Wayne
Township Public Schools

Applied Technology
Grades 10 - 12
Computer Aided Design II
6/3/2022
Patrick Slater/Alina Duran

Wayne School District
Curriculum Format

Content Area/ Grade Level/ Course:	**Applied Technology** **Grades 10-12** **Computer Aided Design II**
Unit Plan Title:	**Unit 1 Bridge to Advanced 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 9-10)

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

Unit Overview

CAD systems have sophisticated tools for automating fundamental geometric constructions. However, the creation of more complex constructions often requires the intervention of the designer. As this unit progresses, students leverage their knowledge of geometry to develop increasingly complex constructions that have applications in architecture and engineering.

Students review the fundamentals of analytic sketching, best practices for digital drafting, and modeling techniques. They analyze verbal and graphic descriptions of design parameters and produce the appropriate models and drawings in response. This unit includes an introduction to digital fabrication technologies such as 3D printing and laser cutting.

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 are some disciplines that make use of CAD technology?
- What is analytic drawing?
- What is the difference between additive and subtractive sketching technique?
- What are some of the CAD tools that are available to us in the lab and how do they differ?
- Why is the understanding of geometric construction prior to drawing in CAD important?
- Why is it important to understand geometric relations even though CAD can automate the process?
- How can we use CAD to draw some basic geometric constructions?
- Name a specific complex construction, describe how it is generated, and discuss its application in engineering or architecture.
- What constitutes good 3D modeling practices in order to avoid modeling failures?
- How are 3D models prepared for prototyping?
- What role could the use Venn Diagram have in understanding the modeling process?
- How do various surfacing techniques differ?
- How are spline objects created and edited?
- What are the three basic modeling operations that are generated using splines?

Enduring Understandings

- Designers in a variety of disciplines use CAD technologies to produce work accurately and economically.
- There are many conceptual similarities between certain 'traditional' sketching methods and digital modeling.
- Different CAD tools have various strengths that are appropriate to different situations.
- CAD systems have several tools to help us draw quickly and accurately.
- Computers cannot design. It is up to designers to appropriately utilize the technologies at their disposal.
- Designers use geometry to improve the quality of the things that they design.
- Understanding how 3D modeling applications generate forms from two-dimensional entities allows us to quickly troubleshoot modeling problems.
- We should take the time to learn how to use our lab tools safely, effectively, and economically.

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

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

Students will:

- Develop expectations for the course and their own performance.
- Explore a variety of design professions.
- Complete visualization tasks.
- Learn best practices for freehand sketching.
- Review best practices for drafting with CAD tools.
- Compare techniques used to generate geometric constructions.
- Solve 'word problems': Create graphics from a verbal problem brief.
- Use geometric constructions to solve design problems.
- Complete a multi-stage 3D modeling task.
- Use digital fabrication/prototyping technologies.

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	**Course Overview** ● Policies and safety ● Past and anticipated projects ● Survey of lab resources ● Introduction to careers **Analytic Sketching**

	● Fundamental techniques ● Single-view sketching ● Elevation oblique **Digital Drafting** ● Coordinate system review ● Transformation review ● Interface – Advanced parameters **Technical Drawing** ● From a graphic description ● From a verbal description ● Problem solving – Respond to multiple constraints **Geometric Constructions** ● Triangles ● Bisectors ● Tangencies **Surface Modeling Systems** ● Surfacing techniques ● Survey of applications ● Use in professional and academic practice **Modeling Fundamentals** ● System interface ● Venn diagrams / Boolean operations ● Troubleshooting 2D to 3D operations **Spline modeling** ● Extrusion ● Revolution ● Sweeping **Modeling Task** ● Interpreting reference material ● Construct 2D entities ● Develop 3D models **Digital Fabrication** ● Safety briefing ● Model integrity ● Software and hardware primer
Differentiation Strategies	**Tiered performance tasks:** ○ **Capstone:** ● Students use CAD technology and their knowledge of 2D and 3D geometric constructions to produce digital drawings and models based on a set of provided reference materials. They generate a 3D print of some part of the digital model. ○ **Extension:** ● Students are given variant problems that reflect a higher degree of difficulty. The problems may be less numerous, but contain more layers of information to dissect and model. They print more complex forms that require the use of load-bearing scaffolds. ○ **Accommodation:** ● The initial descriptions of the problems may be simplified into step-by-step instructions. The problem, desired results, and required constraints may be simplified according to the needs

	of the student.
Windows	

Resources

- CAD workstation/software
- BYOD resources
- Sketching materials
- Internet
- Google Classroom
- Projection system
- Student monitoring system
- Reference materials
- Readings and problem sets
- Digital fabrication hardware/ proprietary software/consumable materials

