<table>
<tr><td><u>Grade, Subject/Course</u>:<br>Advanced CADD / Honors (10-12)</td><td></td></tr>
<tr><td><u>Unit</u>:<br>Introduction to Visual Communication</td><td>__X__ Essential _____ Important _____ Compact</td></tr>
<tr><td><u>Big Idea:</u><br>Technical drawings turn ideas into precise designs, acting as a universal language for visual communication.</td><td></td></tr>
<tr><td><u>STEELS/Tech and Engineering Strand:</u><br>3.5.9-12.A Use various approaches to communicate processes and procedures for using, maintaining, and assessing technological products and systems.<br><br>3.5.9-12.PP Demonstrate the use of conceptual, graphical, virtual, mathematical, and physical modeling to identify conflicting considerations before the entire system is developed and to aid in design decision making.</td><td><u>Pacing:</u><br>1-2 weeks</td></tr>
<tr><td><u>Essential Questions</u>:<br>UEQ: How do technical drawings translate ideas into precise and universally understood designs?<br>LEQ: Why is sketching an essential skill in technical design and communication?<br>LEQ: How does sketching help in transforming conceptual ideas into tangible designs?<br>LEQ: What are the key differences between 3D communication techniques and traditional 2D representations?<br>LEQ: Why is isometric projection effective for representing 3D objects?<br>LEQ: What are the challenges and advantages of using isometric projection in design communication?<br>LEQ: How does orthographic projection convey different views of an object, and why is it important?<br>LEQ: What is the relationship between isometric and orthographic projections in technical design?<br>LEQ: How do technical sketches balance precision with the need for quick visualization?</td><td><u>Understandings</u>: Students will know that…<ul><li>Technical drawings serve as a universal language to translate conceptual ideas into precise, actionable designs.</li><li>Sketching is an essential skill in technical design and communication because it allows for quick visualization and exploration of design ideas.</li><li>Sketching helps transform abstract concepts into tangible designs by providing a visual representation that can be refined and developed further.</li><li>3D communication techniques, such as isometric projections, offer a more realistic view of objects, while traditional 2D representations focus on simplifying designs to convey specific dimensions and features.</li><li>Isometric projection is effective for representing 3D objects because it maintains scale and proportions across all three axes, making it easier to visualize complex shapes.</li><li>Isometric projection has the advantage of showing depth and three-dimensionality but can be challenging when representing irregular shapes or details that are difficult to scale accurately.</li><li>Orthographic projection conveys different views (top, front, side) of an object, offering a clear and detailed representation that is important for manufacturing and assembly.</li></ul></td></tr>
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| LEQ: What tools and techniques improve accuracy in both isometric and orthographic projections?<br>LEQ: How can sketching and projection techniques improve collaboration in design and engineering processes? | • Isometric and orthographic projections are complementary; isometric shows a 3D view while orthographic provides precise, scale-accurate 2D views.<br>• Technical sketches balance precision with the need for quick visualization by focusing on key dimensions and features while leaving out unnecessary details.<br>• Tools and techniques such as grid systems, measurement scales, and drafting tools improve accuracy in both isometric and orthographic projections.<br>• Sketching and projection techniques improve collaboration in design and engineering processes by providing a clear, visual language that all team members can understand and contribute to. |
| **Knowledge:**<br>Technical Sketching<br>Technical Sketching Techniques<br>2D sketching<br>3D sketching<br>Perspective Sketching<br>Isometric Sketching<br>Orthographic Sketching | **Do/Skills:** Students will be able to…<br>• Explain how technical drawings serve as a universal language to translate conceptual ideas into precise, actionable designs.<br>• Demonstrate the importance of sketching as a skill in technical design and communication for quick visualization and idea exploration.<br>• Use sketching techniques to transform abstract concepts into tangible designs through clear and effective visual representation.<br>• Differentiate between 3D communication techniques, such as isometric projections, and traditional 2D representations, highlighting their respective purposes and advantages.<br>• Apply isometric projection to effectively represent 3D objects, ensuring scale and proportion are maintained across all three axes.<br>• Identify the challenges and advantages of using isometric projection, particularly in representing irregular shapes and complex details.<br>• Utilize orthographic projection to convey different views (top, front, side) of an object, understanding its role in manufacturing and assembly.<br>• Compare and contrast isometric and orthographic projections, recognizing how each contributes to technical design through 3D and 2D perspectives.<br>• Balance precision and quick visualization in technical sketches by focusing on key dimensions and features while leaving out unnecessary details.<br>• Use tools and techniques such as grid systems, measurement scales, and drafting tools to improve accuracy in isometric and orthographic projections.<br>• Explain how sketching and projection techniques improve collaboration in design and engineering by providing a clear, visual language that enhances communication. |
| **Vocabulary:**<br>Freehand, Sketching, Drawing, Construction Line, Hidden Line, Object Line, Center Line, Oblique Pictorial, Isometric Pictorial, Wireframe Pictorial, Perspective Pictorial, Pictorial, Title Block, Front View, Top View, Right side, Width, Height, Depth, Miter Line, Projection Line, Orthographic Projection, Miter, Spacing, Dimension, Line | **Core Resources:**<br>Schoology LMS<br>AutoCAD |

| **Common Assessment(s):** | **Supplemental Resources:** |
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| 1. Tech Sketch 1<br>2. Tech Sketch 2<br>3. Perspective Sketch<br>4. Isometric Sketching<br>5. Orthographic Sketching 1<br>6. Orthographic Sketching 2 | Teacher created activities, tutorials and assignments<br>ITEEA Onshape by Design |

