



Computer Aided Design I - Introduction to CAD for 3D Animation, Architecture, and Engineering

Grade(s):	9-12
Discipline/Course:	Technology Education
Course Title:	Computer Aided Design I - Introduction to CAD for 3d Animation, Architecture, and Engineering
Prerequisite(s):	N/A
Course Description: <i>Program of Studies</i>	An introduction to the design process in Animation, Architecture, and Engineering. Students will learn traditional drawing techniques to effectively develop and communicate design concepts as well as learning the fundamentals of CAD, utilizing professional level software to construct 3D computer models of houses, simple machine parts and mechanisms, and textured 3D models which could be used as assets in games or animations. Activities will include: hand sketching, creating 3D computer models, rendering still images, videos, use of a 3D printer to create actual parts made of plastic, and creating basic ‘keyframe animations’.
Course Essential Questions:	<ul style="list-style-type: none"> ● How do people use drawings and computer software to design the products around us? ● What tools are used to create designs, computer models, and physical prototypes? ● What is the design process used to go from concepts to finished products? ● How is important information communicated during and after the design process? ● What are common considerations which must be taken into account when designing architectural spaces? ● How can I communicate my design ideas clearly and efficiently? ● What conventions exist to ensure all architectural drawings are uniform? ● What conventions exist to ensure all mechanical drawings are uniform?
Course Enduring Understandings:	<ul style="list-style-type: none"> ● 3D real world objects can be represented by 2D orthographic and perspective drawings. ● Real world products follow an organized design process to go from concept to completion. ● 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.

	<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. • The design process requires the use of hands-on abilities, such as measuring, drawing, sketching, working with computers, and using tools. • There are many factors that influence a design, including: safety, reliability, quality control, costs, environmental concerns, manufacturability, maintenance, ergonomics, etc.. • The design process can be determined by figuring out small incremental steps, each of which can be organized into a coherent process that is adaptable to many situations. • Design is not a linear, step-by-step process. Rather, it should be an iterative, or repeating process that allows designers to explore different options in a pragmatic way, and to become independent decision makers, and to envision multiple solutions to a problem. • The task of an engineer is more than simply designing a product that works. He or she must consider many other factors, such as safety, environmental concerns, ethical considerations, and risks and benefits. • Staging is critical to creating an impactful animation. • Choosing lighting level, color schemes, composition and camera angles can dramatically change how audiences perceive the idea being conveyed.
Duration: Credit:	Full year 1.0 Credit(s)
Course Materials/Resources:	Drawing tools, computers, software, projector/screen, 3D printing technology, basic hand tools
FPS Course Academic Expectation(s):	Conveying Ideas Creating and Constructing
Year at a Glance (Units):	Unit 1 - Introduction to the Architectural Design Process (3 weeks) Unit 2 - Introduction to 3D Modeling for Architecture (6 weeks) Unit 3 - Introduction to Creating Working Drawings for Architecture (3 weeks)

	<p>Unit 4 - Introduction to the Engineering Design Process (3 weeks) Unit 5 - Introduction to 3D Modeling for Engineering (6 weeks) Unit 6 - Introduction to Creating Working Drawings for Engineering (3 weeks) Unit 7 - Introduction to Sketching and Storyboarding (2 weeks) Unit 8 - Introduction to 3D Modeling for Animation and Games (7 weeks) Unit 9 - Introduction to Creating Rendered Images and Video (3 weeks)</p>
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Unit No. and Title:	Unit 1 - Introduction to the Architectural Design Process
Duration:	3 weeks
Resource(s):	N/A - computer equipment
Unit Overview:	In this unit students explore how architects use information gathered from customers and colleagues to design ideal livable spaces to meet the clients' needs. We will draw bubble diagrams of various layouts to explore the relationship between spaces requested by the client to determine the optimal design and then convert those bubble diagrams into floor plan sketches. Finally, a front elevation will be drawn to give a better sense of the actual shape of the structure.
Learning Goals	
Standard(s):	STEL-7BB. Implement the best possible solution to a design. STEL-7AA. Illustrate principles, elements, and factors of design. STEL-2T. Demonstrate the use of conceptual, graphical, virtual, mathematical, and physical modeling to identify conflicting considerations before the entire system is developed and to aid in design decision making.
Essential Question(s):	<ul style="list-style-type: none"> ● What are common considerations which must be taken into account when designing architectural spaces? ● How can I communicate my design ideas clearly and efficiently? ● What conventions exist to ensure all architectural drawings are uniform?
Enduring Understanding(s):	<ul style="list-style-type: none"> ● The main job of architectural design is to create spaces tailored to the needs of their customers. ● There must be a balance between functionality and aesthetics. ● The design process requires the use of hands-on abilities, such as measuring, drawing, sketching, working with computers, and using tools.
Learning Goal(s): <i>Students will know and</i>	Content: (Students will know...) <ul style="list-style-type: none"> ● how to select and use the appropriate pencil type for constructions and object lines.

