SCHOOL DISTRICT OF THE CHATHAMS
CURRICULUM PROFILE

CONTENT AREA(S): Design & Technology **GRADE LEVEL(S):** 10-12

COURSE: 3D Engineering Design **TIME FRAME:** Full Year (5 Credits)

PRE-REQUISITES: Introduction to Design & Innovation

I. Course Overview

The 3D Engineering Design course focuses on the application of the Engineering Design Process and design thinking framework through 3-Dimensional (3D) Computer Aided Drawing/Design (CAD). Students are challenged to develop and design solutions to problems present in our world while developing their ability to create and communicate ideas and designs by taking an idea from concept to product. Students will learn how to use 3D CAD software, such as AutoDesk Inventor, as well as modeling/animation/rendering software, such as 3D Studio Max, which are both used in the engineering and design industries. This class requires the application of knowledge from various content areas, such as mathematics, design & technology, and science. Furthermore, it provides students with the opportunity to conceive, design, model and create working prototypes for testing. It also develops their ability to express their creative thoughts to others for feedback and critique. Main topics will include 3D design & modeling, assemblies, rendering, rapid prototyping, and portfolio development.

II. Units of Study

Unit 1: Safety *[will be reviewed and embedded within the units listed below, as most appropriate]*

- Overall Safety Expectations & Regulations
- Machine/Tool Safety Considerations, Parts, Safe Use, and Demonstration
    - Followed by written and hands-on assessments
    - Documentation of demonstration/lesson dates, as well as passing of written and hands-on assessment with notes (as well as any reassessments)
- Machines/Tools/Practices:
    - General Safety Practices
    - Eye Safety
    - Hot Glue Gun
    - X-Acto Knives
    - Drill Press
    - Bandsaw
    - Belt & Disc Sanders

Unit 2: Engineering, Problem Solving & Design Thinking

- Definition & History of Engineering
- Problem-Solving Methodologies
    - Engineering Design Process
    - Iterative Design
    - Design Thinking Framework

Unit 3: Engineering Drawings

- Isometric *[review]*

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- Oblique *[review]*
- Orthographic Projections *[review]*
- 1-Pt. Perspective
- 2-Pt. Perspective

Unit 4: Three-Dimensional Modeling
- CAD - Solid Modeling
- Assemblies
- Animations
- Rendering

Unit 5: Reverse Engineering
- Product Analysis
- Redesign Design Challenge
- Presentation, Assembly Animation & Prototyping of Redesign

III. Essential Questions *(The open-ended, provocative questions that help frame inquiry)*

Unit 1: Safety
- Why is it important to comply with the rules, regulations, and procedures in a lab environment?
- Why is it important to pass tool and machine safety exams (both written and hands-on) with a score of 100%?

Unit 2: Engineering, Problem Solving and Design Thinking
- What are the most pressing engineering/technical problems of our time?
- What is an engineer and what does it mean to engage in engineering?
- What are some advantages and disadvantages of an individual problem solving approach versus a design team approach?
- How might we create the best possible solution to a problem?
- Why does an engineer or a designer need to identify criteria and constraints?
- What are some effective ways to generate multiple, potential solutions to a problem?
- How do we know if our solution successfully solves the problem at hand and meets the needs of potential users?

Unit 3: Engineering Drawings Review
- How can we clearly convey a design idea or possible solution to someone unfamiliar with the original problem or design?
- How is engineering drawing similar to and different from artistic drawing?
- What can an isometric view of a shape reveal that an orthographic view cannot?
- How can we depict mechanical parts and mechanical movement?
- What can cause an engineering drawing to be misinterpreted?

Unit 4: Three-Dimensional Modeling
- What is the role of models and prototypes in the design process and would we determine which type of model/prototype is most appropriate for our goals/design?

- What are the essential skills and methods needed to complete an advanced design and assembly of complex engineering designs in 3D CAD programs?
- What essential skills and commands are needed to create animations and short clips depicting assemblies and movements of complex engineering designs in 3D CAD programs?
- How can we make the design and manufacture of a design/product more efficient and less prone to error?
- Using what you know about design and innovation, how can you improve the world around you?

