Engineering Design and Development

Grade 12

Prerequisites: Introduction to Engineering Design
Principles of Engineering
Digital Electronics

Credit Value: 5

ABSTRACT

The Engineering Design and Development course serves as the capstone course within the Project Lead The Way sequence. The purpose of the program is to provide direct application of the skills and knowledge learned in prerequisite courses to real-world problems. Students use *Autodesk Inventor* software to assist in designing solutions to specific problems selected by teams of students. Engineering Design and Development tests time management and team skills which are valuable assets in post-secondary education and the work force. Benchmark assessments are employed to track individual student progress.

*Adopted by the Somerville Board of Education on July 25, 2017*
## Engineering Design and Development – Grade 12

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### Essential Question:
- When are expository and technical writing styles applicable to an engineering notebook?
- Why is creation of a problem statement important in preparation to design and develop solutions to a problem?
- What processes may determine if problems need innovations or newly-developed solutions?
- What are the factors that influence design decisions?
- How do engineers communicate the design solution to others?

### Content:
- **Introduction to Engineering Design and Development**
- **Problem Identification**
- **Research and Development**
- **The Decision Process**
- **Design of the Solution**

### Skills and Topics:
- Evaluate informed decision making as a valuable tool in the problem-solving process
- Demonstrate the ability to use technical and expository writing as an essential communication skill
- Use technical writing to communicate the pertinent aspects of a problem and a potential solution addressing a particular audience
- Identify the aspects of the design process used by engineers:
  - Define the problem
- Research and identify the problem to be studied
- Use brainstorming techniques to generate problem statements to the identified problem
- Write a concise statement specific to the problem
- Determine the level of accuracy required to validate results
- Draw analogies between professional roles and real-world research problems
- Investigate the current status of typical problems
- Research possible problems for projects
- Identify the current environment in which the problem exists
- Recognize that the application of acquired knowledge furthers development of new solutions
- Apply market research techniques to decision making on the development and marketing of new products
- Review patent law and implications
- Examine the process to secure a patent
- Enhance creativity of the specifications for a design solution by identifying the criteria and constraints of the design solution
- Use a decision matrix to evaluate a preliminary design solution based on multiple parameters
- Optimize final design solutions by justifying the specification applied
- Use symbols and drawings to promote clear communications of a design solution
- Organize, record, and communicate ideas to experts using drawings and sketches
- Explore the use of working drawings to show all information needed to make a single part, sub-assembly, or a complete design solution
- Investigate the use of technical drawings to evaluate design solutions for any necessary refinements to the model or prototype
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<td>Skills and Topics:</td>
<td>○ brainstorm solutions</td>
<td>○ research technical limitations</td>
<td>○ identify requirements</td>
<td>○ locate industrial and academic research used to identify existing solutions to technical problems</td>
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<td>○ research technical limitations</td>
<td>○ identify requirements</td>
<td>○ explore possible solutions to a problem</td>
<td>○ investigate the need for innovation to solve a problem (e.g., energy sources, pollution control, transportation improvement)</td>
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<td>○ identify requirements</td>
<td>○ explore possible solutions to a problem</td>
<td>○ select an approach to problem solution</td>
<td>○ examine the integration of various engineering roles while solving a problem as a team</td>
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<td>○ explore possible solutions to a problem</td>
<td>○ select an approach to problem solution</td>
<td>○ develop a design proposal</td>
<td>○ link goal-directed research to inventions and innovations</td>
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<td>○ select an approach to problem solution</td>
<td>○ develop a design proposal</td>
<td>○ make a model or prototype</td>
<td>○ identify economic and cultural influences that shape the development of solutions to technical problems</td>
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<td>○ develop a design proposal</td>
<td>○ make a model or prototype</td>
<td>○ test the performance of the prototype</td>
<td>○ use assessment techniques (e.g., trend analysis) to determine if a solution should be implemented</td>
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<td><strong>use an engineer’s notebook to chronologically document all aspects of the design project</strong></td>
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<td><em>Autodesk Inventor</em> software, Internet, Web Quests, wireless laptop computers, computer laboratory, portable language, laboratory, classroom computers, SMART Boards, multimedia presentations, simulations, video streaming, podcasting</td>
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<td><strong>Performance Assessments:</strong></td>
<td>Assessments Engineer’s notebook Expository essay: the decision-making steps necessary to solve a problem</td>
<td>Assessments Problem statement</td>
<td>Assessments Fabrication and testing report of materials and stress Feasibility report</td>
<td>Assessments Decision matrix Final design solution proposal</td>
<td>Assessments Design briefs Collections of design sketches and models</td>
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<td><strong>21st Century Themes:</strong></td>
<td>☒Global Awareness ☒Civic Literacy ☒Financial, Economic, Business, and Entrepreneurial Literacy ☐Health Literacy</td>
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*2016 NJSLS:*
- RST: Reading in Science and Technical Subjects
- WHST: Writing in History, Science, and Technical Subjects
- SL: Speaking and Listening
- L: Language

- N: Real Number System
- A: Algebra
- F: Functions
- G: Geometry
- S: Statistics and Probability
- MD: Measurement and Data
- N-Q: Quantities

- N-VM: Vector and Matrix Quantities
- A-SSE: Seeing Structure in Expressions
- A-REI: Reasoning with Equations and Inequalities
- F-IF: Interpreting Functions
- F-BF: Building Functions
- F-LE: Linear, Quadratic, and Exponential Models
- F-TF: Trigonometric Functions
- G-CO: Congruence
- G-SRT: Similarity, Right Triangles, and Trigonometry
- G-C: Circles
- G-GPE: Expressing Geometric Properties with Equations
- S-ID: Interpreting Categorical and Quantitative Data
- S-IC: Making Inferences and Justifying Conclusions
- S-CP: Conditional Probability and the Rules of Probability
- S-MD: Using Probability to Make Decisions
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### Essential Question:
- How does the design phase transition into building a product?
- How is an engineer’s testing procedure different from a scientist’s use of the scientific method?
- How do engineers present their design solutions and prototypes to potential users?
- Has the research and development of a product or system been successful?

