

SHORE REGIONAL HIGH SCHOOL DISTRICT

A Regional Collaborative of the Communities Served by the Monmouth Beach, Oceanport, Shore Regional, and West Long Branch School Districts

Aligned to the New Jersey Student Learning Standards as Applicable

Course Title: Advanced Engineering and Architectural Drawing

Content Area: Technology/Industrial Arts

Grade Level(s): 10-12

Course Description: Advanced Engineering and Architectural Drawing is a one-year, five-credit course where students will master advanced traditional drafting techniques in addition to learning advanced functions within industry standard CAD (computer-aided design) software. Students will be tasked with designing solutions to real-world problems with emphasis placed on working drawings that show the use of revolutions, auxiliary views, section views, assemblies, and fastening devices. These designs will be brought to life as models via advanced rapid prototyping such as 3D printing and laser engraving. Students will explore ergonomic design, industrial design, and product redesign throughout the course. Students wishing to pursue college degrees or a license in engineering, design, or architecture are encouraged to take this course.

Curriculum Writer(s): Gregg Malfa

Date Created: July 2019

Date Approved by Board of Education: November 2019

Pacing Guide

Unit 1: Design and Self-Management	2-4 Weeks
Unit 2: Advanced Drawing Techniques	9-10 Weeks
Unit 3: Materials and Manufacturing	3-5 Weeks
Unit 4: Advanced CAD	4-5 Weeks
Unit 5: Engineering/Architectural Design Projects	10-12 Weeks

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Unit 1: Design and Self-Management
<p>Unit Summary: Students will determine a field in engineering or architecture that best represents their expertise. They will collect and organize all original, digital drawings, creating a digital portfolio for their chosen field that showcases updated drawings. Students will then review and critique each other's portfolios with an appropriate rubric.</p>
<p>Interdisciplinary Connections/Content Area Integrations Including Technology:</p> <ul style="list-style-type: none"> • Mathematics: measuring • Science: planning procedures • Technology: use of machines and computers to generate plans and procedures

NJSLS Number	NJSLS Content
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 multipage digital document for a commercial or professional audience and present it to peers and/or professionals in that related area for review.
8.2.12.A.1	Propose an innovation to meet future demands supported by an analysis of the potential full costs, benefits, tradeoffs, and risks related to the use of the innovation.
8.2.12.C.3	Analyze a product or system for factors such as safety, reliability, economic considerations, quality control, environmental concerns, manufacturability, maintenance and repair, and human factors engineering (ergonomics).

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8.2.12.E.3	Use a programming language to solve problems or accomplish a task (e.g., robotic functions, website designs, applications, and games).
8.2.12.E.4	Use appropriate terms in conversation (e.g., troubleshooting, peripherals, diagnostic software, GUI, abstraction, variables, data types, and conditional statements).

Summative Assessments:

- Portfolios, Self and Peer Assessment
- Performance Assessment
- Midterm/Final Exam
- Projects
- Rubric Assessment

Formative Assessments:

- Observations (Peer and Teacher)
- Participatory Rubrics
- Projects
- Oral Presentations

Enduring Understandings:

- Following safety procedures and using PPE (Personal Protection Equipment) will reduce the risk of injury.
- Visually advanced renderings and accurate drawings are essential to the design process.

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- Models and assemblies help to explain the design to clients.

Essential Questions:

- How should you conduct yourself in a technology lab setting?
- Can any procedure be completely safe?
- How do drawings influence the final product?
- Why are renderings so important to the final product?
- How would a designer, engineer, or architect defend his or her design choices?
- Why is it important for a designer, engineer, or architect to communicate his or her solution to a client?

Instructional Outcomes:

- Students will be able to apply concepts of the design process to develop solutions to engineering and architectural problems.
- Students will be able to make safe and informed decisions when selecting and using equipment or tools.
- Students will be able to analyze differences between the fields of engineering and architecture and each role in the real world.
- Students will be able to design and create a digital portfolio of completed work to showcase their abilities.
- Students will be able to communicate their ideas through professional caliber oral and visual presentations.

Suggested Learning Activities:

- Identify and perform proper use and maintenance of tools (computers, monitors, mouse, and printers) utilizing personal PPE as needed.
- Analyze safety protocols and the reasoning behind the protocols when using equipment.

Suggested Differentiation:

- **Tier 1 Learners:** students provided one-to-one direct instruction, additional time, and auditory and visual supports

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<ul style="list-style-type: none">● Tier 2 Learners: students assigned to work with a partner or independently● Tier 3 Learners: students assigned to work independently
Curriculum Development Resources: <ul style="list-style-type: none">● https://www.frhsd.com/cms/lib/NJ01912687/Centricity/Domain/19/Engineering%20Graphics%20II.pdf
Notes/Comments:

Unit 2: Advanced Drawing Techniques

Unit Summary: Students will create models of original design work using autocad software. These projects will include renders of completed drawings, sectioned views, exploded assemblies, and auxiliary views. These will be digitized, added to the digital portfolio, and organized for printing on a large format printer or 3D printer.