Unit 5: Reverse Engineering

- How are the elements and principles of design used to gain a consumer's attention?
- Why is a design aesthetic value and functional efficiency/structural resilience usually perceived as linked/associated by consumers?
- What are the differences between a product's visual and functional qualities?
- What role does reverse engineering play in product development?
- What is the purpose of a design portfolio and how do you decide what information to include?

IV. Learning Objectives

8.1.12.A.1	Create a personal digital portfolio which reflects personal and academic interests, achievements, and career aspirations by using a variety of digital tools and resources.
8.1.12.A.2	Produce and edit a multi-page digital document for a commercial or professional audience and present it to peers and/or professionals in that related area for review.
8.1.12.C.1	Develop an innovative solution to a real world problem or issue in collaboration with peers and experts, and present ideas for feedback through social media or in an online community.
8.2.12.A.1	Propose an innovation to meet future demands supported by an analysis of the potential full costs, benefits, trade-offs and risks, related to the use of the innovation.
8.2.12.B.1	Research and analyze the impact of the design constraints (specifications and limits) for a product or technology driven by a cultural, social, economic or political need and publish for review.
8.2.12.C.2	Analyze a product and how it has changed or might change over time to meet human needs and wants.
8.2.12.C.4	Explain and identify interdependent systems and their functions.
8.2.12.C.5	Create scaled engineering drawings of products both manually and digitally with materials and measurements labeled.
8.2.12.C.6	Research an existing product, reverse engineer and redesign it to improve form and function.
8.2.12.C.7	Use a design process to devise a technological product or system that addresses a global problem, provide research, identify trade-offs and

	constraints, and document the process through drawings that include data and materials.
8.2.12.D.1	Design and create a prototype to solve a real world problem using a design process, identify constraints addressed during the creation of the prototype, identify trade-offs made, and present the solution for peer review.
8.2.12.D.3	Determine and use the appropriate resources (e.g., CNC (Computer Numerical Control) equipment, 3D printers, CAD software) in the design, development and creation of a technological product or system.
9.3.ST-ET.1	Use STEM concepts and processes to solve problems involving design and/or production.
9.3.ST-ET.4	Apply the elements of the design process.
9.3.ST-ET.5	Apply the knowledge learned in STEM to solve problems.
9.3.12.AC-CST.9	Safely use and maintain appropriate tools, machinery, equipment and resources to accomplish construction project goals.
9.3.12.AC-DES.1	Justify design solutions through the use of research documentation and analysis of data.
9.3.12.AC-DES.6	Apply the techniques and skills of modern drafting, design, engineering and construction to projects.
9.3.12.AC-DES.7	Employ appropriate representational media to communicate concepts and project design
9.3.12.AC-DES.8	Apply standards, applications and restrictions pertaining to the selection and use of construction materials, components and assemblies in the project design.

V. Instructional Materials

- Safety Resources & Exams
- Teacher created design briefs and rubrics
- Use of videos, DVD's, computer software, online resources, posters, and other audio-visual materials as appropriate
- Computer Aided Design Software (AutoDesk Suite)
- Adobe Creative Cloud Suite
- G-Suite for Education (Google Docs, Sheets, Slides, etc.)

VI. Key Performance and Benchmark Tasks

- Safety demonstration & assessments.
- Communicate through the use of engineering drawings.
- Interpret 3D objects through 2D drawings.
- Utilize CAD software to design solutions to problems.
- Utilize CAD software to develop professional drawings that adhere to engineering principles and design formats.
- Utilize rapid prototyping to create prototypes of CAD designs.
- Analyze a product's visual and functional characteristics.

Revision Date: June 2018

- Redesign a product to meet the needs of a specific client base.

Student Outcomes and Methods of Assessment:

- Design Challenges/Projects
- Exams & Hands-On Assessments
- Sketches and Engineering Drawings
- Digital Portfolio