Wayne
Township Public Schools

Applied Technology
11-12
Computer Aided Design III
6/3/2022
Patrick Slater/Alina Duran

Wayne School District
Curriculum Format

Content Area/ Grade Level/ Course:	**Applied Technology** **Grades 11-12** **Computer Aided Design III**
Unit Plan Title:	**Unit 1 Industrial Design**
Time Frame	**12 Weeks**

Anchor Standards/Domain* ***i.e: ELA: reading, writing i.e.: Math: Number and Operations in Base 10**

8.2 Design Thinking This standard, previously standard 8.2 Technology Education of the 2014 NJSLS – Technology, outlines the technological design concepts and skills essential for technological and engineering literacy. The new framework design, detailed previously, includes Engineering Design, Ethics and Culture, and the Effects of Technology on the Natural world among the disciplinary concepts

9.2 Career Awareness, Exploration, Preparation and Training. This standard outlines the importance of being knowledgeable about one's interests and talents, and being well informed about postsecondary and career options, career planning, and career requirements.

Standard 9.4 Life Literacies and Key Skills. This standard outline key literacies and technical skills such as critical thinking, global and cultural awareness, and technology literacy* that are critical for students to develop to live and work in an interconnected global economy.
Anchor Companion Standards (Reading and Writing Grades 11-12)

Unit Overview

Industrial designers create with mass production in mind – carefully considering how the intended function of a product affects its form and vice versa. Digital modeling and fabrication tools allow designers to rapidly prototype their ideas virtually and physically. The digital medium encourages (if it doesn't require) consideration of the relationship between mathematics and aesthetic quality.

Students are asked to complete a series of industrial design and modeling challenges. They engage in the Process of Design to model a problem, research precedents, and develop solutions. They investigate the real world application of mathematics concepts that are critical to surface modeling. They are introduced to third party services that can help them fabricate prototypes, market their work, and mass produce products. As the unit progresses, students supplement their existing knowledge of surface modeling technology to prepare for a professional software certification exam.

Standard Number(s) * **i.e: Math: 3.NBT.1 i.e.: RL 8.1**

Progress Indicators- Reading and Writing Standards Grades 9-10
Progress Indicators- Reading and Writing Grades 11-12

8.2.12.ED.1: Use research to design and create a product or system that addresses a problem and make modifications based on input from potential consumers.

8.2.12.ED.2: Create scaled engineering drawings for a new product or system and make modification to increase optimization based on feedback.

8.2.12.ITH.2: Propose an innovation to meet future demands supported by an analysis of the potential costs, benefits, trade-offs, and risks related to the use of the innovation.

8.2.12.NT.2: Redesign an existing product to improve form or function.

9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas (e.g., 1.1.12prof.CR3a

9.4.12.CT.1: Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3).

9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).

9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions (e.g., S-ID.B.6a., 8.1.12DA.5, 7.1.IH.IPRET.8)

9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.

Intended Outcomes - {Essential Questions}

- What roles do precedents have in the creation of new ideas?
- How do a surface's mathematical properties affect its visual quality?
- How do we account for variation in the manufacturing process?
- Why is it advantageous to earn a professional certification?
- Can we streamline the process of communicating with our partners?
- How can we enhance our ability to edit our designs?
- How do professionals incorporate this technologd it?
- How can I prototype and mass produce my idea?
- How does industrial design compare to architecture and engineering?
- What ia a tolerance and what significance do they have in the design and manufacturing process?
- How are virtual studios constructed and how are y in their work?
- What will my product look like once I've fabricatethey used during the design process?
- What comparisons can be made among various surfacing techniques?

Enduring Understandings

- Design can be thought of as a cyclical evolution of ideas: Identify problems, research, conceptualize solutions, develop solutions, prototype, test, identify problems…
- There are relationships between mathematics and the arts.
- Tolerances ensure that mass produced components will function correctly in an assembly.
- Certification demonstrates technical competence and a commitment to professional development.
- Software tools can streamline the process of sharing, combining, and updating group work.

