ESCONDIDO UNION HIGH SCHOOL DISTRICT

Manufacturing Innovation & Design

Approved by the Board of Education on August 2, 2022
Mission and Vision

We relentlessly pursue, with optimism, equitable support for all students to navigate a changing world by providing rigorous and relevant learning experiences that strengthen their capacity as

- Open-minded and invested collaborators;
- Effective and thoughtful communicators;
- Resourceful and creative problem solvers;
- Curious and analytical critical thinkers;
- Informed and compassionate community members.

EUHSD curriculum identifies what students should know and be able to do by grade level in a comprehensive, standards-based course of study. Curriculum may be updated, as needed, based on student academic achievement data, research and best practices, and input from stakeholders. The EUHSD curriculum contains the following information:

- **Course Description** – provides a description of the overarching content and goals of the course and is used in the Course Catalog.
- **Course Information** – provides information specific to length of course, course number, transcript abbreviation, credits earned.
- **Course Requirements** – provides information specific to credits, prerequisites, UC/CSU requirements, and grade level of the course.
- **Course Material(s)** – Instructional materials used in course.
- **Scope and Sequence** – provides the standards-based units of instruction including the Learning Objective and Sample Performance Tasks and Assessments.

To ensure all courses empower every student, specifically emerging multilingual students, to graduate prepared for college, career, and life, all EUHSD courses will:

- Incorporate the English Language Development state standards adopted by the CA Department of Education in 2012. Visit the following website to learn more about the new descriptors and corresponding standards: [https://www.cde.ca.gov/sp/el/er/documents/eldstndspublication14.pdf](https://www.cde.ca.gov/sp/el/er/documents/eldstndspublication14.pdf)
- Highlight specific strategies designed to meet the needs of emerging multilingual students as outlined in the 2014 CA Department of Education ELA-ELD Framework and the 2017 CA EL Roadmap. Visit the following URL to learn more about the new Frameworks: [https://www.cde.ca.gov/ci/rl/cf/documents/elaeldfwchapter11.pdf](https://www.cde.ca.gov/ci/rl/cf/documents/elaeldfwchapter11.pdf). To learn more about the CA EL Roadmap, visit the following website: [https://www.cde.ca.gov/sp/el/rm/](https://www.cde.ca.gov/sp/el/rm/)

Escondido Union High School District prohibits discrimination, harassment, intimidation, and bullying based on actual or perceived ancestry, age color, disability, gender, gender identity, gender expression, nationality, race or ethnicity, religion, sex, sexual orientation, pregnancy, marital or parental status or association with a person or group with one or more of these actual or perceived characteristics.

Dr. Courtney Goode, Assistant Superintendent of Human Resources, Equity and Title IX Compliance Officer
302 N. Midway Drive, Escondido, CA 92027
Office: (760) 291-3281, Email: cgoode@euhsd.org
Manufacturing Innovation & Design will introduce students to an innovative product design curriculum that is related to manufacturing with a focus on design factors such as aesthetics, format, geometric shape and form, perspective drawing, scale, proportion, and presentation techniques. This course incorporates product innovation and design (S.T.E.A.M.) and offers an interdisciplinary collaboration between art & design, physics, chemistry, and product design. Students use computers and shop machinery as a medium/tool for design of project components such as: designing, rendering, sketching, inventing, model making, welding, manufacturing, and product development. This course exposes students to tools, machines, safety training, and processes, and enables students to experience the process of translating an idea into a finished product. This is the first course in a pathway of courses designed to engage students and develop college and career readiness skills within the Manufacturing and Product Development Industry Sector.

<table>
<thead>
<tr>
<th>Course Information</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Semester A: Course Number: 6482 Transcript Abbreviation: MANUFACT INV DSGN A (P) Credits: 5 Weighted: No</td>
<td></td>
</tr>
<tr>
<td>Semester B: Course Number: 6483 Transcript Abbreviation: MANUFACT INV DSGN B (P) Credits: 5 Weighted: No</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Requirements</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of Course: Yearlong Course Learning Environment: Classroom Based Type of Grade: Letter Grade</td>
<td></td>
</tr>
<tr>
<td>Grade Level: 9-12 Course Repeatable: No Maximum Credits, if Repeatable: N/A</td>
<td></td>
</tr>
<tr>
<td>Course Type: College Prep Designated College Prep/CTE: Yes CTE Course Level: Concentrator</td>
<td></td>
</tr>
<tr>
<td>Meets EUHSD Graduation Requirement: Designated College Prep/CTE or Elective Credit Pathway: Product Innovation and Design</td>
<td></td>
</tr>
<tr>
<td>Meets UC/CSU Requirement: D: Laboratory Science UC Honors Designation: No</td>
<td></td>
</tr>
<tr>
<td>Required Prerequisite(s): None</td>
<td></td>
</tr>
<tr>
<td>Recommended Prerequisite(s): None</td>
<td></td>
</tr>
<tr>
<td>Required Corequisite(s): Completion or Concurrent Enrollment in Math 1</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Material(s)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>● This course uses Open Educational Resources (OERs) in order to access current digital libraries that are pivoting rapidly to industry needs.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Standards</th>
<th></th>
</tr>
</thead>
</table>
## Unit 1: Design & Build Metal Coasters

### Unit Description

Students will design & build a metal coaster (oval or round). Students start by researching books, online & retail to generate multiple product ideas on what kinds of designs that could be used on a coaster: logo, family crest, symbol, holiday decoration. They then refine their ideas using critical thinking and come up with one unique metal coaster to produce. Using computers or by hand, the students will draw, draft, and sketch their idea using accurate measurements, math, materials, and processes. Then, they will create a timeline for completion. Students then start to build a “working” metal coaster - and consider manufacturability, cost, finishes and use a variety of tools - lathe, saws, drills, CNC, Laser, etc. When completed students will present their finished “working” metal coaster to the class: including idea research, sketches, drawings & finished product, and receive feedback. The focus of this unit is on choosing the appropriate materials and tools to create this product.