| **Grade, Subject/Course:**<br>Advanced CADD / Honors (10-12) | |
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| **Unit:**<br>Basic 3D Modeling | **__X__ Essential _____ Important _____ Compact** |
| **Big Idea:**<br>3D modeling transforms two-dimensional concepts into tangible, three-dimensional designs, laying the foundation for creative and functional digital creations. | |
| **STEELS/Tech and Engineering Strand:**<br>3.5.9-12.A Use various approaches to communicate processes and procedures for using, maintaining, and assessing technological products and systems.<br>3.5.9-12.P - Apply a broad range of design skills to a design thinking process.<br>3.5.9-12.AA Safely apply an appropriate range of making skills to a design thinking process.<br>3.5.9-12.PP Demonstrate the use of conceptual, graphical, virtual, mathematical, and physical modeling to identify conflicting considerations before the entire system is developed and to aid in design decision making. | **Pacing:**<br>2 weeks |
| **Essential Questions:**<br>UEQ: How does 3D modeling transform two-dimensional concepts into tangible, three-dimensional designs, laying the foundation for creative and functional digital creations?<br>LEQ: How do sketching and geometric construction form the foundation for creating precise technical designs?<br>LEQ: What are the techniques and best practices for advanced sketching to improve accuracy and complexity in designs?<br>LEQ: How does basic extrusion allow for the creation of 3D shapes from 2D sketches?<br>LEQ: In what ways do advanced extrusion techniques and material choices impact the functionality and design of a 3D object?<br>LEQ: How can a 3D design challenge encourage creative problem-solving and the application of advanced design concepts?<br>LEQ: What role do geometric constraints, variables, and measurement play in ensuring the accuracy and functionality of a 3D model? | **Understandings:** Students will know that…<br>● 3D modeling transforms two-dimensional concepts into tangible, three-dimensional designs, forming the foundation for creative and functional digital creations.<br>● Sketching and geometric construction are fundamental for creating precise technical designs by providing the framework for translating ideas into detailed models.<br>● Advanced sketching techniques and best practices improve accuracy and complexity in designs, allowing for greater precision and creativity in the modeling process.<br>● Basic extrusion is a technique that allows for the creation of 3D shapes from 2D sketches by adding depth to the design, turning flat shapes into solid objects.<br>● Advanced extrusion techniques and material choices directly impact the functionality and aesthetic of a 3D object, influencing its strength, weight, and usability.<br>● A 3D design challenge encourages creative problem-solving by requiring the application of advanced design concepts to overcome complex design issues. |

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| LEQ: How do geometric constraints and variables help in controlling and modifying designs efficiently during the 3D design process?<br>LEQ: Why is it important to understand the relationship between geometry, constraints, and materials in advanced 3D modeling?<br>LEQ: How do advanced extrusion techniques contribute to producing more complex, realistic, and functional designs?<br>LEQ: What strategies and tools can be used to solve complex design problems in a 3D design challenge? | ● Geometric constraints, variables, and measurement are essential for ensuring the accuracy and functionality of a 3D model, allowing designers to control dimensions and relationships between parts.<br>● Geometric constraints and variables enable the efficient modification and control of designs during the 3D design process, ensuring consistency and adaptability.<br>● Understanding the relationship between geometry, constraints, and materials is critical in advanced 3D modeling to create designs that are both functional and feasible.<br>● Advanced extrusion techniques contribute to creating more complex, realistic, and functional designs by enabling intricate features and refining the design process.<br>● Various strategies and tools can be used to solve complex design problems in a 3D design challenge, encouraging innovation and improving the design process. |
| **Knowledge:**<br>3D Modeling Transformation<br>Sketching and Geometric Construction<br>Advanced Sketching Techniques<br>Basic Extrusion<br>Advanced Extrusion<br>Geometric Constraints, Variables and Measurement | **Do/Skills:** Students will be able to…<br>● Explain how 3D modeling transforms two-dimensional concepts into tangible, three-dimensional designs, forming the foundation for creative and functional digital creations.<br>● Demonstrate how sketching and geometric construction serve as the foundation for creating precise technical designs by translating ideas into detailed models.<br>● Apply advanced sketching techniques and best practices to improve the accuracy and complexity of designs, enhancing precision and creativity in the modeling process.<br>● Utilize basic extrusion techniques to create 3D shapes from 2D sketches by adding depth, turning flat shapes into solid objects.<br>● Analyze how advanced extrusion techniques and material choices impact the functionality, strength, weight, and usability of 3D objects.<br>● Participate in a 3D design challenge to apply creative problem-solving and advanced design concepts to overcome complex design issues.<br>● Apply geometric constraints, variables, and measurement tools to ensure the accuracy and functionality of 3D models, managing dimensions and relationships between parts.<br>● Use geometric constraints and variables to efficiently modify and control designs during the 3D design process, ensuring consistency and adaptability.<br>● Understand and explain the relationship between geometry, constraints, and materials to create functional and feasible designs in advanced 3D modeling.<br>● Implement advanced extrusion techniques to create complex, realistic, and functional designs by incorporating intricate features into the design process.<br>● Use various strategies and tools to solve complex design problems in a 3D design challenge, fostering innovation and improving the design process. |

| **Vocabulary:** | **Core Resources:** |
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| 3D Modeling, Extrusion, Sketching, Geometric Construction, Advanced Sketching, Geometric Constraints, Variables, Parametric Design, Material Properties, Advanced Extrusion, 3D Design Challenge, Measurement, Prototyping, Functional Design, Surface Modeling, Solid Modeling, CAD (Computer-Aided Design), Rendering, Boolean Operations, Mesh, Topology | Schoology LMS<br>AutoCAD, Fusion 360, Revit, OnShape |
| **Common Assessment(s):**<br>1. Sketching Assignment<br>2. Basic Extrusion Assignment<br>3. 3D Design Challenge 1<br>4. 3D Design Challenge 2 | **Supplemental Resources:**<br>Teacher created activities, tutorials and assignments<br>ITEEA Onshape by Design |

