CHAPTER THREE

THINGIVERSE AND 3D MODELING

When exploring how to best use your 3D printer, you don't have to go it alone. There's a massive online community of millions of 3D printing educators and makers that actively offer advice, answer questions, and contribute their designs for others to use freely. This community is Thingiverse.

Thingiverse is built on the principles of sharing, learning, and making. It's a community where users from all over the world can download free 3D models and 3D printing lesson plans for any age group or subject. MakerBot founded Thingiverse in 2008 while developing the first desktop 3D printers, and several years later it's grown to an enormous size and stands in support of the entire 3D printing industry.

TERMINOLOGY

Thingiverse®: The largest online 3D printing community and library of printable files, accessible at thingiverse.com

Thing: A 3D model uploaded to Thingiverse, this can be a single object or several, and typically comes with pictures and printing instructions

Thingiverse Education™: 3D printing projects and lesson plans for different grades and subjects

Remix: A cornerstone of Thingiverse. This is when a user edits or builds upon a Thing to customize it in some way while providing attribution to the original designer

Licensing: Describes how a designer permits the community to use his/her creation (i.e. whether it can be remixed or sold commercially)

Makes: When a user downloads and prints another designer's model, then uploads a picture of it to demonstrate its appearance and printability

Collection: A curated folder of Things by users, and a great way to organize Things for your class

THINGIVERSE, A UNIVERSE OF THINGS

Thingiverse is a great place to go for inspiration when creating your own 3D models. Instead of designing a hinge or spring from scratch, there are plenty of Things you can look to for guidance, or download and modify to suit your own project.

Several designers use Thingiverse the way photographers use Instagram; designers upload 3D models to share with others and get feedback and recognition for their work. Take some time to explore the more active users' portfolios – you're sure to find some amazing and inspirational Things!

Be mindful of the licensing features that the original designer has chosen when downloading and printing 3D models. In some cases, you are free to use the model however you'd like. However in others, you may not be allowed to remix or use the model commercially, such as selling prints of the model. In all cases, you must provide attribution to the designer, especially when you remix another designer's model.

THING BADGES

When searching Thingiverse, keep an eye out for these icons to help you identify standout Things:

Verified Thing: 3D model has been print tested and verified to print successfully.

Featured Thing: This Thing has been featured on the Thingiverse homepage.

Challenge Winner: This Thing was the winning entry in a Thingiverse Challenge.

Thingiverse Education: This Thing is an educational project.

EXAMPLE THINGS

Subaru WRX EJ20
Boxer Engine Model
Thing: #1643878
@EricThePoolBoy
Licensed under CC BY-NC 3.0

