SCIENTIFIC AND ENGINEERING PRACTICES

The practices below describe behaviors in which scientists and engineers engage. Scientists engage in these practices as they develop models and theories about the natural world and engineers engage in these practices as they design and build models of systems. Engineering design is similar to scientific inquiry. Scientific inquiry involves formulating a question that can be answered through investigation and engineering design involves formulation of a problem that can be solved through design. (*Next Generations Science Standards*; http://www.nextgenscience.org) These practices encompass the process skills originally described in the National Science Education Standards as the "Abilities Necessary to Do Inquiry" (1999).

1. Asking Questions and Defining Problems

- **Formulate empirically answerable questions (S)**
- **Establish what is already known (S)**
- **Determine what questions have yet to be answered (S)**
- **Define a problem that needs to be solved (E)**
- **Determine criteria for a successful solution (E)**
- **Identify constraints (E)**

2. Developing and Using Models

- **Construct and use models and simulations (S)**
- **Develop explanations about natural phenomena (S)**
- **Use models and simulations to analyze existing systems (E)**
- **Recognize the strength and limitations of a design (E)**

3. Planning and Carrying Out Investigations

- **Identify what is to be recorded (dependent/independent variables-if applicable) (S)**
- **Make observations and collect data (S)**
- **Use what is learned to test/revise existing theories/explanations or develop new (S)**
- **Collect data essential for specifying design criteria or parameters (E)**
- **Test designs (E)**
- **Identify how effective, efficient and durable the design is (E)**

4. Analyzing and Interpreting Data

- **Analyze data to derive meaning (S)**
- **Identify sources of error and calculate the degree of certainty (S)**
- **Use a variety of tools to identify significant features and patterns in data (S & E)**
- **Analyze data collected from tests of their designs to compare possible solutions (S)**
- **Determine which design best solves a problem within given constraints (S)**

5. **Using Mathematics and Computational Thinking**
    - **Use to represent physical variables and their relationships in a range of tasks (S)**
    - **Enable the predictions and testing of the behavior of physical systems (S)**
    - **Assess the significance of patterns or correlations (S)**
    - **Use computational representations of established relationships as an integral part of the design process (E)**
    - **Analyze designs for functionality as well budgetary constraints (E)**
    - **Inform the development of designs and their improvement (E)**

6. **Constructing Explanations and Designing Solutions**
    - **Explicitly apply a theory to a specific situation or phenomenon (S)**
    - **Construct logically coherent explanations of phenomena that incorporates their (the students) current understanding and is consistent with available evidence (S)**
    - **Solve engineering problems using a systematic process based on scientific knowledge and models of the material world (E)**

7. **Engaging in Argument from Evidence**
    - **Identify strengths and weaknesses of a line of reasoning to find best explanation for a natural phenomenon (S)**
    - **Collaborate with peers to search for the best explanation (S)**
    - **Formulate the best possible solution to problems using evidence based on test data (E)**
    - **Collaborate with peers to determine the most promising solution in a field of competing ideas (E)**

8. **Obtaining, Evaluating, and Communicating Information**
    - **Learn about the findings of others (S & E)**
    - **Communicate their findings clearly and persuasively (S & E)**
    - **Use a variety of methods to evaluate and communicate findings (S & E)**