

# Unit 02: Engineering Design Process

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Course(s):  
Time Period: **Full Year**  
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## Standards Alignment

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### New Jersey Student Learning Standards

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#### **Practice 1. Asking questions (for science) and defining problems (for engineering)**

**Asking questions and defining problems in 6–8 builds on K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models.**

Ask questions to clarify and/or refine a model, an explanation, or an engineering problem.

#### **Practice 2. Developing and using models**

**Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.**

Evaluate limitations of a model for a proposed object or tool.

#### **Practice 3. Planning and carrying out investigations**

**Planning and carrying out investigations in 6–8 builds on K–5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or solutions.**

Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim.

#### **Practice 5. Using mathematics and computational thinking**

**Mathematical and computational thinking in 6–8 builds on K–5 experiences and progresses to identifying patterns in large data sets and using mathematical concepts to support explanations and arguments.**

Use mathematical representations to describe and/or support scientific conclusions and design solutions.

Create algorithms (a series of ordered steps) to solve a problem.

Apply mathematical concepts and/or processes (e.g., ratio, rate, percent, basic operations, simple algebra) to scientific and engineering questions and problems.

Use digital tools and/or mathematical concepts and arguments to test and compare proposed solutions to an engineering design problem.

#### **Practice 6. Constructing explanations (for science) and designing solutions (for engineering)**

**Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.**

Apply scientific ideas or principles to design, construct, and/or test a design of an object, tool, process or system.

Undertake a design project, engaging in the design cycle, to construct and/or implement a solution that meets specific design criteria and constraints.

Optimize performance of a design by prioritizing criteria, making tradeoffs, testing, revising, and re-testing.

### **Practice 7. Engaging in argument from evidence**

**Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s).**

Respectfully provide and receive critiques about one’s explanations, procedures, models, and questions by citing relevant evidence and posing and responding to questions that elicit pertinent elaboration and detail.

Evaluate competing design solutions based on jointly developed and agreed-upon design criteria.

### **Practice 8. Obtaining, evaluating, and communicating information**

**Obtaining, evaluating, and communicating information in 6–8 builds on K–5 experiences and progresses to evaluating the merit and validity of ideas and methods.**

Communicate scientific and/or technical information (e.g. about a proposed object, tool, process, system) in writing and/or through oral presentations.

### **Connections to Engineering, Technology and Applications of Science Interdependence of Science, Engineering, and Technology**

Science and technology drive each other forward.

### **Connections to the Nature of Science: Most Closely Associated with Crosscutting Concepts Science is a Human Endeavor**

Scientists and engineers rely on human qualities such as persistence, precision, reasoning, logic, imagination and creativity.

Scientists and engineers are guided by habits of mind such as intellectual honesty, tolerance of ambiguity, skepticism and openness to new ideas.

Advances in technology influence the progress of science and science has influenced advances in technology.

LA.K-12.NJSLSA.R3	Analyze how and why individuals, events, and ideas develop and interact over the course of a text.  Integration of Knowledge and Ideas
LA.K-12.NJSLSA.R7	Integrate and evaluate content presented in diverse media and formats, including visually and quantitatively, as well as in words.
LA.RST.6-8	Reading Science and Technical Subjects
LA.RST.6-8.3	Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
LA.RST.6-8.7	Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

## **Integration of Career Readiness, Life Literacies and Key Skills**

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CRP.K-12.CRP1	Act as a responsible and contributing citizen and employee.
CRP.K-12.CRP2	Apply appropriate academic and technical skills.
CRP.K-12.CRP3	Attend to personal health and financial well-being.
CRP.K-12.CRP4	Communicate clearly and effectively and with reason.

CRP.K-12.CRP5	Consider the environmental, social and economic impacts of decisions.
CRP.K-12.CRP6	Demonstrate creativity and innovation.
CRP.K-12.CRP7	Employ valid and reliable research strategies.
CRP.K-12.CRP8	Utilize critical thinking to make sense of problems and persevere in solving them.
CRP.K-12.CRP9	Model integrity, ethical leadership and effective management.
CRP.K-12.CRP10	Plan education and career paths aligned to personal goals.
CRP.K-12.CRP11	Use technology to enhance productivity.
CRP.K-12.CRP12	Work productively in teams while using cultural global competence.