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

- the difference between bubble diagrams and floor plans

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

- create hand drawings of two dimensional primitives.
- create simple orthographic drawings of three dimensional objects.
- apply information in creative ways to satisfy client needs.

Unit No. and Title:	Unit 2 - Introduction to 3D Modeling for Architecture
Duration:	6 weeks
Resource(s):	N/A - Computer Equipment
Unit Overview:	Using the drawings created in unit one, students will begin creating a 3D computer model of their design. Students will learn the basic architectural CAD tools like placing walls, floors, doors, windows, roofs, terrain, plants, as well as adding appropriate textures on those surfaces to simulate actual building materials and landscape elements.
Learning Goals	
Standard(s):	STEL-7Y. Optimize a design by addressing desired qualities within criteria and constraints. STEL-7Z. Apply principles of human-centered design. STEL-7Y. Optimize a design by addressing desired qualities within criteria and constraints.
Essential Question(s):	<ul style="list-style-type: none"> • How do people use drawings and computer software to design the products around us? • What tools are used to create designs, computer models, and physical prototypes?
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. • The design process requires the use of hands-on abilities, such as measuring, drawing, sketching, working with computers, and using tools.
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"> • basic workflow to go from 2D concept drawings to a finished 3D computer model of a basic residence. • how to use professional CAD tools to create simple buildings and sites that are functional and aesthetic.

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

- create terrain- to simulate an actual building site.
- create 3D building models from 2D sketches.
- add basic elements to a building model like doors and windows and change their types to match a desired aesthetic style.
- insert and modify furniture and fixtures as component files.
- create site features like driveways and walkways.
- add landscaping elements to create a more attractive site.
- create new materials and apply them to surfaces to simulate actual building and site materials.

Unit No. and Title:	Unit 3 - Introduction to Creating Working Drawings for Architecture
Duration:	3 weeks
Resource(s):	N/A - Computer Equipment
Unit Overview:	Once the 3D models are created we will learn how to create dimensioned floor plans, elevation views, and realistic rendered images to communicate the final design to customers and construction managers.
Learning Goals	
Standard(s):	<p>STEL-2T. Demonstrate the use of conceptual, graphical, virtual, mathematical, and physical modeling to identify conflicting considerations before the entire system is developed and to aid in design decision making.</p> <p>STEL-7AA. Illustrate principles, elements, and factors of design.</p>
Essential Question(s):	<ul style="list-style-type: none"> • How do people use drawings and computer software to design the products around us? • How is important information communicated during and after the design process?
Enduring Understanding(s):	<ul style="list-style-type: none"> • 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)	<p>Content: (Students will know...)</p> <ul style="list-style-type: none"> • how to create 2D drawings from 3D building models. • basic standards that apply to architectural dimensions. • how to use CAD technology to create realistic images of building designs. <p>Skills: (Students will be able to...)</p> <ul style="list-style-type: none"> • create dimensioned floor plan drawings. • create elevation drawings with appropriate labeling. • add camera views and adjust them for optimal viewing angles • render realistic still images of their CAD model. • set up sheet views with the proper scale for printing.

Unit Number and Title:	Unit 4 - Introduction to the Engineering Design Process
Duration:	3 weeks
Resource(s):	N/A - Computer Equipment
Unit Overview:	In this unit students will discover that the EDP is a multistep, iterative process that involves careful and intentional planning steps in order to meet the needs of people. We will also practice isometric and orthographic drawing techniques commonly used in the engineering and product development fields to quickly communicate design concepts.
Learning Goals	
Standard(s):	STEL-8O. Develop a device or system for the marketplace. STEL-7AA. Illustrate principles, elements, and factors of design. STEL-7Z. Apply principles of human-centered design.
Essential Question(s):	<ul style="list-style-type: none"> ● How can I communicate my design ideas clearly and efficiently? ● What conventions exist to ensure all mechanical drawings are uniform?
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, it is iterative; it is creative; and there are many possible solutions. ● The task of an engineer is more than simply designing a product that works. He or she must consider many other factors, such as safety, environmental concerns, ethical considerations, and risks and benefits.