Wayne School District
Curriculum Format

Content Area/ Grade Level/ Course:	**Applied Technology** **10-12** **Computer Aided Design II**
Unit Plan Title:	**Unit 2 Engineering Modeling and Design**
Time Frame	**Twelve 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 9-10)

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

Unit Overview

During this unit, we introduce students to feature-based, parametric modeling techniques and applications that are widely employed in engineering and architecture. Feature-based modeling utilizes representations of real-world objects and manufacturing processes instead of pure geometry. Where a direct modeling system would see a quarter of a circle or a double line, a feature-based system sees a fillet or a wall and responds appropriately.

After a review of fundamental three-dimensional modeling techniques, students are introduced to an industry standard feature-based modeling system. Students continue to develop the ability to model three-dimensional forms as they learn best practices for parametric modeling. They compare the advantages and disadvantages associated with both direct and parametric modeling platforms so that they can make informed choices and observations about the use of these technologies.

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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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 is meant by Design Intent?

- How does direct modeling compare/contrast to parametric modeling?
- How can you determine the definition of a sketch at a glance?
- What are the relationships between sketch geometry to construction geometry?
- What is a feature and what does it mean to edit the history of model?
- What are the differences between Sketched Features and Placed Features?
- What is a parametric assembly?
- Why is it important to visualize the orthographic views of a 3D model?
- How can virtual simulations be used to illustrate the motion of components in a mechanism ?
- What are the tools, techniques, and strategies for 3D modeling ?
- How are constraints used in the Parametric modeling process?
- How can 3D models be constructed for efficient future editing?
- How are drawings generated from 3D models?
- A drawing is an integral part of a parametric model, how does modifying a model affect a drawing?
- How are digital renderings used as component of the design process?
- How are 3D digital models prepared for 3D printing or CNC operations?

Enduring Understandings

- A machine uses energy to perform an intended action. It can be made of one or more parts.
- We can use virtual simulations to illustrate the motion of components in a mechanism.
- There are many tools, techniques, and strategies for 3D modeling – each with its own advantages and limitations.
- Parametric modeling often involves defining and modifying constraints.
- We can take advantage of patterns and relationships to automate the modeling and editing processes.
- Models should be designed so they can be edited efficiently. They should respond to changes predictably.
- Parametric features are often analogous to fabrication processes.
- Engineers often design to make use of commonly found components.
- Modification made to parts automatically propagate to their instances in assemblies.
- It is possible to automatically generate drawings from 3D models.
- All modeling begins with an understanding of the model's Design Intent.
- Digital 3D models can be fabricated using Additive and Subtractive operations.

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

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

Students will:

- Understand the advantages and limitations of direct and parametric modeling.
- Cite examples of parametric modeling in professional practice.
- Use best practices for generating parametric sketches and parts.
- Utilize features to modify parts.
- Learn and use strategies to maintain design intent.
- Complete visualization tasks.
- Learn how a particular machine functions.
- Complete parametric modeling challenges.
- Utilize pre-defined libraries.
- Create assemblies and multipart components.
- Generate drawings from parts or assemblies.
- Simulate mechanisms in virtual assemblies.

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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

- Comparison of direct modeling and parametric modeling
- Parametric modeling in professional practice
- Parts, assemblies, drawings, and simulations

Engineering case study

- Components
- Function
- Simulation

Feature based modeling concepts

- Feature-based modeling system overview
- Modeling fundamentals
- Solid modeling as a simulation of fabrication

Working with sketches

- Sketch geometry
- Dimensions and relationships
- Definition (fully defined / over-defined / under-defined)

Utilizing features

- Fundamental 3D operations
- Editing with history
- Best practice: 2D vs. 3D features

Using pre-defined elements

- Hole wizard
- Model library
- Applying materials

Modeling for change and iteration

- Design intent
- Constraints
- Formulas

Creating assemblies

	• Bottom-up vs. top-down (model then assemble or in context modeling) • External references • Constraints and mating **Simulating mechanisms** • Interference checking • Applying forces • Exporting animations **Communicating with drawings** • Placing and coordinating views • View types • Automatic versus manual dimensioning **Model Fabrication** • Additive operations (3D printing) • Subtractive operations CNC machining • Model preparation **Digital Rendering** • Materials • Scenes and Image Based Lighting • Rendering effects