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| **<u>Grade, Subject/Course</u>:**<br>Advanced CADD / Honors (10-12) | |
| **<u>Unit</u>:**<br>Additive Manufacturing and Rapid Prototyping | **__X__ Essential     _____ Important     _____ Compact** |
| **<u>Big Idea:</u>**<br>Advanced 3D modeling techniques and rapid prototyping enable the creation of highly detailed functional designs. | |
| **<u>STEELS/Tech and Engineering Strand:</u>**<br>3.5.9-12.A Use various approaches to communicate processes and procedures for using, maintaining, and assessing technological products and systems.<br>3.5.9-12.P - Apply a broad range of design skills to a design thinking process.<br>3.5.9-12.AA Safely apply an appropriate range of making skills to a design thinking process.<br>3.5.9-12.PP Demonstrate the use of conceptual, graphical, virtual, mathematical, and physical modeling to identify conflicting considerations before the entire system is developed and to aid in design decision making. | **<u>Pacing:</u>**<br>3 weeks |
| **<u>Essential Questions</u>:**<br>UEQ: How do advanced 3D modeling techniques and rapid prototyping enable the creation of highly detailed functional designs?<br>LEQ: What are the key strategies for managing complexity in multi-component 3D models?<br>LEQ: How does 3D printing bridge the gap between digital designs and physical prototypes?<br>LEQ: What factors influence the choice of 3D printing technology for specific prototyping needs?<br>LEQ: How do material properties impact the performance, durability, and aesthetics of a 3D-printed prototype?<br>LEQ: In what ways do material selection and design constraints influence the applications of 3D modeling?<br>LEQ: What role does prototyping play in testing and refining complex 3D designs?<br>LEQ: How can iterative prototyping improve the functionality and manufacturability of a design?<br>LEQ: Why is tolerancing critical in ensuring the accuracy and fit of 3D-printed components? | **<u>Understandings</u>:** Students will know that…<br>● Advanced 3D modeling techniques and rapid prototyping provide the tools to create intricate, precise, and functional designs that meet complex project requirements.<br>● Managing complexity in multi-component 3D models involves strategies like modular design, hierarchy management, and effective use of constraints.<br>● 3D printing serves as a bridge between digital and physical designs, enabling rapid prototyping and validation of design concepts.<br>● The choice of 3D printing technology is influenced by factors such as material compatibility, resolution, speed, and cost.<br>● Material properties, including strength, flexibility, and thermal resistance, significantly impact the functionality and aesthetics of 3D-printed prototypes.<br>● Material selection and design constraints are critical in determining the suitability of a model for specific applications or industries.<br>● Prototyping allows designers to test, evaluate, and refine their models, ensuring they meet functional and design objectives before final production.<br>● Iterative prototyping improves the functionality and manufacturability of designs by incorporating feedback and addressing potential issues at each stage.<br>● Tolerancing is essential for ensuring that components fit together accurately and function as intended, especially in assembly-driven designs. |

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| LEQ: How can designers account for tolerances in complex 3D models to optimize performance? | • Accounting for tolerances in complex 3D models involves anticipating material behavior, machine accuracy, and environmental factors to optimize performance. |
| **<u>Knowledge:</u>**<br>3D Modeling Techniques<br>Prototyping and 3D Printing<br>Materials and Properties<br>Iterative Design and Refinement<br>Tolerancing and Accuracy | **<u>Do/Skills</u>:** Students will be able to…<br>• Apply advanced 3D modeling techniques to create intricate, precise, and functional designs that meet specified requirements.<br>• Utilize strategies such as modular design, hierarchy management, and constraints to manage complexity in multi-component 3D models.<br>• Demonstrate how 3D printing bridges digital and physical design by prototyping and validating design concepts.<br>• Evaluate and select appropriate 3D printing technologies based on material compatibility, resolution, speed, and cost.<br>• Analyze material properties like strength, flexibility, and thermal resistance to optimize the functionality and aesthetics of 3D-printed prototypes.<br>• Make informed material and design choices to meet specific application or industry requirements.<br>• Develop and refine prototypes to meet functional and design objectives through iterative testing and evaluation.<br>• Implement iterative prototyping processes to improve the functionality and manufacturability of complex designs.<br>• Define and apply tolerancing techniques to ensure the accuracy and functionality of components, especially in assemblies.<br>• Predict and account for variables such as material behavior, machine accuracy, and environmental factors to optimize tolerances in complex 3D models. |
| **<u>Vocabulary:</u>**<br>3D Modeling, Prototyping, Iterative Design, Advanced Modeling Techniques, Multi-Component Models, Modular Design, Hierarchy Management, Constraints, 3D Printing, Material Properties, Resolution, Printing Speed, Material Compatibility, Thermal Resistance, Design Constraints, Tolerancing, Fit and Assembly, Machine Accuracy, Environmental Factors, Functionality, Aesthetics, Manufacturability, Digital-to-Physical Workflow, Cost Efficiency, Prototype Validation | **<u>Core Resources</u>:**<br>Schoology LMS<br>Fusion 360, Revit, OnShape<br>3D Printers |

| **Common Assessment(s):** | **Supplemental Resources:** |
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| 1. Additive Manufacturing Assignment<br>2. Tolerancing Activity<br>3. 3D Printed Design Challenge | Teacher created activities, tutorials and assignments<br>ITEEA Onshape by Design |

