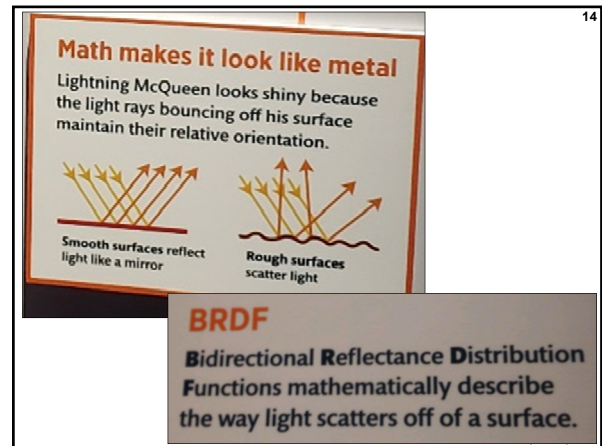
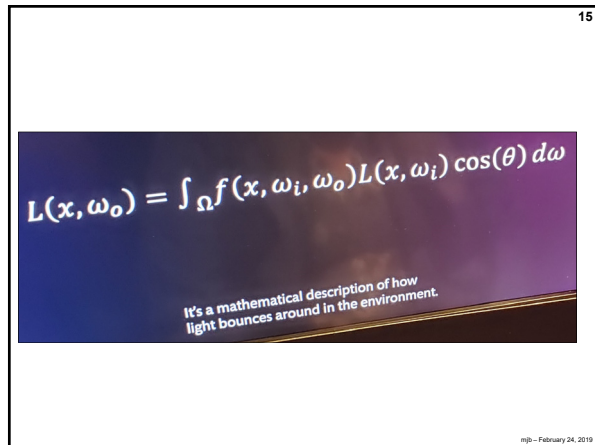


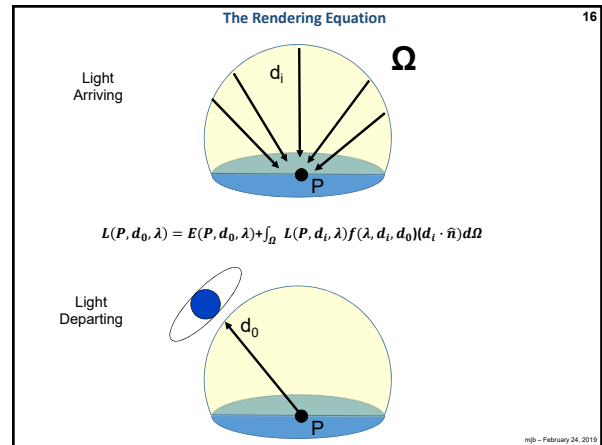
13



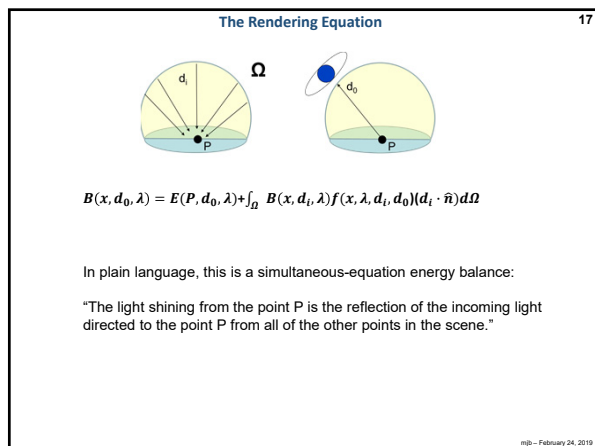
14



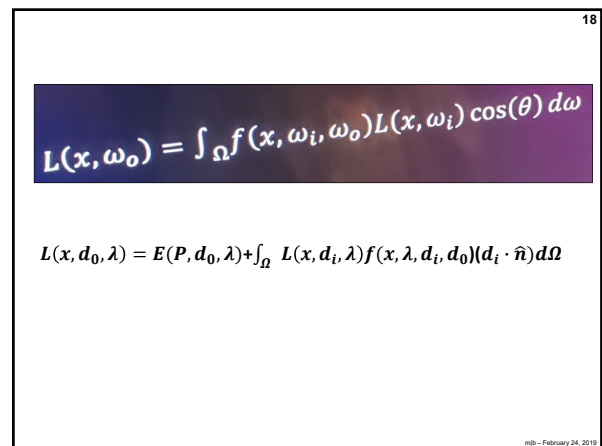
15



16



17



18



19

## 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 works in progress and high resolution renders for the final film.

