

DELAWARE VALLEY SCHOOL DISTRICT

PLANNED INSTRUCTION

A PLANNED COURSE FOR:

Solid Modeling/Engineering and Design

Curriculum writing committee:

Tom Moran

Grade Level: 9-12

Date of Board Approval: July 14, 2022

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Participation	10%
Classwork	60%
Projects	30%
Total	100%

Curriculum Map

Overview: Students will be exposed to the latest advancements in computer-aided drawing and design. Autodesk Inventor will give students a look into the world of solid modeling. Solid modeling is the creation of virtual, three-dimensional models, of any object, on the computer. Students will also perform rapid prototyping, which is the latest concept in engineering and design. Rapid prototyping is the creation of a product by sending a CADD drawing to a 3D printer or computer numerically controlled (CNC) machine. The 3D printer or CNC machine will then make the part. Students will also progress their knowledge of the engineering and design machines they gained base level skills within Mechanical Drawing I. This class is ideal for students interested in engineering, or any career related to drawing and design

Goals:

- Students will learn solid modeling and basic manufacturing terminology
- Students will utilize the engineering software (Inventor Professional) because the software applies common engineering and design terminology to define its electronic tools
- Students will relate the tools to features of a part
- Students will understand the processes which make up the technological system of manufacturing
- Students will read about and discuss the different types of manufacturing
- Students will study manufacturing fundamentals, product development, production planning, production, and high-performance manufacturing
- Students will discuss the impacts of technology on society, the environment, and the economy
- Students will learn basic tools of Inventor Professional
- Student will take precise measurements to .0001 using a micrometer (dial caliper)
- Students will utilize several other advanced measuring tools such as inside and outside diameter calipers, depth gauges and thread gauges.
- Student will reinforce the skills they learned in the instructional tutorials imbedded in the Inventor software
- Student will reverse engineer 2 given parts, one of which will be a Lego because of their extremely tight tolerances

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- Students will print their drawing files using the HP Design Jet 800 plotter
- Student will discuss the importance of rapid prototyping and the advantages of the 3D printer.
- Student will convert their graphic reproduction of their Lego into a prototype using the 3D printer
- Students will know how to use the catalyst software to create a toolpath for their part
- Student will learn how to use the 3D printer
- Students will use hand tools and parts cleaner to remove the soluble support material from their part.
- Students will effectively design, engineer, and draw assembled products.
- Students will master their ability to effectively create parts, assemblies, presentations, mechanism simulations, renderings, animations, and documentation (drawings).

Big Ideas:

Big Idea # 1: Technology is created, used, and modified by humans.

Big Idea #2: Technological design is a creative process that anyone can do which may result in new inventions and innovations.

Big Idea #3: Technological literacy is the ability to use, assess and manage technology around us.

Big Idea #4: Successful STEM professionals exhibit specific personal and professional characteristics that lend themselves to the creative, collaborative, and solution-driven nature of their profession.

Big Idea #5: STEM professionals use professional skills and knowledge to pursue opportunities and create sustainable solutions to improve and enhance the quality of life of individuals and society.

Textbook and Supplemental Resources:

No textbooks used or print resources

Curriculum Plan

UNIT 1: Engineering and Design Vocabulary

Time Range in Days: 9 days

Standards (by number):

- 3.4.12.C2, 3.4.12.D2, 3.4.10.E7

Anchor(s):

- S11.A.2.1, S11.A.3.1

Eligible Content:

- Students will know engineering and design terminology.

Objectives:

1. Students will learn solid modeling and basic manufacturing terminology. (DOK 1)
2. Students will utilize the engineering software (Inventor Professional) because the software applies common engineering and design terminology to define its electronic tools. (DOK 2)
3. Students will relate the tools to features of a part. (DOK 3)

Core Activities and Corresponding Instructional Methods:

1. Students will define terms given to them on a vocabulary sheet via the network public files. They will use the software help database to search for the terms. They type the list in Microsoft Word. The students will also learn special functions and instructions for the tools that relate to the terms. The special function and instruction commands are listed in Appendix A of the Inventor R5 textbook.
 - a. Discussion: terms and electronic tools
 - b. Hands-on: complete terminology assignment

Assessments:

Diagnostic:

Oral response during discussion

Formative:

Terminology list

Summative:

Terminology exam

UNIT 2: Manufacturing Processes

Time Range in Days: 6 days

Standards (by number):

- 3.4 Technology and Engineering Education

Anchor(s):

- S11.A.2.1, S11.A.3.1

Eligible Content:

- To understand the development and engineering of a product you must understand the processes of manufacturing. Students will understand the processes involved in manufacturing.

