SCHOOL DISTRICT OF THE CHATHAMS
CURRICULUM PROFILE

CONTENT AREA(S): iSTEM **GRADE LEVEL(S):** 8th Grade

COURSE: Grand Design Challenge **TIME FRAME:** Quarterly (39-40 days)

I. Course Overview

Students will continually develop and expand upon their understandings of engineering and design by mastering the skills necessary for identifying problems, delineating criteria and constraints for solutions, and framing design briefs. Students will continually apply mathematics, science, and technological understandings to solve contextualized problems framed within the National Academy of Engineering's Grand Challenges of Engineering, as well as problems present in their local communities. Course work provides opportunities for community and global civic engagement and fosters a sense of responsibility and ownership of critical global issues, promoting student choice and autonomy in problem selection and pathways to solutions.

II. Units of Study

1) Grand Accomplishments in Engineering
2) Engineering Within Constraints
3) Solving Real-World Grand Design Challenges

III. Essential Questions

Unit 1: Grand Accomplishments in Engineering

- How have the challenges presented to engineers progressed and what future problems affect engineers?
- How can an understanding of the challenges presented to engineers allow us to develop problem statements, criteria, and constraints?
- How do criteria/requirements and constraints affect engineers in the world?
- How do engineers identify problems and develop solutions to those problems?

Unit 2: Engineering Within Constraints

- What constitutes a "problem" and how is it different from a question, conflict, or performance task?
- How do engineers and designers identify and develop problem statements?
- What is the difference between a requirement/criteria and a constraint?
- How does one determine or set the criteria and constraints for a problem solving process?
- How does the target audience change how a solution must be engineered?
- How is design influenced by outside forces?

Unit 3: Solving Real-World Grand Design Challenges

- In what ways do engineers identify specific needs within a community?
- How does a community's needs and culture influence design?
- In what ways can engineers improve the lives of the people within their communities?

IV. Learning Objectives

NJSLS - Design Technology

- 8.2.8.A.5 Describe how resources such as material, energy, information, time, tools, people, and capital contribute to a technological product or system.
- 8.2.8.B.2 Identify the desired and undesired consequences from the use of a product or system.
- 8.2.8.B.3 Research and analyze the ethical issues of a product or system on the environment and report findings for review by peers and /or experts.

Technology Integration | NJSLS 8.1

- 8.1.8.A.1 Demonstrate knowledge of a real world problem using digital tools.
- 8.1.8.A.2 Create a document (e.g. newsletter, reports, personalized learning plan, business letters or flyers) using one or more digital applications.
- 8.1.8.B.1 Synthesize and publish information about a local or global issue or event (ex. telecollaborative project, blog, school web).
- 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.
- 8.1.8.F.1 Explore a local issue, by using digital tools to collect and analyze data to identify a solution and make an informed decision.

21st Century Integration | NJSLS 9

- 9.1.8.B.1 Use multiple points of view to create alternative solutions.
- 9.1.8.A.1 Develop strategies to reinforce positive attitudes and productive behaviors that impact critical thinking and problem-solving skills.
- 9.1.8.C.1 Determine an individual's responsibility for personal actions and contributions to group activities.
- 9.1.8.C.2 Demonstrate the use of compromise, consensus, and community building strategies for carrying out different tasks, assignments, and projects.

Career Ready Practices

- CRP1. Act as a responsible and contributing citizen and employee.
- CRP2. Apply appropriate academic and technical skills.
- CRP4. Communicate clearly and effectively and with reason.
- CRP5. Consider the environmental, social and economic impacts of decisions.
- CRP6. Demonstrate creativity and innovation.
- CRP7. Employ valid and reliable research strategies.
- CRP8. Utilize critical thinking to make sense of problems and persevere in solving them.
- CRP11. Use technology to enhance productivity.
- CRP12. Work productively in teams while using cultural global competence.

Interdisciplinary Connections

NGSS | Science

- MS-PS3-1. Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.

- MS-PS3-2. Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.
- MS-PS3-5. Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.
- MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
- MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
- MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
- MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

V. Instructional Materials

Core Materials:

- NAE Grand Challenges for Engineering
- Grand Achievements of Engineering
- Teacher computer with Internet access and projector/Smart Board
- Student computing devices
- G-Suite for Education
- Access to basic hand tools, woodworking machines, and fabrication equipment
    - Hot Wire Cutter
    - Soldering Iron
    - Drill Press
    - Bandsaw
    - Combination Disc/Belt Sander
    - Spindle Sander
- Materials for design challenges (foam, wood, wire, acrylic etc.)

