



**INSPIRE!**™

**Elementary Engineering  
Teacher Professional Development:  
Initiation to Integration**

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# Outline of Presentation

- INSPIRE's Elementary Engineering Teacher Professional Development
- Teacher Stages with Engineering Education
- Strategies for Easing Progress Through Stages



# NSF DRK12: R&D: Quality Cyber-Enabled, Engineering Education Professional Development to Support Teacher Change and Student Achievement (E2PD)



- 5-year project with large south-central US school district (50 elementary schools)
- ~170 grade 2-4 teachers (and their students)
- Cohorts: two-year teacher commitment
  - Elementary engineering teacher professional development in summers
  - Academic year implementation of engineering lessons
- Cohorts 1-3: Teacher teams from 13 schools
- Cohort 4: Five schools fully committed
- Cohort 5: Four schools fully committed

# Teacher Professional Development (TPD) Program

## INSPIRE Summer Academy

- Year 1: week-long TPD program
- Year 2: 3-day follow-up
- Goals
  - Convey a broad perspective of engineering
  - Articulate differences between engineering and science thinking
  - Develop a level of comfort in discussing engineers and engineering with elementary students
  - Use problem-solving processes to engage students in open-ended problem solving



# Sources for Developing TPD



*Engineering is Elementary*

**Museum of Science**

National Center For  
Technological Literacy



# Academic Year (Minimum) Commitment

- What is technology?
- What is engineering?
- Introduction to the Engineering Design Process
- *Engineering is Elementary* Unit
  - Connected to grade level science standards

# Teacher Stages with Engineering Education



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1. Fear of Engineering
2. First Year Implementation
  - Consumed with Logistics
3. Towards Fidelity