Vases
Thing: #284006
@LeFabShop

Licensed under CC BY-SA 3.0

Mars Rover
Thing: #404824
@MakerBot

Licensed under CC BY-SA 3.0

WALLY - Wall Plate
Thing: #47956
@TheNewHobbyist

Licensed under CC BY-SA 3.0

Go-Go AirBoat
Thing: #906745
@Macakcat

Licensed under CC BY-SA 3.0

Pip Boxes
Thing: #1766512
@Aaskedall

Licensed under CC BY-NC 3.0

Forest Dragon
Thing: #87458
@DutchMogul

Licensed under CC BY-SA 3.0

Tide the Fish
Thing: #236345
@Cordavi

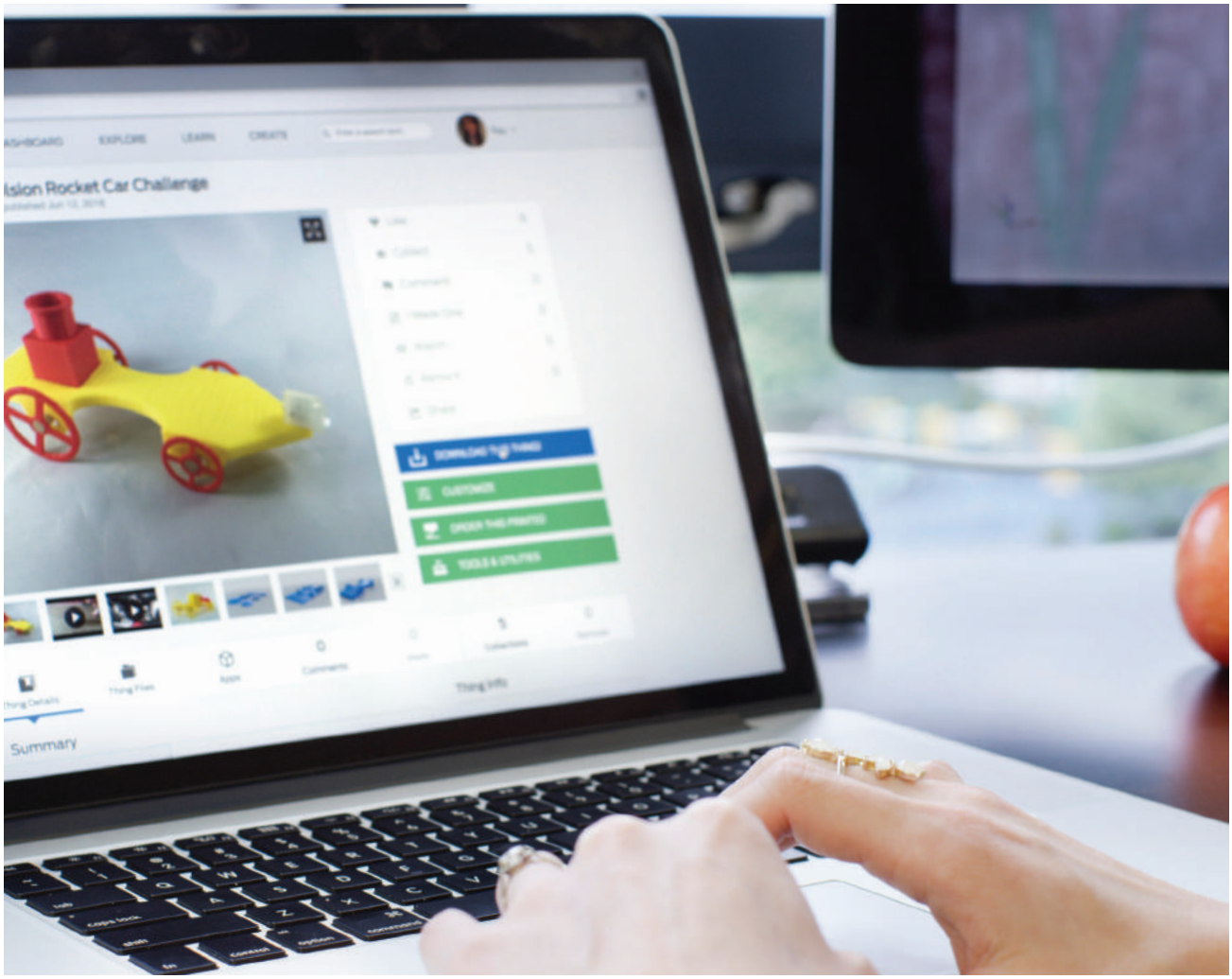
Licensed under CC BY-SA 3.0

Fascinator Hat
Thing: #858954
@Yesquab

Licensed under CC BY-NC 3.0

THINGIVERSE EDUCATION

Thingiverse Education is a collection of 3D printing projects for the classroom. It's where educators go to find lesson plans, remix them to suit their subjects or grade levels, and share best practices on how to incorporate the technology into their classrooms.