### Unit Outline

<table>
<thead>
<tr>
<th>Standards</th>
<th>Learning Objectives</th>
<th>Essential Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>College and Career Readiness Anchor Standards for Reading:</strong></td>
<td>Students will…</td>
<td>1. What is the function of this product?</td>
</tr>
<tr>
<td>- Reading Standard: Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (CCSS.ELA-LITERACY.RST.11-12.7)</td>
<td>- research products available in the desired market.</td>
<td>2. How can the product be improved upon?</td>
</tr>
<tr>
<td>- Reading Standard: Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (CCSS.ELA-LITERACY.RST.11-12.8)</td>
<td>- design a prototype using drawings or design software.</td>
<td>3. Will this ideation of this product be cost effective to manufacture?</td>
</tr>
<tr>
<td>- Reading Standard: Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. (CCSS.ELA-LITERACY.RST.11-12.9)</td>
<td>- compare and contrast prototype with current available designs.</td>
<td>4. How could this new product be marketed?</td>
</tr>
<tr>
<td><strong>Manufacturing and Product Development - Knowledge and Performance Anchor Standards:</strong></td>
<td>- build a prototype using available materials, tools, and machinery.</td>
<td>5. Does this ideation of the product meet market and industry needs?</td>
</tr>
<tr>
<td>- 4.0 Technology: Use existing and emerging technology to investigate, research, and produce products and services, including new information, as required in the Manufacturing and Product Design sector workplace environment. (Direct alignment with WS 11-12.6)</td>
<td>- receive feedback for potential design.</td>
<td></td>
</tr>
<tr>
<td>- 6.0 Health and Safety: Demonstrate health and safety procedures, regulations, and personal health practices and determine the meaning of symbols, key terms, and domain-specific words and phrases as</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Sample Performance Tasks/Assessments

- Working individually, students will research a product design and create a project proposal that will include design concept, a drawn rendering of product, and manufacturing plan. Once the design is accepted, students will use necessary materials and various machines and tools to create a prototype. Prototypes will be presented verbally and visually to class for feedback on design.
related to the Manufacturing and Product Design sector workplace environment. (Direct alignment with RSTS 9-10, 11-12.4)

- **10.0 Technical Knowledge and Skills:** Apply essential technical knowledge and skills common to all pathways in the Manufacturing and Product Design sector, following procedures when carrying out experiments or performing technical tasks. (Direct alignment with WS 11-12.6)

- **11.0 Demonstration and Application:** Demonstrate and apply the knowledge and skills contained in the Manufacturing and Product Design anchor standards, pathway standards, and performance indicators in classroom, laboratory, and workplace settings, and through the career technical student organizations.

**Product Innovation and Design Pathway Standards:**

- **D2.1** Employ research methodologies, using primary research and electronic reference materials, to gather information relevant to the topic or area of opportunity.
- **D2.3** Identify potential design areas (e.g., product, product line, system design, or service) that would address the need, problem, or opportunity.
- **D3.0** Understand and apply various ideation techniques to develop ideas and concepts.
- **D3.1** Apply ideation techniques to explore and produce multiple concepts.
- **D5.0** Develop the concept into a well-defined product for prototyping.
- **D5.1** Produce technical drawings and other specifications required for the prototyping or manufacturing of the product.
- **D5.2** Recognize the safety issues related to the reliability, functionality, and use of the product.
- **D6.0** Produce a prototype of a product.
- **D7.3** Identify any redesigning or additional corrections required to improve the overall quality, look, and performance of the prototype model.
**HS-ETS1 Engineering Design Standards:**

- **HS-ETS1-1:** Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
- **HS-ETS1-2:** Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
- **HS-ETS1-3:** Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.
- **HS-ETS1-4:** Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

**Standards for Mathematical Practice:**

- **2. Reason abstractly and quantitatively:** Mathematically proficient students make sense of quantities and their relationships in problem situations. They bring two complementary abilities to bear on problems involving quantitative relationships: the ability to decontextualize—to abstract a given situation and represent it symbolically and manipulate the representing symbols as if they have a life of their own, without necessarily attending to their referents—and the ability to contextualize, to pause as needed during the manipulation process in order to probe into the referents for the symbols involved. Quantitative reasoning entails habits of creating a coherent representation of the problem at hand; considering the units involved; attending to the meaning of quantities, not just how to compute them; and knowing and flexibly using different properties of operations and objects.
- **4. Model with mathematics:** Mathematically proficient students can apply the mathematics they know to solve problems arising in everyday life, society, and the workplace. In early grades, this might be as simple as writing an additional equation to describe a situation. In middle grades, a student might apply proportional reasoning to plan a school event or analyze a problem in the community. By high school, a student might use geometry to solve a design problem or use a function to
describe how one quantity of interest depends on another. Mathematically proficient students who can apply what they know are comfortable making assumptions and approximations to simplify a complicated situation, realizing that these may need revision later. They are able to identify important quantities in a practical situation and map their relationships using such tools as diagrams, two-way tables, graphs, flowcharts and formulas. They can analyze those relationships mathematically to draw conclusions. They routinely interpret their mathematical results in the context of the situation and reflect on whether the results make sense, possibly improving the model if it has not served its purpose.
## Unit 2: Design & Build a Fidget Toy

### Unit Description

Students will design & build a fidget toy: 2-wing, 2-wing, and 4-wing. Students start by researching online & retail to generate multiple product ideas on what kinds of fidget toys exist, how they work, what they are made of, and how they are made. They then refine their ideas using critical thinking and come up with one unique fidget toy to produce. Using computers or by hand, the students will draw, draft, and sketch their idea using accurate measurements, math, materials, and processes. Then, they will create a timeline for completion. Students then start to build a "working" fidget toy - and consider manufacturability, cost, finishes and use a variety of tools - saws, drills, CNC, etc. When completed students will present their finished "working" fidget toy to the class: including idea research, sketches, drawings & finished product, and receive feedback. The focus of this unit is on identifying how the available materials, tools, and machinery can be leveraged to create an object that moves.