Objectives:

1. Students will understand the processes which make up the technological systems of manufacturing. (DOK 1)
2. Students will read about and discuss the different types of manufacturing. (DOK 1)
3. Students will study manufacturing fundamentals, product development, production planning, production, and high-performance manufacturing. (DOK 1)
4. Students will discuss the impacts of technology on society, the environment and the economy. (DOK 1)

Core Activities and Corresponding Instructional Methods:

1. In class, read unit 4, chapters 11-15, pgs. 226-32. Complete the Understanding Concepts questions at the end of each chapter
 - a. Hands-on: bookwork
2. Discuss the information learned in the 5 manufacturing, engineering and design chapters
 - a. Discussion: bookwork

Assessments:

Diagnostic:

Oral response

Formative:

Chapter discussion

Summative:

Review questions

Materials and Resources

Technology: Engineering and Design textbook

UNIT 3: Introduction to Solid Modeling Software

Time Frame: 13 days

Standards (by number):

- 3.4.12.C2, 3.4.12.D2, 3.4.10.E7

Anchor(s):

- S11.A.2.1, S11.A.3.1

Eligible Content:

- Solid modeling software is used in the engineering and design stages of product development. Students will know how to use the tools and functions of the design software.

Objectives:

1. Students will learn basic tools of Inventor Professional. (DOK 1)
2. Students will use that will transform and 2-dimensional AutoCAD drawing into a 3-dimensional model tools. (DOK 2)
3. Students will create 2D sketches and turn them into 3D models using sketch and part feature tools. (DOK 4)
4. Students will extrude and 2D sketch of a squared shape into a cube or rectangular model. (DOK 4)
5. Students will revolve a half section sketch into a cylindrical model. (DOK 4)

Core Activities and Corresponding Instructional Methods:

1. Use the AutoCAD drawing tool to import 2-dimensional CAD drawings then convert them into 3 dimensional models
 - a. Discuss and demonstrate: commands
 - b. Hands-on: reinforce commands via practice part
2. Create sketches of specific parts on pgs. 215-217 then use the extrude and revolve tools to changed them into solid models
 - a. Discuss and demonstrate: commands
 - b. Hands-on: reinforce commands via practice part

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Assessments:

Diagnostic:

Oral response during discussion

Formative:

Student progress on practice problem

Summative:

CAD to solid and Practice problem parts

Materials and Resources:

Smart board, CADD lab, software: Inventor Pro and Netop, *Exploring Drafting* textbook

UNIT 4: Advanced Solid Modeling Software Processes

Time Frame: 20 days

Standards (by number):

- 3.4.12.C2, 3.4.12.D2, 3.4.10.E7

Anchor(s) or Adopted Anchor(s):

- S11.A.2.1, S11.A.3.1

Eligible Content:

- To be able to use solid modeling software at a professional level, students will have to be able to use its more advanced tools and processes. Students will be able to use solid modeling software at a professional level.

Objectives:

1. Students will complete tutorials imbedded in the Inventor software. (DOK 4)
2. Students will master sketching tools and procedures learned in unit #3. (DOK 4)
3. Students will utilize direct manipulation. (DOK 4)
4. Students will create assemblies. (DOK 4)
5. Students will develop drawings and edit drawing styles. (DOK 4)
6. Students will know how to import and constrain parts from the content center. (DOK 4)
7. Students will make derived parts and edit them. (DOK 4)
8. Students will be able to insert iFeatures. (DOK 4)
9. Students will develop presentation animations. (DOK 4)
10. Students will work with plastic parts and features. (DOK 4)
11. Students will render parts and save them as jpeg files. (DOK 4)
12. Students will animate movements of assemblies and save them as mpeg files. (DOK 4)
13. Students will import parts from the parts library and build bolted connections. (DOK 4)