- We can minimize control points and allow the computer to interpolate the results.
- Case studies allow us to learn from the experiences of others.
- We can use visualization tools to create illustrations of our work.
- 3D printing services provide cost effective methods for producing prototypes and distributing products.
- Industrial designers often create things that are meant to be mass-produced.

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In this unit plan, the following 21st Century themes and skills are addressed.

Check all that apply. 21st Century Themes		*Indicate whether these skills are **E**-Encouraged, **T**-Taught, or **A**-Assessed in this unit by marking **E, T, A** on the line before the appropriate skill.* 21st Century Skills	
X	Global Awareness	A	Creativity and Innovation
X	Environmental Literacy	A	Critical Thinking and Problem Solving
	Health Literacy	A	Communication
X	Civic Literacy	A	Collaboration
X	Financial, Economic, Business, and Entrepreneurial Literacy		

Student Learning Targets/Objectives (Students will know/Students will understand)

Students will:

- Review fundamental modeling techniques.
- Complete surface modeling challenges.
- Prepare for software certification.
- Use technology to coordinate group efforts.
- Learn industrial surfacing concepts.
- Model an existing condition.
- Respond to design constraints.
- Document their design solution
- Learn curve and surface sculpting techniques.
- Study surface modeling case studies.
- Understand best modeling practices for digital fabrication.
- Compare industrial design to other design professions.

Assessments (Pre, Formative, Summative, Other) ***Denote required common assessments with an ****

- **Pre-assessments**
  - Diagnostic tasks
  - Anticipatory sets
- **Formative assessments**
  - Group discussion
  - Individual conference

- Verify understanding during guided activities
- Peer assessment
- Self assessment
- Reflection and goal-setting

○ **Summative assessments**

- Quizzes
- Performance tasks

Teaching and Learning Activities	
Activities	**Unit overview** ● Direct vs parametric modeling ● Modeling challenges / Past student work ● Professional credential **Modeling review** ● Boolean operations ● Surfacing tools ● Surface modification ● History editing **Modeling challenge** ● Process of design ● Virtual studio ● Using calipers **Coordinating with teammates** ● File sharing ● Blocks ● External references **Class 'A' surfacing concepts** ● Math review: Graphing, continuity, and curvature ● Relationship between mathematics and aesthetics ● Curve and surface analysis **Design challenge** ● Technical reference materials ● Design constraints ● Tolerance **Case studies** ● Soft corners ● Domes ● Creased surfaces **Illustration** ● Materiality and lighting ● Rendering ● Non-photorealistic techniques **Digital fabrication: Outsourcing** ● Materials and costs ● Design Specifications ● Mass Production

	Professional credentialing challenge ● Pre-assessment ● Technical reference ● Software resources
Differentiation Strategies	**Tiered performance tasks:** ○ **Capstone:** ● Students complete training and assessment in preparation for certification exams. ● Students complete industrial design modeling challenges. ○ **Extension:** ● An advanced student may design a virtual prototype of an object for rapid iteration. They use a third-party to fabricate a high quality model. ● An advanced student may use an alternative rendering engine to produce superior illustrations. ○ **Accommodation:** ● Students work in project teams to model and fabricate components that have a smaller degree of difficulty. ● Design requirements and timetables are scaled back to allow students to succeed at their own pace. ● Individual and collaborative research, design and problem solving ● Student interest and skill level assessment ● Individual, small group, and large group instruction ● Differentiated checklists and rubrics ● Level of independence ● Differentiation Strategies for Special Education Students ● Differentiation Strategies for Gifted and Talented Students ● Differentiation Strategies for ELL Students ● Differentiation Strategies for At Risk Students
Windows	

Resources

- Calipers
- CAD workstations/software
- BYOD resources
- Internet
- Google Classroom
- Projection system
- Student monitoring system
- Reference materials
- Readings and problem sets

- 3D fabrication equipment/proprietary software

Wayne School District
Curriculum Format

Content Area/ Grade Level/ Course:	**Applied Technology** **Grades 11-12** **Computer Aided Design III**
Unit Plan Title:	**Unit 2 Engineering Modeling**
Time Frame	**12 Weeks**