# Stage 1: Fear of Engineering



*What are the sources of this fear?*



# Stage 1: Fear of Engineering



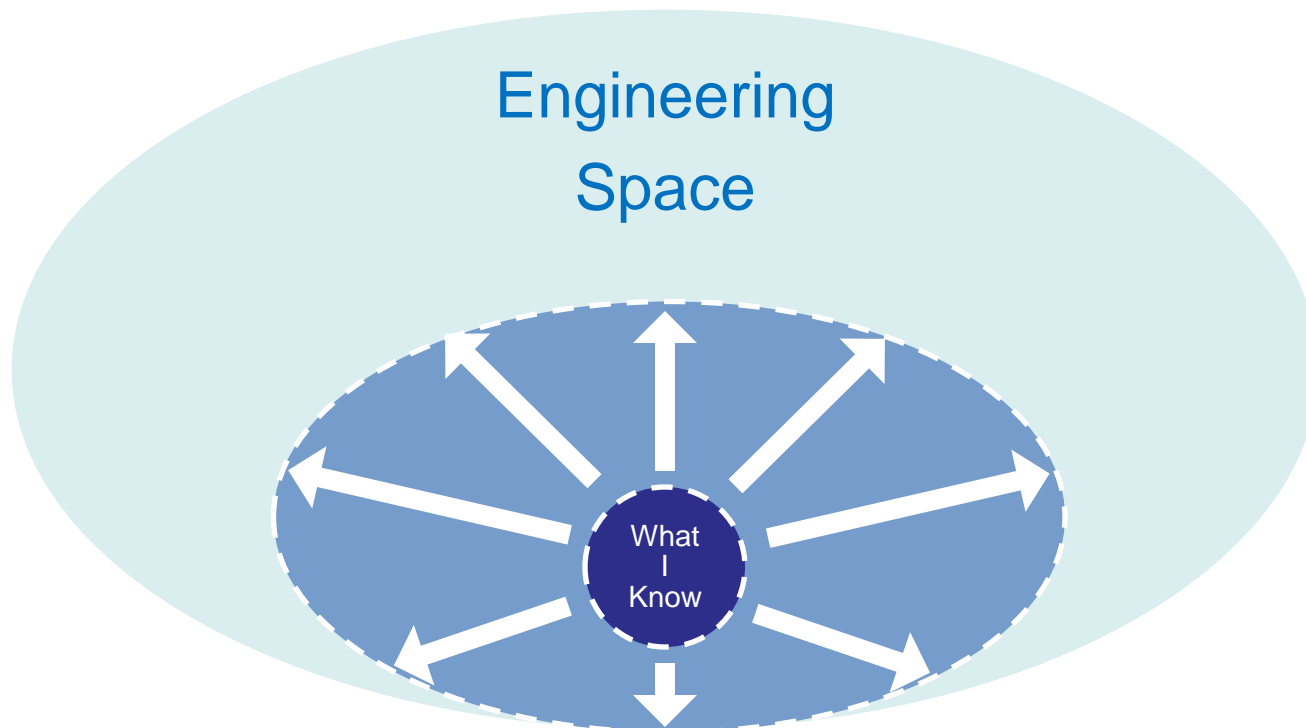
## Sources of Fear

- Afraid of not knowing and looking dumb to PD providers (especially engineers)
- Afraid content will be very technical (“over my head”)
- Not for me, so may not really be for all (any?) elementary students
- Work expectations over and above

