Engineering & Math:

Cultivating Real-World Problem Solvers

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Information and knowledge are totally different…
Information is raw building materials.
Knowledge is what people make out of those materials and build within themselves.

Welcome

Introduce yourself at your table

- Name
- What you do?
- Why you're here?

Share your thinking…

Is engineer a noun or a verb?

Agenda

- Norms
- Learning Goals
- The Student’s Hat: Engineering Challenge
- The Teacher’s Hat: Unpacking it All
- Resources

Norms

- Be present.
- Balance your participation: speak and listen.
- Make sure everyone’s voice is heard.
- Assume positive intent.
- Ask questions.
- Tweet responsibly.

Learning Goals

- Explore the Engineering Design Process
- Understand the Practices and how they support integrated teaching and learning
- Recognize the values, attitudes, and thinking skills associated with the mathematics, science and engineering habits of mind
- Examine support and resources for integrating engineering and mathematics into your teaching and learning through a real-world lens

So WHY Engineering?

Many of the biggest problems facing the United States and the world today…

climate change,

feeding a growing population,

energy independence,

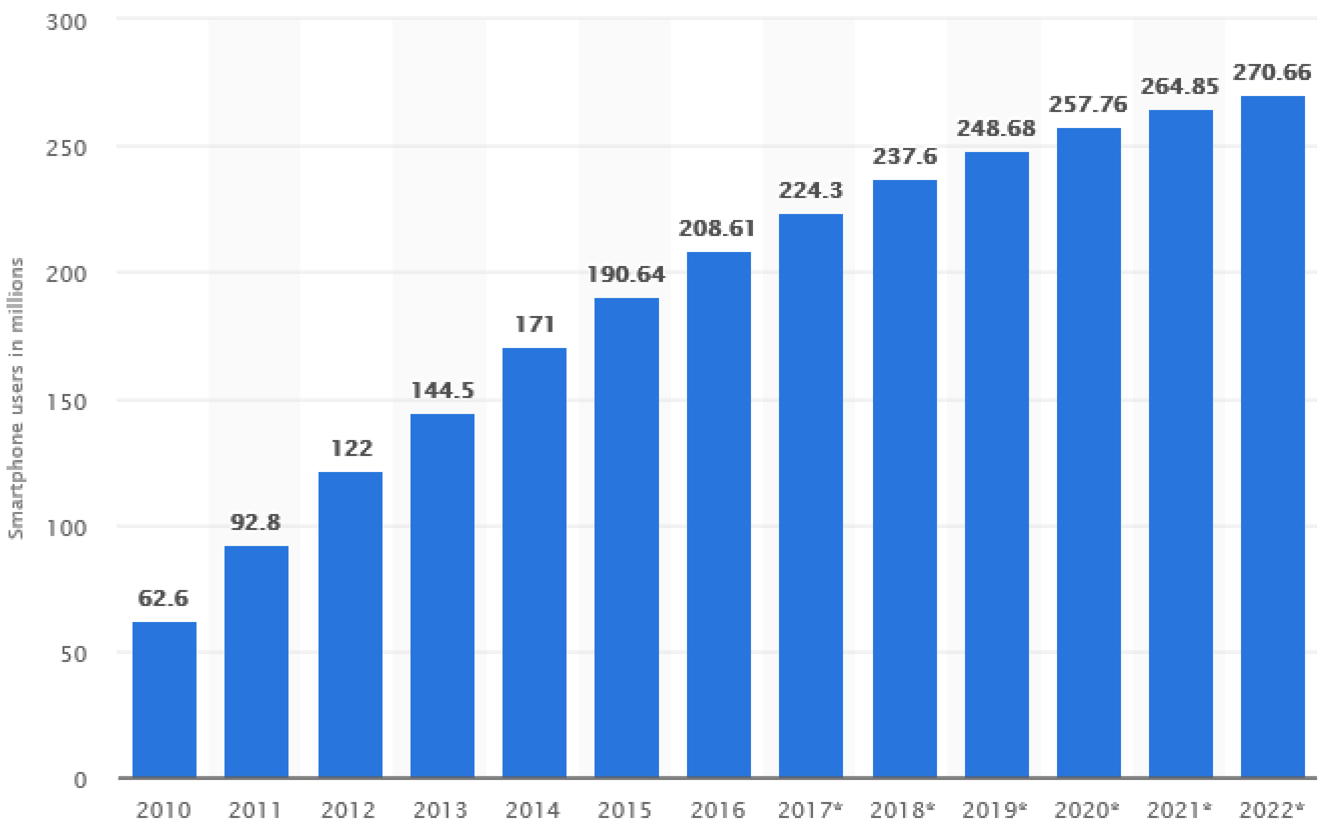
access to clean water,

crumbling infrastructures

require engineering expertise to solve!