Anchor Standards/Domain* ***i.e: ELA: reading, writing i.e.: Math: Number and Operations in Base 10**

8.2 Design Thinking This standard, previously standard 8.2 Technology Education of the 2014 NJSLS – Technology, outlines the technological design concepts and skills essential for technological and engineering literacy. The new framework design, detailed previously, includes Engineering Design, Ethics and Culture, and the Effects of Technology on the Natural world among the disciplinary concepts

9.2 Career Awareness, Exploration, Preparation and Training. This standard outlines the importance of being knowledgeable about one's interests and talents, and being well informed about postsecondary and career options, career planning, and career requirements.

Standard 9.4 Life Literacies and Key Skills. This standard outline key literacies and technical skills such as critical thinking, global and cultural awareness, and technology literacy* that are critical for students to develop to live and work in an interconnected global economy.

Anchor Companion Standards (Reading and Writing Grades 11-12)

Unit Overview

CAD tools derive their effectiveness from their ability to accurately model geometry. Engineering modeling tools take this a step further: Their power lies in their ability to model the intent of the designer. This allows engineers to encode conceptual design in their digital models. Adjustments to the concept can immediately propagate to the final result – saving incredible amounts of time and effort.

This unit is a continued exploration of advanced engineering modeling and assembly techniques. Students not only model mechanical parts and assemblies, but they design their models to most effectively maintain conceptual intent. Students verify their understanding by collaborating to complete an engineering modeling challenge.
Students supplement their knowledge of engineering modeling technology to prepare for a professional software certification exam. We use the opportunity to discuss some of the educational and professional requirements and opportunities for engineers.

Standard Number(s) *** i.e: Math: 3.NBT.1 i.e.: RL 8.1**

Progress Indicators- Reading and Writing Standards Grades 9-10
Progress Indicators- Reading and Writing Grades 11-12

8.2.12.ED.1: Use research to design and create a product or system that addresses a problem and make modifications based on input from potential consumers.

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9.4.12.CT.1: Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3).

9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).

9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions (e.g., S-ID.B.6a., 8.1.12DA.5, 7.1.IH.IPRET.8)

9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.

Intended Outcomes - {Essential Questions}

- Why is it advantageous to earn a professional certification?
- What are the comparisons for licensure between architects and engineers?
- Can a high school graduate become a licensed engineer/architect without going to college?
- What is reciprocity?
- What is the purpose of a gear?
- What types of gears are used for transferring motion?
- What are the key aspects of a spur gear's geometry?
- What is the benefit of specifying and using equations?
- What is a linkage?
- What is interpolation?
- How can you enhance your productivity with a CAD tool?
- How can you enhance your productivity as a modeler?
- How do assemblies differ from multi-part components?
- How are predefined components applied to assemblies?
- What is the function of a cam?
- What are the essential parameters associated with cam design?
- What is meant by degree of freedom?
- What are interferences?
- How are computer simulations used in the design process?

Enduring Understandings

- Certification demonstrates technical competence and a commitment to professional development.
- Licensed professionals enjoy many benefits including higher salaries, professional prestige, job security, and the right to operate a firm.
- Gears transmit torque. A gear's geometry can be optimized to maximize its efficiency.
- Equations add a useful layer of design intent to engineering models.
- Linkages provide a desired output motion in response to a specified input motion.
- Designers can define key moments in a timeline, and leave the computer to resolve the rest.
- Taking the time to devise a strategy in advance can significantly enhance your productivity during the course of a project.
- Virtual simulations are viable alternatives to physical prototyping. They can save time, labor, materials, and money.