# Strategies for Addressing Fear of Engineering



- What is technology?
  - Initial Source: Museum of Science, Boston



# What is Technology?

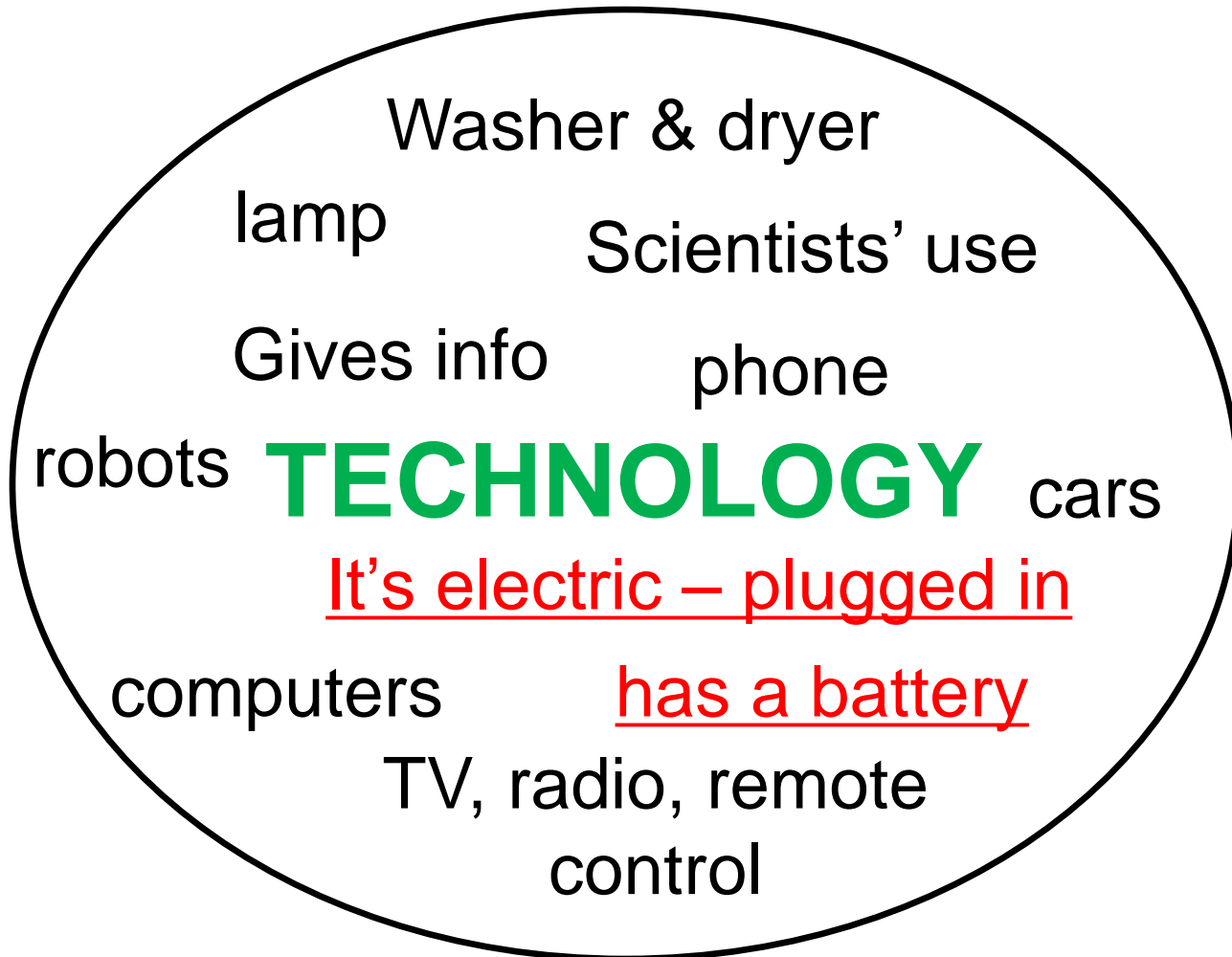
## Circle Map



**TECHNOLOGY**

# What is Technology?

## Circle Map





# What is technology?

An evolving definition:

*Any **object** or **process**  
that **people create and use**  
to **solve** a problem or  
**enhance** the current quality of life*

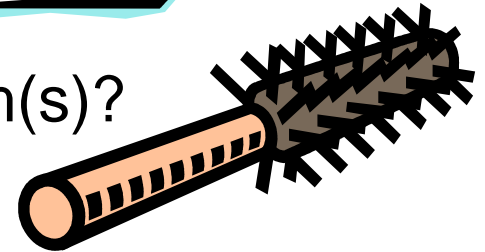
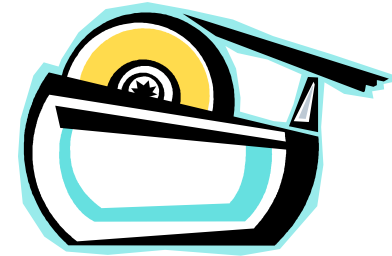
# What is technology?

## Exploring Everyday Objects

(Initial Source: Museum of Science, Boston)



- Examine your everyday technology
- What is your object?
  - Sketch your object. Label the parts.
  - What problem(s) does it solve?
  - How does your object solve the problem(s)?
- Engineers and technology
  - What material(s) is your object made of? Why?
  - What needed to be considered when this object was designed?



# What is technology?

## Compare Two Objects With Similar Function

1. What are the objects?
2. What is their purpose?
3. What do they do? How do they do it?
4. Who is(are) the user(s) of the object?
5. What materials are the objects made out of? Why?
6. What are similarities between the two versions?
  - What are differences?
  - What changes were made? Why were changes made?
7. What needed to be considered when the objects were designed?
  - How does it work? How do the parts work together?
  - How are the parts kept together?
  - How long should the object last? How could it break? What keeps it from being broken?
8. What different types of engineers contributed to the design and creation of these objects?
9. What other versions of objects exist?
10. What could be improved about the objects?
11. What questions do you have about the objects?





# What is engineering?

## How is this related to engineering?

- I believe this is a good example of engineering because

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- *Is this technology?*
- *What problems does it solve?*
- *What are desired functions?*
- *What engineers are involved?*
- *How are they involved?*



Running Shoe

# What is engineering?

## How is this related to engineering?



### Design (Prototype)

- Biomedical
  - Mechanical
- Materials
  - Chemical
- ...

### Manufacturing (Mass Production)

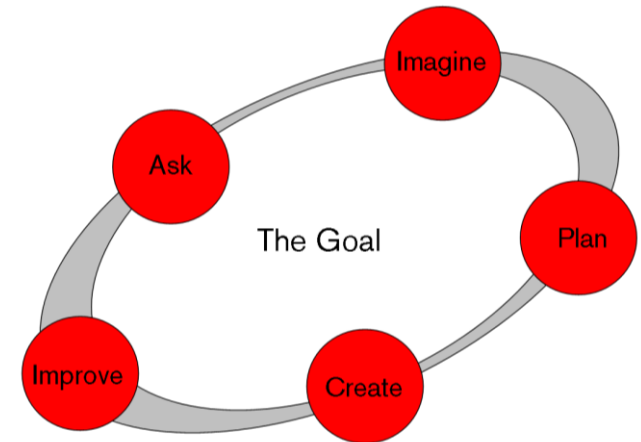
- Materials
  - Chemical
- Electrical
  - Computer
- Mechanical
- Industrial
- ...