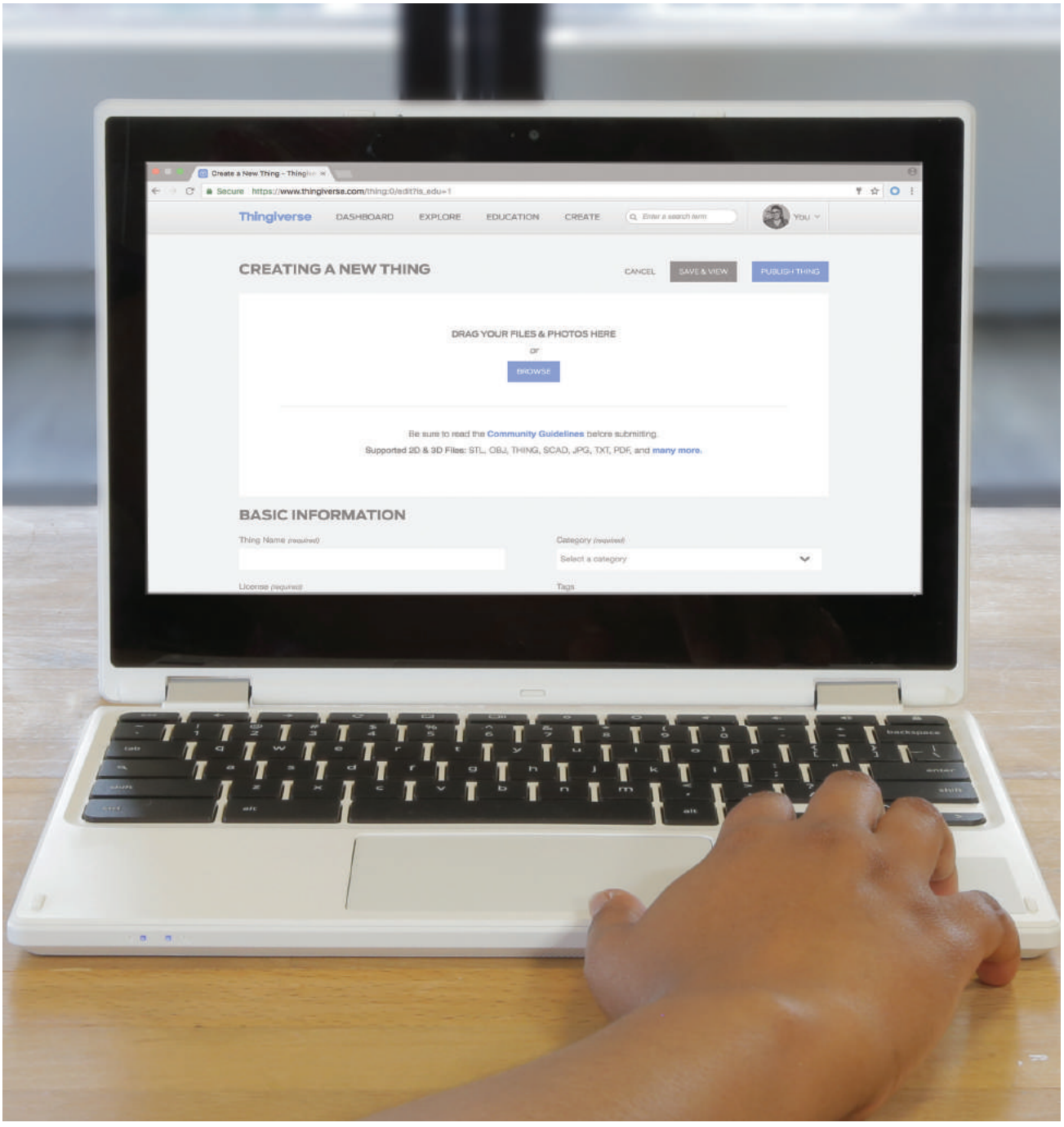
3D printing projects use 3D design and printing in different ways to reinforce core learning objectives in several subjects – from clear STEM applications in engineering and physics, to blended activities in history, music, or foreign languages. Most projects on Thingiverse Education prompt students to plan, design, and print their own solutions to a given problem.

Thingiverse Education organizes projects by grade level, subject, and standards (including Next Generation Science Standards, NGSS and Common Core State Standards, CCSS.) Projects can range in length from a single class period to week-long projects with multiple assignments and objectives.

