



The Science Behind  
**PIXAR**

**Exhibition  
Introduction**



## *The Science Behind Pixar*

### Recommended for Grades 3 – 12

Learn about the filmmaking process through interactive elements inspired by some of Pixar's most treasured films, from *Toy Story* to *Incredibles 2*. This exhibition offers an unparalleled view of the production pipeline and concepts used at Pixar every day. Participate in fun hands-on activities, listen to firsthand accounts from members of the studios' production teams, and even come face-to-face with re-creations of your favorite Pixar film characters, including Buzz Lightyear, Dory, Mike and Sulley, Edna Mode, and WALL•E!

This exhibition was developed by the Museum of Science, Boston in collaboration with Pixar Animation Studios.

Images © Disney / Pixar

### **The Museum of Science is committed to making accessible exhibitions.**

*The Science Behind Pixar* incorporates the ADA Standards for Accessible Design. All videos are open captioned for visitors with hearing impairments. Every component has an audio handset that provides recordings of the text label content and descriptions of the images and activities for guests unable to access printed information.



Audio Descriptions



Open Captioning

Students will have an opportunity to explore a variety of interactives within *The Science Behind Pixar*. Due to the scope of the exhibition, you may want to encourage your students to focus on specific areas or themes. The following pages provide an exhibition overview as well as learning goals and activity sheets to support those goals.

## BEFORE YOUR VISIT

- Review this guide to familiarize yourself with the exhibition and determine the learning goals for your students.
- Identify connections between the exhibition and your curriculum.
- Create your own activity sheets or supplement those provided in this guide. (See pages 11 – 18)
- Facilitate preparation activities for your students before they visit. Review pre-visit activities developed by teachers: [sciencebehindpixar.org/educators](https://sciencebehindpixar.org/educators).
- Share expectations, plans, and schedules for the field trip with your students and chaperones. Provide copies of activity sheets or other materials to chaperones.

## DURING YOUR VISIT

- Most groups will spend 45 – 60 minutes within the exhibition.

## AFTER YOUR VISIT

- Facilitate post-visit activities for your students that connect to what they saw and experienced in the exhibition. For activity details, please visit [sciencebehindpixar.org/educators](https://sciencebehindpixar.org/educators).



Explore Pixar in a Box, a collaboration between Pixar and Khan Academy that builds on videos from the exhibition and provides in-depth lessons on related topics. For more information: [pixarinabox.org](https://pixarinabox.org).

During their visit, students will experience how art, technology, science, math, computer science, and creativity are inseparable in the making of Pixar animated films. Students will leave the exhibition with a greater awareness of diverse STEM careers and the collaborative spirit behind animated filmmaking.

## EDUCATIONAL GOALS

### Knowledge, awareness, and understanding

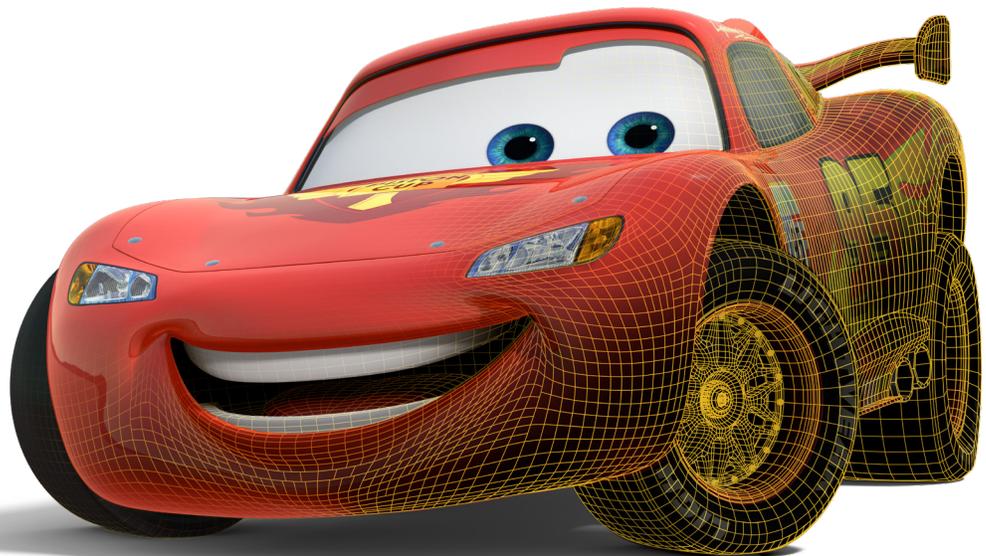
- Students will demonstrate increased knowledge and understanding of the core STEM content that underlies computer animation.
- Students will demonstrate awareness of the interdependence of art and STEM at Pixar.
- Students will be able to systematically approach complex problems and challenges by breaking them down into manageable parts.

### Attitude

- Students will have an increased positive attitude that they can learn about STEM and computer science, and they will gain appreciation for the creativity of careers in those fields.

### Skills

- Students will demonstrate engagement in STEM and computer science process skills that are used at Pixar.