### Life Cycle



# Strategies for Addressing Fear of Engineering

- Motivation
  - Who becomes an engineer?
- Simple, short EDP activities
  - Index Card Tower
  - Paper Table (Design Squad)
- Access to engineers
  - Panel discussion with practicing engineers
  - Tour a manufacturing facility (engineer guide or engineering focus)
- Practice teaching an engineering lesson in non-threatening setting
  - Summer camp associated with TPD



# Stage 2: First Year Implementation



# Stage 2: First Year Implementation



- Time lag from TPD to classroom implementation
  - Forget, even with good notes
- Engineering requires stuff
  - Set-up and maintenance required
  - Familiarity (e.g. pulleys)
- Classroom logistics
  - Timing with materials & content
  - Managing productive chaos
    - Student team dynamics & differing pace
    - Unknown reactions and actions of students (e.g. safety, mess)

# Strategies for Addressing First Year Implementation



Goal: *Not make this the ONLY year of implementation*

- Refresher Before Implementation
- Team Teaching (in same classroom)
  - Sharing the teaching engineering experience
  - Opportunity for teaching 2x (or more) in one year
- (Non-threatening, By-Invitation) Engineering Education Support Specialist in Classroom
  - Eyes-and-ears, provide cues, debrief & feedback
  - Manage materials

# Strategies for Addressing First Year Implementation



Goal: *Not make this the  
ONLY year of implementation*

- Instruction on Teaching with Student Teams
  - Class developed code of cooperation (make visible)
  - Roles of team members
  - Start with shorter team lessons (e.g. EDP) to establish norms

# Stage 3: Towards Fidelity





# Stage 3: Towards Fidelity

## What does fidelity look like?



- Fluid conversations
  - Work of engineers & engineering in our world
- Strategic integration with & connections to other subjects
  - Science and Math: connections improve; aware of student learning
  - Social Studies: provides context (past, present, future)
  - Language Arts: communication of ideas & work, reflection, research
- Commitment to engineering education
  - Adopting & developing authentic engineering lessons
  - Implementing an authentic EDP
  - Establishing learning objectives for engineering
- Imbedded authentic assessment: processes & products

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# Adopting & Developing Authentic Engineering Lessons



# Engineering Design Activities – Making Strong Connections to Curriculum



- The problem is set in a context:
  - The technology prototype being designed solves a problem for *many* users. It is not just a one-time solution for personal use.
  - The design activity can be framed in terms of a clear goal with user(s) and possibly a client in a setting
  - The design criteria and constraints can be clearly stated

# Framing an Authentic Engineering Design Activity



**Goal:** XXX

**Client:** YY

**User:** ZZZ

**Criteria:** XX must:

- yy
- yy

**Constraints:**

- XXX
- Work in pairs or teams of 3-4
- Time: Y minutes

**Tools:**

- Crayons/Markers
- Ruler
- Scissors
- ...

# Example: Pop-Up Card



**Goal:** Pop-up “Engineering Night” Invitation Card

**Client:** Westmark Pop-Up Card Company

**User:** Students, Parents, School District

**Criteria:** The card must:

- have at least two pop-up parts - one foreground and one background
  - Pop-ups must function reliably in 10 repeated tests
  - Pop-up parts must be contained within the card when it is folded
- have an invitation message
- be neat and attractive
- fit into a 9 x12 inch envelope

**Constraints:**

- Construction Paper
- Card Stock
- Tape
- Work in pairs
- Time: 25 minutes

**Tools:**

- Crayons/Markers
- Ruler
- Scissors

# Engineering Design Activities – Making Strong Connections to Curriculum



- Multiple solutions (designs of the technology) are possible
- Creativity is encouraged
- Teamwork is possible
- Mathematics, science, social studies, reading/writing concepts are inherently present and can be explored through the activity
- The engineering design process is employed explicitly
- Improvements to the designed technology are made based on evidence

# Implementing an Authentic EDP

- **Low integration into curriculum**



## Missed Opportunities:

- Design is informed by many things
- Engineers do more than build/make
- Engineers use more than technical knowledge & skills
- Learn from failure