Real world/build the story

Number of smartphone users in the US from 2010 to 2022 (in millions)



Thinking about - 248.68 million smartphone users...

What real world issues/problems do you see arising or expanding with so many smartphone users?

Local Issues with Cell Phones- Towers

https://www.youtube.com/watch?v=mbUP53PGk08

A perfect Arizona disguise….

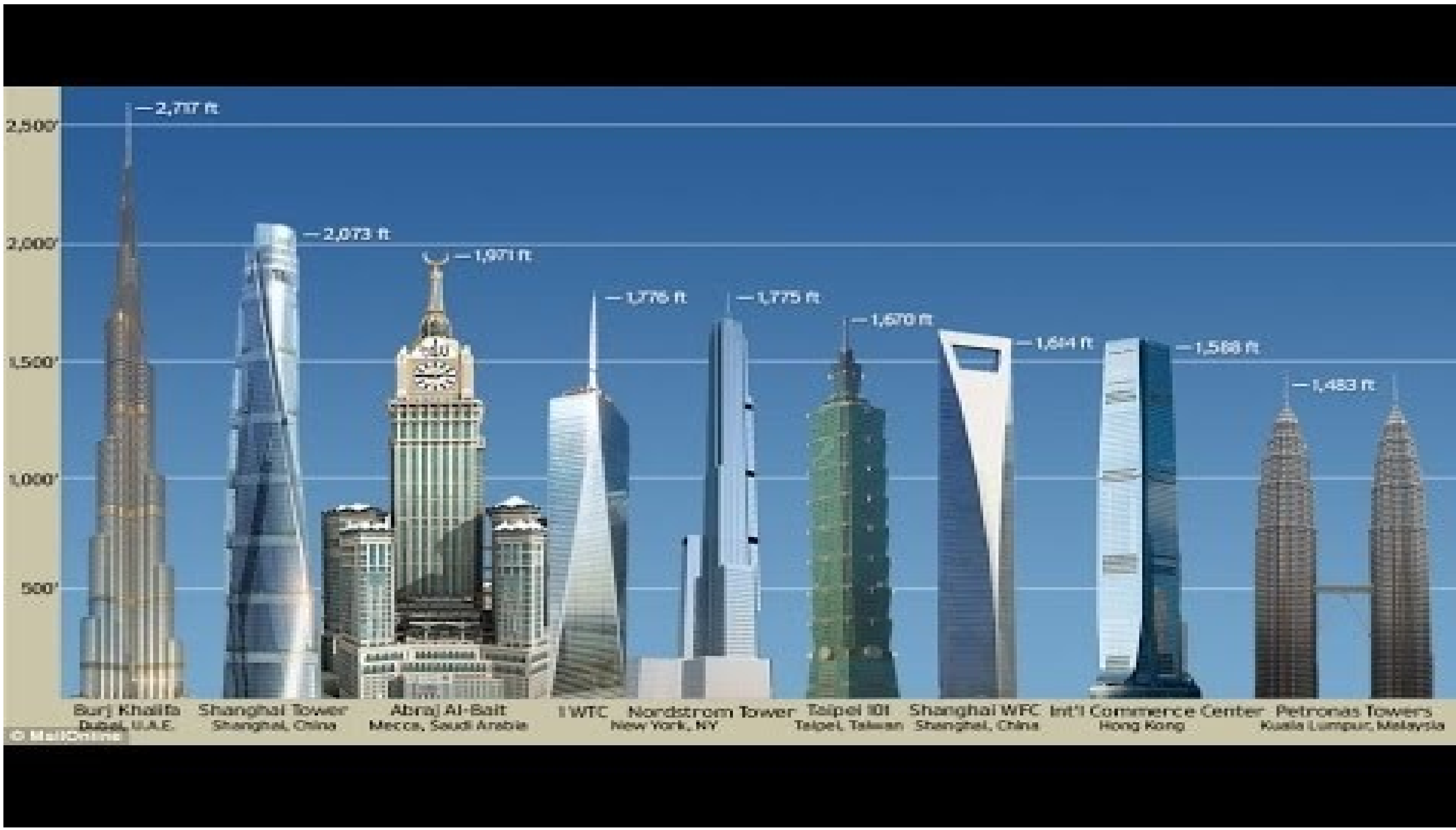
What is inside that Saguaro?

