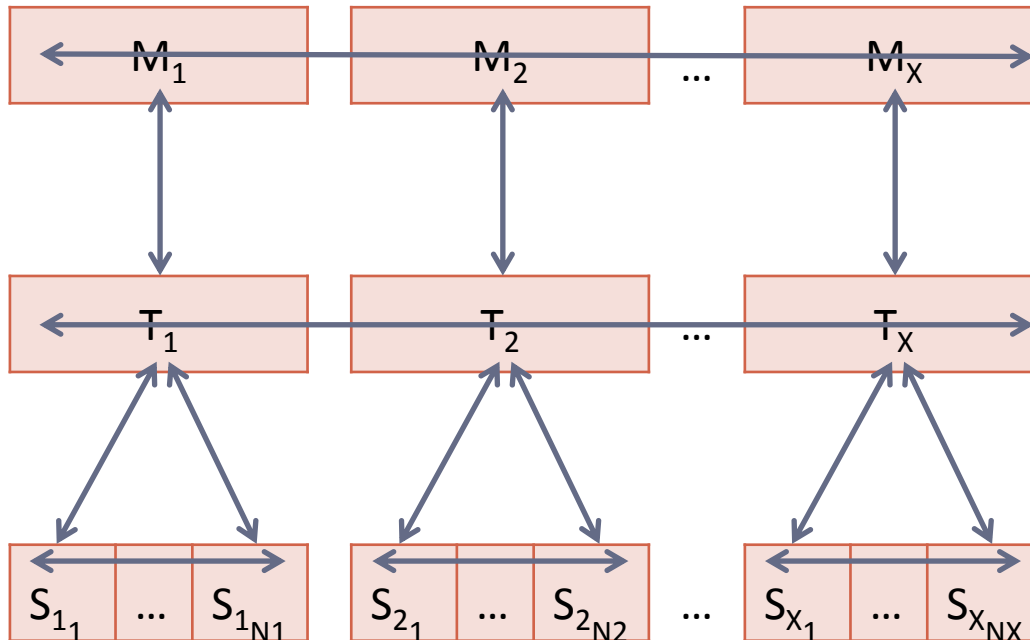
❑ Assessments

- Developing validated assessment tools for assessing student artifacts

❑ Portfolio (AP[®]) Version

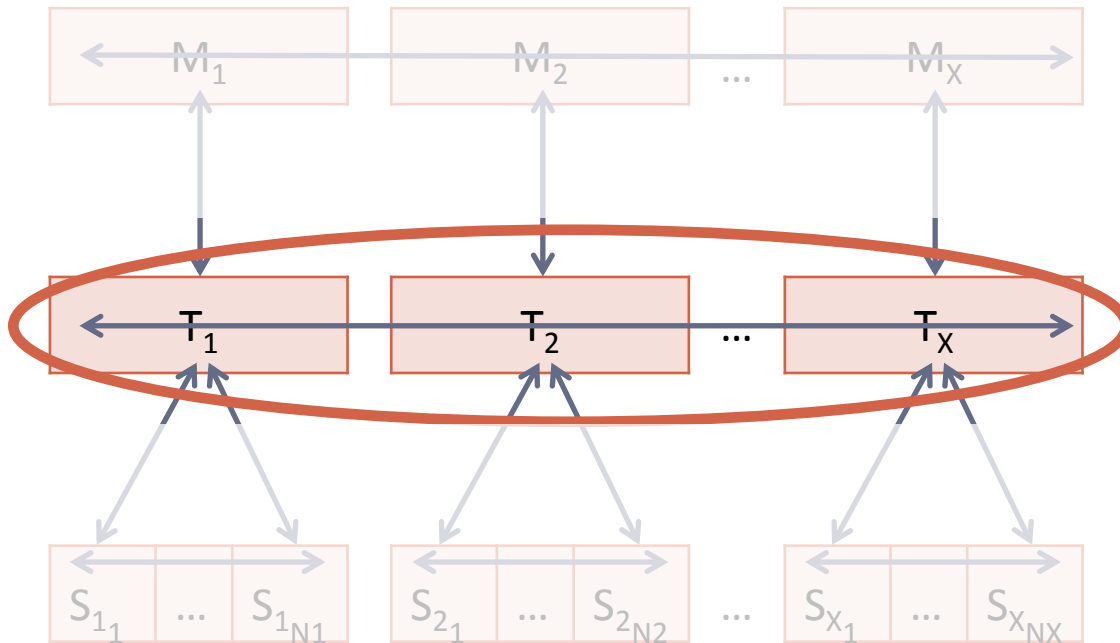
- Piloting portfolio version aligned with current draft AP[®] standards

