West Windsor-Plainsboro Regional School District
Architectural Design and Fabrication

Unit 0: Technology Education

Content Area: Technology Education

Course & Grade Level: Technology Education – Grade 12

Summary and Rationale

The West Windsor-Plainsboro Regional School District recognizes the importance of the study 21st Century Life and Careers standards. Additionally, it is also believed this learning should not be taught in isolation and cross curricular and career ready practices are embedded in every unit of study. Unit 0 is incorporated into each unit of study of this curricular document.

Recommended Pacing:

ELA Companion Standards and Career Ready Practices will be integrated throughout all units of study.

Interdisciplinary Connections

Grades 9-10

Progress Indicators Reading Science and Technical Subjects

Key Ideas and Details

RST.9-10.1. Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions.

RST.9-10.2. Determine the central ideas, themes, or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.

RST.9-10.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

Craft and Structure

RST.9-10.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9-10 texts and topics*.

RST.9-10.5. Analyze the relationships among concepts in a text, including relationships among key terms (e.g., *force, friction, reaction force, energy*).

RST.9-10.6. Determine the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.

Integration of Knowledge and Ideas

RST.9-10.7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
RST.9-10.8. Determine if the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.
RST.9-10.9. Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.

Range of Reading and Level of Text Complexity:

RST.9-10.10. By the end of grade 10, read and comprehend science/technical texts in the grades 9-10 text complexity band independently and proficiently.

Career Ready Practices

CRP1. Act as a responsible and contributing citizen and employee.

CRP2. Apply appropriate academic and technical skills.

CRP4. Communicate clearly and effectively and with reason.

CRP5. Consider the environmental, social and economic impacts of decisions.

CRP6. Demonstrate creativity and innovation.

CRP7. Employ valid and reliable research strategies.

CRP8. Utilize critical thinking to make sense of problems and persevere in solving them.

CRP9. Model integrity, ethical leadership and effective management.

CRP10. Plan education and career paths aligned to personal goals.

CRP11. Use technology to enhance productivity.

CRP12. Work productively in teams while using cultural global competence.

Competencies for 21st Century Learners			
X	Collaborative Team Member	X	Effective Communicator
X	Globally Aware, Active, & Responsible Student/Citizen	X	Information Literate Researcher
X	Innovative & Practical Problem Solver	X	Self-Directed Learner

Unit 1: Technical Drawings

Content Area: Engineering

Course & Grade Level: Architectural Design & Fabrication, 10-12

Summary and Rationale

Planning out ideas is critical in designing any product. Ideas are communicated in the form of drawings and sketches. Students will be introduced to a variety of different engineering style drawings and technical sketches that are used in the planning of a design. This will also include teaching them essential components of these drawings such as lines and line types, dimensions, and scale. These skills will be crucial as students will be asked to call upon them throughout the course of the year and utilize them in the planning of projects and other assignments.

Recommended Pacing

15 Days

NJ Student Learning Standards

8.2: Technology Education, Engineering, and Design: All students will develop an understanding of the nature and impact of technology, engineering, technological design, computational thinking and the designed world as they relate to the individual, global society, and the environment.

Stand C - Design: The design process is a systematic approach to solving problems.

CPI #	Cumulative Progress Indicator (CPI)
8.2.12.C.5	Create scaled engineering drawings of products both manually and digitally with materials and measurements labeled.
NJSLS 9.3 Career and Technical Education	
Architecture and Construction Cluster	
9.3.12.AC-DES.2	Use effective communication skills and strategies (listening, speaking, reading, writing, and graphic communications) to work with clients and colleagues
9.3.12.AC-DES.6	Apply the techniques and skills of modern drafting, design, engineering and construction to projects

9.3.12.AC.1	Use vocabulary, symbols and formulas common to architecture and construction
9.3.12.AC.6	Read, interpret and use technical drawings, documents and specifications to plan a project

Instructional Focus

Unit Enduring Understandings

- There are various types and purposes of technical drawings
- Communicating and engineering design requires effective visual representation.
- Computer-aided design and traditional drafting each have their place in the world of engineering and design.