Focus on Towers -

Tower –

a building or structure typically higher than its diameter and high relative to its surroundings that may stand apart (such as a campanile) or be attached (such as a church belfry) to a larger structure and that may be fully walled in or of skeleton framework (such as an observation or transmission tower)

Famous Towers - What do you notice?



https://www.youtube.com/watch?v=wSGt05DaBNY

Cell Towers in Arizona

Brainstorm content around the areas of STEM that are critical knowledge around cell phones and cell towers..

S T E M

Arizona Cell Towers Must Endure…

Haboobs!!!!

An Engineering Challenge

Build a better, stronger cell tower that can withstand intense weather.

1. With your team draft a prototype/model in your engineering log.
2. Your prototype/model must also include justification for your structural ideas.

   HINT: Use what you know and research what you need to know about the materials and geometry!
3. Once your sketch has team approval you can begin the construction process.

What will you need to know to get started?

Constraints

What does success look like?

- Your draft model/sketch contains justification and argumentation for the design choices (both mathematically and scientifically)
- The entire electronic communication device (a.k.a. marshmallow) must be on the top *(Cutting or eating part of the ECD will disqualify the team)*
- Use as much or as little of the kit, but you cannot use the paper bag as part of your cell tower.
- You can break the spaghetti, cut up the tape and string.
- You cannot hold on to the cell tower when the time runs out.

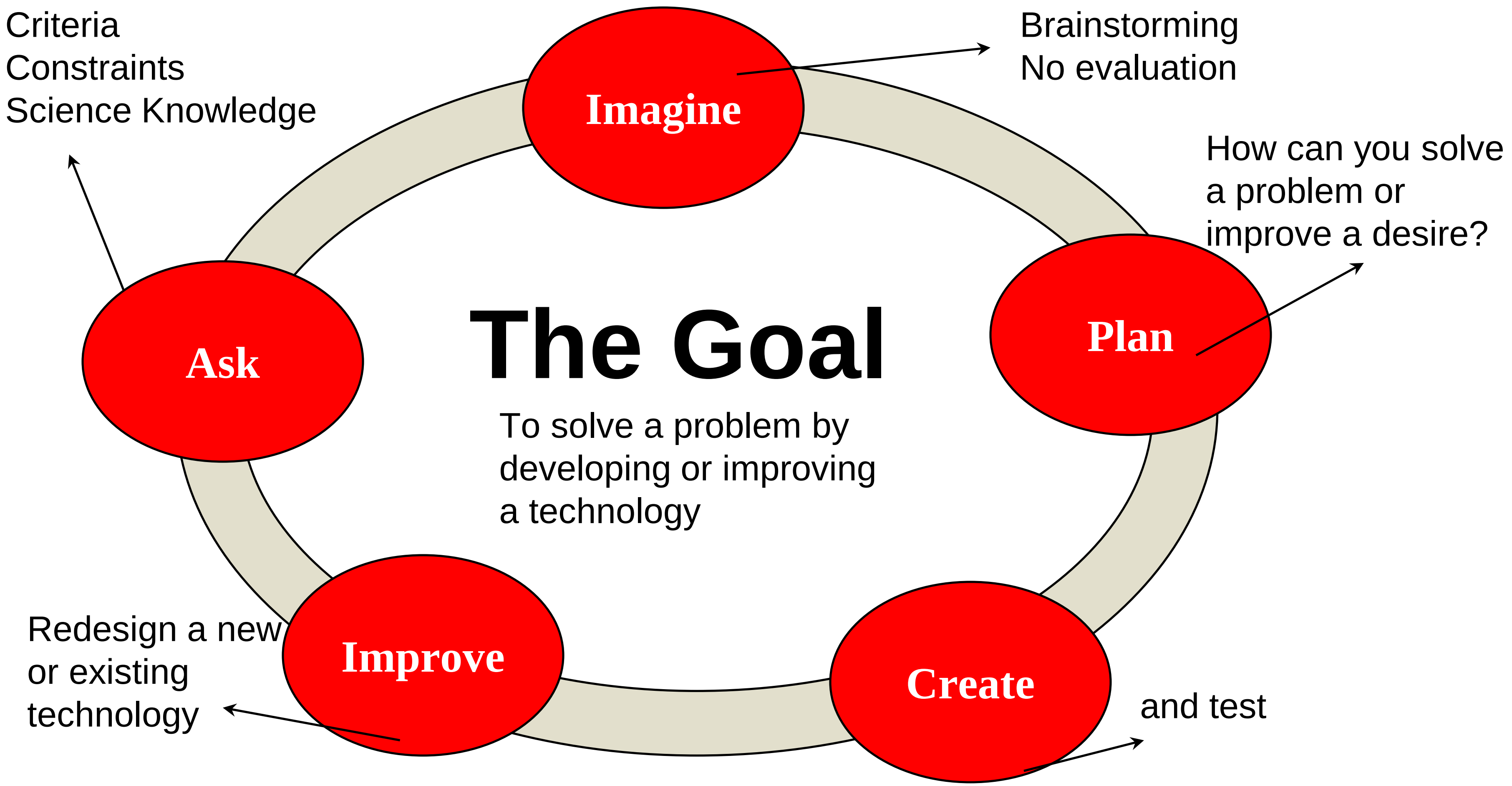
You have 45 minutes to complete everything!