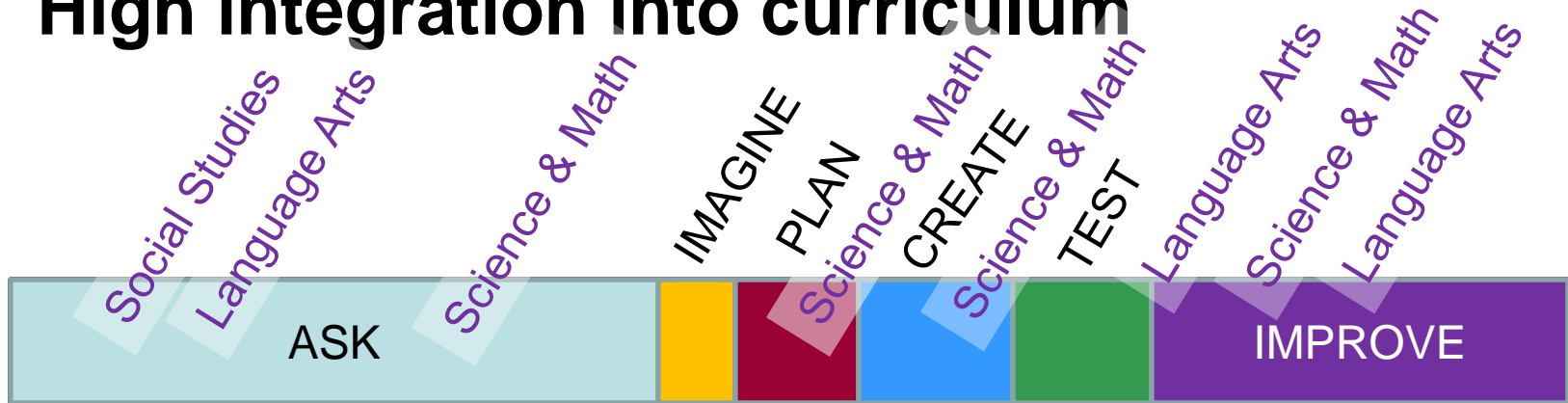


# Implementing an Authentic EDP

- Low integration into curriculum

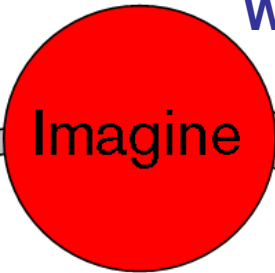
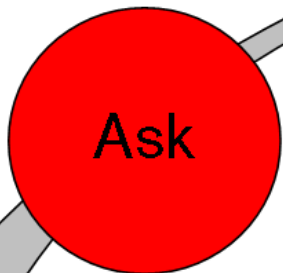


- High integration into curriculum

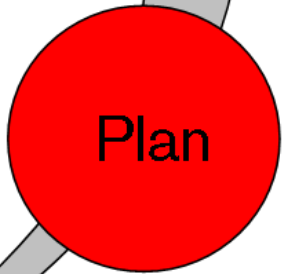


# Engineering Design Process

What is the problem?  
What have others done?  
What are the constraints?



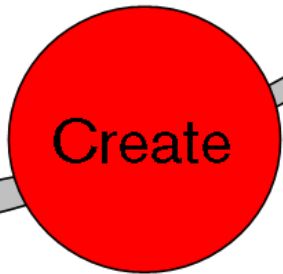
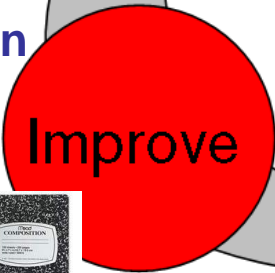
What could be some solutions?  
Brainstorm ideas.  
Choose the best one.



The Goal



Draw a diagram.  
Make a list of the materials you'll need.



Follow your plan and create it.  
Test it out!

## Production

Design satisfies the goal

Make your design even better.  
Test it out!