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	Global Awareness	A	Creativity and Innovation
	Environmental Literacy	A	Critical Thinking and Problem Solving
X	Health Literacy	A	Communication
X	Civic Literacy	A	Collaboration
X	Financial, Economic, Business, and Entrepreneurial Literacy		

Student Learning Targets/Objectives (Students will know/Students will understand)

Students will:

- Produce parametric drawings.
- Manage project parameters.
- Model mechanical components.
- Use geometric relationships to assemble parts.
- Complete tasks to prepare for software certification.
- Know pathways to licensure for engineers.
- Define equations to automate modifications.
- Model a gear to required design specifications.
- Model and simulate a linkage.

- Work in a project team to model and document a mechanism.

Assessments (Pre, Formative, Summative, Other) ***Denote required common assessments with an ****

o **Pre-assessments**
- Diagnostic tasks
- Anticipatory sets

o **Formative assessments**
- Group discussion
- Individual conference
- Verify understanding during guided activities
- Peer assessment
- Self assessment
- Reflection and goal-setting

o **Summative assessments**
- Quizzes
- Performance tasks

Teaching and Learning Activities

Activities	**Unit Overview** ● Professional credentials ● Mechanisms ● Design challenge **Drawing toolset** ● Placing views ● View types ● Annotations **Project setup** ● Material properties ● Units and measurement ● Adjusting project coordinate systems **Assembly fundamentals** ● Placing components ● Geometric mates/constraints ● Defining angular relationships ● Working with reference geometry **Professional credentialing challenge** ● Drawings ● Modeling ● Assemblies **Path to the Profession** ● Rationale for licensure and credentials ● Educational requirements and opportunities

	• Exams and professional development **Equations** • Evaluation • Expressions • Variables **Gears** • Technical reference • Drafting an involute • Geometry of a gear • Types of gear systems **Linkages** • Degrees of freedom • Links and joints • Case studies **Simulation** • Interpolation • Motor • Export and share **Assembly techniques** • Advanced / mechanical mates/constraints • In-context modeling • Conceptual modeling **Digital fabrication: 3D printer** • Design specifications • Materials • Hardware settings **Engineering modeling challenge** • Problem solving process • Development • Presentation
Differentiation Strategies	**Tiered performance tasks:** **o Capstone:** • Students complete training and assessment in preparation for certification exams. • Students complete engineering modeling challenges. **o Extension:** • An advanced student may design a virtual prototype of a part or mechanical assembly for rapid iteration. They use a third party to fabricate a high quality model. • An advanced student may produce animations for visualization of complex linkages. **o Accommodation:** • Students work in project teams to model and fabricate components that have a smaller degree of difficulty. • Design requirements and timetables are scaled back to allow

	students to succeed at their own pace.
Windows	

Resources

- Calipers
- CAD workstations/software
- BYOD resources
- Internet
- Google Classroom
- Projection system
- Student monitoring system
- Reference materials
- Readings and problem sets

Wayne School District
Curriculum Format

Content Area/ Grade Level/ Course:	**Applied Technology** **Grades 11-12** **Computer Aided Design III**
Unit Plan Title:	**Unit 3 Building Information Modeling**
Time Frame	**12 Weeks**

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Anchor Companion Standards (Reading and Writing Grades 11-12)

Unit Overview

For architects, Building Information Modeling represents a significant advance in design and visualization technologies. A CAD drawing is a collection of geometry, but a BIM model can be conceptualized as a database of building components and their assembly. The walls and floors that were once modeled as 3D solids are now modeled as walls and floors. This allows designers to define relationships and behavior. If we decide to adjust a level, the floor and the wall move with it. This technology is powerful, and the advantage in efficiency that it offers is widely recognized. However, its effective use requires a significant amount of domain specific knowledge from the modeler. During this unit, students leverage the power of BIM technology to create a virtual architectural model. They design spaces with technical, legal, and programmatic restrictions in mind. They consider the design of the model as well as the design of the building to ensure that potential modifications propagate through the project predictably. As the unit progresses, students produce a draft set of architectural drawings and renderings that they continue to refine for their portfolios.

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Intended Outcomes - {Essential Questions}

- Compare zoning, codes, and standards. Why are regulations important?
- What is a program? Who develops it?