Unit Essential Questions

- How do engineers and architects communicate the elements of their designs?
- What are the various types and purposes of technical drawings?
- What is the purpose of a multi-view drawing?
- How are different views of an object laid out?
- What is an orthographic projection?
- How is geometry applied in creating multi-viewed technical drawings?
- How are hidden features expressed in an orthographic projection?
- How are multi-viewed drawings presented?

Objectives

Students will know:

- How to identify a single view drawing
- How to identify an orthographic sketch
- How to identify an isometric perspective sketch
- The difference between visible and hidden lines
- What is scale

Students will be able to:

- Create a clean engineering drawing with accurate dimensions
- Create precise lines using scales and triangles
- Accurately use drafting tools
- Properly record measurements of 3D objects
- Draw 2D engineering drawings of 3D objects using tools and machine
- Draw isometrics using tools

Evidence of Learning

Assessment

Common Assessment 1.1

Competencies for 21st Century Learners

	Collaborative Team Member	X	Effective Communicator
	Globally Aware, Active, & Responsible Student/Citizen		Information Literate Researcher
X	Innovative & Practical Problem Solver	X	Self-Directed Learner

Resources

- http://www1.udel.edu/present/Becky/ruler/
- http://www.davis.k12.ut.us/cms/lib09/UT01001306/Centricity/Domain/8327/Technical%20Design%20I/Textbook%20Chapters/Chapter%204_Orthographic%20Projection.pdf
- Engineering Design: An Introduction (Karsnitz, O'Brien, Hutchinson)

Materials

- Graph paper
- Architect's scale
- Triangles
- Protractor
- Compass

Unit 2: Computer Aided Design (CAD)

Content Area: Engineering

Course & Grade Level: Architectural Design & Fabrication, 10-12

Summary and Rationale

Computer Aided Design, or CAD, has become an industry standard in 21st Century engineering. This process involves creating a computer generated 3D model of a design which provides an engineer with the full specifications needed to develop it. Having experienced how to create technical drawings by hand, students will now have the opportunity to create them through the use of CAD software. They will understand the process of creating a 3D model which they can then use to generate a technical blueprint.

Recommended Pacing

30 days

NJ Student Learning Standards

8.2 Technology Education, Engineering, and Design: All students will develop an understanding of the nature and impact of technology, engineering, technological design, and the designed world, as they relate to the individual, global society, and the environment.

Strand C - Design: The design process is a systematic approach to solving problems

Strand D - Abilities for a Technological World: The designed world is the product of a design process that provides the means to convert resources into products and systems.

CPI #	Cumulative Progress Indicator (CPI)
8.2.12.C.5	Create scaled engineering drawings of products both manually and digitally with materials and measurements labeled.
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.

NJSLS 9.3 Career and Technical Education

Architecture and Construction Cluster

9.3.12.AC-DES.2	Use effective communication skills and strategies (listening, speaking, reading, writing, and graphic communications) to work with clients and colleagues

9.3.12.AC-DES.6	Apply the techniques and skills of modern drafting, design, engineering and construction to projects
9.3.12.AC.1	Use vocabulary, symbols and formulas common to architecture and construction
9.3.12.AC.6	Read, interpret and use technical drawings, documents and specifications to plan a project

Instructional Focus

Unit Enduring Understandings

- There are various types of CAD programs, each with their own unique way of designing objects
- Communicating a CAD design requires effective visual representation.
- Computer-aided design and traditional drafting each have their place in the world of engineering and design.

- What is CAD?
- What is CAD used for and how is it utilized today?
- What are the pros and cons of creating a CAD model versus a technical drawing?
- What is an extrude?
- Identify the difference between a chamfer and a bevel.
- What is the path tool and what kinds of objects can you design with it?
- What is the pattern tool and in what circumstances would you want to use it?