### Content:
- **Building the Prototype**
- **Testing Methods**
- **Presentation**
- **Juried Presentation**

### Skills and Topics:
- **Building the Prototype**
  - recognize tool machine safety to prevent accidents during construction of prototypes
  - review the use of the Computer and Network Systems (CNS) machine and program the robotic arm
  - write step-by-step instructions to program the robotic arm for prototype assembly
  - compare and contrast the applications of appropriate materials to best serve as the prototype
  - perform a cost analysis of available materials and equipment to produce the prototype
  - detail a scale working model of the prototype

- **Testing Methods**
  - identify prototype testing as a controlled procedure
  - determine specific criteria to assess the success or failure of a test of the prototype
  - write a detailed description of the testing procedure to ensure validity of design solution tests
  - evaluate test results to determine accuracy and repeatability of the testing procedure
  - use the results of prototype testing to refine the design and improve the design solution

- **Presentation**
  - identify the advantages and disadvantages of web-based exchanges of information over bound, printed material
  - use Microsoft Office applications to develop presentation of design solution
  - create a PowerPoint presentation using visual aids, sketches, scale models, and project information in a professional manner
  - produce a technical report providing thorough communication of all aspects of the design solution
  - select and use various media formats to effectively communicate the design solution process for a target audience

- **Juried Presentation**
  - develop public speaking skills to effectively communicate design solutions
  - use computerized visual presentations to emphasize the content of the engineer’s design process
  - present and display the design solution to effectively promote the implementation of the project
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| Performance Assessments: | Fabrication program code for the robotic arm
Spreadsheet of attribute comparison of materials used for the prototype
Spreadsheet cost analysis
Prototype scale model | Written evaluations
Written description of the prototype-testing procedure
Report of test results
Prototype refinement plan | *PowerPoint* presentation
Technical report | Display board of year-long research project
Peer review analysis
Juried evaluations |
*Mathematics: N-Q.1-3, N-VM.1-5, F-IF.1-2, F-IF.4-7, F-BF.1.a-c, F-L.E.1-5
Arts: The Arts are exemplified through the implementation of the elements of design applied while developing industrial solutions via prototypes.
World Language: 7.1.A.L.B.5
| 21st Century Themes: | ★Global Awareness ★Civic Literacy
★Financial, Economic, Business, and Entrepreneurial Literacy ★Health Literacy |
| 21st Century Skills: | ★Creativity and Innovation ★Media Literacy ★Critical Thinking and Problem Solving ★Life and Career Skills
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Engineering Design and Development
Course Requirements

Grade: 12  Prerequisite: Introduction to Engineering Design
Credit Value: 5
Principles of Engineering
Digital Electronics
Length of Course: Academic Year

Course Description

The Engineering Design and Development course serves as the capstone course within the Project Lead The Way sequence. The purpose of the program is to provide direct application of the skills and knowledge learned in prerequisite courses to real-world problems. Students use Autodesk Inventor software to assist in designing solutions to specific problems selected by teams of students. Engineering Design and Development tests time management and team skills which are valuable assets in post-secondary education and the work force. Benchmark assessments are employed to track individual student progress.

Course Content

This course will consist of the following units of study:

- Introduction to Engineering Design and Development
- Problem Identification
- Research and Development
- The Decision Process
- Design of the Solution
- Building the Prototype
- Testing Methods
- Presentation
- Juried Presentation

Course Objectives

The student will demonstrate the ability to answer in detail the following essential questions:

- When are expository and technical writing styles applicable to an engineering notebook?
- What is creation of a problem statement important in preparation to design and develop solutions to a problem?
- What processes may determine if problems need innovations or newly-developed solutions?
- What are the factors that influence design decisions?
Course Objectives (continued)

- How do engineers communicate the design solution to others?
- How does the design phase transition into building a product?
- How is an engineer’s testing procedure different from a scientist’s use of the scientific method?
- How do engineers present their design solutions and prototypes to potential users?
- Has the research and development of a product or system been successful?
- What are the post-graduation and/or career options that apply to the course content?

Evaluation Process

A final average of 65% or better is required to be awarded course credit. Throughout the length of this course, students may be evaluated on the basis of, but not limited to:

- Formative Assessments, such as writing prompts, journals, and portfolios
- Summative Assessments, such as quizzes, tests, and midterm and final examinations
- Performance Assessments, such as projects and presentations
- Technology-based Applications, such as electronic portfolios, Web Quests, ThinkQuest, and podcasting
- Class Participation
- Homework

Specific weights will be determined by course and level.
Engineering Design and Development
Student Agreement

STUDENT NAME: ____________________________________________

Last Name                                      First Name

GRADE: ______________________

My signature below indicates that I have received a copy of the Somerville Public Schools Course Requirements for Engineering Design and Development.

I acknowledge my responsibility to read and understand all of the information contained in the Engineering Design and Development Course Requirements information and syllabus packet.

__________________________________________  ________________________
Student Signature                           Date

Note: Please share the course requirements for Engineering Design and Development with your parents.