<table>
<thead>
<tr>
<th>Standards</th>
<th>Learning Objectives</th>
<th>Essential Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>College and Career Readiness Anchor Standards for Reading:</strong></td>
<td>Students will…</td>
<td>1. What is the function of this product?</td>
</tr>
<tr>
<td>- Reading Standard: Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (<a href="#">CCSS.ELA-LITERACY.RST.11-12.7</a>)</td>
<td>- build a moving prototype using available materials, tools, and machinery.</td>
<td>2. How might movement enhance or contribute to the function of this product?</td>
</tr>
<tr>
<td>- Reading Standard: Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (<a href="#">CCSS.ELA-LITERACY.RST.11-12.8</a>)</td>
<td>- understand how the component parts of a product interact with one another to support free movement.</td>
<td>3. Does this ideation of the product meet market and industry needs?</td>
</tr>
<tr>
<td>- Reading Standard: Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. (<a href="#">CCSS.ELA-LITERACY.RST.11-12.9</a>)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Manufacturing and Product Development - Knowledge and Performance Anchor Standards:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- 4.0 Technology: Use existing and emerging technology to investigate, research, and produce products and services, including new information, as required in the Manufacturing and Product Design sector workplace environment. (Direct alignment with WS 11-12.6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- 6.0 Health and Safety: Demonstrate health and safety procedures, regulations, and personal health practices and</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Sample Performance Tasks/Assessments

- Working individually, students will research a product design and create a project proposal that will include design concept, a drawn rendering of product, and manufacturing plan. Once the design is accepted, students will use necessary materials and various machines and tools to create a prototype. Prototypes will be presented verbally and visually to class for feedback on design.
determine the meaning of symbols, key terms, and domain-specific words and phrases as related to the Manufacturing and Product Design sector workplace environment. (Direct alignment with RSTS 9-10, 11-12.4)

- 10.0 Technical Knowledge and Skills: Apply essential technical knowledge and skills common to all pathways in the Manufacturing and Product Design sector, following procedures when carrying out experiments or performing technical tasks. (Direct alignment with WS 11-12.6)

- 11.0 Demonstration and Application: Demonstrate and apply the knowledge and skills contained in the Manufacturing and Product Design anchor standards, pathway standards, and performance indicators in classroom, laboratory, and workplace settings, and through the career technical student organizations.

**Product Innovation and Design Pathway Standards:**

- D2.1 Employ research methodologies, using primary research and electronic reference materials, to gather information relevant to the topic or area of opportunity.
- D2.3 Identify potential design areas (e.g., product, product line, system design, or service) that would address the need, problem, or opportunity.
- D3.0 Understand and apply various ideation techniques to develop ideas and concepts.
- D4.1 Create a preliminary design of a product concept utilizing drawing, computer software (graphic or CAD), and/or conceptual model fabrication techniques.
- D4.2 Identify materials, mechanisms, technologies, and other requirements (e.g., safety, manufacturing, sustainability) the concept may require.
- D5.0 Develop the concept into a well-defined product for prototyping.
- D5.1 Produce technical drawings and other specifications required for the prototyping or manufacturing of the product.
- D6.0 Produce a prototype of a product.
● D7.0 Evaluate the prototype to determine if it meets the requirements and objectives.
● D7.1 Create a performance criteria and a quality standard to measure and evaluate a prototype.
● D7.2 Test the functionality and other features of the prototype against the performance criteria and quality standard and evaluate the results.

**HS-ETS1 Engineering Design Standards:**

● HS-ETS1-1: Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
● HS-ETS1-2: Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
● HS-ETS1-3: Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.
● HS-ETS1-4: Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

**Standards for Mathematical Practice:**

● 2. Reason abstractly and quantitatively: Mathematically proficient students make sense of quantities and their relationships in problem situations. They bring two complementary abilities to bear on problems involving quantitative relationships: the ability to decontextualize—to abstract a given situation and represent it symbolically and manipulate the representing symbols as if they have a life of their own, without necessarily attending to their referents—and the ability to contextualize, to pause as needed during the manipulation process in order to probe into the referents for the symbols involved. Quantitative
reasoning entails habits of creating a coherent representation of the problem at hand; considering the units involved; attending to the meaning of quantities, not just how to compute them; and knowing and flexibly using different properties of operations and objects.

4. **Model with mathematics**: Mathematically proficient students can apply the mathematics they know to solve problems arising in everyday life, society, and the workplace. In early grades, this might be as simple as writing an additional equation to describe a situation. In middle grades, a student might apply proportional reasoning to plan a school event or analyze a problem in the community. By high school, a student might use geometry to solve a design problem or use a function to describe how one quantity of interest depends on another. Mathematically proficient students who can apply what they know are comfortable making assumptions and approximations to simplify a complicated situation, realizing that these may need revision later. They are able to identify important quantities in a practical situation and map their relationships using such tools as diagrams, two-way tables, graphs, flowcharts and formulas. They can analyze those relationships mathematically to draw conclusions. They routinely interpret their mathematical results in the context of the situation and reflect on whether the results make sense, possibly improving the model if it has not served its purpose.
### Unit 3: Design & Build/Replicate a Child's Toy

#### Unit Description

Students will design & build a "working" child's toy. Students start by researching books, online & retail to generate multiple product ideas on what kinds of toys exist, how they work, what they are made of, and how they are made. They then refine their ideas using critical thinking and come up with one unique toy to produce. Using computers or by hand, the students will draw, draft, and sketch their idea using accurate measurements, math, materials, and processes. Then, they will create a timeline for completion. Students then start to build a “working” toy - and consider manufacturability, cost, finishes and use a variety of tools - lathe, saws, drills, CNC, Laser, etc. When completed, students will present their finished “working” toy to the class: including idea research, sketches, drawings & finished product, and receive feedback. The focus of this unit is on identifying the needs of the end user and creating a prototype that supports them.