Objectives

Students will know:

- What the acronym CAD stands for
- How CAD is used in modern day engineering
- The benefits of CAD as an engineering tool

Students will be able to:

- Create basics shapes through CAD software
- Turn shapes into 3D objects
- Manipulate 3D objects
- Provide additional detailing to 3D objects such rounded edges or bevels
- Add texture to objects
- Create 3D text
- Pattern 3D objects
- Create 3D objects that follow the direction of a path

Evidence of Learning

Assessment

Common Assessment 2.1

Competencies for 21st Century Learners

	Collaborative Team Member	X	Effective Communicator
	Globally Aware, Active, & Responsible Student/Citizen		Information Literate Researcher
X	Innovative & Practical Problem Solver	X	Self-Directed Learner

Resources

For PTC Creo: https://www.youtube.com/watch?v=ju4vebPPzI4

For AutoCad: https://www.youtube.com/watch?v=zM3TTdGNNrQ

Materials

- Computer
- CAD Software (Recommended programs: AutoCAD or PTC Creo)

Unit 3: Modeling Techniques

Content Area: Engineering

Course & Grade Level: Architectural Design & Fabrication, 10-12

Summary and Rationale

This unit will focus on the Modeling and Prototyping phase of the Design Process. The model is a nonfunctioning version of the product which is typically used to determine characteristics such as size, shape and other physical properties. The product is then produced as a prototype before its final release. This is to ensure that the product will function as desired. Students will be taking an in-depth look into some of these processes. This will include learning how to work with certain modeling materials as well as different tooling and machinery.

Recommended Pacing

40 days

NJ Student Learning Standards

8.2 Technology Education, Engineering, and Design: All students will develop an understanding of the nature and impact of technology, engineering, technological design, and the designed world, as they relate to the individual, global society, and the environment.

Strand D - Abilities for a Technological World: The designed world is the product of a design process that provides the means to convert resources into products and systems.

CPI #	Cumulative Progress Indicator (CPI)
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.
9.3 Career and Technical Education	
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.8	Apply standards, application and restrictions pertaining to the selections and use of construction materials, components and assemblies in the project design.

Instructional Focus

Unit Enduring Understandings

- There are numerous types of materials that can be used in a variety of situations
- Some materials are best used in specific situation
- A model will communicate form while a prototype will communicate function

Unit Essential Questions

- What is the difference between a model and a prototype?
- What are the advantages/disadvantages of a model over a prototype and vice versa?
- What does CNC stand for and how is it used in the modern engineering industry?
- Explain the process of 3D printing. How does it create a model from a 3D CAD file?
- What is the primary purpose of 3D printing and the benefits of using it?
- How are certain modeling techniques advantageous over others and what are some of their disadvantages as well?

Objectives

Students will know:

- How 3D printing has revolutionized different industries
- Legal and ethical concerns regarding 3D printing
- How different tools can be used to manipulate various types of materials
- What modeling techniques are best to use under certain conditions or in particular situations

Students will be able to:

- Communicate design solutions through models and prototypes
- Create models and prototypes using various tools and techniques
- Differentiate between models and prototypes

Evidence of Learning

Assessment

Common Assessment 3.1

Competencies for 21st Century Learners

	Collaborative Team Member	X	Effective Communicator
	Globally Aware, Active, & Responsible Student/Citizen		Information Literate Researcher
X	Innovative & Practical Problem Solver	X	Self-Directed Learner

Resources

http://istqbexamcertification.com/what-is-prototype-model-advantages-disadvantages-and-when-to-use-it/

"Print The Legend" - 2014 documentary film on 3D Printing

Engineering Design: An Introduction (Karsnitz, O'Brien, Hutchinson)

Materials

- Lumber
- Clay
- Hot wire cutters
- Foam
- Acrylic sheets
- 3D printing filament
- Vinyl cutter
- Vinyl rolls
- CNC milling machine
- Laser cutter

Unit 4: Ergonomics

Content Area: Engineering

Course & Grade Level: Architectural Design & Fabrication, 10-12

Summary and Rationale

The designed world around us was developed by humans. Therefore, it is important that the products that shape it are suitable for human usage. In this unit, students will be introduced to the concept of ergonomics and how to best integrate human form and function into design.

Recommended Pacing

20 Days

NJ Student Learning Standards

8.2 Technology Education, Engineering, and Design: All students will develop an understanding of the nature and impact of technology, engineering, technological design, and the designed world, as they relate to the individual, global society, and the environment.