CREATE A PROJECT ON THINGIVERSE EDUCATION

Whether you design your own 3D model or remix someone else's, every Thingiverse Education project starts with a 3D printable file (.STL). There are some great projects out there, look at existing ones for examples of how to build your own. The projects featured in the second half of this guidebook can all be found on Thingiverse Education.

Here are the steps to create your own Thingiverse Education project for sharing with other teachers.



Cloud Types and Display Stands
Designed by @devansic

Grades: 1-4 **Subject:** Science

This project prompts students to design and print models for each of the ten different cloud formations.

SAMPLE PROJECT FROM
Thingiverse.com/Education

01. Create a new Thing:

› Navigate to Thingiverse.com

› Click **Create** then **upload a Thing**

02. Upload your files:

› **.STL file(s):** This could be a starter model, an example of the project's output, a challenge, a tutorial, a demonstration, etc.

› **Photo(s):** This should be a photo of the printed model, or of the project in action. The more photos the better.

› Other files like handouts, rubrics, etc.

03. Complete the Basic Information section:

› Complete the required fields

› Check the box to **submit to Thingiverse Education for approval**

04. Complete the Thing Information sections:

› **Summary:** Short description of the 3D model and the project involved

› **Grade:** Select the recommended grade level for the project

› **Subject:** Include any relevant subjects i.e. science or math

› **Standards:** Select the standards that your project meets

› **Overview and Background:** Give an intro to what students will learn by completing this project

› **Activity / Lesson Plan:** The meat of your project. Be sure to list every step. Remember, a picture is worth 1,000 words

› **Materials Needed:** Itemize the materials for this project

05. Add more information to help other educators:

› **Skills Learned:** List what skills will be gained by completing this project and include specific standards here

› **Duration:** Estimate how long it will take to complete

› **Preparation:** List anything that students should already know or that the teacher needs to do before starting this project

› **Handouts and Assets:** If there are any documents that accompany your project, attach them to the Thing's files and include a brief description here

› **Rubric and Assessment:** Describe what students should have designed, made, printed, or achieved at the end of your project, and any guidelines you have for assessment

› **References:** Include links to valuable resources

06. Publish Thing

Thingiverse

The world's largest 3D printing file library and community.
Discover. Share. Create.

Thingiverse.com

3D DESIGN SOFTWARE

Learning how to design in 3D is essential to creating custom 3D printable models. The broad capabilities of the printer will push you to design increasingly complex objects. Once you begin to experiment, you'll discover the unique advantages that different 3D design programs offer for different applications.

We recommend starting with easy solid modeling programs before branching out to digital sculpting or parametric modeling as you become more comfortable. No single program is right for everyone, and it may take a few tries before you find one that you're comfortable with.

There are a lot of 3D design programs available, all with different strengths and weaknesses. When looking at 3D modeling programs, you'll find that all of them fall into three major categories; **solid modeling**, **digital sculpting**, or **polygon modeling**. The projects in this guidebook focus mainly on free programs.

TERMINOLOGY

Solid Modeling: Define and construct solid objects with real world dimensions

Digital Sculpting: Simulate clay sculpting. Push and pull surfaces to create detail and texture

Polygon Modeling: Define outer surfaces like edges and corners to create intricate models

Parametric Modeling: A feature in 3D design programs, use dynamic variables for object parameters so that entire designs can be easily altered or scaled

