

# Educator's Guide

## Innovating Through Digital Design

### Curriculum Collection Description:

The United States is in the middle of the 4th Industrial (Industry 4.0) Revolution. This Industrial Revolution is driven by the interdependence of advanced technology like artificial intelligence & robotics, data analysis & information systems, and the ever-changing knowledge and skills workers require. To remain globally competitive, American industries must leverage Industry 4.0 technologies to manage and complete their work. There is a profound shortage of workers with the knowledge and skills to work with and alongside these new technologies. Companies refer to this lack of workers and/or skills in existing workers as the “skills gap.” Manufacturing America™ was created in 2014 by the federal government as part of a national initiative to support America’s manufacturing ecosystem, from basic research and development to designing new products and materials to deploying them to market first globally.

JASON Learning, in partnership with the Ohio Valley Employment Resource (OVER), has collaborated to create curriculum models and provide local career exploration experiences for students in Appalachian Ohio. The Innovating Through Digital Design Module is designed to launch students along a learning pathway to inspire them to pursue a SolidWorks Certification and generate an awareness of the many careers that leverage the basic knowledge and skills introduced in this module.

**Time Requirements:** approximately 4 - 5 weeks

**Audience:** 9-12th grade courses: science, math, Pre-Engineering, Manufacturing, Engineering Design, computer science, architecture, art

***Students will need access to a computer, 3 - Button Mouse, and CAD software. This module was designed around the use of TinkerCAD®. However, beyond the TinkerCAD® specific tutorials, all other activities could be completed with any available CAD software including Fusion360, Autocad, and Solidworks.***

### Quick Links to other parts of the document:

- [Stage 1: Getting Started with 3D Models](#)
- [Stage 2: Gaining Traction](#)
- [Stage 3: Designing the Built World](#)
- [Portfolio Project & Career Connections: Innovating Through Digital Design](#)
- [Master Material List](#)

## Stage 1: Getting Started with 3D Models

### Description:

In Stage 1, students are introduced to computer-aided design (CAD) and TinkerCAD®. Students will leverage TinkerCAD® to become familiar with the digital design tools in the platform.

### Time frame:

Approximately five 45-minute class periods. Some articles could be assigned for out-of-class work.

### Learning Outcomes:

Students will be introduced to:

- Tinkercad's Design Tools
- 2D and 3D digital schematics
- Calipers as a measuring tool
- Design specifications and tolerances

### Key Vocabulary:

digital design, schematic, specifications, tolerances, precision, caliper, accuracy, precision, scaled

### Resource Table:

Type of Resource	Name of Resource	Description of Resource
Activity	Tinkercad: Getting Started with Digital Design	In this activity, students will be introduced to TinkerCAD®'s interface and basic functions by completing the Let's Learn TinkerCAD® lesson.
Article	The Power of Digital Design	This article introduces students to digital design and how digital design is used in manufacturing to create information, optimize designs, and improve efficiency.
Activity	Let's Learn TinkerCAD®: Manipulating Solids	This activity continues to introduce students to Tinkercad's interface and basic functions. Students will navigate the Tinkercad workspace, create solids, move and manipulate solids, align objects, and modify workplaces.

Activity	Debris Field Modeling	In this activity, students will create an accurate and precise 3D digital model of a mock debris field.
Article	The Rising Challenge of Space Debris: A Looming Threat to Space Exploration	In this article, students will explore the challenges associated with the debris field and the measures being taken to mitigate this growing problem.
Activity	Block It Up	In this activity, students will use basic TinkerCAD® skills to create a scaled 3D model of a plastic building block with two studs, also known as a 1 x 2.
Activity	Moon Topography: Advanced TinkerCAD® Skills	In this activity, students expand on the basic TinkerCAD® concepts they have learned. The students will follow a series of tutorials on how to create more complex solid models and expand their skill set in TinkerCAD®.
Article	Modeling Surface Features	In this article, students will learn about creating 3D models of surface features of large objects like the Earth to small objects like molecules.

## Pacing Guide:

Time (45 - 50 minutes class period)	Resources utilized presented in recommended sequence
Day 1	<ul style="list-style-type: none"> <li>● <b>Activity</b> -Tinkercad: Getting Started with Digital Design</li> <li>● <b>Article:</b> The Power of Digital Design</li> </ul>
Day 2	<ul style="list-style-type: none"> <li>● <b>Activity</b> - Tinkercad: Manipulating Solids</li> </ul>
Day 3	<ul style="list-style-type: none"> <li>● <b>Activity</b> - Debris Field Modeling;</li> <li>● <b>Article</b> - The Rising Challenge of Space Debris: A Looming Threat to Space Exploration</li> </ul>
Day 4	<ul style="list-style-type: none"> <li>● <b>Activity</b> - Block It Up</li> </ul>
Day 5	<ul style="list-style-type: none"> <li>● <b>Activity</b> - Moon Topography: Advanced TinkerCAD® Skills</li> <li>● <b>Article</b> - Modeling Surface Features</li> </ul>

## Stage 2: Gaining Traction

### Description:

In Stage 2, students are provided the opportunity to continue to build their digital design specifically around manipulation and texturizing of surface features on objects.

