Unit 5 Guide - Engineering is Intentional

Driving Questions
What is invention and innovation?
When do we know we are solving the real problem?
How does the wording of the Grand Challenges impact my daily life?
How do I constructively contribute to a team when there is conflict?

Description
Units thus far have introduced students to class led and stakeholder engagement and teacher-led inquiry. This unit opens the door to student led engagement and provides activities to guide brainstorming to help students identify which areas are in need of creative problem solving. It provides a framework for organizational and team-based creativity that guides teams into constructive conflict, with the goal being surprising and novel ideas that attempt to 'do the impossible'. Students are expected to see that the world is both social and technical.

Key Concepts
Traits of inventions that change the world (and get to scale)

How to:

- Assemble a diversity of perspectives
- Find trends that constructively conflict (identify a REAL problem)
- Establish a shared vision (set a high quality target)
- Construct hybrid solutions (take multiple shots on goal that are unique)

Learning Outcomes

Discover Engineering		
Iterate and evolve the definition of what it means to engineer and be an engineer.	E.A	
Awareness of changing perspectives on one's current identities with respect to engineering through regular reflection.	E.B	
Recognize the value of engineering for all regardless of one's potential career.	E.C	
Explain and apply ethical considerations when exploring an engineering problem.	E.D	a
Engineering in Society		
Explore the impacts of past engineering successes and failures on society as a whole.	S.A	
Use systems thinking to propose and analyze the relationship between inputs, intention, and impacts of technology in society.	S.B	a
Recognize and investigate the world's greatest challenges and the role that engineering plays in solving these challenges (e.g., Engineering Grand Challenges, UN sustainability goals, etc.).	S.C	
Integrate diverse disciplinary thinking and expertise to inform design solutions that add value to society.	S.D	a
Identify and analyze issues when bringing a solution to scale.	S.E	
Engineering Professional Skills		
Apply strategies to collaborate effectively as a team.	P.A	a
Use various forms of communication (oral, written, visual).	P.B	a
Recognize when to use various communication tools based on audience.	P.C	
Develop, implement, and adapt a project management plan.	P.D	
Contribute individually to overall team efforts.	P.E	a
Engineering Design		
Uncover a problem that can be solved with a potentially new product or process.	D.A	a
Identify appropriate stakeholders and evaluate stakeholder input.	D.B	a
Plan and conduct research by gathering relevant and credible data, facts, and information.	D.C	a
Model physical situations using mathematical equations.	D.D	a
Evaluate solution alternatives and select a final design by considering assumptions, tradeoffs, criteria, and constraints.	D.E	a
Use and recognize when to use computational tools.	D.F	
Create a prototype.	D.G	
Create and implement a testing plan to evaluate the performance of design solutions.	D.H	a
Apply iteration to improve engineering designs.	D.I	a

Misconceptions
Innovation is only ‘new technology’
Good managers make good innovators (management is the reduction of deviance, innovation typically includes the introduction of deviance)
Innovation is widely accepted and desired by communities (It is often resisted and fails the first time!)
Engineers are not helpful during the design of the plan or idea because they only focus on feasibility (corollary - Engineers should only be tasked with ‘execution’)
A group of experts is automatically an expert group

Teaching Challenges
Having students move beyond their or their groups ‘first idea’ to the ‘next iteration’ and the next iteration...
Choosing big over fast (project isn’t do-able)
Choosing ‘previous competency’ over growth (project doesn’t require any skill acquisition or practice, only execution)
Having more ambition than capability (not letting students move forward with plans that will fail)
Listening to the wrong ideas
Student diversity in projects requires responsiveness and ‘Lead learner’ attitude
Student projects should?/must? involve physical product creation
Student/Teacher fluency and competency with MyDesign, among other needed physical and digital tools
Treat them like adults - (everyone stays humble)

Lesson and Content Overview

Lesson Name	Lesson Description	Activity	Assessment
5.1: What inventions have changed the world? (1.5 hr)	Define invention and innovation and explore a brief history of inventions.	Create a list of inventions that have changed the world for the students in class. Before Class Videos	[HW] Report on the history of an inventor and invention using Model i and Innovation Genome.
5.2: Why include ethics in design? (1.5 hrs)	Students examine the Grand Challenges in Engineering and discuss as a class 'who sets these as challenges' - what are some ways that ethics intersects with engineering.	Students will create their own list of 'Grand Challenges' and look for connections to any NAE grand challenges or United Nationals Sustainability Targets Video: Who is manipulating Facebook?	[In Class] - Class publishes a list of their top 10 "Grand Challenges" Each problem should establish a clear need and a clear barrier.
5.3: What's the real problem? (1 hrs)	When identifying real problems, ideation is a creative process of generating, developing, and sharing ideas. Using the ideation process which includes innovation, helps to identify the real problem.	Students will select into teams of 3-4 around the grand challenges identified by the class the and use ideation to identify their real problem and convince others as well.	The prompt - "How do you change the world with $1000?" - Team Ideation process notes and teacher observations. An 'elevator pitch' that brings to light something specific about a grand challenge issue.
5.4: What's important about setting a high quality target? (2 hrs)	Show an example (or examples) of groups who have discovered an unexpected solution by continuing to ask questions. Explain that	Finding a vision for the future that we can all agree on is difficult. We have to 'Make stone soup' - Each team of 3-4 will	Inventor Report Due Choosing from that list of 100, each individual will plot at least 5 ideas along the Impact (Y)

	new and emerging activity is like predicting the weather - sometimes you fail! But that doesn't mean that people aren't still interested in your next prediction.	generate a list of 100 trends. What are high and low visibility things that students can see around them? What's in the news? What's on TV? What's in the library? What do adults talk about? Where do students look?	and Probability(X) axes. (Google sheets activity) Evidence for impact and probability should be at least 3 regions (low, med, high) **with evidence** to support the student rating.
5.5: How do I find and engage deep and diverse domain experts? (1 hr)	Once the team has spent time thinking about what is happening around them, they can start to look for solutions that should easily be able to gain traction. Ideas that aren't ahead of, or behind the times. The 'yoda' model of mentorship is flawed. We need a network of advice to move ideas forward. Teacher presents 'how to pitch a prospectus'	Suggest / identify an expert or two who can give them advice and mentorship. This doesn't need to be a world expert. Any working engineering professional and business person will suffice. They simply need a skeptic who will keep asking the team "Where's your evidence?" or "Find a counter example."	Project Elevator Pitch Due Team will generate a list of at least 5 potential mentors. *Teacher *Parent/Family *External Mentor *Librarian *Coach *Boss Inspiration from NCFDD Mentoring Map
5.6: What counts when you take multiple shots on goal? (1 hr)	Coming up with many potential project ideas, rather than just one is one of the keys to success. This allows for more stretch and reach		[HW] Each student should craft a one page 'solution' that includes a problem pitch, and a solution with three features. A sketch, a measure (mathematical or scientific principle) and the approach to the stakeholder
5.7: What is our plan for the future? (1 hr)	Identifying the most viable solution to a problem includes a comparison of how it	Working in teams, students will select (or hybridize) the best solution to their	Documentation of their solution choice. Criteria and constraints table that includes their

	meets the criteria and constraints.	problem based upon how well it meets the criteria and constraints.	reasoning of how each of their solutions met or didn't meet the criteria and constraints. Journal reflections on teamwork strategies they used.