



Computer Aided Design II - Beginning CAD for Architecture, Engineering, and 3D Animation

Course Information

Grade(s):	10-12
Discipline/Course:	Technology Education
Course Title:	Computer Aided Design II - Beginner CAD for Architecture, Engineering, and 3D Animation
Prerequisite(s):	Computer Aided Design I - Introduction to CAD for Architecture, Engineering, and 3D Animation
Course Description: <i>Program of Studies</i>	This course is a continuation of Introduction to CAD and the three areas of concentration. Students will engage with increasingly more advanced CAD concepts and techniques as they apply their CAD skills to real-world projects such as: residential building design, creating construction drawings, or rendering images and video of 3D models. Students will learn about 3D CAD and BIM software, and about creating computer simulations. They will also learn about CAD workflows, such as hand drawing, design and development, construction documentation, and rendering.
Course Essential Questions:	<ul style="list-style-type: none"> ● What is the design process used to go from concepts to finished products? ● How can I communicate my design ideas clearly and efficiently? ● How do people use drawings and computer software to design the products around us? ● How can CAD software communicate interesting functional design ideas clearly and efficiently? ● What are the different ways that design can improve quality of life and influence our culture and society? ● How is CAD used to solve issues pertaining to function, aesthetics, budget, and environmental impact ● What are the challenges and opportunities of designing for a diverse population with a wide range of needs and preferences? ● What are the challenges and opportunities of using CAD to design for the future, given the uncertainties of climate change and other global trends? ● How can computer modeling tools create realistic representations of objects in real world scenarios? ● How can I utilize the skills and processes learned in the CAD courses combined with my interests to create a prototype/model that solves a real world problem?

	<ul style="list-style-type: none"> • What are the most important elements to include in a design portfolio? • Which elements should be included in a CAD portfolio to most effectively showcase your talents and skills?
Course Enduring Understandings:	<ul style="list-style-type: none"> • The design process requires the use of hands-on abilities, such as measuring, drawing, sketching, working with computers, and using tools. • Design is a problem-solving discipline that must consider a wide range of factors, including function, aesthetics, budget, and environmental impact. • Design is a distinctive process with a number of defining characteristics: it is purposeful; it is based on certain requirements; it is systematic, iterative and creative and there are many possible solutions. • 3D real world objects can be represented by 2D orthographic and perspective drawings. • Construction is a complex process that involves many different materials and systems and there is usually more than one way to create desired shapes when building 3D computer models • There is usually more than one way to create desired shapes when building 3D computer models • There are many factors that influence a design, including: safety, reliability, quality control, costs, environmental concerns, manufacturability, maintenance, ergonomics, etc.. • Choosing materials and systems involves weighing tradeoffs such as efficiency vs cost, and practicality vs beauty. • Architecture has a significant impact on our lives. The buildings we live in, work in, and learn in can shape our moods, our productivity, and even our sense of well-being. • There are many factors that influence a design including: safety, reliability, quality control, costs, environmental concerns, manufacturability, maintenance, and ergonomics. • Problem solving means facing obstacles and devising a solution to overcome them • CAD is a creative discipline that allows us to express ourselves in unique ways.
Duration/Credit:	Full year/1.0 credit
Course Materials/Resources:	Drawing tools, computers, software, internet, projector/screen, 3D printing technology, basic hand tools, building supplies. CT Technology Education Standards 2014 as called out in independent Units.

FPS Course Academic Expectation(s):	CI: Conveying Ideas, CC: Creating and Constructing, UCT: Using Communication Tools
Year at a Glance (Units):	Unit 1 – Drawing Basic Elevations and Site Plans, Perspective Drawing (4-5 weeks) Unit 2 – Basic Design Processes and Workflows (3-5 weeks) Unit 3 – Novice Level CAD Tools and 3-D Modeling Techniques (5-6 weeks) Unit 4: Simulating Physics Systems, PBR Materials, Lighting and Rendering Images (3-5 weeks) Unit 5 – Introduction to sustainable materials and design. -(2-3 weeks) Unit 6- Prototyping, Model-making and Animation Production. (5-8 weeks) Unit 7 – Final Summative Project and Creating a Design Portfolio (8 weeks)