Wayne School District
Curriculum Format

Content Area/ Grade Level/ Course:	**Applied Technology** **Grades 10-12** **Computer Aided Design**
Unit Plan Title:	**Unit 3 Architectural Modeling and Design**
Time Frame	**12 Weeks**
Anchor Standards/Domain*	***i.e: ELA: reading, writing i.e.: Math: Number and Operations in Base 10**

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Anchor Companion Standards (Reading and Writing Grades 9-10)

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Unit Overview

Building Information Modeling (BIM) is a technology that is derived from engineering parametric modeling. It is widely used by architects, engineers, interior designers, and anyone who needs to represent, construct, and analyze spaces.
Instead of using CAD drafting tools to create a series of two-dimensional drawings to represent a building, construction professionals use BIM tools to create a single, complete three-dimensional representation of the edifice. The role of coordinating relationships among plans, sections, and elevations is now left to the computer – allowing designers to rapidly and accurately produce schematics and edit construction documents.
During this unit, students compare technologies and techniques for digital drafting, engineering modeling, and architectural modeling. They learn best practices for modeling 'components' – BIM entities that can be used and easily edited by others to assemble digital models of buildings. As the unit continues, they explore the relationships among their core subjects and the architectural design process. They learn industry specific terminology and architectural design standards. By the end of the unit, students will be familiar with the design of a small building and they will have used BIM tools to create a virtual replica of it.

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

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Intended Outcomes - {Essential Questions}

- Compare how architectural drawings were produced in 1585, 1985, 2000, and today. What are the advantages of more contemporary techniques? What are the disadvantages?
- What is BIM and how does it compare with CAD?
- How do architects use math/science/history to design buildings?
- Define datum. What kind of datum elements do we see in plan and elevation views?
- What is passive solar design? Provide some examples.
- How do building codes dictate and compare to design standards?
- What are some strategies that architects use to organize spaces?
- What is BIM?
- How does BIM compare to conventional CAD techniques?
- How are drawings generated in a BIM system?
- What are the requirements for the placement of Hosted Elements?
- What are the calculation rules for stairs?
- How are topographic models generated?
- How are digital materials applied to architectural elements?
- How can architectural elements be edited to meet the requirements for the intended design?

Enduring Understandings

- BIM systems excel at project coordination.
- BIM brings many of the advantages and limitations of parametric modeling to architecture.
- Architects use mathematical concepts and history to inform their design process.
- A grid is often used to define the conceptual and physical framework of a building.
- BIM requires modeling with a 'kit of parts' specific to architecture.
- Hosting is a way to automatically embed design intent.
- We can conserve resources by designing intelligently.
- Safety should be the primary concern of an architect, engineer, or any designer.
- With careful consideration, we can design spaces that are functional and economical.

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

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

Students will:

- Understand the advantages and limitations of Building Information Modeling.
- Cite examples of Building Information Modeling in professional practice.
- Study the strategy employed to design a significant work of architecture.
- Use best practices for generating parametric components.
- Build a topographic site model.
- Use reference geometry to define the framework of a building model.
- Understand the purpose of a building's foundation.
- Use context specific tools to model and edit building components.
- Identify and model various roof types.
- Know how to generate and edit parametric stairs.
- Generate architectural illustrations.

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** **Computer Aided Design** ● BIM in professional practice ● Components, massing, projects, and drawings ● Comparison of Building Information Modeling and Computer

Architectural case study

- Architect
- Design strategies
- Regulations and standards

Creating component families

- Datum, constraints, and parameterization
- Instance vs. type parameters
- Nesting components

Datum

- Plan vs. elevation
- Managing symbols
- Constraints in ‘project’ mode

Site

- Topography
- Entourage
- Building pad
- Plantings

Foundation

- Purpose and types
- Examples of structural failure
- Implementation in Revit

Envelope

- Construction methods
- Passive solar design
- Modeling building entities

Roof

- Roof types and construction
- Pitch
- Dormers

Stairs

- Building regulations
- Rise/Run calculation
- Overhead clearance

CGI

- Material editor fundamentals

	● Solar simulation ● Still camera setup ● Cloud rendering
Differentiation Strategies	**Tiered performance tasks:** ○ **Capstone:** ● Students are given architectural drawings of a building. As the unit progresses, they analyze and model the building. By the end of the unit, they will have built a digital replica of the building. ○ **Extension:** ● Students may select some part of the building to redesign. They work with the teacher to develop and execute a concept. ○ **Accommodation:** ● In consultation with the teacher, students may omit parts of the assignment. Students may be provided with video tutorials or step-by-step instructions to help them complete the required models.
Windows	

Resources

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