#### Unit Outline

<table>
<thead>
<tr>
<th>Standards</th>
<th>Learning Objectives</th>
<th>Essential Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>College and Career Readiness Anchor Standards for Reading:</strong></td>
<td><strong>Students will...</strong></td>
<td>1. What is the function of this product?</td>
</tr>
<tr>
<td>• Reading Standard: Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (CCSS.ELA-LITERACY.RST.11-12.7)</td>
<td>• design a prototype with an end user in mind, considering their needs.</td>
<td>2. How is this product created with an end user in mind?</td>
</tr>
<tr>
<td>• Reading Standard: Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (CCSS.ELA-LITERACY.RST.11-12.8)</td>
<td>• build a prototype using available materials, tools, and machinery, with due consideration for the safety and needs of the user.</td>
<td>3. Does this ideation of the product meet market and industry needs?</td>
</tr>
<tr>
<td>• Reading Standard: Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. (CCSS.ELA-LITERACY.RST.11-12.9)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Manufacturing and Product Development - Knowledge and Performance Anchor Standards:

<table>
<thead>
<tr>
<th></th>
<th>Sample Performance Tasks/Assessments</th>
</tr>
</thead>
<tbody>
<tr>
<td>• 4.0 Technology: Use existing and emerging technology to investigate, research, and produce products and services, including new information, as required in the Manufacturing and Product Design sector workplace environment. (Direct alignment with WS 11-12.6)</td>
<td>• Working individually, students will research a product design and create a project proposal that will include design concept, a drawn rendering of product, and manufacturing plan. Empathy interviews with parents or caregivers will be used to assess user needs. Once the design is accepted, students will use necessary materials and various machines and tools to create a prototype. Prototypes will be presented verbally and visually to class for feedback on design.</td>
</tr>
<tr>
<td>• 6.0 Health and Safety: Demonstrate health and safety procedures, regulations, and personal health practices and determine the meaning of symbols, key terms, and domain-specific words and</td>
<td></td>
</tr>
</tbody>
</table>
phrases as related to the Manufacturing and Product Design sector workplace environment. (Direct alignment with RSTS 9-10, 11-12.4)

- 10.0 Technical Knowledge and Skills: Apply essential technical knowledge and skills common to all pathways in the Manufacturing and Product Design sector, following procedures when carrying out experiments or performing technical tasks. (Direct alignment with WS 11-12.6)

- 11.0 Demonstration and Application: Demonstrate and apply the knowledge and skills contained in the Manufacturing and Product Design anchor standards, pathway standards, and performance indicators in classroom, laboratory, and workplace settings, and through the career technical student organizations.

**Product Innovation and Design Pathway Standards:**

- D1.0 Understand the basic product design and development process as it relates to the design of a product, line of products, system design, or services.

- D1.1 Identify the variations in the product design and development process as it relates to the designing of a product, product line, system design, or service.

- D1.2 Apply and identify the various phases of the product design development process to an existing product, product line, system design, or service.

- D2.0 Understand and apply research methodologies as a means to identify a need, problem, or opportunity for a new product, product line, system design, or service.

- D2.1 Employ research methodologies, using primary research and electronic reference materials, to gather information relevant to the topic or area of opportunity.

- D2.2 Organize information to identify and define an area of opportunity, need, or problem that can be resolved through design.

- D2.3 Identify potential design areas (e.g., product, product line, system design, or service) that would address the need, problem, or opportunity.
- D2.4 Research and identify the user demographic for the product, product line, system design, or service (local, national, global market).
- D3.0 Understand and apply various ideation techniques to develop ideas and concepts.
- D3.1 Apply ideation techniques to explore and produce multiple concepts.
- D3.2 Edit concepts and identify key idea(s) that solve the problem, fulfill a need, or address an opportunity.
- D3.3 Assess the environmental impact of the design solution and other sustainability issues and product life cycle considerations.
- D3.4 Synthesize information and experiment with nontraditional possibilities for innovative design solutions.
- D4.0 Apply various two-dimensional (2-D) graphic and/or three-dimensional (3-D) modeling techniques to develop concepts.
- D4.1 Create a preliminary design of a product concept utilizing drawing, computer software (graphic or CAD), and/or conceptual model fabrication techniques.
- D4.2 Identify materials, mechanisms, technologies, and other requirements (e.g., safety, manufacturing, sustainability) the concept may require.
- D4.3 Analyze and assess the strengths and weaknesses in the design, function, ergonomics, features, and benefits and identify possible resolutions for improvement.
- D5.0 Develop the concept into a well-defined product for prototyping.
- D5.1 Produce technical drawings and other specifications required for the prototyping or manufacturing of the product.
- D5.2 Recognize the safety issues related to the reliability, functionality, and use of the product.
- D5.3 Communicate and collaborate with fabricators, manufacturers, engineers, technologists, or other industry experts to review requirements and specifications and to validate the design.
- D6.0 Produce a prototype of a product.
• D6.1 Build a looks-like, works-like prototype of the model using the appropriate fabrication, manufacturing, or reproduction techniques or technologies.
• D6.2 Assess the outcome of the prototype product and analyze any issues that need redesigning or refining related to function, construction, or other factors.
• D6.3 Resolve and/or redesign issues with a prototype.
• D7.0 Evaluate the prototype to determine if it meets the requirements and objectives.
• D7.1 Create a performance criteria and a quality standard to measure and evaluate a prototype.
• D7.2 Test the functionality and other features of the prototype against the performance criteria and quality standard and evaluate the results.
• D7.3 Identify any redesigning or additional corrections required to improve the overall quality, look, and performance of the prototype model.
• D8.0 Understand and apply basic business and entrepreneurial principles and identify potential markets and/or other business opportunities for distribution of the product.
• D8.1 Apply research methodologies to identify potential investors or business opportunities to market the product.
• D8.2 Create a marketing plan for the product that includes target consumer, price, product name, brand, and product positioning in the retail market.
• D9.0 Produce a package design concept for a product or line of products.
• D9.1 Understand physical packaging construction and materials used; e.g., chipboard, cardboard, PVC, plastic blisters, etc. as it relates to protecting the product, costs, and logistic requirements.
• D9.2 Understand and apply packaging graphic strategies that effectively communicate and influence the purchasing of the product.
• D9.3 Create a packaging concept utilizing drawing computer software (graphic or CAD).
• D9.4 Produce a physical package with graphics for the product.
- D10.0 Produce a presentation of the product, product line, system design, or service.
- D10.1 Create a presentation of the design solution (e.g., product, product line, system design, or service) that effectively communicates its features and benefits.
- D10.2 Integrate into the presentation a marketing plan that may include an advertisement, promotion, and packaging/retail strategy using one or more visual communication tools (e.g., graphics, multimedia).