Unit Number and Title:	Unit 1: Drawing Basic Elevations, Site Plans, Two and Three Point Perspectives.
Duration:	4-5 weeks
Resource(s):	Computers, projector, paper, pencils, pens, erasers, internet connection
Unit Overview:	This unit introduces students to hand drawing skills. Students will learn the basics of drawing varied views in proportion and two and three point perspectives. These are essential skills for architects, engineers and 3D modeling and animation. Students learn how to construct two and three point perspective drawings using simple geometric shapes. Drawing subjects increase in difficulty and complexity leading directly to the use of CAD software for 3D drawing.
Learning Goals	
Standard(s):	CADD.02.04 Describe and demonstrate the use of graphic communication skills through sketching. CADD.05.11 Explain and demonstrate the process for creating orthographic, isometric, section views, and auxiliary view CADD.08.01 Produce proportional two- and three-dimensional sketches and designs. CADD.08.02 Use sketching techniques as they apply to a variety of objects.
Essential Question(s):	<ul style="list-style-type: none"> • How can I communicate my design ideas clearly and efficiently? • How do people use drawings and computer software to design the products around us?
Enduring Understanding(s):	<ul style="list-style-type: none"> • The design process requires the use of hands-on abilities, such as measuring, drawing, sketching, working with computers, and using tools. • 3D real world objects can be represented by 2D orthographic and perspective drawings.
Learning Goal(s): <i>Students will know and will be able to use their learning to:</i> (Content/ Skills)	Content: (Students will know...) <ul style="list-style-type: none"> • different types of elevation views and site plans. • the importance of perspective and proportion when creating accurate and realistic drawings with two and three point perspectives.

- symbols used in shop drawings, animations, elevations and site drawings.

Skills: (Students will be able to...)

- define and explain the purpose of elevation views and site plans in architecture.
- define and explain perspective using two vanishing points versus three vanishing points.
- draw elevation views of buildings, characters or objects, using perspective and proportion to create accurate and realistic drawings.
- use a variety of hand drawing techniques, such as line weight, hatching, and shading, to create visually appealing drawings.

Unit Number and Title:	Unit 2: Basic Design Processes and Workflows
Duration:	3 - 5 weeks
Resource(s):	Computers, projector, paper, pencils, erasers, internet connection
Unit Overview:	This unit will introduce students to the basics of animation, residential and product design. Students learn about building types, factors influencing design, and the process of designing products, building and animations from start to finish. Students will study the design process as purposeful, systematic, iterative and creative with many possible solutions. The students will be challenged to solve real world problems utilizing prior knowledge and new learning.
Learning Goals	
Standard(s):	DD.01.04 Plan multiple design solutions to solve a problem. DD.01.06 Critique designs and products created to solve a problem. CADD.0207 Express a design of an object as a 3D model. CADD.02.10 Revise a design and update finished drawings appropriately.
Essential Question(s):	<ul style="list-style-type: none"> ● What is the design process used to go from concepts to finished products? ● What are the different ways that design can improve quality of life and influence our culture and society? ● What are the challenges and opportunities of designing residential spaces or other products for a diverse population with a wide range of needs and preferences?
Enduring Understanding(s):	<ul style="list-style-type: none"> ● Design is a distinctive process with a number of defining characteristics: it is purposeful; it is based on certain requirements; it is systematic, it is iterative; it is creative; and there are many possible solutions. ● Design is a problem-solving discipline. Designers must consider a wide range of factors when designing a building or a product, including function, aesthetics, budget, and environmental impact.

	<ul style="list-style-type: none"> ● Architecture has a significant impact on our lives. The buildings we live in, work in, and learn in can shape our moods, our productivity, and even our sense of well-being. ● Design and production reflect human culture and the people and values of a society.
<p>Learning Goal(s): <i>Students will know and will be able to use their learning to:</i> (Content/ Skills)</p>	<p>Content: (Students will know...)</p> <ul style="list-style-type: none"> ● major design styles that have been used over the centuries. ● major types of residential building typology, such as single-family homes, multi-family homes, and condominiums. ● factors that influence the design of products. ● components of effective videos and animations. <p>Skills: (Students will be able to...)</p> <ul style="list-style-type: none"> ● define and explain the different design elements over time. ● explain how the factors such as climate, budget, and the needs of the end users influence design decisions. ● describe the process of designing from start to finish. ● create their own projects, using the knowledge and skills they have learned in the unit. ● apply the principles of design, such as balance, proportion, and unity, and how to apply them to residential design, engineering design, and animation.