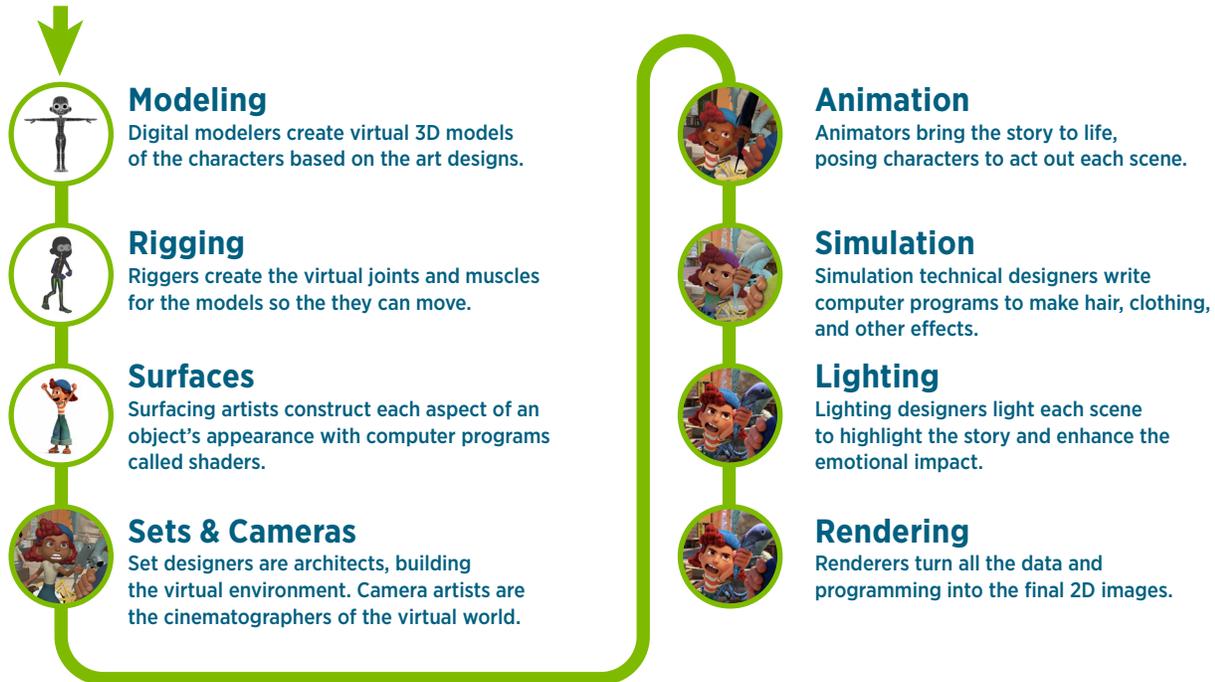


*The Science Behind Pixar* has been designed to give students a behind-the-scenes immersive look at the process used to create Pixar's groundbreaking films. Below, you will find an introduction to the exhibition content and layout.

**Introductory Theater:** Students will begin their exhibition experience with a fun and engaging video on the process that Pixar uses to turn an idea into a film.

Upon leaving the Introductory Theater, students may approach the exhibition in any order they choose. The exhibition is organized around eight steps of the Pixar production pipeline:

## START



## EACH AREA INCLUDES:

- **Screen-based activities** that will give students an opportunity to explore real-world challenges faced by the Pixar production team.
- **Physical interactives** that will allow students to gain tactile experiences to help them better understand what happens in the virtual world created by Pixar.
- **Video stories** in which Pixar employees share insight into the complex challenges Pixar has overcome in the development of its ground-breaking films. Additional video interviews highlight the variety of careers at Pixar and will broaden students' views of what it means to work in a STEM field.

## MODELING

### Digital sculpting creates virtual 3D models

Character design starts with artists who create sketches and clay sculptures called maquettes to get each character just right. Then, a digital modeler creates a virtual 3D model of the character, sometimes digitally scanning the maquette. The final model is a virtual digital wireframe of points and the edges that connect them.

## RIGGING

### Digital rigs make movement possible

Riggers create rigs—the virtual bones, joints, and muscles for models. Rigs specify the relationships between body parts so that bending a knee will raise the foot, but not move the hands. A good rig allows the animators to create poses easily and efficiently. Without the right controls, the model won't move the way it should. Too much flexibility makes posing the model too time consuming.

## SURFACES

### Appearance is controlled separately from shape

The way something looks tells a story. What is it made of? Is it new or old? Well taken care of or neglected? After a virtual 3D model is created, a surfacing artist constructs its appearance with computer programs called shaders. They determine the way light scatters off the surface so it looks shiny, transparent, and smooth (like glass) or dull and rough (like rust).

## SETS & CAMERAS

### Virtual cameras view virtual 3D worlds

Movies need more than just characters. The setting of each scene and the way each image is framed convey the context, story, and emotion. Set designers are architects. They build virtual environments from the ground up. Every pebble, tree, and building helps turn the storyboards into a believable world. Camera artists use virtual cameras to shape what is shown on screen. They choose the composition, camera movement, and lens type to support the story.



Photo © Michael Malyszko



Photo © Michael Malyszko



Photo © Michael Malyszko



Photo © Nicolaus Czamecki

## ANIMATION

### Animation is acting

Pixar animators bring a story to life, posing characters to act out each scene. Animators start by creating key frames that mark out important positions in a movement. Then, they use a computer program to describe how the object moves between those key frames so that the resulting animation conveys the desired emotions.

## SIMULATION

### Computer programs create automated motion

While animators focus on acting, simulation programmers create motion that makes scenes feel alive and believable. Some simulations—hair, fur, and clothing—respond to the way a character moves. Other simulations re-create natural phenomena, such as fire or water. Programmers start with the underlying physics, but they balance believability with the artistic needs and the time it takes to run the simulation.

## LIGHTING

### Virtual lights enhance mood and believability

Lighting is an essential part of telling a story. Light shows you where to look and enhances the emotional feel of each scene. Pixar's lighting designers have the additional task of defining virtual lights in the computer. The color, position, and intensity of each light needs to be programmed to achieve the desired artistic effect.

## RENDERING

### Rendering turns a virtual 3D scene into a 2D image

The virtual scene is set—the characters are shaded and posed, the lights and camera are in position, and the simulations are ready to run. But no one knows what it looks like until the rendering process turns all that data and programming into an image we can see. Pixar generates low-resolution renders for work in progress and high-resolution renders for the final film.



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