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| **Grade, Subject/Course:**<br>Advanced CADD / Honors (10-12) | |
| **Unit:**<br>Subtractive Manufacturing | **__X__ Essential _____ Important _____ Compact** |
| **Big Idea:**<br>Subtractive manufacturing transforms raw materials into precise, functional parts by systematically removing material through a variety of techniques. | |
| **STEELS/Tech and Engineering Strand:**<br>3.5.9-12.A Use various approaches to communicate processes and procedures for using, maintaining, and assessing technological products and systems.<br>3.5.9-12.P - Apply a broad range of design skills to a design thinking process.<br>3.5.9-12.Q - Implement and critique principles, elements, and factors of design.<br>3.5.9-12.AA Safely apply an appropriate range of making skills to a design thinking process.<br>3.5.9-12.PP Demonstrate the use of conceptual, graphical, virtual, mathematical, and physical modeling to identify conflicting considerations before the entire system is developed and to aid in design decision making. | **Pacing:**<br>3 weeks |
| **Essential Questions:**<br>UEQ: How does subtractive manufacturing transform raw materials into precise, functional parts by systematically removing material through a variety of techniques?<br>LEQ: How does subtractive manufacturing differ from additive manufacturing, and what are its key applications?<br>LEQ: What is the role of CAD/CAM in enabling precise subtractive manufacturing processes?<br>LEQ: How do CNC machines interpret CAD models to produce physical components?<br>LEQ: What are the key steps in generating and optimizing toolpaths for CNC machining?<br>LEQ: How does the choice of materials impact the subtractive manufacturing process and final product quality?<br>LEQ: What are the critical safety considerations when working with CNC machines and subtractive manufacturing tools? | **Understandings:** Students will know that…<br>● Subtractive manufacturing systematically removes material to transform raw materials into precise and functional parts.<br>● Subtractive manufacturing differs from additive manufacturing in process, material usage, and applications, making each suitable for specific needs.<br>● CAD/CAM systems play a critical role in subtractive manufacturing by enabling precise design translation and automated machining processes.<br>● CNC machines interpret CAD models and follow programmed toolpaths to accurately produce physical components.<br>● Generating and optimizing toolpaths is essential for ensuring efficiency, precision, and material conservation in CNC machining.<br>● Material properties, such as hardness and machinability, directly impact the effectiveness of subtractive manufacturing and the quality of the final product.<br>● Safety is a crucial consideration in subtractive manufacturing, requiring knowledge of machine operation, protective equipment, and proper procedures.<br>● Tolerancing ensures the accuracy and functionality of parts by specifying acceptable deviations in dimensions during machining. |

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| LEQ: How does tolerancing ensure accuracy and functionality in subtractive manufacturing?<br>LEQ: What factors influence the efficiency and precision of subtractive processes like milling, turning, and drilling? | ● The efficiency and precision of subtractive processes, like milling, turning, and drilling, are influenced by factors such as tool selection, cutting speed, and feed rate. |
| **<u>Knowledge:</u>**<br>CNC Machining Basics<br>Toolpath Generation<br>Subtractive Manufacturing | **<u>Do/Skills</u>:** Students will be able to…<br>● Explain how subtractive manufacturing removes material to create precise and functional parts.<br>● Compare subtractive manufacturing to additive manufacturing, highlighting differences in processes, material usage, and applications.<br>● Demonstrate the use of CAD/CAM systems to translate designs into machine-readable formats for subtractive manufacturing.<br>● Describe how CNC machines interpret CAD models and execute toolpaths to produce accurate physical components.<br>● Create and optimize toolpaths for CNC machining to improve efficiency, precision, and material usage.<br>● Analyze the impact of material properties, such as hardness and machinability, on subtractive manufacturing processes and final product quality.<br>● Apply safety procedures and protocols for operating CNC machines and subtractive manufacturing tools.<br>● Use tolerancing techniques to ensure the accuracy and functionality of parts produced through subtractive manufacturing.<br>● Identify factors like tool selection, cutting speed, and feed rate that influence the efficiency and precision of subtractive processes such as milling, turning, and drilling.<br>● Develop strategies to optimize subtractive manufacturing processes for improved performance and reduced waste. |
| **<u>Vocabulary:</u>**<br>Subtractive Manufacturing, Additive Manufacturing, CAD, CAM, CNC, Toolpath, Machining, Milling, Turning, Drilling, Tolerancing, Material Properties, Hardness, Machinability, Cutting Speed, Feed Rate, Precision, Accuracy, Safety Protocols, Machine Operation, Protective Equipment, Automated Machining | **<u>Core Resources</u>:**<br>Schoology LMS<br>Fusion 360, Revit, OnShape<br>CNC Router Machine |

| Common Assessment(s): | Supplemental Resources: |
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| 4. Additive vs Subtractive Manufacturing Assignment<br>5. G-Code Activity<br>6. M-Code Activity<br>7. CNC Production Project | Teacher created activities, tutorials and assignments<br>ITEEA Onshape by Design |