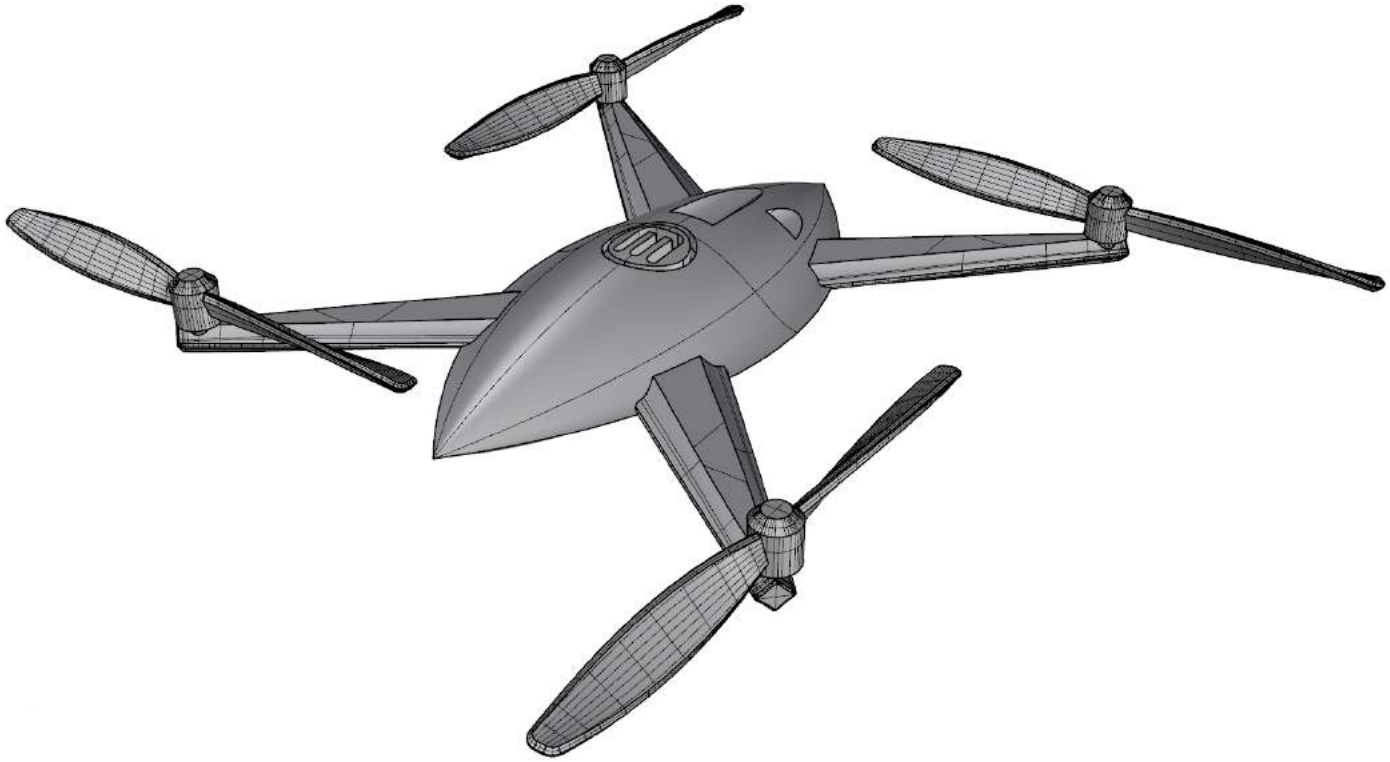
Mesh: The collection of vertices, edges, and faces that make up the surface of a 3D model

Watertight: A continuous outer surface with no holes in it, necessary for successful 3D printing

Perspective View: Objects further away appear smaller than objects closer to the viewpoint

Orthographic View: Fixes the point of view to a single perspective, where similarly sized objects appear the same size regardless of their distance from the viewpoint

SOLID MODELING



QUADCOPTER DRONE: *Created in Rhinoceros*

Solid modeling programs work well for creating models with real-world dimensions and are used to make functional parts. In some of the advanced programs you can form complex assemblies of objects and run simulations.

Industries: Engineering, industrial design, architecture
Free software: Autodesk Tinkercad™, Autodesk® Fusion 360™, Onshape® and more
Paid software: SolidWorks®, Autodesk Inventor®, Rhinoceros

STRENGTHS

- Creating mechanical structures with dimensions
- Building assemblies
- Simulating real-world conditions
- Access to material property libraries

WEAKNESSES

- Poor organic shape creation
- Difficult to create detailed surface textures and patterns

DIGITAL SCULPTING

ROSE: *Created in Sculptris*

Digital sculpting simulates the process of sculpting with physical clay. Users can push and pull digital clay to create organic, highly detailed and textured models.