Developing Courseware: LMS + Virtual Collaboration Tool



- Mentor/mentor collaboration
- Teacher/mentor collaboration
- Teacher/teacher collaboration
- Teacher-student communication
- Student/student collaboration

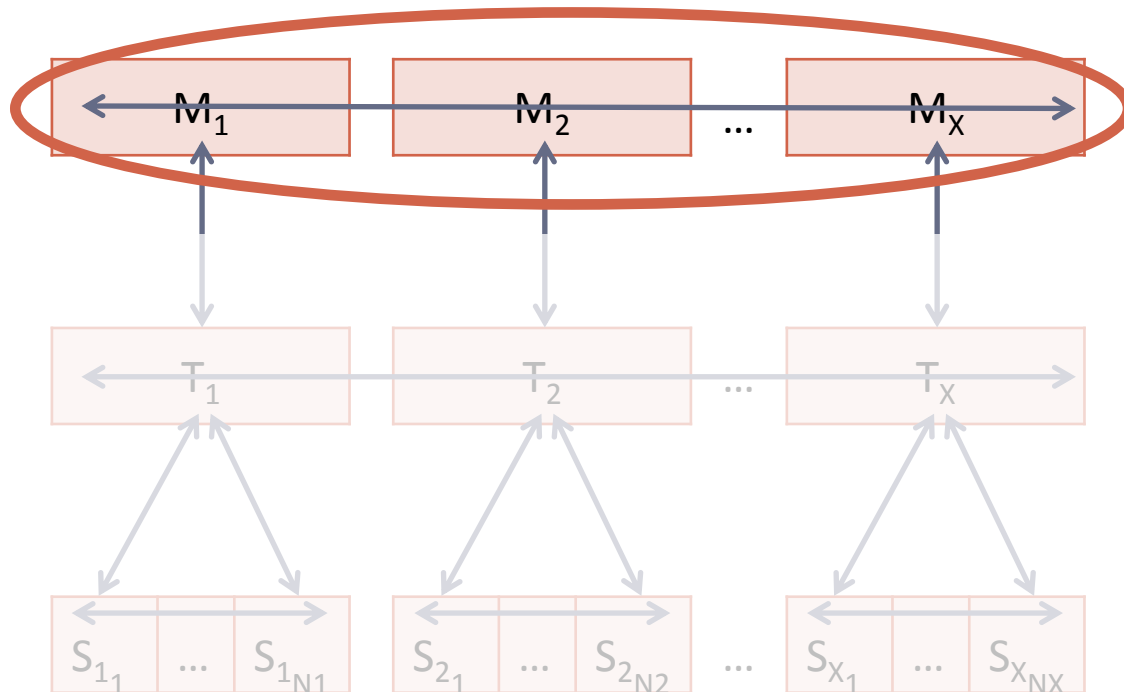
Developing Courseware: LMS + Virtual Collaboration Tool



For teachers, access to

- **Course Materials**
 - Lesson plans
 - Background materials
 - Supporting resources
- **Ongoing PD**
 - Refresher videos
 - On-time training
 - Webinars on practice
- **Course Management Tools**
 - Share resources with students
 - Assign, view, assess student work
- **Collaboration Tools**
 - Teacher-to-teacher
 - Teacher-to-mentor

