Madison Public Schools
Computer Aided Design and Drafting Curriculum

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Course Overview

Description

The Computer Aided Design and Drafting (CADD) I course is an introductory semester course designed to introduce fundamental principles of engineering, architecture, and interior design. This course will provide each student with a strong foundation and application of the Engineering Design Cycle and other principles through the use of the leading industry software. It will develop and/or strengthen each student's problem solving, mathematical, computer application, and logical reasoning skills through the analysis, design, and production of their work. Throughout the course, major emphasis will be placed on solving real-world problems utilizing the key concepts and application methods taught throughout this course.

Goals

This course aims to:

- Introduce students to 3D design through the use of 3D modeling software.
- Introduce students to the engineering design process.
- Introduce students to 3D printing by turning their digital designs into usable objects.
- Have students solve real-world problems using these acquired skills.

Materials

Core: Inventor By Autodesk, Fusion By Autodesk.
Supplemental: Lulzbot, Cura for Lulzbot, Form 2, Preform, Universal Laser, Adobe Illustrator, and Drive File Stream.

Resources

Suggested activities and resources page

Benchmark Assessments

This course will consist of three benchmark assessments that will be given at the end of each major unit, this includes Introduction to 3D Modeling, Introduction to 3D printing, Advanced 3D Modeling Techniques, and Product Design and Fabrication.

Modifications and Adaptations for Special Needs Learners

(Gifted and Talented Students, English Language Learners, Students with Special Needs, At-Risk Students, and Students with 504 Plans)

Scope and Sequence
(Pacing Guide)

Unit Number	Topic of Study	Duration (Weeks Taught)
1	Room Orientation/Safety Training	1
2	Introduction to the Engineering Design Process	1
3	Introduction to 3D Modeling	3
4	Introduction to 3D Printing	4
5	Advanced 3D Modeling Techniques	5
6	Product Design and Fabrication	5

Unit 1 Overview

Unit Title: Room Orientation & Machine Safety

Unit Summary:
In this unit, students will be learning where supplies and tools are located in the engineering lab. Students will also be trained on the proper techniques and procedures for using the different production machinery. Students will then be certified for use of these machines after successful completion of ITEEA's machine safety quizzes.

Suggested Pacing: 4-5 Lessons

Learning Targets

Unit Essential Questions:

- When is the proper time to wear eye safety?
- Who should know the lab safety procedures?
- How can I ensure my safety in the lab?
- What are the ramifications for not following lab safety procedures?
- How do I efficiently and safely operate the prototyping equipment?

Unit Enduring Understandings:

- Lab safety is important to everyone at all times.
- Safety is the most critical component of an optimum work environment.
- Understanding how to properly operate machines is a lifelong skill.

Evidence of Learning

Formative Assessments: Students will be assessed based on their cooperation and participation in class discussions and safety demonstrations.

Summative Assessment: Students will be assessed based on the scores they receive after completing the ITEEA safety test for each machine.

Alternative Assessments: Students will demonstrate their ability to properly follow safety procedures through a series of hand on test of their skills.

Objectives (Students will be able to…)	**Key Concepts** (Students will know…)	**Suggested Assessments**	**Standards (NJSLS)**
Identify the proper times that they should be wearing eye protection. Identify situations where secondary eye protection may be required.	General lab safety procedures. Eye safety procedures. How to identify potential hazards. Vocabulary: Machine Guards, Primary Protectors, Machine Shields, Adjustments, Spectacles, Goggles, Welding Helmet	Students will be assessed based on their cooperation and participation in the class discussions, safety demonstrations, and the ITEEA safety test for general lab safety.	**RST.9-10.3.** Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text. **RST.11-12.7.** Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

Efficiently and safely use the portable, and stationary power and hand tools. Identify when a machine is operating properly and when it may need adjustment.	How to identify a machine that is functioning properly and one that is not. How to follow a proper procedure in order to safely and effectively use hand and power tools.	Students will be assessed based on their cooperation and participation in the class discussions, safety demonstrations, and the ITEEA safety tests for each of the stationary and portable machines in the engineering lab.	**9.3.MN-HSE.1** Demonstrate the safe use of manufacturing equipment.