<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">● basic steps of the engineering design process.● basic ANSI standards related to creating mechanical drawings. <p>Skills: (Students will be able to...)</p> <ul style="list-style-type: none">● create hand drawings from two dimensional primitives.● list the common types of lines used in mechanical drawings.● create simple orthographic and isometric drawings of 3 dimensional objects.
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Unit No. and Title:	Unit 5 - Introduction to 3D Modeling for Engineering
Duration:	6 weeks
Resource(s):	N/A - Computer Equipment
Unit Overview:	Students will create 3D CAD models from 2D computer sketches which represent single parts. We will also learn how to make simple assemblies combining a few part files to simulate a basic machine. Practicing file management is key when using parametric modeling in order for assembly files to function. During this unit students will learn how to properly export files into the correct format for 3D printing actual parts.
Learning Goals	
Standard(s):	STEL-7W. Determine the best approach by evaluating the purpose of the design. STEL-7X. Document trade-offs in the technology and engineering design process to produce the optimal design. STEL-7Y. Optimize a design by addressing desired qualities within criteria and constraint
Essential Question(s):	<ul style="list-style-type: none"> ● How do people use drawings and computer software to design the products around us? ● What tools are used to create designs, computer models, and physical prototypes?
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. ● The design process requires the use of hands-on abilities, such as measuring, drawing, sketching, working with computers, and using tools. ● There are many factors that influence a design, including: safety, reliability, quality control, costs, environmental concerns, manufacturability, maintenance, ergonomics, etc.. ● Design is not a linear, step-by-step process. Rather, it should be an iterative, or repeating process that allows designers to explore different options in a pragmatic way, become independent decision makers, and envision multiple solutions to a problem.

Learning Goal(s):

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

Content: (Students will know...)

- basic workflow involved in going from 2D concept drawings to a finished 3D computer model of a basic mechanism.
- how to use professional CAD tools to create simple parts and assemblies that are functional and aesthetic.

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

- create fully constrained 2D CAD sketches.
- manipulate 2D sketches using editing tools and transforms.
- create 3D part models from 2D sketches.
- create fully constrained 3D part assemblies.
- apply basic physics simulations to test digital prototypes.
- export CAD models for 3D printing.

Unit No. and Title:	Unit 6 - Introduction to Creating Working Drawings for Engineering
Duration:	3 weeks
Resource(s):	N/A - Computer Equipment
Unit Overview:	During this time students will learn the process for converting their 3D CAD models into dimensioned drawings needed by manufacturers in order to physically construct their designs in a factory or workshop. Basic ANSI dimensioning conventions will be applied. In addition to dimensioned drawings we will learn how to create realistic colored renderings of 3D still images and videos of physics simulations on their machines.
Learning Goals	
Standard(s):	STEL-8N. Use various approaches to communicate processes and procedures for using, maintaining, and assessing technological products and systems.
Essential Question(s):	<ul style="list-style-type: none"> ● How is important information communicated during and after the design process? ● How can I communicate my design ideas clearly and efficiently? ● What conventions exist to ensure all mechanical drawings are uniform?
Enduring Understanding(s):	<ul style="list-style-type: none"> ● 3D real world objects can be represented by 2D orthographic and perspective drawings. ● Real world products follow an organized design process to go from concept to completion. ● The design process requires the use of hands-on abilities, such as measuring, drawing, sketching, working with computers, and using tools.
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"> ● how to set up a sheet in the CAD software and add 2D views of 3D objects ● how to use CAD tools to dimension sheet views ● how to use the software tools to render a video animation

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

- create dimensioned drawings from part files and assembly files.
- correctly apply basic ANSI dimensioning standards
- create video animations showing the functionality of assembly files and simulations.