Interdisciplinary Connections/Content Area Integrations Including Technology:

- **Mathematics:** measuring
- **Science:** planning procedures
- **Technology:** use of machines and computers to generate plans and procedures

NJSLS Number	NJSLS Content
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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.
8.1.12.D.5	Analyze the capabilities and limitations of current and emerging technology resources and assess their potential to address personal, social, lifelong learning, and career needs.
8.1.12.F.1	Evaluate the strengths and limitations of emerging technologies and their impact on educational, career, personal, and/or social needs.
8.2.12.C.5	Create scaled engineering drawings of products both manually and digitally with materials and measurements labeled.
8.2.12.E.4	Use appropriate terms in conversation (e.g., troubleshooting, peripherals, diagnostic software, GUI, abstraction, variables, data types, and conditional statements).

<p>Summative Assessments:</p> <ul style="list-style-type: none"> ● Portfolios, Self and Peer Assessment ● Performance Assessment ● Midterm/Final Exam ● Projects ● Rubric Assessment
<p>Formative Assessments:</p> <ul style="list-style-type: none"> ● Observations (Peer and Teacher) ● Participatory Rubrics

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- Projects
- Oral Presentations

Enduring Understandings:

- Visually advanced renderings and accurate drawings are essential to the design process.
- Both manual and computer-aided drawings have their purpose in the design world.

Essential Questions:

- How are working drawings used in the real world?
- Are there instances where it is better to use one method of creating working drawings over another?
- How do drawings influence the final product?

Instructional Outcomes:

- Students will be able to use mechanical drawing tools and drafting techniques to apply concepts of measurement and scale in order to create accurate section drawings, exploded drawings, and auxiliary views.
- Students will be able to apply 2D and 3D concepts in a visual medium to effectively create professional, elegant solutions to engineering problems.

Suggested Learning Activities:

- Utilize CAD software to design and redesign a solution to a real-world problem to be teacher and peer reviewed.
- Utilize CAD software to create scaled engineering drawings (including auxiliary and exploded views that provide all of the details for the manufacturing of a product).
- Generate a step-by-step guide for the design process and a model on a rapid prototyping device.

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Suggested Differentiation:

- **Tier 1 Learners:** students provided one-to-one direct instruction, additional time, and auditory and visual supports
- **Tier 2 Learners:** students assigned to work with a partner or independently
- **Tier 3 Learners:** students assigned to work independently

Curriculum Development Resources:

- <https://www.frhsd.com/cms/lib/NJ01912687/Centricity/Domain/19/Engineering%20Graphics%20II.pdf>

Notes/Comments:

Unit 3: Materials and Manufacturing

Unit Summary: After students create a project prototype, students will use the 3D printer to create a physical model of an original design utilizing materials and manufacturing techniques that would be needed to create the product. The design should be appropriate for the 3D printer and contain a variety of exterior edges and contours. It is not to be overly detailed with interior elements.

Interdisciplinary Connections/Content Area Integrations Including Technology:

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NJSLS Number	NJSLS Content
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.
8.2.12.D.5	Explain how material processing impacts the quality of engineered and fabricated products.

<p>Summative Assessments:</p> <ul style="list-style-type: none"> ● Portfolios, Self and Peer Assessment ● Performance Assessment ● Midterm/Final Exam ● Projects ● Rubric Assessment
<p>Formative Assessments:</p> <ul style="list-style-type: none"> ● Observations (Peer and Teacher) ● Participatory Rubrics ● Projects ● Oral Presentations
<p>Enduring Understandings:</p> <ul style="list-style-type: none"> ● The choice of materials and the manufacturing process must be fully understood in order to develop real-world solutions.

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- Both manual and computer-aided drawings have their purpose in the design world.

Essential Questions:

- Should you choose quality or cost when choosing final product design?
- When should material exploration begin?
- Are there instances where it is better to use one method of creating working drawings over another?

Instructional Outcomes:

- Students will be able to test and analyze different materials to identify the best material choice for a specific task based on the design need.
- Students will be able to utilize multiple different traditional and computer numerical control (CNC) manufacturing techniques to create models and prototypes with different materials.
- Students will be able to make safe and informed decisions when selecting and using equipment or tools.

Suggested Learning Activities:

- Generate a step-by-step guide for the design process and a model on a rapid prototyping device.
- Follow the computer drawings and make modifications to designs in order to properly produce them on rapid prototyping machines.

Suggested Differentiation:

- **Tier 1 Learners:** students provided one-to-one direct instruction, additional time, and auditory and visual supports
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Notes/Comments:

Unit 4: Advanced CAD

Unit Summary: Students will create a 3D drawing of an original engineering design containing multiple components. These components will not be static but instead be parts of a mechanism. The mechanism should be a straightforward design that incorporates multiple simple machines to accomplish a specific goal for the client. The design will be communicated via the digital portfolio and as a presentation to the class or company.