Building Time….

Reflecting on the process…

- Arrange the words in the order your team worked through the cell tower engineering design challenge.
- Use the arrows to describe your team’s thinking and actions.
- Select a spokesperson to explain.

A Natural Process of Problem Solving



Core Ideas of an Engineering Design

A. Defining and delimiting engineering problems involves stating the problem to be solved as clearly as possible in terms of criteria for success and constraints or limits.

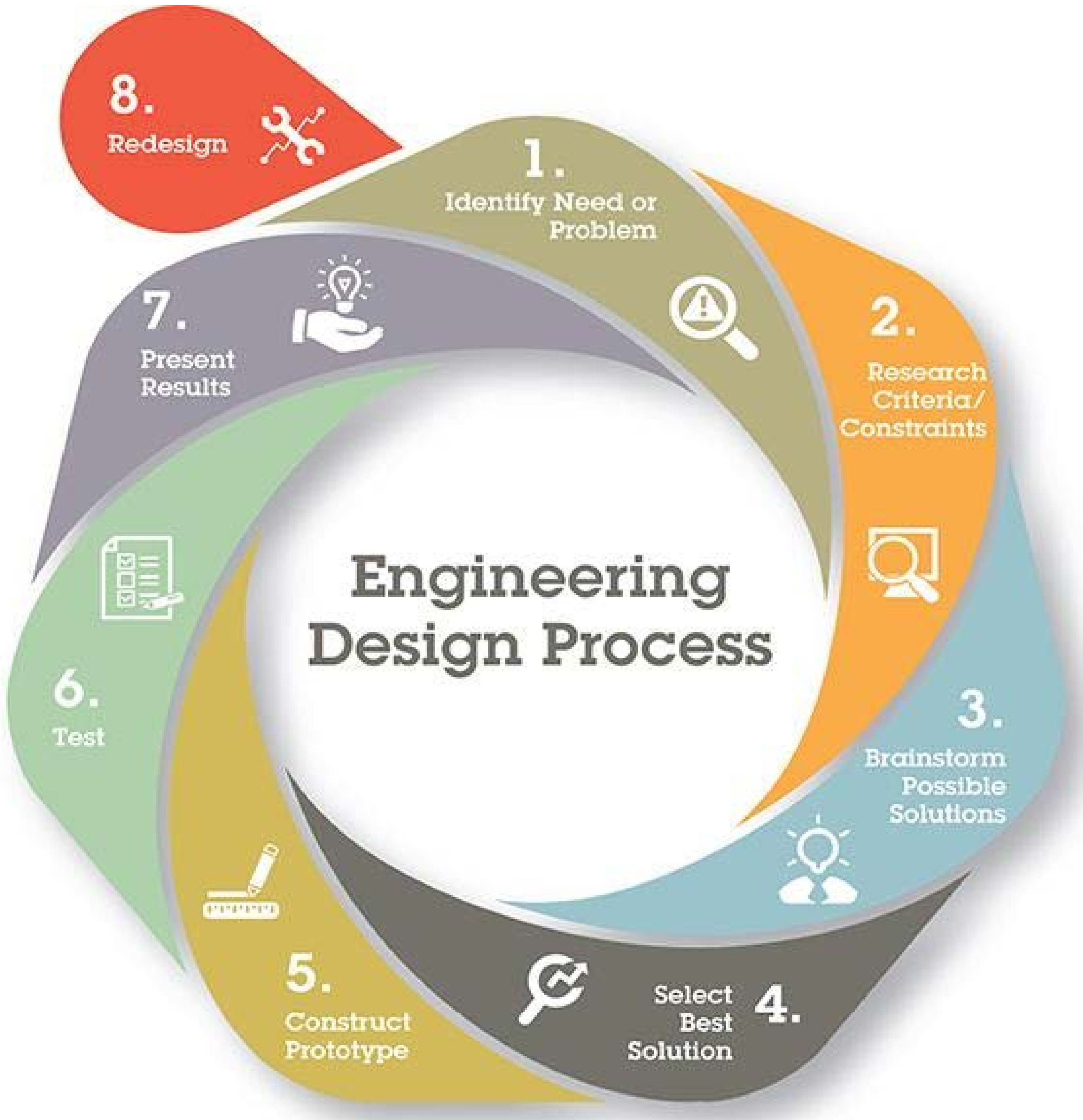
B. Designing solutions to engineering problems begins with generating a number of different possible solutions, then evaluating potential solutions to see which ones best meet the criteria and constraints of the problem.