Supplemental/District Created Materials:

- Grand Design Challenges Project
- LED Poster Project
- Helmet Redesign Project
- Hot Wire Cutter Safety Sheet
- Soldering Iron Safety Sheet
- Final Project Outline
- Community-Based Project Ideas
- Makerspace Paper Circuits

VI. Key Performance and Benchmark Tasks

Assessment Methods:

- Students will complete approximately four (4) projects between unit 1 and 2.
- When a student completes a project, s/he will complete a critique sheet, reflecting on their work and answer thoughtful questions on their design process.

- A rubric is outlined on the critique sheet, delineating the project parameters and expectations.
- Students present their final projects to their class explaining their project proposal and their solution.

Summative:

Unit 1: Engineering within Constraints

- Evaluate challenges in engineering today.
- Students will determine factors that prevent the solution of a problem.
- Describe how the importance of understanding each grand design challenge is helpful to have a clear understanding of global challenges and problem solving in general.
- Compile research about the progress of attempts to solve a global grand design challenge.
    - Develop a "fact sheet."
    - Create an informational presentation/poster.
- Grand Design Challenges Project
- LED Poster Project
- Helmet Redesign Project

Unit 2: Fundamentals of Problem Solving

- Students will be able to complete "design under constraint" challenges using the engineering design process by utilizing simple tools and physical models.
- Students will be able to use different tools and methods to troubleshoot a design problem.
- Students will be able to compile, arrange, format, and present their documentation.
- Safely utilize the hot wire cutter and/or soldering iron following all directions and proper procedures.
- Students will be able to identify a problem that affects one or more people.
- Students will be able to create a problem statement for a design problem.
- Students will be able to develop and build a project within criteria and constraints to solve a problem.
- Hot Wire Cutter Safety Exam
- Soldering Iron Safety Exam

Unit 3: Solving Real-World Grand Design Challenges

- Identify a school-wide or local problem, delineate criteria and constraints, and propose and prototype solutions for the problem.
- Students will be able to apply the engineering design process to solve a problem they have identified in their school or local community.
- Students will be able to compile, arrange, format, present and defend information in an engineer's notebook or design portfolio.
- Final Project

Formative:

- Peer Feedback: TAG (Tell, Ask, Give) Sticky Notes
- Peer Feedback Form
- Self-Reflection: 2 Stars & 1 Wish
- Critique Guide
- Reflective Exit Tickets/Slips
- Grand Design Challenges Project

    - Compile research about the progress of attempts to solve a global grand design challenge.
- LED Poster Project
    - Checklist/Self-Assessment
- Helmet Redesign Project
    - Plan, Create & Improve documentation & journaling
- Final Project
    - ASK STEP:
        - Identify the problem.
        - Identify the design statement.
        - Identify the requirements and constraints.
        - Ask scientific research questions.
        - Compile information about the science behind the challenge.
        - Explain who benefits from the solution
        - Brainstorm multiple solutions using a variety of techniques.
    - IMAGINE STEP:
        - Sketch ideas for solutions.
        - Collaborate with others to choose a final solution.
    - PLAN STEP:
        - Create a technical drawing of the proposed solution.
        - Explain why this solution will solve the problem.
    - CREATE STEP:
        - List the steps to create the product.
        - Note the changes made while building.
        - Follow safety rules while building.
        - Use various tools in the classroom to create a prototype.
    - IMPROVE STEP:
        - Provide feedback to peers.
        - Utilize feedback to improve design.
        - Reflect on experience and redesign design in multiple ways.

Alternative:

- Student choice is built into each project, which makes each project unique for each and every student.
- Adjustments to assessment criteria and assessments themselves are described below in Section VII.

VII. Accommodations & Modifications for Special Education, Students at Risk for School Failure, English Language Learners, Gifted & Talented, and 504s

Special Education

- Student choice in projects to allow for appropriate skill levels to be applied.