Unit No. and Title:	Unit 7 - Introduction to Sketching and Storyboarding
Duration:	2 weeks
Resource(s):	N/A - Computer Equipment
Unit Overview:	For this unit students will learn how to create concept sketches and storyboards are used to design 3D models and animations used in many industries including video games, film, advertising, and cartoons. These communication tools are invaluable for teams who all need to understand the shared vision in order to create a quality product.
Learning Goals	
Standard(s):	STEL-8N. Use various approaches to communicate processes and procedures for using, maintaining, and assessing technological products and systems. STEL-2T. Demonstrate the use of conceptual, graphical, virtual, mathematical, and physical modeling to identify conflicting considerations before the entire system is developed and to aid in design decision making.
Essential Question(s):	<ul style="list-style-type: none"> ● What is the design process used to go from concepts to finished products? ● How is important information communicated during and after the design process? ● How can I communicate my design ideas clearly and efficiently?
Enduring Understanding(s):	<ul style="list-style-type: none"> ● Creating animated scenes for the film and video game industries requires multiple teams following an organized process to create a shared vision. ● The design process requires the use of a variety of strategies, such as problem solving, creative thinking, visual imagery, critical thinking, and reasoning. ● The design process requires the use of hands-on abilities, such as measuring, drawing, sketching, working with computers, and using tools.
Learning Goal(s):	Content: (Students will know...)

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

- how to describe their vision of an animation concept using visual tools.

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

- use basic 2D primitives to draw character concept sketches.
- create a basic storyboard to communicate their plan for a short animation.

Unit No. and Title:	Unit 8 - Introduction to 3D Modeling for Animation
Duration:	7 weeks
Resource(s):	N/A - Computer Equipment
Unit Overview:	During this time students will learn the basic modeling, texturing, and lighting tools needed to create 3D computer models which can be used in industries ranging from video games, animations, architecture, and special effects. We will practice modeling with 3D primitives and simple editable polygon shapes. Students will learn how to use some of the common modifiers to manipulate those shapes or adjust textures to fit better. We will add lighting to the scene to control the look of textures and shadows. Basic keyframing techniques will be explored to make their models move on the screen.
Learning Goals	
Standard(s):	STEL-8N. Use various approaches to communicate processes and procedures for using, maintaining, and assessing technological products and systems. STEL-2T. Demonstrate the use of conceptual, graphical, virtual, mathematical, and physical modeling to identify conflicting considerations before the entire system is developed and to aid in design decision making
Essential Question(s):	<ul style="list-style-type: none"> • What tools are used to create designs, computer models, and physical prototypes? • How do people use drawings and computer software to design the products around us?
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. • Animators communicate ideas and emotions using the movement and expressions of characters
Learning Goal(s): <i>Students will know and will be able to use their</i>	Content: (Students will know...) <ul style="list-style-type: none"> • which tools are used to create and modify basic geometry.

learning to:
(Content/ Skills)

- which tools are used to animate geometry.
- how to create and apply basic PBR materials.
- how to add and adjust lighting.

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

- create basic primitive shapes and prepare them for modeling.
- create an original low polygon character model.
- create a basic set for the character to exist within.
- apply premade materials to 3D objects to give them color and shading properties.
- use the internet and computer software to create and apply their own custom PBR textures.
- utilize keyframe animation techniques to produce a short animation.
- load HDRI to create lighting and shadows.

Unit No. and Title:	Unit 9 - Introduction to Creating Rendered Images and Video
Duration:	3 weeks
Resource(s):	N/A - Computer Equipment
Unit Overview:	Once the modeling and animation is complete students will learn how to control cameras and fine tune the render engine settings to get their finished still and video renders to look great while efficiently balancing system resources used to avoid excessive render times. Students will learn how to use professional video editing software to convert image sequences into fully rendered video.
Learning Goals	
Standard(s):	STEL-8N. Use various approaches to communicate processes and procedures for using, maintaining, and assessing technological products and systems. STEL-2T. Demonstrate the use of conceptual, graphical, virtual, mathematical, and physical modeling to identify conflicting considerations before the entire system is developed and to aid in design decision making
Essential Question(s):	<ul style="list-style-type: none"> • What is the design process used to go from concepts to finished products? • How is important information communicated during and after the design process?
Enduring Understanding(s):	<ul style="list-style-type: none"> • Staging is critical to creating an impactful animation. • Choices on lighting level, color schemes, and camera angles can dramatically change how audiences perceive the message conveyed.
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"> • how camera angles can be used for dramatic effect. • how to adjust lighting settings and camera settings to control the illumination of characters and set pieces. • the process for rendering all the frames of an animation into still image and video format.

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

- create camera views.
- adjust exposure values to balance lighting.
- modify render engine settings to balance quality and efficient render times.
- create high quality rendered still images.
- export image sequences.
- combine image sequences into quality rendered video files.