Unit 2 Overview

Unit Title: Introduction to the Design Process

Unit Summary:
In this unit, students will be learning where supplies and tools are located in the engineering lab. Students will also be trained on the proper techniques and procedures for using the different production machinery. Students will then be certified for use of these machines after successful completion of ITEEA's machine safety quizzes.

Suggested Pacing: 2-3 Lessons

Learning Targets

Unit Essential Questions:

- What is the design process?
- How can we use the design process to help us invent & design?
- Why is it important to document our work?

Unit Enduring Understandings:

- The design process gives us a procedure to follow when problem-solving.
- There is always room for improvement when using the design process.
- Documentation helps us have the ability to recreate and improve our designs or the processes used to create them.

Evidence of Learning

Formative Assessments: Students will be assessed based on their cooperation and participation in class discussions.

Summative Assessment: Students will be asked to identify the different steps in the design process and the tasks that they should be performing during each step. Scoring will be done using the provided rubric.

Alternative Assessments: Students will complete the design process template with examples of different tasks that should be completed at each step.

Objectives (Students will be able to…)	**Key Concepts** (Students will know…)	**Suggested Assessments**	**Standards (NJSLS)**
Use the design process to aid them in designing and creating their projects. Understand that documenting their work is one of the most important things engineers do.	The steps in the MHS design process. The proper format to follow when documenting their work. How to evaluate their work using the SWOT method. Vocabulary: Documentation, Design Process, SWOT Method, Evaluation, Constraint, Prototype, Viable	Students will be assessed based on their cooperation and participation in the class discussions.	**ITEEA: Standards for Technological Literacy 8H:** The design process includes defining a problem, brainstorming, researching and generating ideas, identifying criteria and specifying constraints, exploring possibilities, selecting an approach, developing a design proposal, making a model or prototype, testing and evaluating the design using specifications, refining the design, creating or making it, and communicating processes and results.

			8.2.12.E.4: Use appropriate terms in conversation (e.g., troubleshooting, peripherals, diagnostic software, GUI, abstraction, variables, data types, and conditional statements). **8.2.12.C.7** Use a design process to devise a technological product or system that addresses a global problem, provide research, identify trade-offs and constraints, and document the process through drawings that include data and materials.

Unit 3 Overview

Unit Title: Introduction to 3D Modeling

Unit Summary:
In this unit, students will be given an introduction to 3D modeling software. This software will be the foundation of this course and it is imperative that the students become familiar with the tools and processes to be successful. In this unit, we will go over the standard functions, processes, and tools that the software has to offer by doing a set of tutorials. Students will also learn how to use measuring tools such as micrometers and calipers.

Suggested Pacing: 10-12 Lessons

Learning Targets

Unit Essential Questions:

- What is the purpose of 3D modeling software?
- What are the basic features of our 3D modeling software?
- What is a coordinate plane?
- What is the origin?
- How can I ensure accurate measurements in the software?
- How can the following basic procedures ensure I am drawing the parts of my device correctly?
- How can we use measuring tools to ensure our products are properly sized?

Unit Enduring Understandings:

- 3D modeling software is designed to help users convert 2D sketches into functional parts.
- All files should be saved to Google Drive.
- The basic features of 3D modeling software will allow us to draw the majority of our device.
- Measuring and planning are imperative to a successful model.
- Following basic procedures help improve drawing efficiency.

Evidence of Learning

Formative Assessments: Students will be assessed based upon their participation and completion of tutorials.

Summative Assessments: Students will be assessed by their ability to accurately measure and digitally recreate 8 given objects. Scoring will be completed using the given rubric.