C. Optimizing the design solution involves a process in which solutions are systematically tested and refined and the final design is improved by trading off less important features for those that are more important.

A Framework for K-12 Science Education, 2012

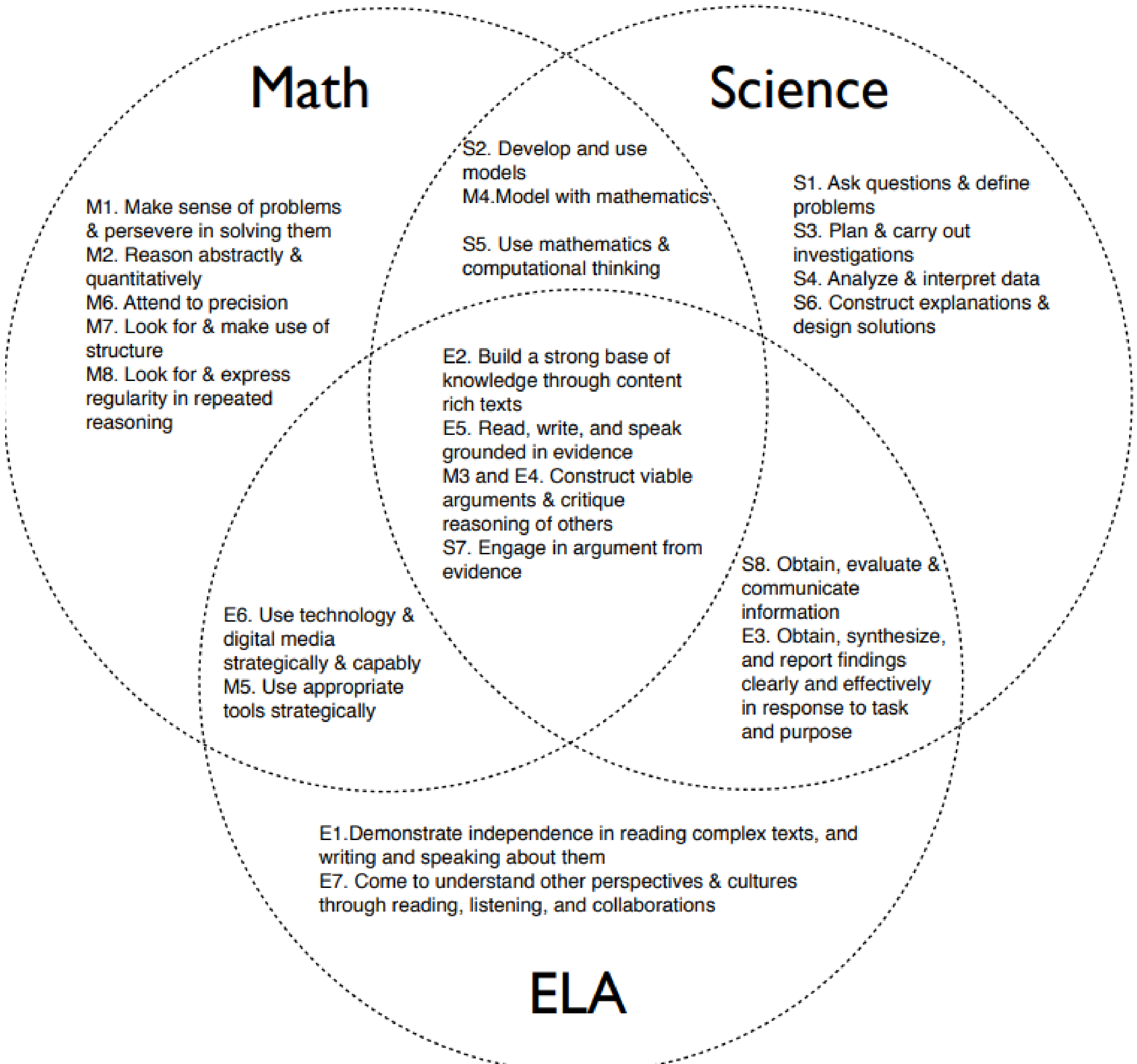
“The new Arizona Math Standards call for students to practice applying mathematical ways of thinking to real world issues and challenges. Those real world challenges naturally exist when engineers use math to explain science and design technologies, products, and processes to positively impact society.”

Common Core State Standards Initiative, 2013


8.
Redesign
1.
Identify Need or Problem
2.
Research Criteria/ Constraints
3.
Brainstorm Possible Solutions
Select Best Solution
4.
5.
Construct Prototype
6.
Test
7.
Present Results
Engineering Design Process

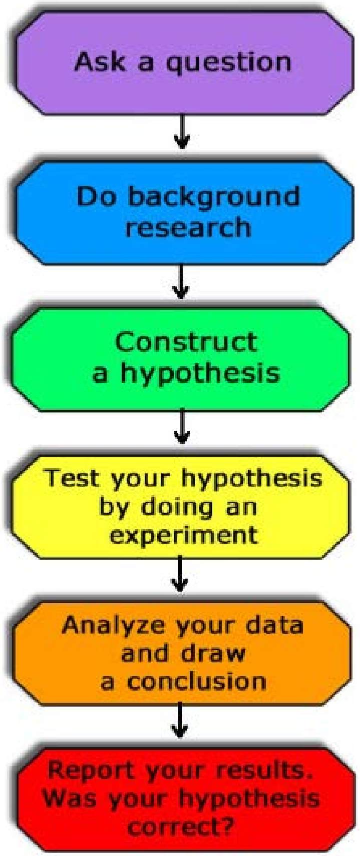
Integrations - a natural fit

The Science Framework will be used to guide the production of the Next Generation Science Standards.



Sources:
Common Core State Standards for English Language Arts & Literacy* in History/Social Studies, Science, and Technical Subjects, p7.
Common Core State Standards for Mathematical Practice p6-8

What do you notice?



Supporting Logic and Reasoning

- Engineering: Design, Structure, Foundation, Stability, Mapping/Planning, Slope, Chain Reaction
- Physical Science: Physics, Force, Momentum, Trajectory, Cause and Effect
- Data and Analysis: Prediction, Probability, Hypothesis, Test, Result
- Number and Operations: Quantity, Quantitative, Relationships (more, less, etc.)
- Geometry: Shape, Spatial Relationships (higher, lower, near, etc.), Direction, Angle, Pitch, Course
- Measurement and Patterning: Speed, Distance, Height, Length, Order.