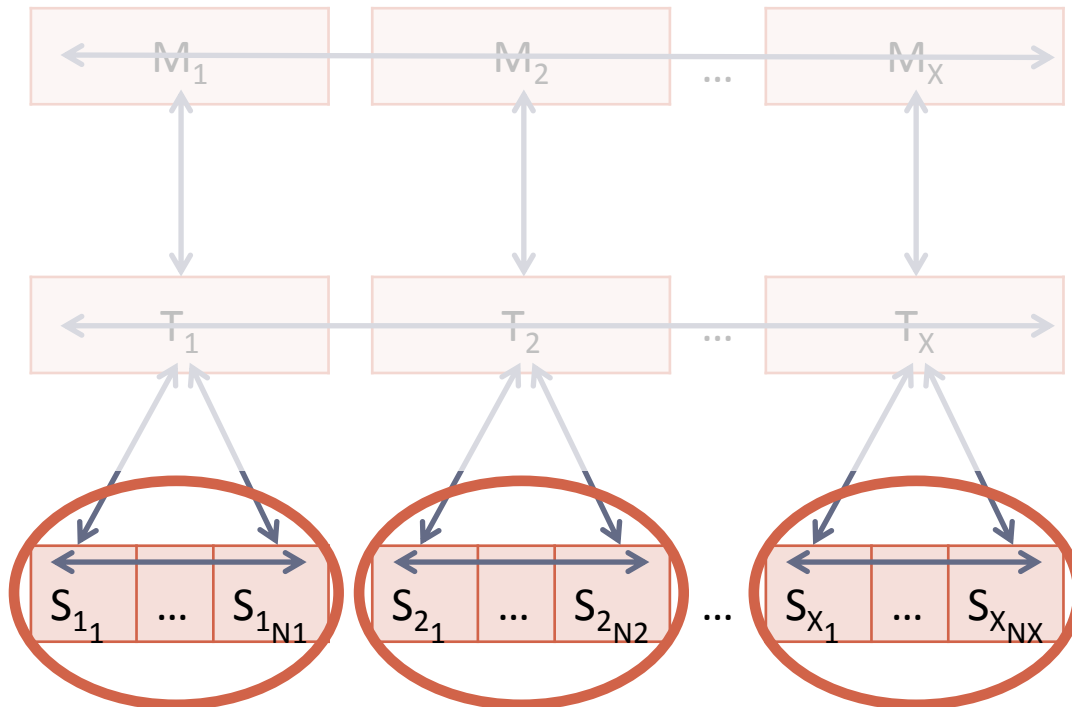
Developing Courseware: LMS + Virtual Collaboration Tool



For mentors, access to

- **Course Materials**
 - Lesson plans
 - Background materials
 - Supporting resources
- **Teacher PD Materials**
 - Refresher videos
 - On-time training
- **Collaboration Tools**
 - Mentor-to-mentor
 - Mentor-to-teacher

Developing Courseware: LMS + Virtual Collaboration Tool

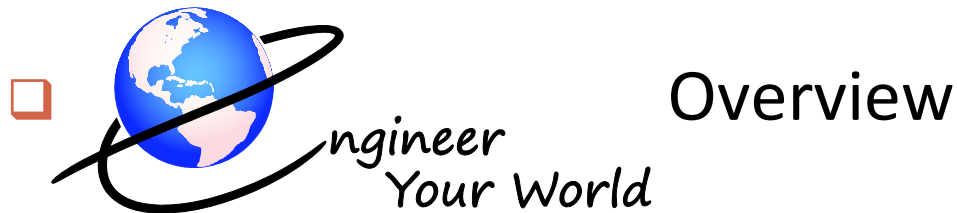


For students, access to

- **Course Materials**
 - Background materials and supporting resources shared by teacher
 - Assignments
- **Virtual Engineering Notebook**
 - Document work for self
 - Submit work to teacher
 - Prepare portfolio for AP or admissions
- **Collaboration Tools**
 - Student-to-student
 - Student-to-teacher

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