**The virtual 3D scene**  
This wireframe is a visualization of the data that defines the scene.

**The rendered 2D image**  
Rendering calculates the color of every pixel in an image.

mpb - February 24, 2019

20

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 works in progress and high resolution renders for the final film.

**The virtual 3D scene**  
This wireframe is a visualization of the data that defines the scene.

**The rendered 2D image**  
Rendering calculates the color of every pixel in an image.

mpb - February 24, 2019

21

▲ Simplified images render quickly and show if a work in progress looks right.

mpb - February 24, 2019

22

## Pixar's Animation Challenge

**Moving with math**  
Computer animators position digital models into key poses. Then the computer fills in the transitions based on mathematical functions called splines.

**Acting from pose to pose**  
Mr. Incredible is posed to run, but the transition to the next pose will tell if he is bounding along or tiring out.

mpb - February 24, 2019

23

## Moving with math

Computer animators position digital models into key poses. Then the computer fills in the transitions based on mathematical functions called splines.

## Acting from pose to pose

Mr. Incredible is posed to run, but the transition to the next pose will tell if he is bounding along or tiring out.

mpb - February 24, 2019

24

mpb - February 24, 2019

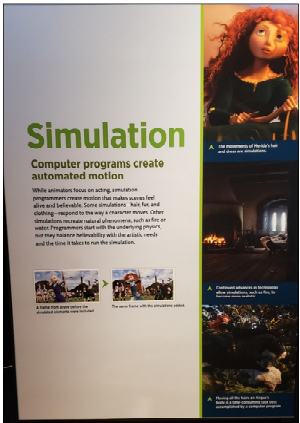


25

## Simulation

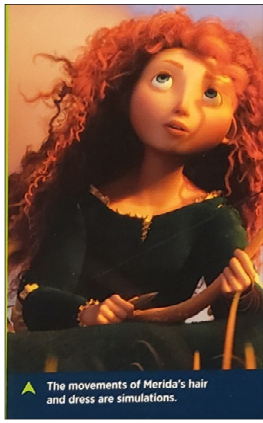
Computer programs create automated motion

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 recreate 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.



mpb - February 24, 2019

26




▲ The movements of Merida's hair and dress are simulations.


mpb - February 24, 2019

27

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 recreate 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.



A frame from *Brave* before the simulated elements were included.



The same frame with the simulations added.

mpb - February 24, 2019

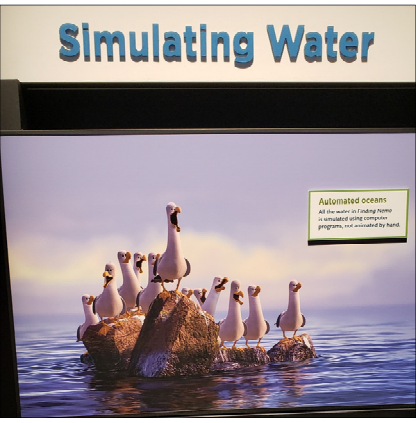
28




mpb - February 24, 2019

29

## Simulating Water



Automated oceans  
All the water in *Finding Nemo* is simulated using computer programs, not animated by hand.

mpb - February 24, 2019

30

## Automated oceans

All the water in *Finding Nemo* is simulated using computer programs, not animated by hand.

mpb - February 24, 2019

*The Science of Pixar*

At the Oregon Museum of Science and Industry (OMSI)



mjb - February 24, 2019