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| **<u>Grade, Subject/Course</u>:**<br>Advanced CADD / Honors (10-12) | |
| **<u>Unit</u>:**<br>3D Design & Laser Fabrication | **__X__ Essential _____ Important _____ Compact** |
| **<u>Big Idea:</u>**<br>3D design and laser fabrication transforms digital designs into physical creations. | |
| **<u>STEELS/Tech and Engineering Strand:</u>**<br>3.5.9-12.A Use various approaches to communicate processes and procedures for using, maintaining, and assessing technological products and systems.<br>3.5.9-12.P - Apply a broad range of design skills to a design thinking process.<br>3.5.9-12.Q - Implement and critique principles, elements, and factors of design.<br>3.5.9-12.AA Safely apply an appropriate range of making skills to a design thinking process.<br>3.5.9-12.PP Demonstrate the use of conceptual, graphical, virtual, mathematical, and physical modeling to identify conflicting considerations before the entire system is developed and to aid in design decision making. | **<u>Pacing:</u>**<br>3 weeks |
| **<u>Essential Questions</u>:**<br>UEQ: How does 3D design and laser fabrication transform digital designs into physical creations?<br>LEQ: What are the key components and functions of a laser cutting system?<br>LEQ: How do laser cutting and engraving technologies work to create precise designs?<br>LEQ: What are the fundamental differences between cutting and engraving with a laser?<br>LEQ: What are the safety precautions and best practices to follow when operating a laser cutting system?<br>LEQ: How do material properties affect the laser cutting and engraving process?<br>LEQ: What techniques are used to design effective 2D laser cutting projects?<br>LEQ: How do advanced CAD assemblies differ from basic designs, and how are they used in multi-part projects? | **<u>Understandings</u>:** Students will know that…<br>● 3D design and laser fabrication transform digital models into precise physical creations through cutting and engraving techniques.<br>● Laser cutting systems consist of key components like the laser source, optics, and motion control, each contributing to the cutting or engraving process.<br>● Laser cutting and engraving work by directing high-powered lasers to remove or mark material, creating detailed and precise designs.<br>● Cutting with a laser removes material to create shapes, while engraving etches the surface, each offering distinct visual and functional effects.<br>● Operating a laser cutting system requires following strict safety precautions, such as wearing protective gear, ensuring ventilation, and proper machine setup.<br>● Material properties, including thickness, composition, and reflectivity, significantly influence the outcome of laser cutting and engraving processes.<br>● Effective 2D laser cutting designs rely on clear, precise vector paths and considerations of material behavior during cutting.<br>● Advanced CAD assemblies integrate multiple parts, allowing for complex designs to be accurately represented and prepared for laser cutting. |

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| LEQ: What are the strategies for managing and organizing components in multi-part CAD assemblies?<br>LEQ: How can multi-part assemblies be effectively designed for laser cutting?<br>LEQ: How do multi-part laser design projects require integration of CAD techniques with laser cutting capabilities for successful outcomes? | ● Organizing and managing components in multi-part CAD assemblies requires strategic layout, alignment, and consideration of material constraints.<br>● Multi-part assemblies for laser cutting are designed with considerations for nesting, material optimization, and ease of assembly.<br>● Successful multi-part laser design projects require a combination of CAD skills and knowledge of laser cutting capabilities to ensure precise and functional outcomes. |
| **Knowledge:**<br>Laser Cutting Systems & Safety<br>Material Properties<br>2D Design Fundamentals<br>Advanced CADD Assemblies | **Do/Skills:** Students will be able to…<br>● Describe how 3D design and laser fabrication transform digital models into precise physical creations using cutting and engraving techniques.<br>● Identify and explain the key components of a laser cutting system, including the laser source, optics, and motion control.<br>● Demonstrate an understanding of how laser cutting and engraving work to create precise designs by removing or marking material.<br>● Distinguish between the processes of cutting and engraving with a laser, and explain their different visual and functional effects.<br>● Follow safety protocols when operating a laser cutting system, including wearing protective gear, ensuring proper ventilation, and setting up the machine correctly.<br>● Analyze how material properties such as thickness, composition, and reflectivity influence the laser cutting and engraving process.<br>● Design effective 2D laser cutting projects using clear, precise vector paths and considering material behavior during cutting.<br>● Apply advanced CAD assembly techniques to integrate multiple parts into a cohesive design for laser cutting.<br>● Organize and manage components in multi-part CAD assemblies by optimizing layout, alignment, and considering material constraints.<br>● Design multi-part assemblies for laser cutting with considerations for nesting, material optimization, and ease of assembly.<br>● Integrate CAD skills with laser cutting capabilities to complete successful multi-part laser design projects that are precise and functional. |
| **Vocabulary:**<br>Laser Cutting, Engraving, Vector Paths, Raster Design, Material Properties, Thickness, Reflectivity, Composition, Laser Safety, Ventilation, CADD (Computer-Aided Drafting & Design), CAM (Computer-Aided Manufacturing), Toolpath, Nesting, Multi-Part Assemblies, Alignment, Material Optimization, Optics, Advanced CAD Assemblies, Prototyping, Precision, Tolerances, Etching, Machine Setup, Cutting Speed, Power Settings, Kerf, Beam Focus, Resolution | **Core Resources:**<br>Schoology LMS<br>Fusion 360, Revit, OnShape<br>Laser Cutter and Engraver |

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| **<u>Common Assessment(s):</u>**<br>1. Laser Cutting Introduction Activity<br>2. CADD Assembly Assignment 1<br>3. CADD Assembly Assignment 2<br>4. Multi-Part Laser Design Project | **<u>Supplemental Resources:</u>**<br>Teacher created activities, tutorials and assignments<br>ITEEA Onshape by Design |