Unit Number and Title:	Unit 3: Novice Level CAD Tools and 3-D Modeling Techniques
Duration:	5-6 weeks
Resource(s):	Computers, projector, paper, pencils, erasers, internet connection, software
Unit Overview:	Students will begin to explore beyond basic CAD tools learned in the CAD I course. Students will learn to utilize tools such as: curved walls, complex toposurfaces, basic massing, custom models using extrusions and sweeps, freeform mesh modeling, and adding modifier tools to primitive geometry to create more complex shapes. Students will gain understanding of constraints and joints in 3D assemblies to combine part files into functional models of machines.
Learning Goals	
Standard(s):	CADD.02.07 Express a design of an object as a 3D model. CADD.07 Create assemblies and views in 3D format. CADD.03 Utilize measurement and annotation systems as they apply to CADD technology design. CADD.06 Demonstrate use and application of alternate view applications and functions.
Essential Question(s):	<ul style="list-style-type: none"> ● What tools are used to create designs, computer models, and physical prototypes? ● How can CAD be used to create more interesting looking yet functional buildings? ● How can CAD tools be used to create custom shapes when making buildings and component models?
Enduring Understanding(s):	<ul style="list-style-type: none"> ● The design process requires the use of a variety of strategies, such as problem solving, creative thinking, visual imagery, critical thinking, and reasoning.. ● There is usually more than one way to create desired shapes when building 3D computer models ● Design is a problem-solving discipline that must consider a wide range of factors, including function, aesthetics, budget, and environmental impact.
Learning Goal(s):	Content: (Students will know...)

Students will know and will be able to use their learning to:
(Content/ Skills)

- options for building computer models (e.g. drawings walls one at a time vs using massing tools.
- to create a form and then applying wall types to the massing model.
- a variety of modeling techniques incorporating more complex tools
- strategies for placing cameras for impactful renderings.
- a variety of 2D drawing types are used to clearly communicate design intent
- multiple methods for creating the same 3D shapes
- the importance of keeping low polygon counts to maximize model efficiency

Skills: (Students will be able to...)

- utilize the CAD tools in increasingly creative ways to create more complex shapes and interesting designs.
- accurately express their creative visions by creating their own custom shapes and components.
- modify the properties and settings to create visually stunning rendered images of their designs.
- produce a basic set of construction drawings.
- use the extrude, loft, sweep, and void form tools.
- modify component properties.
- set up 2D drawing views of their 3D models.
- adjust the sun position and time of day.

Unit Number and Title:	Unit 4: Simulating Physics Systems, PBR Materials, Lighting and Rendering Images
Duration:	3-5 weeks
Resource(s):	Computers, projector, internet
Unit Overview:	Students will learn about computer simulations in CAD, the different types of simulations that can be performed, how to set up and run simulations, and how to interpret the results of simulations. They will also learn how to use simulations to improve the design of buildings, engineering products and systems, as well as the realism of the images and animations they create.
Learning Goals	
Standard(s):	CADD.05.03 Differentiate the various techniques for viewing objects. CADD.05.07 Describe the process for setting and editing drawing elements. CADD.06.02 Demonstrate the use of cutting planes to clarify hidden features of an object. CADD.06.03 Create and edit construction planes through reference geometry. CADD.02.08 Export and import images/files in a variety of file formats
Essential Question(s):	<ul style="list-style-type: none"> ● What is the design process used to go from concepts to finished products? ● How can we be as energy efficient as possible when producing things? ● How can computer modeling tools create realistic representations of objects in real world scenarios? ● How can CAD software communicate interesting functional design ideas clearly and efficiently?
Enduring Understanding(s):	<ul style="list-style-type: none"> ● Design is a complex process that involves many different materials and systems. ● Design is a problem-solving discipline that must consider a wide range of factors, including function, aesthetics, budget, and environmental impact. ● Choosing materials and systems involves weighing tradeoffs such as efficiency vs cost, and practicality vs beauty.