Industries: Film, video games, art
Free software: Sculptris™, SculptGL
Paid software: ZBrush®, Mudbox®, 3D-Coat

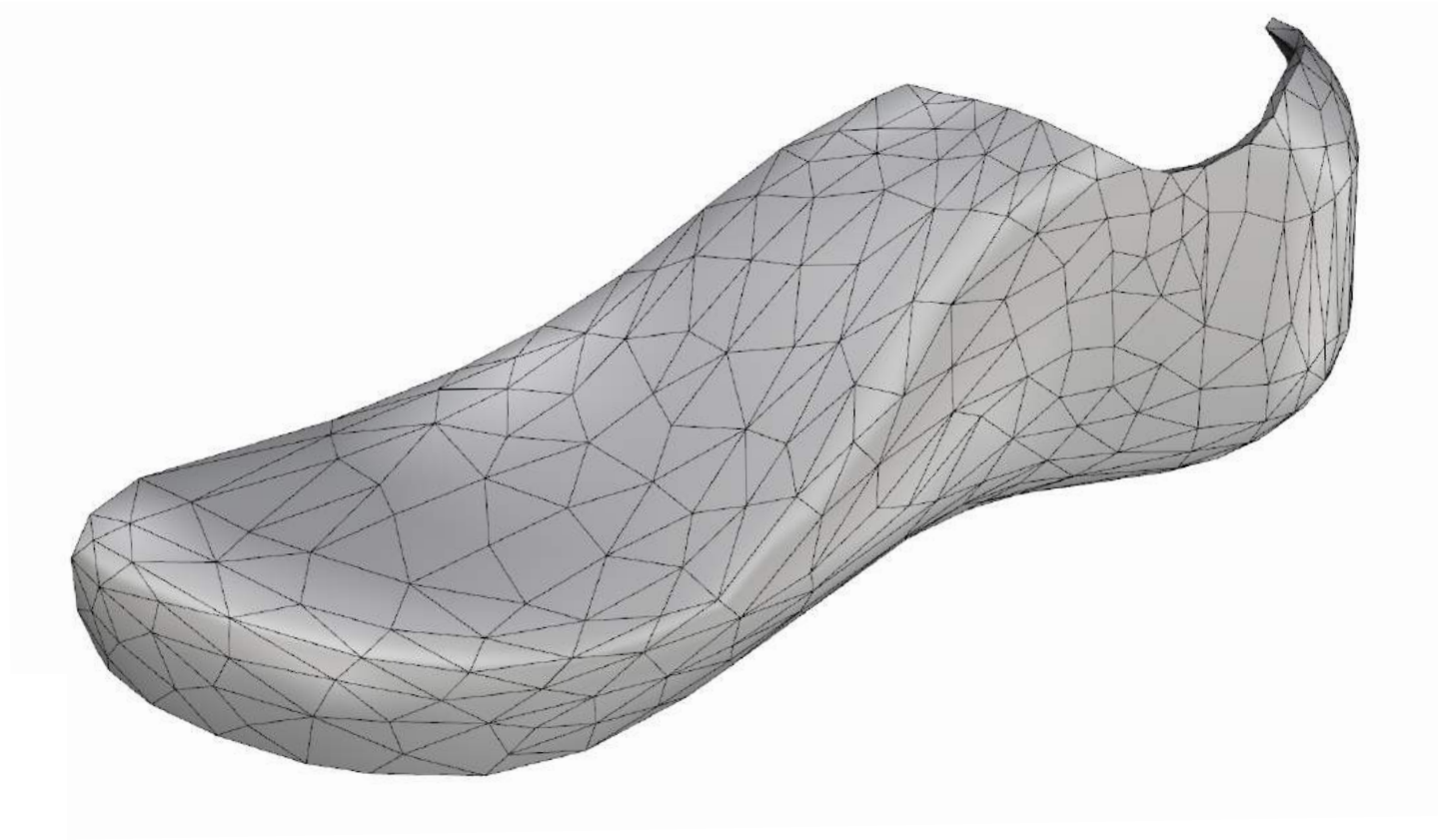
STRENGTHS

- Highly detailed models
- Organic shapes
- Digital painting

WEAKNESSES

- Creating functional parts is difficult
- Often requires additional hardware like a drawing tablet
- Difficult to design for manufacturing