Key Idea…

Mistakes, failures and constraints

are a natural part of

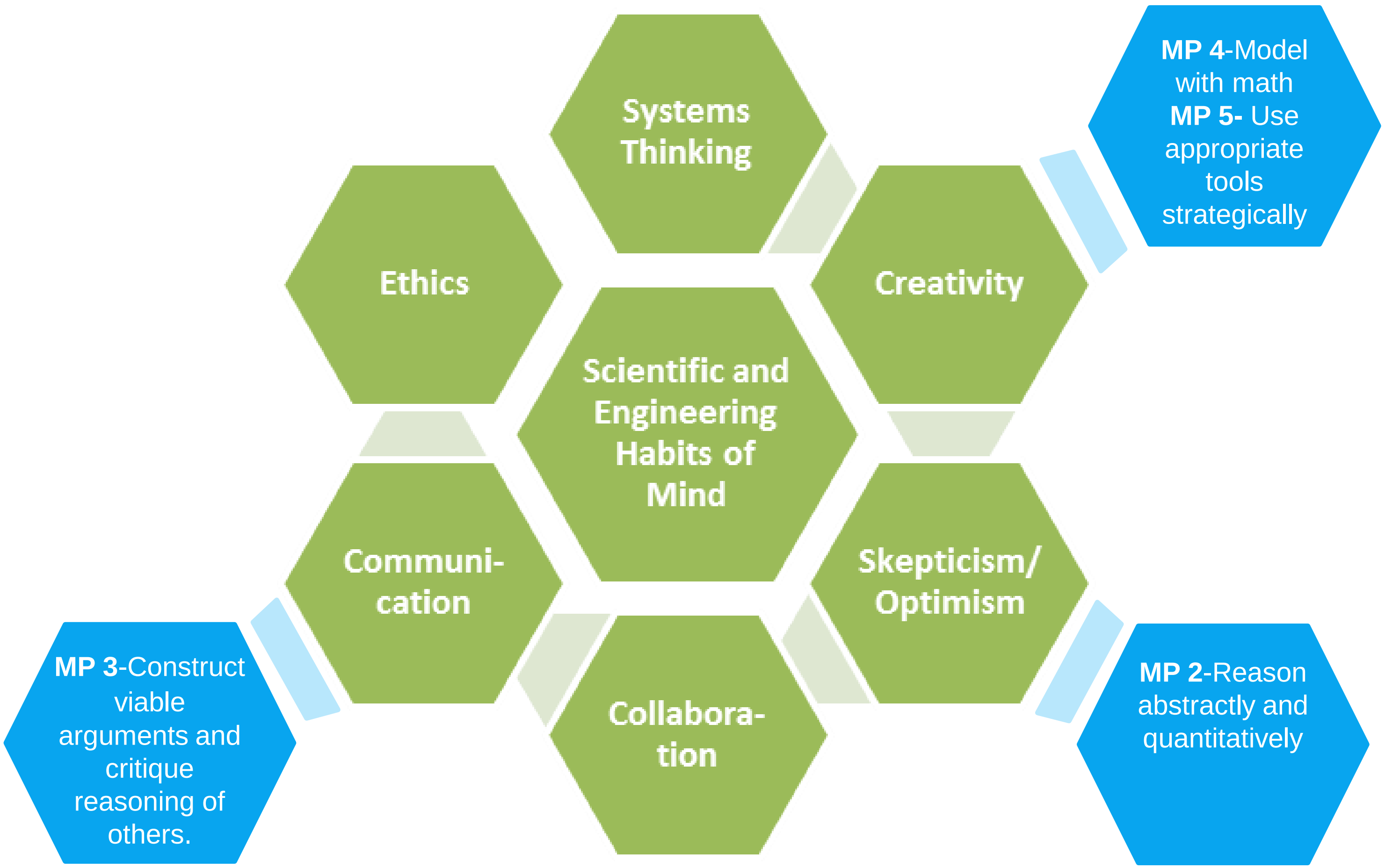
Engineering and the

design process.