<p>Learning Goal(s): <i>Students will know and will be able to use their learning to:</i> (Content/ Skills)</p>	<p>Content: (Students will know...)</p> <ul style="list-style-type: none"> ● there are many different types of simulation methods and materials. ● each system has pros and cons. ● techniques for rendering quality images efficiently. <p>Skills: (Students will be able to...)</p> <ul style="list-style-type: none"> ● apply simulated physics to objects to mimic real world phenomena ● create custom PBR materials ● apply texture mapping tools to understand how they display on a surface. ● adjust sun position, date, and geographic location. ● describe the advantages and disadvantages of different materials and systems. ● create various drawings showing what materials were used and how the pieces fit together.
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Unit Number and Title:	Unit 5: Introduction to Sustainable Design and Materials
Duration:	2-3 weeks
Resource(s):	Computers, software, projector, paper, pencils, erasers, internet access
Unit Overview:	This unit will introduce students to the principles of sustainable design. Students will learn about the environmental and social impacts of design. They will also learn how to design buildings and products sustainably using different tools and techniques and material choices.
Learning Goals	
Standard(s):	<p>CADD.01.04 Explain the significance of the development Computer Aided Drafting and Design had on society.</p> <p>EKS.07.04 Consider issues related to self, team, community, diversity, environment, and global awareness when leading others.</p> <p>ARCH.02.01 Identify how location, resources and materials influence design.</p> <p>ENG.01.05 Describe ethics related to engineering in the following situations: environmental, sustainable engineering, and corrupt practices.</p>
Essential Question(s):	<ul style="list-style-type: none"> ● How is CAD used to solve issues pertaining to function, aesthetics, budget, and environmental impact? ● What are the challenges and opportunities of using CAD to design for the future, given the uncertainties of climate change and other global trends? ● How can CAD be used to create more sustainable and energy-efficient products?
Enduring Understanding(s):	<ul style="list-style-type: none"> ● Choosing materials and systems involves weighing tradeoffs such as efficiency vs cost, and practicality vs beauty. ● There are many factors that influence a design, including: safety, reliability, quality control, costs, environmental concerns, manufacturability, maintenance, ergonomics, etc.

<p>Learning Goal(s): <i>Students will know and will be able to use their learning to:</i> (Content/ Skills)</p>	<p>Content: (Students will know...)</p> <ul style="list-style-type: none"> ● industry standard materials. ● how some materials and methods are more environmentally sustainable than others. ● how the design process allows choice between numerous materials and systems. <p>Skills: (Students will be able to...)</p> <ul style="list-style-type: none"> ● apply the principles of sustainability by choosing environmentally sustainable materials to be used in their designs. ● consider the pros and cons of various design options.
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Unit Number and Title:	Unit 6: Prototyping, Model-making and Animation Production.
Duration:	5-8 weeks
Resource(s):	Computers, projector, consumables
Unit Overview:	A very important step in the design process is building models to test your solutions. Students will learn how to use their computer simulations, 2D drawings, and 3D renderings to build physical prototypes of their designs in order to assess the effectiveness of their design choices. This will give them the tools they need to evaluate their own proposed solutions and modify their designs to improve functionality and aesthetics and ultimately the quality of the final product.
Standard(s):	CADD.02.07 Express a design of an object as a 3D model. CADD.02.08 Export and import images/files in a variety of file formats. CADD.05.15 Scale and print hard copy on an output device. ENG.02.09 Build a prototype from working drawings using appropriate materials.
Essential Question(s):	<ul style="list-style-type: none"> • What is the design process used to go from concepts to finished products? • How can computer modeling tools create realistic representations of objects in real world scenarios? • How can I utilize the skills and processes in the course with my interests to create a prototype/model that solves a real world problem?
Enduring Understanding(s):	<ul style="list-style-type: none"> • The design process requires the use of hands-on abilities, such as measuring, drawing, sketching, working with computers, and using tools. • Design is a distinctive process with a number of defining characteristics: it is purposeful; it is based on certain requirements; it is systematic, iterative and creative and there are many possible solutions.
Learning Goal(s):	Content: (Students will know...)