## **Technology / Integration of Computer Science and Design Thinking**

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TECH.8.1.8	Educational Technology: All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge.
TECH.8.1.8.A	Technology Operations and Concepts: Students demonstrate a sound understanding of technology concepts, systems and operations.
TECH.8.1.8.A.1	Demonstrate knowledge of a real world problem using digital tools.
TECH.8.1.8.E	Research and Information Fluency: Students apply digital tools to gather, evaluate, and use information.
TECH.8.1.8.E.1	Effectively use a variety of search tools and filters in professional public databases to find information to solve a real world problem.
TECH.8.2.8	Technology Education, Engineering, Design, and Computational Thinking - Programming: All students will develop an understanding of the nature and impact of technology, engineering, technological design, computational thinking and the designed world as they relate to the individual, global society, and the environment.
TECH.8.2.8.A	The Nature of Technology: Creativity and Innovation: Technology systems impact every aspect of the world in which we live.
TECH.8.2.8.A.1	Research a product that was designed for a specific demand and identify how the product has changed to meet new demands (i.e., telephone for communication - smart phone for mobility needs).
TECH.8.2.8.A.2	Examine a system, consider how each part relates to other parts, and discuss a part to redesign to improve the system.
TECH.8.2.8.A.3	Investigate a malfunction in any part of a system and identify its impacts.
TECH.8.2.8.C	Design: The design process is a systematic approach to solving problems.
TECH.8.2.8.C.1	Explain how different teams/groups can contribute to the overall design of a product.
TECH.8.2.8.C.3	Evaluate the function, value, and aesthetics of a technological product or system, from the perspective of the user and the producer.
TECH.8.2.8.C.8	Develop a proposal for a chosen solution that include models (physical, graphical or mathematical) to communicate the solution to peers.
TECH.8.2.8.C.5b	Create a technical sketch of a product with materials and measurements labeled.
TECH.8.2.8.D	Abilities for a Technological World: The designed world is the product of a design process that provides the means to convert resources into products and systems.
TECH.8.2.8.D.1	Design and create a product that addresses a real world problem using a design process under specific constraints.

TECH.8.2.8.D.2

Identify the design constraints and trade-offs involved in designing a prototype (e.g., how the prototype might fail and how it might be improved) by completing a design problem and reporting results in a multimedia presentation, design portfolio or engineering notebook.

## **Interdisciplinary Connections: NJSL for ELA, Social Studies, Science and/or Math Section**

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LA.K-12.NJSLSA.W	Writing
LA.K-12.NJSLSA.W2	Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.
LA.K-12.NJSLSA.W6	Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.  Research to Build and Present Knowledge
LA.K-12.NJSLSA.W7	Conduct short as well as more sustained research projects, utilizing an inquiry-based research process, based on focused questions, demonstrating understanding of the subject under investigation.
LA.W.7.2	Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.
LA.W.7.6	Use technology, including the Internet, to produce and publish writing and link to and cite sources as well as to interact and collaborate with others, including linking to and citing sources.
LA.W.7.7	Conduct short research projects to answer a question, drawing on several sources and generating additional related, focused questions for further research and investigation.

## **Integration of Diversity, Equity and Inclusion; Climate Change; Informational and Media LiteracyNew Section**

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see Crosswalks

## **21st Century Life and Careers**

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### **Stage I: Desired Results**

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### **Transfer/Overview/Rationale**

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**Transfer / Overview / Rationale**

## Unit Rationale

The purpose of this unit...

In this unit, students will be introduced to new challenges and concepts that require communication, patience and effort. Colls Makers can provides a pathway for students to solve real-world design and engineering problems. Once students understand how to follow the guidelines to certain challenges and tasks, they can begin to grow. Using the Engineering Design Process, students will be able to challenge each other and improve new concepts, propelling the students into the future of education and STEM careers.

## Meaning

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## Essential Questions

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Essential Questions

1. How can students use TSA design challenges to gear them for the future?
2. Why do engineers and designers strive to improve products used in our daily lives?
3. Why do we use the engineering design process to solve design challenges?
4. How can the engineering design process benefit us in solving problems in our daily lives?

## Enduring Understanding/Indicators of Understanding

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Enduring Understanding/Indicators of Understanding

- Engineering Design Process is a design process with a series of steps that engineers follow to come up with a solution to a problem.
- The design process gives structure to creativity.
- Technology Student Association (TSA) is a national organization of students engaged in science, technology, engineering and math
- STEM-related career fields available to them through in-depth classroom discussion and project-based design challenges.
- Problem solving and communication skills valuable in all areas of learning, both in and out of the classroom.
- Rules and guidelines must be followed correctly for specific tasks, challenges and projects, etc.

## **Acquisition (Student Learning Objectives)**

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### **Knowledge**

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Knowledge

Students will know...

- **The Engineering Design Process is a multi-step method that is used to solve technological challenges to change and improve products.**
- **Improvising and revision are important to the design process.**
- **Specific rules and guidelines must be followed when working on a challenge or task.**
- **Collaborative communication skills with peers and adults.**
- **Engineers, architects, teachers and students who engage in design and technology use scientific knowledge to solve practical problems.**
- **Computer technology is needed to access and retrieve data.**
- **Use the Engineering Design Process to solve design challenges in classroom.**

### **Skills**

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Skills

Student will be skilled at ...