Strand B- Technology and Society: knowledge and understanding of human, cultural and societal values are fundamental when designing technological systems and products in the global society

Strand C - Design: The design process is a systematic approach to solving problems.

CPI #	Cumulative Progress Indicator (CPI)
8.2.12.B.4	Investigate a technology used in a given period of history, e.g., stone age, industrial revolution or information age, and identify their impact on how they may have changed to meet human needs and wants
8.2.12.B.5	Research the historical tensions between environmental and economic considerations as driven by human needs and wants in the development of a technological product, and present the competing viewpoints to peers 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.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 (ergonomics)

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
9.3 Career and Technical Education	
9.3.12.AC-DES.2	Use effective communication skills and strategies (listening, speaking, reading, writing, and graphic communications) to work with clients and colleagues
9.3.12.AC-DES.6	Apply the techniques and skills of modern drafting, design, engineering and construction to projects

Instructional Focus

Unit Enduring Understandings

- Many man-made objects need to be designed with the human form in mind.
- Products are designed to maximize their comfort and ease of use by their human users
- Human ergonomics can differ with factors such as age and gender.
- Any living being or species has their own different ergonomic needs

Unit Essential Questions

- What are the limits of the human body?
- Why is in necessary to understand human factors to be a successful designer?
- How are principles of human characteristics, behavior, and abilities applied during the design process?
- What comfort features do people desire in products?
- How can universal design principles help everyone?
- How do human ergonomics differ from that of certain animals?

Objectives

Students will know:

- Understand the limits and function of the human body and how that plays into design
- How to Improve ergonomics to optimize performance and well being
- How anthropometric data is used in the design process
- How the principles of universal design are used to design and evaluate potential new products

Students will be able to:

- Design a product that takes human form and function into account
- Maximize a product's ease of use for human beings
- Evaluate and redesign an existing product to be more ergonomically pleasing.

Evidence of Learning

Assessment

Common Assessment 3.1

Competencies for 21st Century Learners

X	Collaborative Team Member	X	Effective Communicator
X	Globally Aware, Active, & Responsible Student/Citizen	X	Information Literate Researcher
X	Innovative & Practical Problem Solver	X	Self-Directed Learner

Resources

Engineering Design: An Introduction (Karsnitz, O'Brien, Hutchinson)

https://simanaitissays.files.wordpress.com/2014/06/computerstation.jpg

http://www.arch.mcgill.ca/prof/castro/arch304/winter2001/dander3/frame/ergonomics1.gif

Materials

- Manilla
- Brass fasteners
- Unit 1 - 3 materials

Unit 5: Architectural Design

Content Area: Engineering

Course & Grade Level: Architectural Design & Fabrication, 10-12

Summary and Rationale

Everything in the man-made world is designed with a purpose in mind, whether that purpose is functional or aesthetic. However, there are many times where people do not ask the question of why something was made the way it is. This unit will allow students an opportunity to examine the architecture of a variety of designs and determine the reasons behind the design choices made.

Recommended Pacing

20 days

NJ Student Learning Standards

8.2 Technology Education, Engineering, and Design: All students will develop an understanding of the nature and impact of technology, engineering, technological design, and the designed world, as they relate to the individual, global society, and the environment.

Strand C - Design: The design process is a systematic approach to solving problems.

Strand D - Abilities for a Technological World: The designed world is the product of a design process that provides the means to convert resources into products and systems.

CPI #	Cumulative Progress Indicator (CPI)
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 (ergonomics)
8.2.12.C.5	Create scaled engineering drawings of products both manually and digitally with materials and measurements labeled
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 Career and Technical Education	
9.3.12.AC-DES.2	Use effective communication skills and strategies (listening, speaking, reading, writing, and graphic communications) to work with clients and colleagues
9.3.12.AC-DES.6	Apply the techniques and skills of modern drafting, design, engineering and construction to projects

Unit Enduring Understandings

- All design decisions are made with a purpose in mind.
- Meaning can be found both in function and aesthetics.
- Different cultures throughout history expressed themselves through their own unique design styles and ideas.
- The architecture of design can be studied through any man-made product.