<p><i>Students will know and will be able to use their learning to:</i> (Content/ Skill</p>	<ul style="list-style-type: none"> ● the tools and methods designers use to solve real-world problems. ● the advantages and limits of tools and materials used to construct physical models ● strategies for saving time when working on long term projects ● the importance of planning ahead and budgeting time appropriately <p>Skills: (Students will be able to...)</p> <ul style="list-style-type: none"> ● apply knowledge and skills from across the curriculum to solve a real-world problem. ● conduct independent research and analyze complex information. ● demonstrate problem-solving and critical thinking skills. ● use a variety of communication tools and strategies to effectively convey their design concepts to an audience. ● export scale drawings to create a prototype. ● export their drawings in the correct file formats to create 3-D outputs. ● construct physical prototypes using common materials and fastener techniques. ● demonstrate safe use of hand and power tools.
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Unit Number and Title:	Unit 7: Final Summative Project and Creating a Design Portfolio
Duration:	7-8 weeks
Resource(s):	Computers, projector, consumables
Unit Overview:	Students will design a custom “model” (house, animation/engineered product). Hand drawings of their designs will be created, and with teacher feedback, improvements made to build a computer model and/or physical model. Students will assemble a set of dimensioned construction/fabrication drawings and renderings, as well as photos and/or videos of physical models built for use in portfolios. Students will begin a design portfolio assembling their best work from CAD 1 and CAD 2 to demonstrate their talent and skill to potential employers. Students will learn about the different types of portfolios, choosing the correct format or media for their portfolio, and how to select their work to present it professionally.
Learning Goals	
Standard(s):	<p>CADD.02.04 Describe and demonstrate the use of graphic communication skills through sketching.</p> <p>CADD.02.05 Evaluate and select appropriate methods of communication for a given problem.</p> <p>CADD.02.07 Express a design of an object as a 3D model.</p> <p>CADD.05 Utilize proper projection techniques to develop orthographic and pictorial drawings.</p> <p>CADD.08 Explain and utilize the concepts of sketching and the sketching process used in preliminary design and development.</p> <p>CADD.10.01 Gather educational and work highlights to include in portfolio. CADD.10.02 Organize and provide a compact disc, web site and/or other digital media for use in demonstrating knowledge, skills, and experience.</p> <p>CADD.10.03 Prepare and conduct effective portfolio oral presentation(s).</p>
Essential Question(s):	<ul style="list-style-type: none"> ● What are the best strategies for managing my time so I can complete long term assignments by the deadline? ● How can I utilize the skills and processes learned in the CAD courses combined with my

	<p>interests to create a prototype/model that solves a real world problem?</p> <ul style="list-style-type: none"> • What are the most important elements to include in a design portfolio?
Enduring Understanding(s):	<ul style="list-style-type: none"> • Problem solving means facing obstacles and devising a solution to overcome them • CAD is a creative discipline that allows us to express ourselves in unique ways. • Solving real world problems is a challenge for everyone.
Learning Goal(s): <i>Students will know and will be able to use their learning to:</i> (Content/ Skills)	<p>Content: (Students will know...)</p> <ul style="list-style-type: none"> • multiple methods of displaying their work from physical portfolios to digital portfolios. • which elements of a design portfolio are the most important. • Research practices and protocols. <p>Skills: (Students will be able to...)</p> <ul style="list-style-type: none"> • apply knowledge and skills from across the curriculum to solve a real-world problem. • conduct independent research and analyze complex information. • manage time effectively and meet deadlines. • demonstrate problem-solving and critical thinking skills. • use a variety of communication tools and strategies to effectively convey their design concepts to an audience. • how to identify and define a real-world problem • how to conduct research and gather evidence to inform their work. • how to analyze and interpret complex information. • how to develop and implement a plan to solve a problem.