- Clarify and repetition of expectations, review of expectations at the start of class, highlighting expectations on student hardcopies, provide specific tasks as needed to clarify goals.
- Support of student focus: verbal prompts, visual cues (lights out, etc.).
- Positive reinforcement.
- Pacing and guidance in long term projects.
    - Work chunked out based on tasks, individual check ins.
    - Extended projects are broken down into manageable tasks with frequent check-ins from the teacher.
- Potential Grand Design Challenges Project Modifications:
    - Allow students to research ideas online including videos to gather ideas.
    - Chunk out big picture plans into more manageable goals.
        - Students are given specific tasks to complete at the start of class and are to check in when they are completed so that additional tasks can be discussed
    - Students are heterogeneously grouped.
    - Clarification and additional scaffolding of directions.
    - Ensure students understand directions by providing additional processing time, repeat or rephrase directions.
    - Provide frequent redirection/prompts to refocus attention.
- Potential LED Poster Project Modifications:
    - Allow students to use online resources to review creating circuits
    - Assist students with physical skills such as cutting, measuring, and/or soldering.
    - Reduce accuracy requirements for catapult.
    - Chunk out big picture plans into more manageable goals.
        - Students are given specific tasks to complete at the start of class and are to check in when they are completed so that additional tasks can be discussed
    - Students are heterogeneously grouped.
    - Clarification and additional scaffolding of directions.
    - Ensure students understand directions by providing additional processing time, repeat or rephrase directions.
    - Provide frequent redirection/prompts to refocus attention.
- Potential Helmet Redesign Project Modifications:
    - Modify online resources by eliminating superfluous information and highlighting key facts
    - Assist students with physical skills such as cutting and measuring.
    - Reduce accuracy requirements for catapult.
    - Chunk out big picture plans into more manageable goals.
        - Students are given specific tasks to complete at the start of class and are to check in when they are completed so that additional tasks can be discussed
    - Students are heterogeneously grouped.
    - Clarification and additional scaffolding of directions.
    - Ensure students understand directions by providing additional processing time, repeat or rephrase directions.
    - Provide frequent redirection/prompts to refocus attention.
- Potential Final Project Modifications:
    - Provide example projects that students can choose instead of creating their own project proposal

- Assist students with physical skills such as cutting and measuring.
- Reduce accuracy requirements for catapult.
- Chunk out big picture plans into more manageable goals.
  - Students are given specific tasks to complete at the start of class and are to check in when they are completed so that additional tasks can be discussed
- Students are heterogeneously grouped.
- Clarification and additional scaffolding of directions.
- Ensure students understand directions by providing additional processing time, repeat or rephrase directions.
- Provide frequent redirection/prompts to refocus attention.

English Language Learners

- Use of Google Translate to assist students with instructions and lessons so they can follow along.
- Adjust goals to allow for language acquisition.
- Visual prompts and demonstrations.
- Teacher modeling of skills.
- Simplified written and verbal instructions. Include written instructions to supplement verbal.
- Preferential seating.

Gifted & Talented

- Access to additional materials to develop ideas and project details.
  - <u>Potential Grand Design Challenges Project Extensions:</u>
    - Students will develop a more in depth understanding of the Grand Design Challenge
      - Students will explore a specific technology and create a slides presentation explaining that technology
      - Students will explore the history of the grand design challenge and create a timeline for the technologies that have led to this challenge
  - <u>Potential LED Poster Project Extensions:</u>
    - Students will research and include a pressure switch in their design
    - Students will use basic circuit boards to add a new element to their design
  - <u>Potential Helmet Redesign Project Extensions:</u>
    - Students will be asked to create an advertising campaign that would sell their helmet design to their target audience
  - <u>Potential Final Project Extensions:</u>
    - Students will need to provide multiple reliable sources giving background to their project proposal and why it is necessary
    - Students will be asked to reach out to members of the community to receive feedback and explain how their project would benefit the community

Students at Risk of School Failure

- Student choice in projects to allow for appropriate skill levels to be applied.
- Clarify and repetition of expectations, review of expectations at the start of class, highlighting expectations on student hardcopies, provide specific tasks as needed to clarify goals.
- Support of student focus: verbal prompts, visual cues (lights out, etc.).
- Positive reinforcement.
- Pacing and guidance in long term projects: Work chunked out based on tasks, individual check ins.
- Extended projects are broken down into manageable tasks with frequent check-ins from the teacher.

504s

- Completely dependent on the student's 504 plan.
    - If the student cannot utilize computers or look at screens, research, planning, and computer-based learning experiences can be done on paper.
    - If the students' level of mobility is limited, making it difficult for the students to navigate the classroom, the student will be assigned a buddy to help with acquiring the necessary materials and supplies.
    - If the students' fine or gross motor skills are impacted, s/he will receive assistance from the teacher for the specific skills that require them.

GENERAL NOTES:

- The order in which the units are taught can be adjusted at the teacher's discretion.
- Days are fluid and some activities may extend longer.
- Lessons and units will be adjusted as per students' prior knowledge.