### Time frame:

Approximately five - seven 45-minute class periods. Some articles could be assigned for out-of-class work.

### Learning Outcomes:

Students will be introduced to:

- Advanced Tinkercad's Design Tools
- 2D and 3D digital schematics
- Rapid Prototyping
- History of tire design, tire safety & regulations

### Key Vocabulary:

Industry 4.0, digital design, schematic, specifications, tolerances, precision, caliper, accuracy, precision, scaled, STL files, modeling, rapid prototyping, careers, digital twin

### Resource Table:

Type of Resource	Name of Resource	Description of Resource
Article	Counterfeit Defense Using Digital Design	In this article, students will learn more about digital design and its practical application to designing new currency.
Activity	Stamping Your Way	In this activity, students will design a plastic stamp and learn how to use digital models to 3D print a physical model.
Article	On the Road Again	In this article, students will be introduced to the importance of tire inspections and maintenance.
Activity	When the Rubber Hits the Road	In this activity, students will explore tire treads and their properties and then make a clay tread model.

Activity	Rolling Down the Road: Part 1	In this activity, students will prototype tread patterns to optimize performance on a downhill ramp.
Activity	Rolling Down the Road: Part 2	In this activity, students will create a clay tread prototype into a 3D digital model.
Article	Simulating the World through Solid Modeling	This article describes how the world can be simulated using 3D models created in CAD software.
Activity	Engineered Surface Textures	In this activity, students will research an engineered surface and create a short presentation to share what they have learned.

## Pacing Guide:

Time (45 - 50 minute class period)	Resources utilized presented in recommended sequence
Day 1	<ul style="list-style-type: none"> <li>● <b>Article:</b> Counterfeit Defense Using Digital Design (could be used for homework)</li> <li>● <b>Activity:</b> Stamping Your Way (If 3D printing, additional time will be required.)</li> </ul>
Day 2	<ul style="list-style-type: none"> <li>● <b>Article:</b> On the Road Again</li> <li>● <b>Activity:</b> When the Rubber Hits the Road</li> </ul>
Day 3	<ul style="list-style-type: none"> <li>● <b>Activity:</b> Rolling Down the Road: Part 1</li> </ul>
Day 4	<ul style="list-style-type: none"> <li>● <b>Activity:</b> Rolling Down the Road: Part 2</li> </ul>
Days 5 - 6	<ul style="list-style-type: none"> <li>● <b>Article:</b> Simulating the World through Solid Modeling</li> <li>● <b>Activity:</b> Engineered Surface Textures</li> </ul>

## Stage 3: Manufacturing using the Digital Design

### Description:

In Stage 3, students are provided the opportunity to continue to build their digital design skills as they explore the different applications in the built world.

### Time frame:

Approximately five to six 45-minute class periods. Some articles could be assigned for out-of-class work.

### Learning Outcomes:

Students will be introduced to:

- Advanced Tinkercad's Design Tools
- 2D and 3D digital schematics
- Sustainable Design & the Circular Economy

### Key Vocabulary:

digital design, schematic, UN Sustainable Development Goals, sustainable design, circular economy, Industry 4.0

### Resource Table:

Type of Resource	Name of Resource	Description of Resource
Activity	Domes in Architecture: Creating Composite Figures	In this activity, students expand on the basic TinkerCAD® concepts they have learned. The students will follow a series of tutorials on how to create more complex solid models and expand their skill set in TinkerCAD®.
Activity	Designing a Spaceship: Advanced TinkerCAD® Skills	In this activity, students expand on the basic TinkerCAD® concepts they have learned. The students will follow a series of tutorials that allow them to create more complex solid models and expand their skill set in TinkerCAD®.
Article	Digital Design: Careers Opportunities and Education Pathways	This article introduced students to career opportunities and education pathways related to digital design.

Activity	Digital Design Speed Challenge	In this activity, students will take part in a speed challenge in the creation and assembly of an object.
Article	Uniting Corporate Sustainability with the U.N. Sustainable Development Goals	In this article, students will learn how manufacturers collaborate with their communities to support progress toward meeting the United Nations Sustainable Development Goals.
Activity	A Picture Is Worth a 1000 Words	In this activity, students will create a compelling digital representation of local data related to one of the United Nations Sustainable Development Goals.
Article	Designing for a Sustainable Future	In this article, students will explore the concepts related to the circular economy and sustainable design.
Activity	Containerized Living: A Sustainable Housing Solution	In this activity, students will be an architect who will design a shipping container home. You will then share your home's design and feature through an information flyer.