### HS-ETS1 Engineering Design Standards:
- HS-ETS1-1: Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
- HS-ETS1-2: Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
- HS-ETS1-3: Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.
- HS-ETS1-4: Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

### Standards for Mathematical Practice:
- 2. **Reason abstractly and quantitatively:** Mathematically proficient students make sense of quantities and their relationships in problem situations. They bring two complementary abilities to bear on problems involving quantitative relationships: the ability to decontextualize—to abstract a given situation and represent it symbolically and manipulate the representing symbols as if they have a life of their own, without necessarily attending to their referents—and the ability to contextualize, to pause as needed during the manipulation process in order to probe into the
referents for the symbols involved. Quantitative reasoning entails habits of creating a coherent representation of the problem at hand; considering the units involved; attending to the meaning of quantities, not just how to compute them; and knowing and flexibly using different properties of operations and objects.

- **4. Model with mathematics:** Mathematically proficient students can apply the mathematics they know to solve problems arising in everyday life, society, and the workplace. In early grades, this might be as simple as writing an additional equation to describe a situation. In middle grades, a student might apply proportional reasoning to plan a school event or analyze a problem in the community. By high school, a student might use geometry to solve a design problem or use a function to describe how one quantity of interest depends on another. Mathematically proficient students who can apply what they know are comfortable making assumptions and approximations to simplify a complicated situation, realizing that these may need revision later. They are able to identify important quantities in a practical situation and map their relationships using such tools as diagrams, two-way tables, graphs, flowcharts and formulas. They can analyze those relationships mathematically to draw conclusions. They routinely interpret their mathematical results in the context of the situation and reflect on whether the results make sense, possibly improving the model if it has not served its purpose.
## Unit 4: Design & Build a Video Game Prop

### Unit Description

Students will design & build a video game prop. Students start by researching books, online & retail to generate multiple product ideas on what kinds of video game props exist, how they work, what they are made of, and how they are made. They then refine their ideas using critical thinking and come up with one unique video game prop to produce. Using computers or by hand, the students will draw, draft, and sketch their idea using accurate measurements, math, materials, and processes. Then, they will create a timeline for completion. Students then start to build a video game prop - and consider manufacturability, cost, finishes and use a variety of tools - lathe, saws, drills, CNC, Laser, etc. When completed students will present their finished video game prop to the class: including idea research, sketches, drawings & finished product, and receive feedback. The focus of this unit is on creative thinking and ideation surrounding how to generate a 3D object from a 2D rendering. *This unit is interchangeable with unit 5 dependent on lathe instruction.*

### Unit Outline

#### College and Career Readiness Anchor Standards for Reading:
- **Reading Standard:** Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. *(CCSS.ELA-LITERACY.RST.11-12.7)*
- **Reading Standard:** Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. *(CCSS.ELA-LITERACY.RST.11-12.8)*
- **Reading Standard:** Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. *(CCSS.ELA-LITERACY.RST.11-12.9)*

#### Learning Objectives

<table>
<thead>
<tr>
<th>Students will…</th>
<th>Essential Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>design a prototype in 3D using a 2D mode.</td>
<td>1. What are the differences between 2D and 3D product development?</td>
</tr>
<tr>
<td>compare and contrast prototype with origin material.</td>
<td>2. How does this ideation of the product meet market and industry needs?</td>
</tr>
<tr>
<td>reflect on the creative process and how it differs based on medium.</td>
<td></td>
</tr>
</tbody>
</table>

#### Sample Performance Tasks/Assessments

- Working individually, students will research a product design and create a project proposal that will include design concept, a drawn rendering of product, and manufacturing plan. Once the design is accepted, students will use necessary materials and various machines and tools to create a prototype.Prototypes will be presented verbally and visually to class for feedback on design.

### Manufacturing and Product Development - Knowledge and Performance Anchor Standards:
- **4.0 Technology:** Use existing and emerging technology to investigate, research, and produce products and services, including new information, as required in the Manufacturing and Product Design sector workplace environment. *(Direct alignment with WS 11-12.6)*
- **6.0 Health and Safety:** Demonstrate health and safety procedures, regulations, and personal health practices and
determine the meaning of symbols, key terms, and domain-specific words and phrases as related to the Manufacturing and Product Design sector workplace environment. (Direct alignment with RSTS 9-10, 11-12.4)

- 10.0 Technical Knowledge and Skills: Apply essential technical knowledge and skills common to all pathways in the Manufacturing and Product Design sector, following procedures when carrying out experiments or performing technical tasks. (Direct alignment with WS 11-12.6)

- 11.0 Demonstration and Application: Demonstrate and apply the knowledge and skills contained in the Manufacturing and Product Design anchor standards, pathway standards, and performance indicators in classroom, laboratory, and workplace settings, and through the career technical student organizations.

Product Innovation and Design Pathway Standards:

- D1.0 Understand the basic product design and development process as it relates to the design of a product, line of products, system design, or services.

- D3.4 Synthesize information and experiment with nontraditional possibilities for innovative design solutions.

- D4.0 Apply various two-dimensional (2-D) graphic and/or three-dimensional (3-D) modeling techniques to development concepts.

- D4.1 Create a preliminary design of a product concept utilizing drawing, computer software (graphic or CAD), and/or conceptual model fabrication techniques.

- D4.2 Identify materials, mechanisms, technologies, and other requirements (e.g., safety, manufacturing, sustainability) the concept may require.

- D6.1 Build a looks-like, works-like prototype of the model using the appropriate fabrication, manufacturing, or reproduction techniques or technologies.

- D6.2 Assess the outcome of the prototype product and analyze any issues that need redesigning or refining related to function, construction, or other factors.
• D6.3 Resolve and/or redesign issues with a prototype.
• D7.0 Evaluate the prototype to determine if it meets the requirements and objectives.