Test

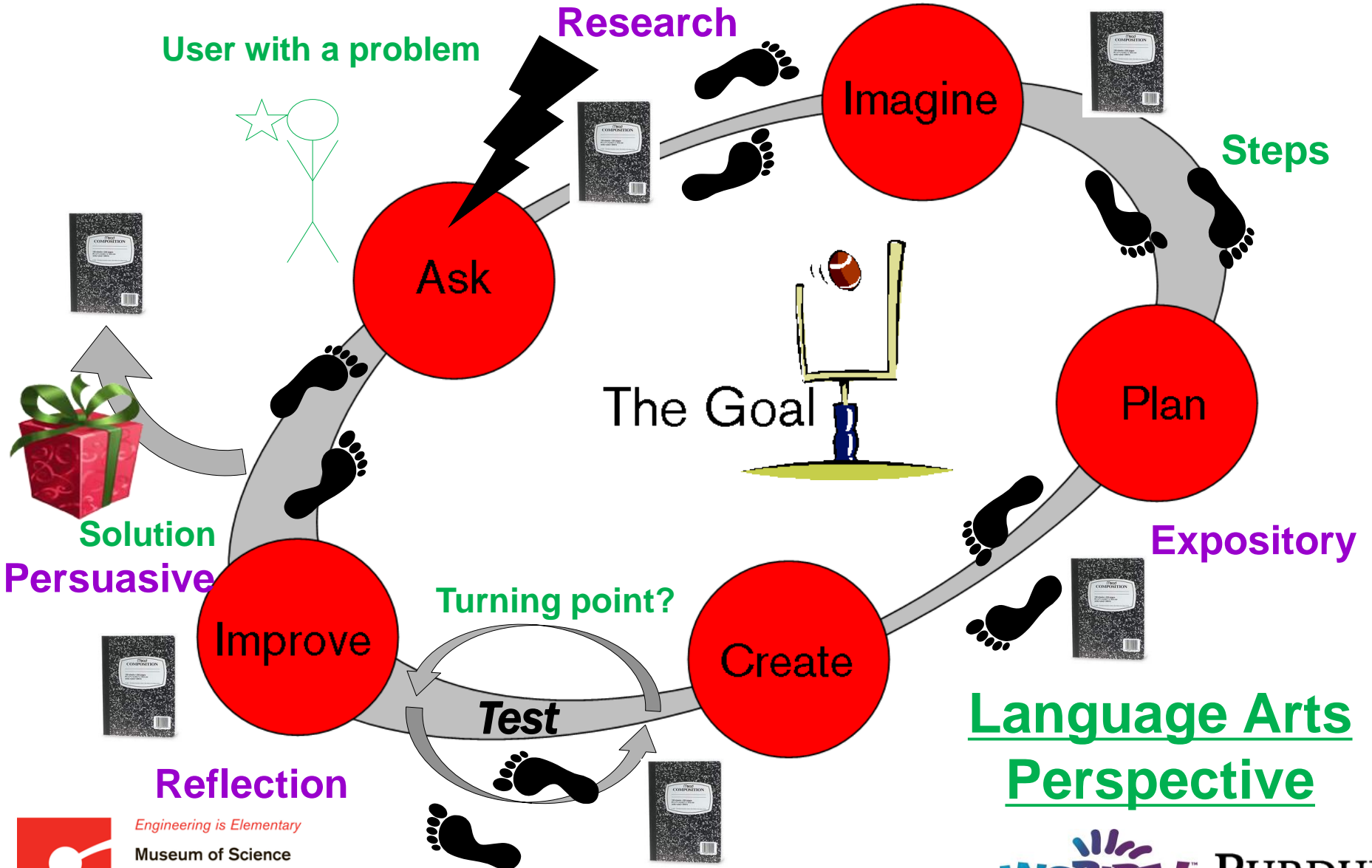
**STEM**

**Perspective**

# Engineering Design Process



# Engineering Design Process



Engineering is Elementary  
Museum of Science  
National Center For  
Technological Literacy



# Takeaway: Teacher Go Through Stages with Engineering Education



## 1. Fear of Engineering

Goal: Increase understanding of engineering

## 2. First Year Implementation

Goal: Minimize stress

## 3. Towards Fidelity

Goal: Sustain engineering education through integration and authentic engineering practice

# Questions?

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