Alternative Assessments: N/A

Objectives (Students will be able to…)	**Key Concepts** (Students will know…)	**Suggested Assessments**	**Standards (NJSLS)**
Use 3D modeling software to draw simple and complex shapes. Identify key terminology used in 3D modeling,	How to use 3D modeling software to create different parts. How to measure to .001" accuracy.	Students will be assessed based upon their participation and completion of the different tutorials.	**HS-ETS1-4.** Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

Use the basic features of the 3D modeling software. Take accurate measurements using an assortment of measuring tools.	How to export their parts to be 3D printed. How to create 2D representations of their 3D parts.		**ITEEA: Standards for Technological Literacy 12 P:** Use computers and calculators to access, retrieve, organize, process, maintain, interpret, and evaluate data and information in order to communicate. Many resources, such as library books, the Internet, word processing and spreadsheet software, in addition to computer-aided design (CAD) software, can be used to access information. **MP.4** Model with mathematics

Unit 4 Overview

Unit Title: Introduction to 3D Printing

Unit Summary:
This unit will introduce students to the idea of bringing their digital files to life by using the 3D printers. Students will be given an overview of the 3D printers and their parts and shown how to export their 3D modeling files so that they can be read by the 3D printer. Students will then use their newly acquired skills to design and create an individual project that relates to a given theme.

Suggested Pacing: 12-16 Lessons

Learning Targets

Unit Essential Questions:

- What is 3D printing?
- Is 3D printing a new technology?
- What types of 3D printers are there?
- How does an FDM printer work?
- How does an SLA printer work?
- What is an extruder?
- What is an STL file?
- How does the printer break down your model in order to figure out the best way to print it?

Unit Enduring Understandings:

- 3D printing has been around since the ’60s.
- FDM printers use an extruder to carefully and precisely place plastic in desired locations.
- SLA uses UV light to harden a special resin in desired locations.
- Prints are broken down into layers.

Evidence of Learning

Formative Assessments: Students will be assessed based upon their participation and completion of projects through the use of a provided class participation rubric.

Summative Assessments: Students will create an electronic device accessory that meets all given criteria and constraints.Scoring will be done using the provided rubric.

Alternative Assessments: N/A

Objectives (Students will be able to…)	**Key Concepts** (Students will know…)	**Suggested Assessments**	**Standards (NJSLS)**
Use their newly acquired modeling skills to create a model that meets the criteria and constraints. Export their 3D modeled project from the computer to the Post Processor.	How to design within a set of criteria and constraints. The basic operations of a 3D printer and its post processor. How to use the export function on their 3D modeling software.	Students will be assessed based upon their participation and completion for a group project using the provided rubric.	**8.2.12.D.3** Determine and use the appropriate resources (e.g., CNC (Computer Numerical Control) equipment, 3D printers, CAD software) in the design, development , and creation of a technological product or system. **8.2.12.C.5** Create scaled engineering drawings of products both manually and

Use the post processor to break their model down into layers. Export from the post processor to the 3D printer.			digitally with materials and measurements labeled. **9.3.MN.6** Demonstrate workplace knowledge and skills common to manufacturing. **CRP11.** Use technology to enhance productivity.

Unit 5 Overview

Unit Title: Advanced 3D Modeling Techniques

Unit Summary:
This unit will introduce students to the more advanced features of our 3D modeling software. Some of the new features will include coordinate plane modification, assemblies, mirroring, and constraining. To reinforce these concepts students will be creating a project that requires the use of all of the above advanced techniques.

Suggested Pacing: 12-16 Lessons

Learning Targets

Unit Essential Questions:

- Why would we need to modify a coordinate plane?
- Why would we need to assemble parts together before we print them?
- When would the mirror tool be useful?
- What is a tolerance?
- How do I use the constraint tool?
- What is the difference between the mate and flush functions?

Unit Enduring Understandings:

- Modification of a coordinate plane allows you to draw on any surface no just the origin planes.
- It is more efficient to check your assembles parts for fit before wasting time and resources on the printers.
- A tolerance is the margin or error that is allowed for a part.

Evidence of Learning

Formative Assessments: Students will be assessed based upon their participation and completion of projects through the use of a provided class participation rubric.