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| **<u>Grade, Subject/Course</u>:**<br>Advanced CADD / Honors (10-12) | |
| **<u>Unit</u>:**<br>Production Quality Prototyping | **__X__ Essential    _____ Important    _____ Compact** |
| **<u>Big Idea:</u>**<br>Production quality prototyping combines design for manufacturing and design for assembly to develop precise, functional prototypes that meet real-world production standards. | |
| **<u>STEELS/Tech and Engineering Strand:</u>**<br>3.5.9-12.A Use various approaches to communicate processes and procedures for using, maintaining, and assessing technological products and systems.<br>3.5.9-12.P - Apply a broad range of design skills to a design thinking process.<br>3.5.9-12.Q - Implement and critique principles, elements, and factors of design.<br>3.5.9-12.AA Safely apply an appropriate range of making skills to a design thinking process.<br>3.5.9-12.PP Demonstrate the use of conceptual, graphical, virtual, mathematical, and physical modeling to identify conflicting considerations before the entire system is developed and to aid in design decision making. | **<u>Pacing:</u>**<br>3 weeks |

| **<u>Essential Questions</u>:** | **<u>Understandings</u>:** Students will know that… |
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| UEQ: How does combining design for manufacturing and design for assembly enable the creation of precise, functional prototypes that meet real-world production standards?<br>LEQ: How does design for manufacturing (DFM) differ from design for assembly (DFA)?<br>LEQ: What factors must be considered when designing for efficient manufacturing processes?<br>LEQ: How does mold design enable the creation of precise and repeatable parts in manufacturing?<br>LEQ: What are the fundamental principles of designing molds for different materials and manufacturing methods?<br>LEQ: How do material selection and mold design influence the functionality and durability of a product?<br>LEQ: What steps are involved in translating a digital model into a functional production mold?<br>LEQ: How can prototyping with molds improve the efficiency and accuracy of the production process?<br>LEQ: What are the key challenges and solutions in creating high-quality prototypes that meet production standards?<br>LEQ: How do DFM and DFA principles apply to the development of multi-component prototypes?<br>LEQ: How can iterative prototyping and testing ensure the success of a production quality prototyping design project? | ● Combining DFM and DFA principles enables the creation of prototypes optimized for efficient production and seamless assembly.<br>● DFM focuses on optimizing manufacturing processes by considering material properties, cost, and production methods, while DFA simplifies assembly to improve functionality and scalability.<br>● Designing for manufacturing requires analyzing factors such as material behavior, tooling requirements, production volume, and cost-effectiveness.<br>● Effective mold design is essential for producing precise, repeatable parts, ensuring consistency across production runs.<br>● Mold design must account for the specific properties of materials, including their flow, cooling, and shrinkage characteristics.<br>● The success of a production mold depends on accurate tolerancing, material compatibility, and alignment with the manufacturing method used.<br>● Material selection and mold design influence the durability, precision, and performance of a product.<br>● Understanding the relationship between material properties and manufacturing techniques is critical to achieving high-quality prototypes.<br>● Translating a digital model into a functional production mold involves steps like CAD design, toolpath generation, and mold testing.<br>● Iterative prototyping and testing help refine molds and prototypes, addressing potential issues before full-scale production.<br>● Creating high-quality prototypes requires overcoming challenges like tolerancing, material inconsistencies, and complex geometries.<br>● Solutions involve leveraging advanced CAD tools, iterative testing, and adherence to DFM and DFA principles to optimize the design process.<br>● DFM and DFA principles are vital for developing multi-component prototypes, ensuring compatibility and efficiency in both manufacturing and assembly.<br>● Multi-component designs must consider alignment, fastening methods, and assembly order to maintain production quality.<br>● Iterative prototyping allows for continuous improvement of designs by testing functionality, identifying weaknesses, and implementing refinements.<br>● A systematic prototyping and testing process ensures that production-quality prototypes meet performance and production standards. |

| **Knowledge:** | **Do/Skills:** Students will be able to… |
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| Design for Manufacturing<br>Design for Assembly<br>Mold Design Principles<br>Digital Modeling and Prototyping | • Apply DFM and DFA principles to optimize prototypes for efficient production and seamless assembly.<br>• Differentiate between DFM and DFA approaches and analyze their roles in manufacturing and assembly processes.<br>• Evaluate factors such as material behavior, tooling requirements, production volume, and cost when designing for manufacturing.<br>• Design effective molds to produce precise and repeatable parts while ensuring consistency across production runs.<br>• Analyze material properties, including flow, cooling, and shrinkage, to create molds suited for specific manufacturing processes.<br>• Ensure production mold success through accurate tolerancing, material compatibility, and alignment with manufacturing methods.<br>• Select appropriate materials and design molds to enhance the durability, precision, and performance of a product.<br>• Demonstrate an understanding of the relationship between material properties and manufacturing techniques to achieve high-quality prototypes.<br>• Translate digital models into functional production molds by completing steps like CAD design, toolpath generation, and mold testing.<br>• Refine molds and prototypes through iterative prototyping and testing to identify and address potential issues before production.<br>• Develop strategies to overcome challenges in creating high-quality prototypes, such as tolerancing, material inconsistencies, and complex geometries.<br>• Utilize advanced CAD tools and iterative testing to optimize the design process, adhering to DFM and DFA principles.<br>• Apply DFM and DFA principles in the development of multi-component prototypes to ensure manufacturing and assembly compatibility.<br>• Design multi-component assemblies with considerations for alignment, fastening methods, and assembly order to maintain quality.<br>• Implement iterative prototyping to improve design functionality, address weaknesses, and refine prototypes effectively.<br>• Execute a systematic prototyping and testing process to ensure production-quality prototypes meet performance and production standards. |