**HS-ETS1 Engineering Design Standards:**

- HS-ETS1-1: Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
- HS-ETS1-2: Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
- HS-ETS1-3: Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.
- HS-ETS1-4: Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

**Standards for Mathematical Practice:**

- 2. **Reason abstractly and quantitatively:** Mathematically proficient students make sense of quantities and their relationships in problem situations. They bring two complementary abilities to bear on problems involving quantitative relationships: the ability to decontextualize—to abstract a given situation and represent it symbolically and manipulate the representing symbols as if they have a life of their own, without necessarily attending to their referents—and the ability to contextualize, to pause as needed during the manipulation process in order to probe into the referents for the symbols involved. Quantitative reasoning entails habits of creating a coherent representation of the problem at hand; considering the units involved; attending to the meaning of quantities, not just how to
compute them; and knowing and flexibly using different properties of operations and objects.

- 4. **Model with mathematics:** Mathematically proficient students can apply the mathematics they know to solve problems arising in everyday life, society, and the workplace. In early grades, this might be as simple as writing an additional equation to describe a situation. In middle grades, a student might apply proportional reasoning to plan a school event or analyze a problem in the community. By high school, a student might use geometry to solve a design problem or use a function to describe how one quantity of interest depends on another. Mathematically proficient students who can apply what they know are comfortable making assumptions and approximations to simplify a complicated situation, realizing that these may need revision later. They are able to identify important quantities in a practical situation and map their relationships using such tools as diagrams, two-way tables, graphs, flowcharts and formulas. They can analyze those relationships mathematically to draw conclusions. They routinely interpret their mathematical results in the context of the situation and reflect on whether the results make sense, possibly improving the model if it has not served its purpose.
<table>
<thead>
<tr>
<th>Unit 5: Design &amp; Build a Metal Lightsaber on the Lathe</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unit Description</strong></td>
</tr>
<tr>
<td>Students will design &amp; build a lightsaber on the lathe. Students start by researching books, online &amp; retail to generate multiple product ideas on what kinds of lightsabers exist, how they work, what they are made of, and how they are made. They then refine their ideas using critical thinking and come up with one unique lightsaber to produce. Using computers or by hand, the students will draw, draft, and sketch their idea using accurate measurements, math, materials, and processes. Then, they will create a timeline for completion. Students then start to build a Lightsaber - and consider electronics, lights, manufacturability, cost, finishes and use a variety of tools - lathe, saws, drills, CNC, Laser, etc. When completed students will present their finished “working” lightsaber to the class: including idea research, sketches, drawings &amp; finished product, and receive feedback. The focus of this unit is on the intersection between previously studied ideas: movement, end user/market needs, creativity, and form. <em>This unit is interchangeable with unit 4 dependent on lathe instruction.</em></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Standards</th>
<th>Learning Objectives</th>
<th>Essential Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>College and Career Readiness Anchor Standards for Reading:</strong></td>
<td>Students will…</td>
<td>1. What different components go into building a lightsaber model?</td>
</tr>
<tr>
<td>● <strong>Reading Standard:</strong> Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (CCSS.ELA-LITERACY.RST.11-12.7)</td>
<td>● identify the various considerations that go into successfully building a lightsaber model.</td>
<td>2. How might a product like this one be marketed to end users?</td>
</tr>
<tr>
<td>● <strong>Reading Standard:</strong> Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (CCSS.ELA-LITERACY.RST.11-12.8)</td>
<td>● design and build a prototype using drawings or design software and available machinery and tools.</td>
<td></td>
</tr>
<tr>
<td>● <strong>Reading Standard:</strong> Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. (CCSS.ELA-LITERACY.RST.11-12.9)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| **Manufacturing and Product Development - Knowledge and Performance Anchor Standards:** | | |
| ● 4.0 Technology: Use existing and emerging technology to investigate, research, and produce products and services, including new information, as required in the Manufacturing and Product Design sector workplace environment. (Direct alignment with WS 11-12.6) | | |
| ● 6.0 Health and Safety: Demonstrate health and safety procedures, regulations, and personal health practices and determine the meaning of symbols, key terms, and | | |

**Sample Performance Tasks/Assessments** |

● Working individually, students will research a product design and create a project proposal that will include design concept, a drawn rendering of product, and manufacturing plan. Once the design is accepted, students will use necessary materials and various machines and tools to create a prototype. Prototypes will be presented verbally and visually to class for feedback on design.
domain-specific words and phrases as related to the Manufacturing and Product Design sector workplace environment. (Direct alignment with RSTS 9-10, 11-12.4)

- 10.0 Technical Knowledge and Skills: Apply essential technical knowledge and skills common to all pathways in the Manufacturing and Product Design sector, following procedures when carrying out experiments or performing technical tasks. (Direct alignment with WS 11-12.6)
- 11.0 Demonstration and Application: Demonstrate and apply the knowledge and skills contained in the Manufacturing and Product Design anchor standards, pathway standards, and performance indicators in classroom, laboratory, and workplace settings, and through the career technical student organizations.

**Product Innovation and Design Pathway Standards:**

- D2.1 Employ research methodologies, using primary research and electronic reference materials, to gather information relevant to the topic or area of opportunity.
- D3.0 Understand and apply various ideation techniques to develop ideas and concepts.
- D4.1 Create a preliminary design of a product concept utilizing drawing, computer software (graphic or CAD), and/or conceptual model fabrication techniques.
- D4.2 Identify materials, mechanisms, technologies, and other requirements (e.g., safety, manufacturing, sustainability) the concept may require.
- D5.0 Develop the concept into a well-defined product for prototyping.
- D5.1 Produce technical drawings and other specifications required for the prototyping or manufacturing of the product.
- D6.0 Produce a prototype of a product.
- D7.0 Evaluate the prototype to determine if it meets the requirements and objectives.
- D7.1 Create a performance criterion and a quality standard to measure and evaluate a prototype.
● D7.2 Test the functionality and other features of the prototype against the performance criteria and quality standard and evaluate the results.
● D10.1 Create a presentation of the design solution (e.g., product, product line, system design, or service) that effectively communicates its features and benefits.