Core Activities and Corresponding Instructional Methods:

1. Complete the specified tutorials listed in the public files.
Demonstration: tutorials, commands, and procedures
Hands-on: tutorials

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Assessments:

Diagnostic:

Oral response during discussion

Formative:

Student progress and understanding of tutorials

Summative:

Tutorials and final project

Materials and Resources:

Smart board, CADD lab, software: Inventor Pro, and Netop

UNIT 5: Precision Measuring Devices / Reverse Engineering

Time Range in Days: 14 days

Standards (by number):

- 3.4.12.C2, 3.4.12.D2, 3.4.10.E7

Anchor(s):

- S11.A.2.1, S11.A.3.1

Eligible Content:

- Reverse engineering is a widely used process in engineering, and design and the ability to accurately use precision measuring devices is a crucial part of the process. Students will know how to correctly use precision measuring devices to reverse engineer a part. Students will also learn how to use the 3D scanner to reverse engineer a part. This is a modern tool that will replace using a dial caliper to take precise measurements.

Objectives:

1. Students will take precise measurements to .0001 using a micrometer (dial caliper). (DOK 2)
2. Students will utilize several other advanced measuring tools such as inside and outside diameter calipers, depth gauges and thread gauges. (DOK 2)
3. Students will reinforce the skills they learned in the instructional tutorials imbedded in the Inventor software. (DOK 1)
4. Student will create an exact virtual replica of 2 given parts, one of which will be a Lego because of their extremely tight tolerances. (DOK 4)
5. Students will use the 3D scanner to reverse engineer a part. (DOK 2)
6. Students will print their drawing files using the HP Design Jet 800 plotter. (DOK 2)

Core Activities and Corresponding Instructional Methods:

1. Students will create exact graphic reproductions of and draw two specifically chosen parts. The parts will challenge them to use the measuring tools and procedures they have learned so far. Students have the option of finding their own parts, but the instructor must approve the parts.
 - a. Demonstration: use of advanced measuring tools

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- b. Demonstration: use of the 3D scanner
 - c. Hands-on: graphic reproductions
2. They will have to develop a drawing file of one of the reproductions, which will reinforce their ability to create drawing files. All these skills will be applied during the creation of their final project
- a. Demonstration: drawing files and use of plotter
 - b. Hands-on: create drawing file and print it out on the plotter

Assessments:

Diagnostic:

Oral response during demonstration

Formative:

Graphic reproductions and drawing files

Summative:

Final project

Materials and Resources

Smart board, CADD lab, software: Inventor Pro, and Netop

UNIT 6: Rapid Prototyping / 3D Printer

Time Range in Days: 4 days

Standards (by number):

- 3.4.10.C1, 3.4.10.C2, 3.4.12.C2, 3.4.12.D2, 3.4.10.E7

Anchor(s) or Adopted Anchor(s):

- S11.A.2.1, S11.A.3.1

Eligible Content:

- Rapid prototyping is the process of using computer driven machines (3D printer) to create a working prototype in a fraction of the time compared to more traditional methods. Rapid prototyping is a key element in production today. Students will know how to use a 3D printer to create a prototype.

Objectives:

1. Students will know how to use different slicer software to create a toolpath for their part. (DOK 2)
2. Students will be able to use the driver software to operate the 3D printer controls. (DOK 2)
3. Students will learn how to use the 3D printer. (DOK 2)

Core Activities and Corresponding Instructional Methods:

1. Discuss the safest and most efficient process for using the 3D printer.
2. Create pack in printer and build part.
 - a. Demonstration: 3D printer slicer and driver software
 - b. Hands-on: create toolpath
3. Remove support material and clean part to be graded.
 - a. Demonstration: 3D printer operation
 - b. Hands-on: create prototype

Assessments:

Diagnostic:

Observation of oral response during demonstration of 3D printer and software

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Formative:

Digital image and toolpath of parts

Summative:

Prototype of parts

Drawing printout of prototype

Materials and Resources

Smart board, Computer, Inventor Software, 3D printer software, 3D printer, consumable materials (model and support material)

UNIT 7: Advanced Adobe Illustrator and Vinyl Cutting

Time Range in Days: 6 days

Standards (by number):

- 3.4.10.C1, 3.4.10.C2, 3.4.12.C2, 3.4.12.D2, 3.4.10.E7

Anchor(s):

- S11.A.2.1, S11.A.3.1

Eligible Content:

- Learn and use more advanced Adobe Illustrator tools to create an image with a cut contour to be printed and cut on the Roland SG-540 vinyl cutter.