- **Demonstrate how to use the Engineering design process is and how it works.**
- **Explain the steps taken when given a specific challenge through a variety of media.**
- **Communicating their ideas from beginning with questions to completing a finished product with peers and adults as needed.**
- **Discover multiple ways to complete a challenge using the TSA guidelines.**
- **Reflect on assignments, tasks, projects and challenges through oral and written communication.**
- **Present research information to peers and adults.**
- **Design a project that requires certain rules and regulations to be complete.**

## **Stage 3: Learning Plan**

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### **Resource and Mentor Texts**

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Resources and Mentor Texts

Chromebooks  
Internet/videos  
Google Drive  
Google Slides/Forms/Docs/Classroom  
Interactive websites  
Document camera/digital camera  
Design notebooks  
Design materials  
Measuring devices

## **Formative Assessment Strategies**

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Formative Assessment Strategies

Observations  
Questions/polling  
Group discussions/critiques  
Digital design notebooks/checks  
Peer/self assessment (reflection)

## **Learning Activities/Unit of Study**

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Learning Activities/Unit of Study

Daily warm-ups  
Inquiry-based learning  
Non-fiction reading/writing  
Note taking/annotations  
Prompted designs  
Classroom/small group discussion/critique  
Functional prototyping

## **Modifications and/or Accommodations**

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## **Suggested Modifications (ELL, Sp. Ed, Gifted, At-risk of Failure)**

### **English Language Learners**

Native language support: The teacher provides auditory or written content to students in their native language.

Adjusted Speech: The teacher changes speech patterns to increase student comprehension. This could include facing the students, paraphrasing, clearly indicating the most important ideas, and speaking more slowly.

Visuals: The teacher uses graphics, pictures, visuals, and manipulatives. This helps ELL students better understand and comprehend the subjects at hand.

Front-Loading Vocabulary: The teacher front loads vocabulary. This means providing students with a list of important vocabulary words they will need to know for a book, lesson, etc. prior to the lesson being taught. Including pictures to go with the vocabulary words is also very beneficial for the students.

### **Special Education Students**

Chunking: The teacher presents information in a way that makes it easy for students to understand and remember. Chunking is based on the presumption that our working memory is easily overloaded by excessive detail. The best way to deliver information is to organize it into meaningful units. Because students with special needs get overloaded easily, chunking is an effective strategy to use with them.

Checking for Understanding: It is important to constantly check for understanding, especially for students who have accommodations. Teachers want to make sure students understand the concepts being covered in a way that makes sense to them.

Extra time: The teacher provides students with special needs extra time to complete work or answer questions. It is important to give students enough time to process their thoughts.

Oral Reading: The teacher will read work orally to students. Class work such as tests and literature circles may need to be read aloud to the student.

Timers: The teacher will use timers as an instructional tool. The use of timers is beneficial for students who have trouble completing tasks. Timers can be helpful so the student is aware of how much time they have to complete an assignment.

### **Students with 504 Plans**

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## **Gifted & Talented Strategies**

**Extensions/Enrichments:** Teachers will provide gifted and talented students with extension/enrichment projects. Students will be challenged to further their understanding, to apply acquired knowledge, and/or to produce something in reference to acquired knowledge.

**Modify/Change Activities:** Teachers will monitor and modify activities to accommodate those students who need to be challenged further. Additional reading, problem-solving, writing, or project work is necessary for those students who are ready to move on at a rate more accelerated than their peers. In this way, G & T students are provided the same opportunity for support as special needs students.

## **Students at Risk of School Failure**

**Directions or Instructions:** Make sure directions and/or instructions are given in limited numbers. Give directions/instructions verbally and in simple written format. Ask students to repeat the instructions or directions to ensure understanding occurs. Check back with the student to ensure he/she hasn't forgotten.

**Peer Support:** Peers can help build confidence in other students by assisting in peer learning. Many teachers use the 'ask 3 before me' approach. This is fine, however, a student at risk may have to have a specific student or two to ask. Set this up for the student so he/she knows who to ask for clarification before going to you.

**Alternate or Modified Assignments:** Always ask yourself, "How can I modify this assignment to ensure the students at risk are able to complete it?" Sometimes you'll simplify the task, reduce the length of the assignment or allow for a different mode of delivery. For instance, many students may hand something in, the at-risk student may jot notes and give you the information verbally. Or, it just may be that you will need to assign an alternate assignment.

**Increase One to One Time:** When other students are working, always touch base with your students at risk and find out if they're on track or needing some additional support. A few minutes here and there will go a long way to intervene as the need presents itself.

**Contracts:** It helps to have a working contract between you and your students at risk. This helps prioritize the tasks that need to be done and ensure completion happens. Each day write down what needs to be completed, as the tasks are done, provide a checkmark or happy face. The goal of using contracts is to eventually have the student come to you for completion sign-offs.

**Hands On:** As much as possible, think in concrete terms and provide hands-on tasks. This means a

child doing math may require a calculator or counters. The child may need to tape record comprehension activities instead of writing them. A child may have to listen to a story being read instead of reading it him/herself.

Tests/Assessments: Tests can be done orally if need be. Break tests down in smaller increments by having a portion of the test in the morning, another portion after lunch and the final part the next day.

Seating: Seat students near a helping peer or with quick access to the teacher. Those with hearing or sight issues need to be close to the instruction which often means near the front.