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| **Vocabulary:**<br>DFM, DFA, Prototyping, Iterative Design, Mold Design, Tolerancing, CAD, CAM, Toolpath Generation, Material Properties, Shrinkage, Flow Analysis, Cooling Analysis, Manufacturing Processes, Assembly Processes, Multi-Component Design, Fastening Methods, Alignment, Production Standards, Material Compatibility, Refinement, Testing, Cost-Effectiveness, Scalability, Tooling Requirements, Production Volume, Durability, Precision, Performance, Advanced CAD Tools, Assembly Order, Manufacturing Techniques | **Core Resources:**<br>Schoology LMS<br>Fusion 360, Revit, OnShape<br>3D Printers<br>Mold Making Supplies |
| **Common Assessment(s):**<br>1. Mold Negative Assignment<br>2. Mold Creation Assignment<br>3. Production Quality Prototype Project | **Supplemental Resources:**<br>Teacher created activities, tutorials and assignments<br>ITEEA Onshape by Design |

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| **Grade, Subject/Course:**<br>Advanced CADD / Honors (10-12) | |
| **Unit:**<br>Capstone Project & Presentation | **__X__ Essential _____ Important _____ Compact** |
| **Big Idea:**<br>Students will apply their mastery of design and fabrication technologies to create an innovative solution in a comprehensive capstone project. | |
| **STEELS/Tech and Engineering Strand:**<br>3.5.9-12.H Evaluate ways that technology and engineering can impact individuals, society, and the environment.<br>3.5.9-12.M Develop a device or system for the marketplace.<br>3.5.9-12.N Analyze and use relevant and appropriate design thinking processes to solve technological and engineering problems.<br>3.5.9-12.O Apply appropriate design thinking processes to diagnose, adjust, and repair systems to ensure precise, safe, and proper functionality. | **Pacing:**<br>3 weeks |

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| 3.5.9-12.P Apply a broad range of design skills to a design thinking process.<br>3.5.9-12.Q Implement and critique principles, elements, and factors of design.<br>3.5.9-12.S Conduct research to inform intentional inventions and innovations that address specific needs and wants.<br>3.5.9-12.U Evaluate and define the purpose of a design.<br>3.5.9-12.W Optimize a design by addressing desired qualities within criteria and constraints while considering trade-offs.<br>3.5.9-12.X Implement the best possible solution to a design using an explicit process.<br>3.5.9-12.AA Safely apply an appropriate range of making skills to a design thinking process. | |
| **Essential Questions:**<br>UEQ: How can students apply their knowledge of design and fabrication technologies to create an innovative solution in a comprehensive capstone project?<br>LEQ: How can you integrate design principles and fabrication technologies to create an innovative product or solution?<br>LEQ: What are the key steps in the design and prototyping process, and how do they contribute to the success of your final project?<br>LEQ: How do you select the appropriate materials, tools, and technologies for different stages of your project?<br>LEQ: How can CAD and CAM systems enhance the accuracy and efficiency of your design and manufacturing process?<br>LEQ: What role does testing and iteration play in refining your design to meet performance and production standards?<br>LEQ: How do you balance creativity, functionality, and manufacturability when developing a project?<br>LEQ: How can you manage project timelines, resources, and team collaboration to ensure successful project completion?<br>LEQ: How does your design demonstrate an understanding of the principles learned throughout the course, such as DFM, DFA, and prototyping?<br>LEQ: What strategies can be used to troubleshoot and solve problems encountered during the design and manufacturing phases?<br>LEQ: How can you communicate your design ideas effectively through presentations, documentation, and visual representations? | **Understandings:** Students will know that…<br>● Integrating design principles and fabrication technologies is essential for creating innovative products or solutions.<br>● The design and prototyping process are key to the success of the final project.<br>● Selecting appropriate materials, tools, and technologies is crucial for different stages of the project.<br>● CAD and CAM systems can enhance the accuracy and efficiency of design and manufacturing processes.<br>● Testing and iteration play a critical role in refining designs to meet performance and production standards.<br>● Balancing creativity, functionality, and manufacturability is essential when developing a project.<br>● Managing project timelines, resources, and team collaboration is necessary for successful project completion.<br>● Demonstrating an understanding of DFM, DFA, and prototyping principles is crucial to the design.<br>● Troubleshooting and solving problems are vital during the design and manufacturing phases.<br>● Effectively communicating design ideas through presentations, documentation, and visual representations is key to sharing the work. |

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| **<u>Knowledge:</u>**<br>Engineering Design Process<br>Prototyping Techniques and Methodology<br>Materials Selection and Properties<br>CAD (Computer-Aided Design) Systems<br>CAM (Computer-Aided Manufacturing) Systems<br>Fabrication Technologies and Tools<br>DFM (Design for Manufacturing) and DFA (Design for Assembly)<br>Iterative Testing and Design Refinement | **<u>Do/Skills</u>:** Students will be able to…<br>● Integrate design principles and fabrication technologies to create innovative products or solutions.<br>● Understand and apply the design and prototyping process to ensure the success of the final project.<br>● Select appropriate materials, tools, and technologies for different stages of the project.<br>● Utilize CAD and CAM systems to enhance the accuracy and efficiency of design and manufacturing processes.<br>● Employ testing and iteration to refine designs and meet performance and production standards.<br>● Balance creativity, functionality, and manufacturability when developing a project.<br>● Manage project timelines, resources, and team collaboration to ensure successful project completion.<br>● Demonstrate an understanding of DFM, DFA, and prototyping principles in the design process.<br>● Troubleshoot and solve problems encountered during the design and manufacturing phases.<br>● Effectively communicate design ideas through presentations, documentation, and visual representations. |
| **<u>Vocabulary:</u>**<br>Engineering Design Process, Prototyping, Materials Selection, CAD (Computer-Aided Design), CAM (Computer-Aided Manufacturing), Fabrication Technologies, DFM (Design for Manufacturing), DFA (Design for Assembly), Iterative Testing, Design Refinement, Troubleshooting, Problem-Solving | **<u>Core Resources</u>:**<br>Schoology LMS<br>Fusion 360, Revit, OnShape<br>3D Printers<br>Mold Making Supplies<br>Laser Cutter and Engraver<br>CNC Router Machine |