POLYGON MODELING



RUNNING SHOE: *Created in Blender*

Polygon modeling gives users direct control of the mesh, faces, vertices, or edges of a model. This allows for the creation of highly detailed and intricate 3D models. These models can be organic or inorganic.

Industries: Animation, visualization, film, video games
Free software: Blender®, Wings 3D
Paid software: Maya®, 3DS Max®, Cinema 4D®

STRENGTHS

› Highly detailed, intricate models

› Direct control of the mesh

WEAKNESSES

› Steep learning curve

› Models aren't always watertight

3D MODELING APPLICATIONS

If you're just getting started, here are some recommended free 3D Design program options to try out.

BR

BLENDER®

Difficulty: Advanced

Type: Polygon Modeling, Digital Sculpting

Platform: Mac, Windows, Linux

Price: Free

Supports modeling, rigging, animation, simulation and even video editing and game creation.

AF

AUTODESK® FUSION 360™

Difficulty: Intermediate

Type: Solid Modeling

Platform: Mac, Windows

Price: Free/$

Powerful software for creating and analyzing complex geometries and assemblies.

AM

AUTODESK® MESHMIXER

Difficulty: Intermediate

Type: Polygon Modeling, Digital Sculpting

Platform: Mac, Windows

Price: Free

Manipulate meshed objects in preparation for 3D printing. Create custom supports, fix mesh errors, and add detail.

MO

MORPHI®

Difficulty: Easy

Type: Solid Modeling

Platform: Mac, iOS, Windows

Price: Free/$

Create 3D designs on mobile devices with this simple and intuitive program.

ON

ONSHAPE®

Difficulty: Advanced

Type: Solid Modeling

Platform: Online

Price: Free/$

Browser-based software for creating and analyzing complex geometries and assemblies.

OS

OPENSCAD

Difficulty: Intermediate

Type: Solid Modeling

Platform: Mac, Windows, Linux

Price: Free

Use code to define object dimensions and dynamic variables for easy resizing and alteration.

SC

SCULPTRIS™

Difficulty: Easy

Type: Digital Sculpting

Platform: Mac, Windows

Price: Free

Push and pull object surfaces. Great for organic, high-detail models. Use SculptGL for a browser-based version.

SK

SKETCHUP®

Difficulty: Easy

Type: Solid Modeling

Platform: Mac, Windows, Online

Price: Free/$

Draw objects with dimensions. Good for accurate, geometric forms, especially architectural models.

TC

TINKERCAD™

Difficulty: Easy

Type: Solid Modeling

Platform: Online

Price: Free

Design in-browser by combining and resizing simple shapes and holes.

MC

MINECRAFT®

Difficulty: Easy

Type: Solid Modeling

Platform: Mac, Windows

Price: $

Though not a traditional 3D modeling program, Minecraft helps to teach core 3D modeling skills.

STUDENT PRIVACY

The projects in Section 2 of this book involve student usage of many 3D design programs. For any program that requires user information and/or account creation, be sure to consult the Terms associated with each program before beginning the project. Students under 13 years of age often are restricted from creating accounts or entering personal information in these programs without explicit consent from their parent/guardian. Here are some suggestions to keep your students' information safe:

DO'S

- Create a generic MakerBot account for students under 13 to use
- Use only school computer and equipment for students under 13

DON'TS

- Allow or require students under 13 to create their own MakerBot account
- Require students under 13 to use their own laptop or mobile devices