Unit Essential Questions

- Why are there so many different variations of design styles?
- What makes certain design styles unique over others?
- Why did certain cultures and civilizations design their world in the styles they chose?
- What stands out about modern design styles used in the 21st century?
- Do any modern design styles reference back to those used in a previous time period?

Objectives

Students will know:

- How to analyze designs to determine the purpose of different design choices
- How to recognize different design styles and techniques from different civilizations

Students will be able to:

- Identify the defining elements of a design
- Apply either classic or modern design styles to a product they create

Evidence of Learning

Assessment

Common Assessment 4.1

Competencies for 21st Century Learners

X	Collaborative Team Member	X	Effective Communicator
X	Globally Aware, Active, & Responsible Student/Citizen	X	Information Literate Researcher
X	Innovative & Practical Problem Solver	X	Self-Directed Learner

Resources
- http://static.davidreport.com/2011/04/dr_2011_13_1.pdf - http://www.diynetwork.com/how-to/rooms-and-spaces/exterior/26-popular-architectural-home-styles-pictures - http://www.humanfactors.com/newsletters/cross-cultural-considerations-for-user-interface-design.asp
Materials
- Unit 1 - 4 materials

Unit 6: Final Design Project

Content Area: Engineering

Course & Grade Level: Architectural Design & Fabrication, 10-12

Summary and Rationale

Students will end the course with a final design project that is meant to assess their knowledge, skills, and abilities developed through the year. This project will take the form of a design challenge that will also require students to apply their critical thinking abilities that were learned from Architectural Design and Fabrication and reinforced throughout the course of this class.

Recommended Pacing

20 days

NJ Student Learning Standards

8.2 Technology Education, Engineering, and Design: All students will develop an understanding of the nature and impact of technology, engineering, technological design, and the designed world, as they relate to the individual, global society, and the environment.

Strand A - The Nature of Technology: Creativity and Innovation Technology systems impact every aspect of the world in which we live.

Stand C - Design: The design process is a systematic approach to solving problems.

Strand D - Abilities for a Technological World: The designed world is the product of a design process that provides the means to convert resources into products and systems.

CPI #	Cumulative Progress Indicator (CPI)
8.2.12.C.5	Create scaled engineering drawings of products both manually and digitally with materials and measurements labeled.
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 Career and Technical Education	
9.3.12.AC-DES.2	Use effective communication skills and strategies (listening, speaking, reading, writing, and graphic communications) to work with clients and colleagues

9.3.12.AC-DES.6	Apply the techniques and skills of modern drafting, design, engineering and construction to projects
9.3.12.AC.6	Read, interpret and use technical drawings, documents and specifications to plan a project

Unit Enduring Understandings

- Engineering is a collaborative process in which many of its different fields come together in order to design a product.
- Communicating an engineering design requires effective visual representation.
- The Design Loop is an essential process in problem solving.
- Design plays an important role in the creation of products and prototyping.
- All design decisions are made with a purpose in mind.
- Many man-made objects need to be designed with the human form in mind.

Unit Essential Questions

- What are the specifications/limitations of this project?
- What kinds of technical expertise you will need and/or develop as a result of undertaking this project?

Objectives

Students will know:

- How to combine the skill sets from multiple engineering fields
- How to address a problem using technology and the design process
- Integrate different fields of engineering to design a prototype
- Incorporate math and science principles in relation to technology and engineering

Students will be able to:

- Create a technical drawing that will provide an initial visual basis for the solution to their problem.
- Develop a CAD drawing that will act as a final solution sketch
- Solve a problem using various modeling techniques and materials
- Apply an architectural design style to a product
- Design a product that keeps human form and function in mind

Evidence of Learning			
Assessment			
Common Assessment 5.1			
Competencies for 21st Century Learners			
X	Collaborative Team Member	X	Effective Communicator
X	Globally Aware, Active, & Responsible Student/Citizen	X	Information Literate Researcher
X	Innovative & Practical Problem Solver	X	Self-Directed Learner
Resources			
- Unit 1 - 5 resources			
Materials			
- Unit 1 - 5 materials			