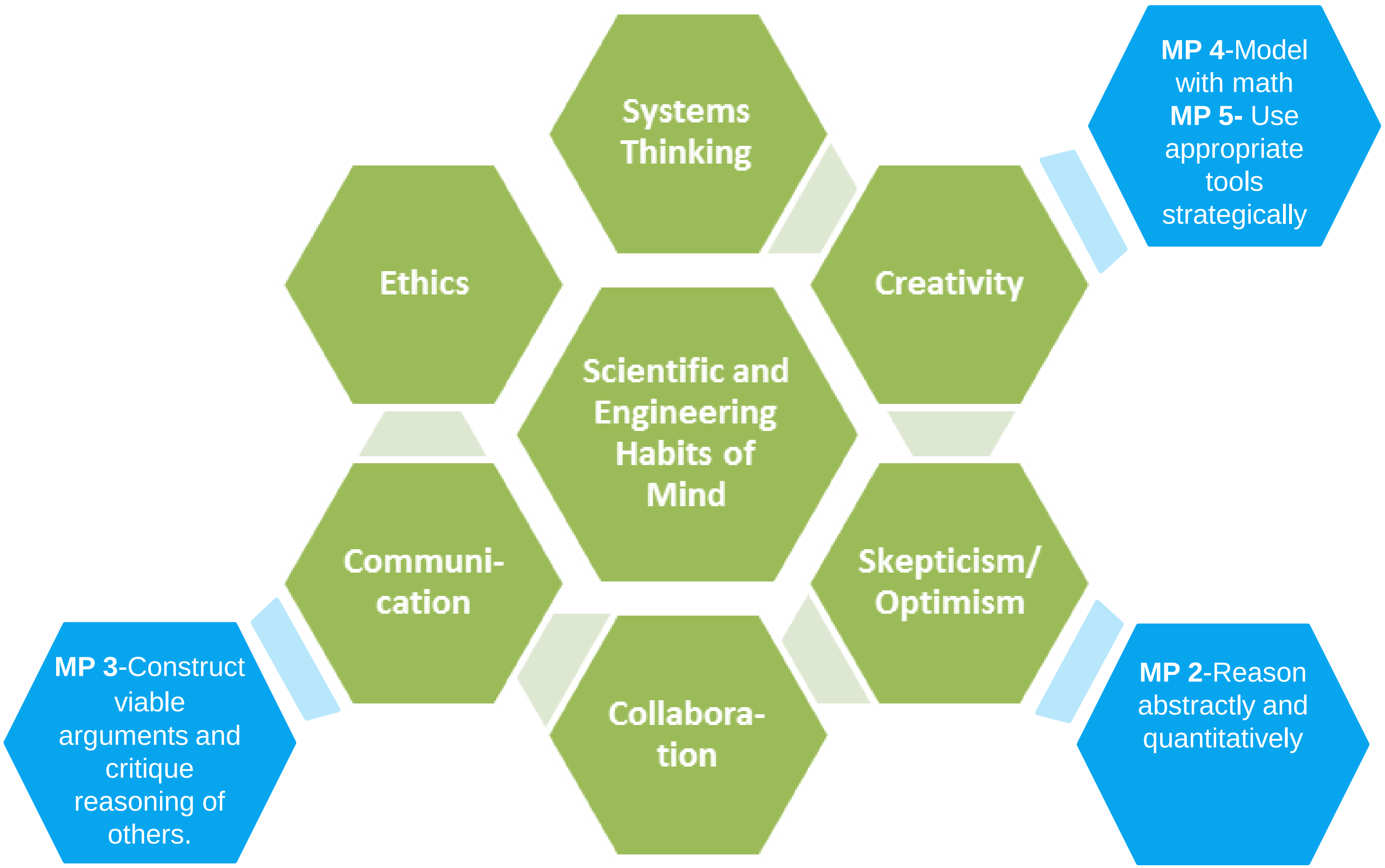
and…

math, and science learning.

Engineering Habits of Mind



Thinking about your design...



Questions?

Thoughts…

AH- HAs!

"In a complex world, cultivating problem-solving repertoire is an essential key to learning and the future.
It is far better for a child to learn how to solve a problem five different ways, than to solve the same problem five different times.
When we teach our students how to think in these ways, we're teaching them how to learn in new and creative ways."

Ken Wesson
STEM Ed Consultant, Neuroscience

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