## Pacing Guide:

Time (45 - 50 minute class period)	Resources utilized presented in recommended sequence
Day 1	<ul style="list-style-type: none"> <li>● <b>Activity:</b> Domes in Architecture: Creating Composite Figures</li> </ul>
Day 2	<ul style="list-style-type: none"> <li>● <b>Activity:</b> Designing a Spaceship: Advanced TinkerCAD® Skills</li> <li>● <b>Article:</b> Digital Design: Careers Opportunities and Education Pathways (homework)</li> </ul>
Day 3	<ul style="list-style-type: none"> <li>● <b>Activity:</b> Digital Design Speed Challenge</li> </ul>
Day 4	<ul style="list-style-type: none"> <li>● <b>Article:</b> Uniting Corporate Sustainability with the U.N. Sustainable Development Goals</li> <li>● <b>Activity:</b> A Picture Is Worth a 1000 Words</li> </ul>
Day 5 - 6	<ul style="list-style-type: none"> <li>● <b>Article:</b> Designing for a Sustainable Future</li> <li>● <b>Activity:</b> Containerized Living: A Sustainable Housing Solution</li> </ul>

# Portfolio Project and Career Connections

## Description:

In the culminating challenge, students redesign an existing consumer product to maintain or enhance consumer satisfaction while increasing its circularity and sustainability.

## Time frame:

Approximately five to six 45-minute class periods. Some work could be completed outside of the regular class period.

## Learning Outcomes:

Students will provide digital documentation guided by a Rubric of how their digitally designed solution meets the specific criteria for each area:

- Maintaining customer satisfaction.
- Increasing the circularity of the existing product
- Incorporating Principles of Sustainable Design

## Resource Table:

Type of Resource	Name of Resource	Description of Resource
Article	Challenge Guidelines for Innovating Through Digital Design	This resource will guide students as they redesign an existing consumer product to increase its circularity and sustainability.
Article	Technical Brief Rubric for Innovating Through Digital Design	This resource will guide students in developing their technical brief for the Innovating Through Digital Design Challenge.
Article	Pitch Rubric for Innovating Through Digital Design	This resource will guide students as they develop and present a pitch to influence the product's manufacturer to implement their recommended product redesign.
Article	Digital Design Careers and Education Paths	A brief article listing possible career and education paths for students in digital design.



Article	File Management for Projects	In this article, you will learn about the importance of establishing a file management protocol at the beginning of a project.
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## Pacing Guide:

Time (45 - 50 minute class period)	Resources presented in recommended sequence
Day 1	<ul style="list-style-type: none"> <li>● <b>Introduce the Challenge:</b> <ul style="list-style-type: none"> <li>○ Review Challenge Guidelines, Technical Brief Rubric, and Pitch Rubric with students.</li> <li>○ Students begin identifying potential consumer products to redesign.</li> </ul> </li> </ul>
Day 2	<ul style="list-style-type: none"> <li>● Students conduct background research on products and materials.</li> <li>● Students create a digital model of the original product.</li> </ul>
Day 3	<ul style="list-style-type: none"> <li>● Students redesign the product.</li> <li>● Students create digital models of redesigned products.</li> </ul>
Day 4	<ul style="list-style-type: none"> <li>● Students create onTechnical Briefs.</li> </ul>
Day 5	<ul style="list-style-type: none"> <li>● Students create and practice Pitch Presentations</li> </ul>
Day 6	<ul style="list-style-type: none"> <li>● Students present Pitches.</li> </ul>

# Master Materials List

In addition to a device with internet access and **3 button mouse**, you will need the following materials.

## **Stage 1:**

### Activity: Debris Field Modeling

- Caliper (one per pair of students)
- Machinist ruler (one per pair of students)
- Graph paper
- Cube-shaped object (e.g., die)
- Sphere-shaped object (e.g., marble)
- Cylinder-shaped object (e.g., chapstick)
- Printed copy of rubric

### Activity: Block It Up!

- Caliper (one per pair)
  - Machinist ruler (one per pair)
  - Micrometer (one to be shared among the class)
  - 1 x 2 plastic building block (1 per pair of students)
  - Printed copies of rubrics
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## **Stage 2:**

### Activity: Stamping Your Way

- Caliper (one per pair)
- Machinist ruler (one per pair)
- Quarter (1 per class)
- Sample stamps - so students can measure typical depth
- Printed copies of rubrics
- 3D printer: if available, can be used to print the stamp
  - Cardstock
  - Ink pads or Sharpie markers for inking the stamps

### Activity: When the Rubber Hits the Road

- Penny (to test tread depth)
- Caliper (one per pair)
- Machinist ruler (one per pair)
- Crayons
- Tracing paper or some other lightweight paper
- Clay
- Carving tools (toothpicks, popsicle sticks, etc.)
- Rigid cylinder provided by your instructor
- Plastic Wrap, plastic bag or aluminum foil to prevent clay model from drying out.

### Activity: Rolling Down the Road: Part 1

- Clay tread and wheel from the “When the Rubber Hits the Road” Activity.
- Clay if needed to modify treads
- Carving tools (toothpicks, popsicle sticks, etc.)
- Timing device (could be student phones)
- Printed copies of rubric

### Activity: Rolling Down the Road: Part 2

- Caliper (one per pair)
- Machinist ruler (one per pair)

## **Stage 3:**

Activity: Speed Challenge

- Printed copies of design and rubric.

Activity: A Picture Is Worth 1000 Words

- Printed copies of the rubric.

Activity: Containerized Living: A Sustainable Housing Solution

- Printed copies of the rubric.

## **Portfolio:**

- Printed copies of the Challenge Guidelines.
- Printed copies of the Technical Rubric.
- Printed copies of the Pitch Presentation.