Objectives:

1. Students will learn how to create a detailed image in Adobe Illustrator.
2. Students will know how to draw a cut contour in Adobe Illustrator.
3. Students will understand how to use the VersaWorks software to set up and drive the Roland vinyl printer/cutter.
4. Students will be able to operate the Roland vinyl cutter.

Core Activities and Corresponding Instructional Methods:

1. Create an image with a cut contour in Adobe Illustrator that will be printed and cut out in sticker/decal format on the Roland vinyl cutter.
 - a. Lecture on the software procedures
 - b. Demonstration of the software tools
 - c. Hands-on creation of the image
2. Setup the graphic made in Adobe Illustrator in VersaWorks so it can be made by the vinyl cutter.
 - a. Lecture on the software procedures
 - b. Demonstration of the software tools
 - c. Hands-on creation of the graphic
3. Use the Roland vinyl cutter to make the sticker/decal
 - a. Demonstration of the machine's functions
 - b. Hands-on printing of the project

Assessments:

Diagnostic:

Oral response during the lectures and demonstrations

Formative:

The student's artwork on Adobe Illustrator

Summative:

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Printed and cut sticker/decal from the vinyl cutter.

Materials and Resources

Adobe Illustrator, Roland VersaWorks, Roland SG-540 vinyl printer/cutter, vinyl roll, computers.

UNIT 8: Final Project / Applying Design Process and CAD Software

Time Range in Days: 18 days

Standards (by number):

- 3.4.10.C1, 3.4.10.C2, 3.4.12.C2, 3.4.12.D2, 3.4.10.E7

Anchor(s):

- S11.A.2.1, S11.A.3.1

Eligible Content:

- The content learned in this class needs to be reinforced to a mastery level and is essential to understanding the process of developing an effective product. Students will be able to effectively develop an invention or innovation of a product.

Objectives:

1. Students will be able to effectively design, engineer and draw an assembled product. (DOK 4)

Core Activities and Corresponding Instructional Methods:

1. Students will create their final project. Students will be given little if any assistance during the final project. Students will have to refer to earlier tutorials and the help function within the software to work through their problems.
 - a. Hands-on: final project

Assessments:

Formative:

Progress of final projects

Summative:

Final project

Materials and Resources

Computer, Inventor software, plotter

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Primary Textbook(s) Used for this Course of Instruction

- There are no primary textbooks used in this class

Appendix

STANDARDS:

3.4. Technology and Engineering Education

3.4.A The Scope of Technology

- 3.4.10.A2 - Interpret how systems thinking applies logic and creativity with appropriate comprises in complex real-life problems.

3.4.C Technology and Engineering Design

- 3.4.10.C1: Apply the components of the technological design process.
- 3.4.10.C2: Analyze a prototype and/or create a working model to test a design concept by making actual observations and necessary adjustments
- 3.4.12.C2: Apply the concept that engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly.

3.4.D Abilities for a Technological World

- 3.4.12.D2: Verify that engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly.

3.4.E The Design World

- 3.4.10.E7: Evaluate structure design as related to function, considering such factors as style, convenience, safety, and efficiency

ANCHORS:

S11.A.1: Reasoning and Analysis

- S11.A.1.1: Analyze and explain the nature of science in the search for understanding the natural world and its connection to technological systems.
- S11.A.1.2: Identify and analyze the scientific or technological challenges of societal issues; propose possible solutions and discuss implications.

S11.A.1.3: Describe and interpret patterns of change in natural and human-

S11.A.2 Processes, Procedures, and Tools of Scientific Investigations

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- S11.A.2.1 - Apply knowledge of scientific investigation or technological design to develop or critique aspects of the experimental or design process.

S11.A.3 Systems, Models, and Patterns

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