**HS-ETS1 Engineering Design Standards:**
● HS-ETS1-1: Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
● HS-ETS1-2: Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
● HS-ETS1-3: Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.
● HS-ETS1-4: Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

**Standards for Mathematical Practice:**
● 2. **Reason abstractly and quantitatively:** Mathematically proficient students make sense of quantities and their relationships in problem situations. They bring two complementary abilities to bear on problems involving quantitative relationships: the ability to decontextualize—to abstract a given situation and represent it symbolically and manipulate the representing symbols as if they have a life of their own, without necessarily attending to their referents—and the ability to contextualize, to pause as needed during the manipulation process in order to probe into the referents for the symbols involved. Quantitative reasoning entails habits of creating a coherent representation of the problem at hand;
considering the units involved; attending to the meaning of quantities, not just how to compute them; and knowing and flexibly using different properties of operations and objects.

- **4. Model with mathematics:** Mathematically proficient students can apply the mathematics they know to solve problems arising in everyday life, society, and the workplace. In early grades, this might be as simple as writing an additional equation to describe a situation. In middle grades, a student might apply proportional reasoning to plan a school event or analyze a problem in the community. By high school, a student might use geometry to solve a design problem or use a function to describe how one quantity of interest depends on another. Mathematically proficient students who can apply what they know are comfortable making assumptions and approximations to simplify a complicated situation, realizing that these may need revision later. They are able to identify important quantities in a practical situation and map their relationships using such tools as diagrams, two-way tables, graphs, flowcharts and formulas. They can analyze those relationships mathematically to draw conclusions. They routinely interpret their mathematical results in the context of the situation and reflect on whether the results make sense, possibly improving the model if it has not served its purpose.
**Unit 6: Design, Invent & Build a Product (Open)**

**Unit Description**

Based on previous units of study and utilizing Stanford’s Design Thinking Model, students will problem solve and think critically to create alternative solutions to answer a question or solve a problem. They understand and apply research methodologies as a means to validate a need, problem, or opportunity for a new product, product line, system design, or service. Students understand and apply various ideation techniques to develop ideas and concepts. They synthesize information and experiment with non-traditional possibilities for innovative design solutions. Leveraging the skills developed in the previous units of study students will develop and build a project of their choice. Students start by researching books, online & retail to generate multiple product ideas on what kinds of products exist, how they work, what they are made of, and how they are made. They then refine their ideas using critical thinking and come up with one unique product to produce. Using computers or by hand, the students will draw, draft, and sketch their idea using accurate measurements, math, materials, and processes. Then, they will create a timeline for completion. Students then start to build a “working” product - and consider manufacturability, cost, finishes and use a variety of tools - lathe, welder, saws, drills, CNC, etc. When completed students will present their finished “working” product to the class: including idea research, sketches, drawings & finished product, and receive feedback.

**Unit Outline**

<table>
<thead>
<tr>
<th>Standards</th>
<th>Learning Objectives</th>
<th>Essential Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>College and Career Readiness Anchor Standards for Reading:</strong></td>
<td>Students will...</td>
<td>1. What is the function of this product?</td>
</tr>
<tr>
<td>● Reading Standard: Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (CCSS.ELA-LITERACY.RST.11-12.7)</td>
<td>● research products available in the desired market.</td>
<td>2. How can the product be improved upon?</td>
</tr>
<tr>
<td>● Reading Standard: Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (CCSS.ELA-LITERACY.RST.11-12.8)</td>
<td>● design a prototype using drawings or design software.</td>
<td>3. Will this ideation of this product be cost effective to manufacture?</td>
</tr>
<tr>
<td>● Reading Standard: Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. (CCSS.ELA-LITERACY.RST.11-12.9)</td>
<td>● compare and contrast prototype with current available designs.</td>
<td>4. How could this new product be marketed?</td>
</tr>
</tbody>
</table>

| **Manufacturing and Product Development - Knowledge and Performance Anchor Standards:** | | 5. Does this ideation of the product meet market and industry needs? |
| ● 4.0 Technology: Use existing and emerging technology to investigate, research, and produce products and services, including new information, as required in the Manufacturing and Product Design sector workplace environment. (Direct alignment with WS 11-12.6) | ● Working individually, students will research a product design and create a project proposal that will include design concept, a drawn rendering of product, and manufacturing plan. Once the design is accepted, students will use necessary materials and various machines and tools to create a prototype. Prototypes will be presented verbally and visually to class for feedback on design. |

**Sample Performance Tasks/Assessments**

- Working individually, students will research a product design and create a project proposal that will include design concept, a drawn rendering of product, and manufacturing plan. Once the design is accepted, students will use necessary materials and various machines and tools to create a prototype. Prototypes will be presented verbally and visually to class for feedback on design.
- 6.0 Health and Safety: Demonstrate health and safety procedures, regulations, and personal health practices and determine the meaning of symbols, key terms, and domain-specific words and phrases as related to the Manufacturing and Product Design sector workplace environment. (Direct alignment with RSTS 9-10, 11-12.4)
- 10.0 Technical Knowledge and Skills: Apply essential technical knowledge and skills common to all pathways in the Manufacturing and Product Design sector, following procedures when carrying out experiments or performing technical tasks. (Direct alignment with WS 11-12.6)
- 11.0 Demonstration and Application: Demonstrate and apply the knowledge and skills contained in the Manufacturing and Product Design anchor standards, pathway standards, and performance indicators in classroom, laboratory, and workplace settings, and through the career technical student organizations.