| **Common Assessment(s):** | **Supplemental Resources:** |
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| 1. Capstone Project Proposal<br>2. Capstone Project Portfolio<br>3. Capstone Project Prototype | Teacher created activities, tutorials and assignments<br>ITEEA Onshape by Design |

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| **<u>Grade, Subject/Course</u>:**<br>Advanced CADD / Honors (10-12) | |
| **<u>Unit</u>:**<br>Honors Project | **__X__ Essential    _____ Important    _____ Compact** |
| **<u>Big Idea:</u>**<br>Advanced manufacturing technologies empower designers to transform ideas into precise, functional, and innovative products through efficient processes and strategic material choices. | |
| **<u>STEELS/Tech and Engineering Strand:</u>**<br>3.5.9-12.A Use various approaches to communicate processes and procedures for using, maintaining, and assessing technological products and systems.<br>3.5.9-12.F Evaluate a technological innovation that arose from a specific society's unique need or want.<br>3.5.9-12.G Evaluate a technological innovation that was met with societal resistance impacting its development.<br>3.5.9-12.S Conduct research to inform intentional inventions and innovations that address specific needs and wants.<br>3.5.9-12.U Evaluate and define the purpose of a design.<br>3.5.9-12.GG Evaluate how technology and engineering have been powerful forces in reshaping the social, cultural, political, and economic landscapes throughout history.<br>3.5.9-12.KK Relate how technological and engineering developments have been revolutionary, often the result of a series of refinements to basic inventions or technological knowledge. | **<u>Pacing:</u>**<br>Every 2 weeks throughout the semester |
| **<u>Essential Questions</u>:**<br>UEQ: How can advanced manufacturing technologies such as 3D printing, CNC machining, laser fabrication, and production-quality prototyping be integrated to enhance the design, development, and creation of innovative, functional, and high-quality products?<br>LEQ: How do different types of 3D printing technologies impact the design, functionality, and production of objects in various industries?<br>LEQ: How does CNC manufacturing revolutionize precision, efficiency, and creativity in modern product design and fabrication?<br>LEQ: How can 3D design and laser fabrication be utilized to transform creative ideas into precise, functional, and visually compelling products? | **<u>Understandings</u>:** Students will know that…<br>● Different types of 3D printing technologies vary in materials, processes, and applications, each impacting the design, functionality, and production of objects.<br>● CNC manufacturing enhances precision, efficiency, and design flexibility through automated control systems and specialized tooling.<br>● 3D design software is essential for creating detailed models that guide laser fabrication and other manufacturing processes.<br>● Laser fabrication techniques allow for precise cutting, engraving, and marking to achieve detailed and accurate designs.<br>● Production-quality prototyping methods are critical for evaluating design feasibility, ensuring product functionality, and improving overall quality before mass production. |

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| LEQ: How can production-quality prototyping methods balance accuracy, functionality, and efficiency to effectively develop and test new product designs? | • Integrating multiple manufacturing technologies can streamline workflows, enhance product innovation, and improve design outcomes.<br>• Material selection plays a crucial role in determining the success of manufacturing processes, influencing durability, aesthetics, and functionality.<br>• Design constraints, such as size, complexity, and intended use, influence the choice of manufacturing technology and production methods.<br>• Iterative prototyping allows designers to refine and improve product designs by testing and evaluating different manufacturing approaches.<br>• Understanding safety protocols and proper equipment operation is essential for ensuring successful and secure use of manufacturing technologies. |
| **Knowledge:**<br>Additive Manufacturing (3D Printing)<br>Subtractive Manufacturing (CNC)<br>3D Design & Laser Fabrication<br>Production Quality Prototyping (PQP) | **Do/Skills:** Students will be able to…<br>• Research and present information about a real-world problem, the solution to the problem, how computer aided design works, and the positive and negative impacts on society. |
| **Vocabulary:**<br>3D printing, FDM (Fused Deposition Modeling), SLA (Stereolithography), SLS (Selective Laser Sintering), CNC manufacturing, G-code, toolpath, spindle speed, feed rate, 3D modeling, CAD (Computer-Aided Design), STL file, slicing software, laser fabrication, vector file, raster engraving, kerf, prototyping, rapid prototyping, design iteration, material properties, tensile strength, infill density, support structures, design constraints, tolerances, scalability, workflow integration, manufacturing efficiency, product feasibility, quality control, safety protocols, PPE (Personal Protective Equipment), machine calibration, post-processing, surface finish, structural integrity, dimensional accuracy | **Core Resources:**<br>Schoology LMS<br>Wix |
| **Common Assessment(s):**<br>1. Blog (8 Posts) | **Supplemental Resources:**<br>Teacher created activities, tutorials and assignments |