Summative Assessments: Students will be assessed based on their completion of a puzzle project that tests their ability to properly plan and tolerance their models so that all pieces fit together correctly. Scoring will be done using the provided rubric.

Alternative Assessments: N/A

Objectives (Students will be able to…)	**Key Concepts** (Students will know…)	**Suggested Assessments**	**Standards (NJSLS)**
Use the assembly, drafting, and part builder portions of our 3D modeling software. Identify is an assembled device has the appropriate tolerancing based on the assembled view. Use the constraints tool to aid in the assembly of their models.	How to use all main portions of our 3D modeling software. How to tolerance parts for printing. How to modify coordinate planes to suit their needs.	Students will be assessed based upon their participation and completion for a group project using the provided rubric.	**8.2.12.D.1** Design and create a prototype to solve a real-world problem using a design process, identify constraints addressed during the creation of the prototype, identify trade-offs made, and present the solution for peer review**.** **RST.9-10.3.** Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or

Modify planes so that they have more freedom when modeling.			performing technical tasks, attending to special cases or exceptions defined in the text. **8.2.12.D.5** Explain how material processing impacts the quality of engineered and fabricated Products.

Unit 6 Overview

Unit Title: Product Design and Fabrication

Unit Summary:
In this unit, students will use their acquired knowledge of 3d Modeling and prototyping to create a product with a given set of criteria and constraints. Students will be challenged to use all of the different tools and processes that they have learned in this course in order to produce a truly unique product or system. When completed the product with be made with a variety of manufacturing and 3D modeling techniques.

Suggested Pacing: 16-20 Lessons

Learning Targets

Unit Essential Questions:

- How can we use our accumulated skills in order to create a custom product or system that satisfies the criteria and constraints?
- How can we use our prototyping equipment to help us create a product in the most efficient way possible?
- What is the first step we should take when designing this product?
- How can we use the engineering design process to help us?

Unit Enduring Understandings:

- The engineering design process helps us break down designing into manageable steps.
- Our design software and prototyping equipment allow us to create high precision professional quality parts with little assembly or manufacturing by hand.

Evidence of Learning

Formative Assessments: Students will be assessed based upon their participation and completion of projects through the use of a provided class participation rubric.

Summative Assessments: Students will be assessed based on their ability to utilize all of their given tools to create a product that solves a real world problem and falls under a given set of criteria and constraints. Scoring will be done using the provided rubric.

Alternative Assessments: N/A

Objectives (Students will be able to…)	**Key Concepts** (Students will know…)	**Suggested Assessments**	**Standards (NJSLS)**
Completely design and create a device that consists of multiple parts by following the procedures they have been taught throughout the course. Use finishing techniques to remove any imperfections from their manufactured parts to make their finished products high quality.	How to use the engineering design process effectively. How to follow their procedures and processes to efficiently design on our 3D modeling software. When it is appropriate to use prototyping tools instead of the 3D printers.	Students will be assessed based upon their participation and completion for a group project using the provided rubric.	**ITEEA: Standards for Technological Literacy 8H:** The design process includes defining a problem, brainstorming, researching and generating ideas, identifying criteria and specifying constraints, exploring possibilities, selecting an approach, developing a design proposal, making a model or prototype, testing and evaluating the design using specifications, refining the design, creating or making it, and communicating processes and results.

			8.2.12.D.3 Determine and use the appropriate resources (e.g., CNC (Computer Numerical Control) equipment, 3D printers, CAD software) in the design, development and creation of a technological product or system.
Evaluate their designs to see if they met all criteria and constraints. Reflect on aspects of the project they would have improved upon.	SWOT Evaluation Technique. How to thoughtfully reflect on their work so that improvements can be made.	Students will be assessed based upon their participation and completion for a group project using the provided rubric.	**HS-ETS1-3.** Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts. **9.3.MN-PPD.5** Develop procedures to create products that meet customer needs. **CRP2.** Apply appropriate academic and technical skills.