**Product Innovation and Design Pathway Standards:**

- D1.0 Understand the basic product design and development process as it relates to the design of a product, line of products, system design, or services.
- D1.1 Identify the variations in the product design and development process as it relates to the designing of a product, product line, system design, or service.
- D1.2 Apply and identify the various phases of the product design development process to an existing product, product line, system design, or service.
- D2.0 Understand and apply research methodologies as a means to identify a need, problem, or opportunity for a new product, product line, system design, or service.
- D2.1 Employ research methodologies, using primary research and electronic reference materials, to gather information relevant to the topic or area of opportunity.
- D2.2 Organize information to identify and define an area of opportunity, need, or problem that can be resolved through design.
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>D2.3 Identify potential design areas (e.g., product, product line, system design, or service) that would address the need, problem, or opportunity.</td>
</tr>
<tr>
<td></td>
<td>D2.4 Research and identify the user demographic for the product, product line, system design, or service (local, national, global market).</td>
</tr>
<tr>
<td></td>
<td>D3.0 Understand and apply various ideation techniques to develop ideas and concepts.</td>
</tr>
<tr>
<td></td>
<td>D3.1 Apply ideation techniques to explore and produce multiple concepts.</td>
</tr>
<tr>
<td></td>
<td>D3.2 Edit concepts and identify key idea(s) that solve the problem, fulfill a need, or address an opportunity.</td>
</tr>
<tr>
<td></td>
<td>D3.3 Assess the environmental impact of the design solution and other sustainability issues and product life cycle considerations.</td>
</tr>
<tr>
<td></td>
<td>D3.4 Synthesize information and experiment with nontraditional possibilities for innovative design solutions.</td>
</tr>
<tr>
<td></td>
<td>D4.0 Apply various two-dimensional (2-D) graphic and/or three-dimensional (3-D) modeling techniques to development concepts.</td>
</tr>
<tr>
<td></td>
<td>D4.1 Create a preliminary design of a product concept utilizing drawing, computer software (graphic or CAD), and/or conceptual model fabrication techniques.</td>
</tr>
<tr>
<td></td>
<td>D4.2 Identify materials, mechanisms, technologies, and other requirements (e.g., safety, manufacturing, sustainability) the concept may require.</td>
</tr>
<tr>
<td></td>
<td>D4.3 Analyze and assess the strengths and weaknesses in the design, function, ergonomics, features, and benefits and identify possible resolutions for improvement.</td>
</tr>
<tr>
<td></td>
<td>D5.0 Develop the concept into a well-defined product for prototyping.</td>
</tr>
<tr>
<td></td>
<td>D5.1 Produce technical drawings and other specifications required for the prototyping or manufacturing of the product.</td>
</tr>
<tr>
<td></td>
<td>D5.2 Recognize the safety issues related to the reliability, functionality, and use of the product.</td>
</tr>
</tbody>
</table>
|   | D5.3 Communicate and collaborate with fabricators, manufacturers, engineers, technologists, or other industry
experts to review requirements and specifications and to validate the design.

- D6.0 Produce a prototype of a product.
- D6.1 Build a looks-like, works-like prototype of the model using the appropriate fabrication, manufacturing, or reproduction techniques or technologies.
- D6.2 Assess the outcome of the prototype product and analyze any issues that need redesigning or refining related to function, construction, or other factors.
- D6.3 Resolve and/or redesign issues with a prototype.
- D7.0 Evaluate the prototype to determine if it meets the requirements and objectives.
- D7.1 Create a performance criteria and a quality standard to measure and evaluate a prototype.
- D7.2 Test the functionality and other features of the prototype against the performance criteria and quality standard and evaluate the results.
- D7.3 Identify any redesigning or additional corrections required to improve the overall quality, look, and performance of the prototype model.
- D8.0 Understand and apply basic business and entrepreneurial principles and identify potential markets and/or other business opportunities for distribution of the product.
- D8.1 Apply research methodologies to identify potential investors or business opportunities to market the product.
- D8.2 Create a marketing plan for the product that includes target consumer, price, product name, brand, and product positioning in the retail market.
- D9.0 Produce a package design concept for a product or line of products.
- D9.1 Understand physical packaging construction and materials used; e.g., chipboard, cardboard, PVC, plastic blisters, etc. as it relates to protecting the product, costs, and logistic requirements.
- D9.2 Understand and apply packaging graphic strategies that effectively communicate and influence the purchasing of the product.
- D9.3 Create a packaging concept utilizing drawing computer software (graphic or CAD).
- D9.4 Produce a physical package with graphics for the product.
- D10.0 Produce a presentation of the product, product line, system design, or service.
- D10.1 Create a presentation of the design solution (e.g., product, product line, system design, or service) that effectively communicates its features and benefits.
- D10.2 Integrate into the presentation a marketing plan that may include an advertisement, promotion, and packaging/retail strategy using one or more visual communication tools (e.g., graphics, multimedia).

**HS-ETS1 Engineering Design Standards:**
- HS-ETS1-1: Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
- HS-ETS1-2: Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
- HS-ETS1-3: Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.
- HS-ETS1-4: Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

**Standards for Mathematical Practice:**
- 2. Reason abstractly and quantitatively: Mathematically proficient students make sense of quantities and their relationships in problem situations. They bring two complementary abilities to bear on problems involving quantitative relationships: the ability to decontextualize—to abstract a given situation and represent it symbolically and
manipulate the representing symbols as if they have a life of their own, without necessarily attending to their referents—and the ability to contextualize, to pause as needed during the manipulation process in order to probe into the referents for the symbols involved. Quantitative reasoning entails habits of creating a coherent representation of the problem at hand; considering the units involved; attending to the meaning of quantities, not just how to compute them; and knowing and flexibly using different properties of operations and objects.

4. Model with mathematics: Mathematically proficient students can apply the mathematics they know to solve problems arising in everyday life, society, and the workplace. In early grades, this might be as simple as writing an additional equation to describe a situation. In middle grades, a student might apply proportional reasoning to plan a school event or analyze a problem in the community. By high school, a student might use geometry to solve a design problem or use a function to describe how one quantity of interest depends on another. Mathematically proficient students who can apply what they know are comfortable making assumptions and approximations to simplify a complicated situation, realizing that these may need revision later. They are able to identify important quantities in a practical situation and map their relationships using such tools as diagrams, two-way tables, graphs, flowcharts and formulas. They can analyze those relationships mathematically to draw conclusions. They routinely interpret their mathematical results in the context of the situation and reflect on whether the results make sense, possibly improving the model if it has not served its purpose.