- How is the living space in your home organized? How would you improve its layout?
- How does a building's orientation affect its design?
- What is a drawing set?
- Where can you find standards for stair design?
- What can you do to make a stair dangerous?
- What governs the width of the hallways in your home? In your school?
- We know that BIM has revolutionized the practice of architecture. What are some other industries that have begun to rely on BIM?
- Why is visualization critically important to any designer?
- Compare the path to licensure for architects and engineers. Can a high school graduate become a licensed engineer/architect without going to college?
- What is reciprocity?

Enduring Understandings

A design usually starts as a conceptual idea and develops into increasingly tangible forms.
Architects adhere to rules that are designed to ensure public safety and preserve the character of communities.
An architect will often design the way a building is used as well as the physical edifice.
Typical layout strategies consider solar orientation, circulation, layers of privacy, and functional requirements.
Architects are responsible for producing documents that govern the fabrication of the built environment.
Designers use technical references to ensure compliance with standards and regulations. BIM is used in a variety of industries that involve the creation of spaces and architectural details such as: set design, interior design, illustration, interactive design, and industrial design.

Designers use illustration as a tool to refine their own ideas, to communicate their intentions to clients, and to market their work. Licensed professionals enjoy many benefits including higher salaries, professional prestige, job security, and the right to operate a firm.

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	Global Awareness	**A**	**Creativity and Innovation**
X	**Environmental Literacy**	**A**	**Critical Thinking and Problem Solving**
X	**Health Literacy**	**A**	**Communication**

X	**Civic Literacy**	A	**Collaboration**
	Financial, Economic, Business, and Entrepreneurial Literacy		

Student Learning Targets/Objectives (Students will know/Students will understand)

Students will:

- Understand fundamental regulations for architectural design.
- Review the process of design.
- Analyze architectural reference material.
- Model pre existing project conditions.
- Establish reference elements.
- Define project constraints.
- Model the building envelope.
- Implement strategies for designing architectural layouts.
- Produce design documents.
- Create custom components.
- Experiment with CGI techniques to render scenes.
- Create solar studies and walkthrough animations.

Assessments (Pre, Formative, Summative, Other) *Denote required common assessments with an **

o **Pre-assessments**

- Diagnostic tasks
- Anticipatory sets

o **Formative assessments**

- Group discussion
- Individual conference
- Verify understanding during guided activities
- Peer assessment
- Self assessment
- Reflection and goal-setting

o **Summative assessments**

- Quiz
- Performance task

Teaching and Learning Activities

Activities	**Unit overview** ● Precedent ● Design ● Presentation **Constraints** ● Zoning, codes, and standards ● Building shell

- Programming

Site

- Location and orientation
- Topography and surroundings
- Building pad
-

Digital fabrication: Laser cutter

- Designing the model
- Materials
- Preparing outlines

Datum

- Reference geometry
- Relationships and constraints
- Structure

Envelope

- Exterior walls
- Roof
- Fenestration

Interiors

- Floors / ceilings
- Partitions
- Stairs / rails

Documentation

- Drawing set
- Annotations
- Scheduling

Material editor

- Procedurals
- Bitmaps
- Material palette

Visualization

- Composing views
- Solar study
- Rendering parameters

Conceptual Design

- Spatial relationships
- Layout strategies
- Diagramming

Development

- Building sections
- Floor plans
- Elevation layouts

Stair design

- Standards for stairs
- Customizing risers and treads
- Customizing railings

Differentiation Strategies	Tiered performance tasks: **o Capstone:** ● Students analyze reference materials. ● Students use BIM technology to produce architectural models and drawings. ● Students use CGI tools to produce renderings and animations. **o Extension:** ● Students may produce enhanced architectural illustrations of their projects. ● Students may preview 3D printing technology to generate a physical model of their building or its details. **o Accommodation:** ● Students may use BIM technology to digitize a set of dimensioned drawings. ● Students may work in a project team to develop simpler aspects of the building model.
Windows	

Resources

CAD workstations/software
BYOD resources
Internet
Google Classroom
Projection system
Student monitoring system
Reference materials
Readings and problem sets