Interdisciplinary Connections/Content Area Integrations Including Technology:

- **Mathematics:** measuring
- **Science:** planning procedures
- **Technology:** use of machines and computers to generate plans and procedures

NJSLS Number	NJSLS Content
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.
8.1.12.D.5	Analyze the capabilities and limitations of current and emerging technology resources and assess their potential to address personal, social, lifelong learning, and career needs.

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8.1.12.F.1	Evaluate the strengths and limitations of emerging technologies and their impact on educational, career, personal, and/or social needs.
8.2.12.C.5	Create scaled engineering drawings of products both manually and digitally with materials and measurements labeled.
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 tradeoffs made, and present the solution for peer review.
8.2.12.E.4	Use appropriate terms in conversation (e.g., troubleshooting, peripherals, diagnostic software, GUI, abstraction, variables, data types, and conditional statements).

<p>Summative Assessments:</p> <ul style="list-style-type: none"> ● Portfolios, Self and Peer Assessment ● Performance Assessment ● Midterm/Final Exam ● Projects ● Rubric Assessment 	
<p>Formative Assessments:</p> <ul style="list-style-type: none"> ● Observations (Peer and Teacher) ● Participatory Rubrics ● Projects ● Oral Presentations 	

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Enduring Understandings:

- Models and assemblies help to explain the design to teachers and clients.
- Visually advanced renderings and accurate drawings are essential to the design process.

Essential Questions:

- How would a designer or engineer defend his or her design choices?
- How do drawings influence the final product?

Instructional Outcomes:

- Students will be able to construct highly detailed and rendered 3D representations of complex problems utilizing CAD software.
- Students will be able to create interconnected 3D solids that meet design criteria and will be presented as a solution to various engineering problems.
- Students will be able to create functional models and assemblies based on the design specifications provided by a client.

Suggested Learning Activities:

- Utilize CAD software to design and redesign a solution to a real-world problem to be teacher and peer reviewed.
- Utilize CAD software to create scaled engineering drawings (including auxiliary and exploded views that provide all of the details for the manufacturing of a product).

Suggested Differentiation:

- **Tier 1 Learners:** students provided one-to-one direct instruction, additional time, and auditory and visual supports
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Notes/Comments:

Unit 5: Engineering/Architectural Design Projects

Unit Summary: Students will use the design process to create a product that utilizes at least two different functional mechanisms and different materials. Students will document the project online as a set of instructions for public use, review, and critique (i.e. Instructables.com, diy.com, hackaday.com, howto.com, thingiverse.com, etc.). This project will allow students to gain insight into the need for clear documentation of the material testing, troubleshooting, design process, and visual representation of a product for others to recreate a specific design.

Interdisciplinary Connections/Content Area Integrations Including Technology:

- **Mathematics:** measuring
- **Science:** planning procedures
- **Technology:** use of machines and computers to generate plans and procedures

NJSLS Number	NJSLS Content
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.

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8.2.12.C.5	Create scaled engineering drawings of products both manually and digitally with materials and measurements labeled.
8.2.12.C.7	Use a design process to devise a technological product or system that addresses a global problem, provide research, identify tradeoffs 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 tradeoffs 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.

<p>Summative Assessments:</p> <ul style="list-style-type: none"> ● Portfolios, Self and Peer Assessment ● Performance Assessment ● Midterm/Final Exam ● Projects ● Rubric Assessment
<p>Formative Assessments:</p> <ul style="list-style-type: none"> ● Observations (Peer and Teacher) ● Participatory Rubrics ● Projects ● Oral Presentations

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Enduring Understandings:

- Engineers need to be good designers as well as good marketers of ideas.
- Visually advanced renderings and accurate drawings are essential to the design process.
- The choice of design and materials and the process of manufacturing must be fully understood in order to develop real-world solutions.

Essential Questions:

- Why is marketing an important skill for designers, architects, and engineers?
- How do engineering and architectural drawings influence the final product?
- Should you choose quality or cost when choosing final product design?

Instructional Outcomes:

- Students will be able to design and create functional mechanisms and designs by using in depth 3D prototyping.
- Students will be able to redesign and further develop mechanical prototypes and designs after being critiqued and critiquing the work of others.
- Students will be able to construct highly detailed and rendered 3D representations of complex problems utilizing CAD software.

Suggested Learning Activities:

- Design a product to be created on a 3D printer within a tolerance range.
- Evaluate task needs in order to identify and select the correct equipment and software.
- Utilize proper and safe procedures for 3D printers and laser engravers (future).
- Create a prototype with visual and functional properties.

Suggested Differentiation:

- **Tier 1 Learners:** students provided one-to-one direct instruction, additional time, and auditory and visual supports
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