Three-Dimensional Computer Animation

Visual Imaging in the Electronic Age

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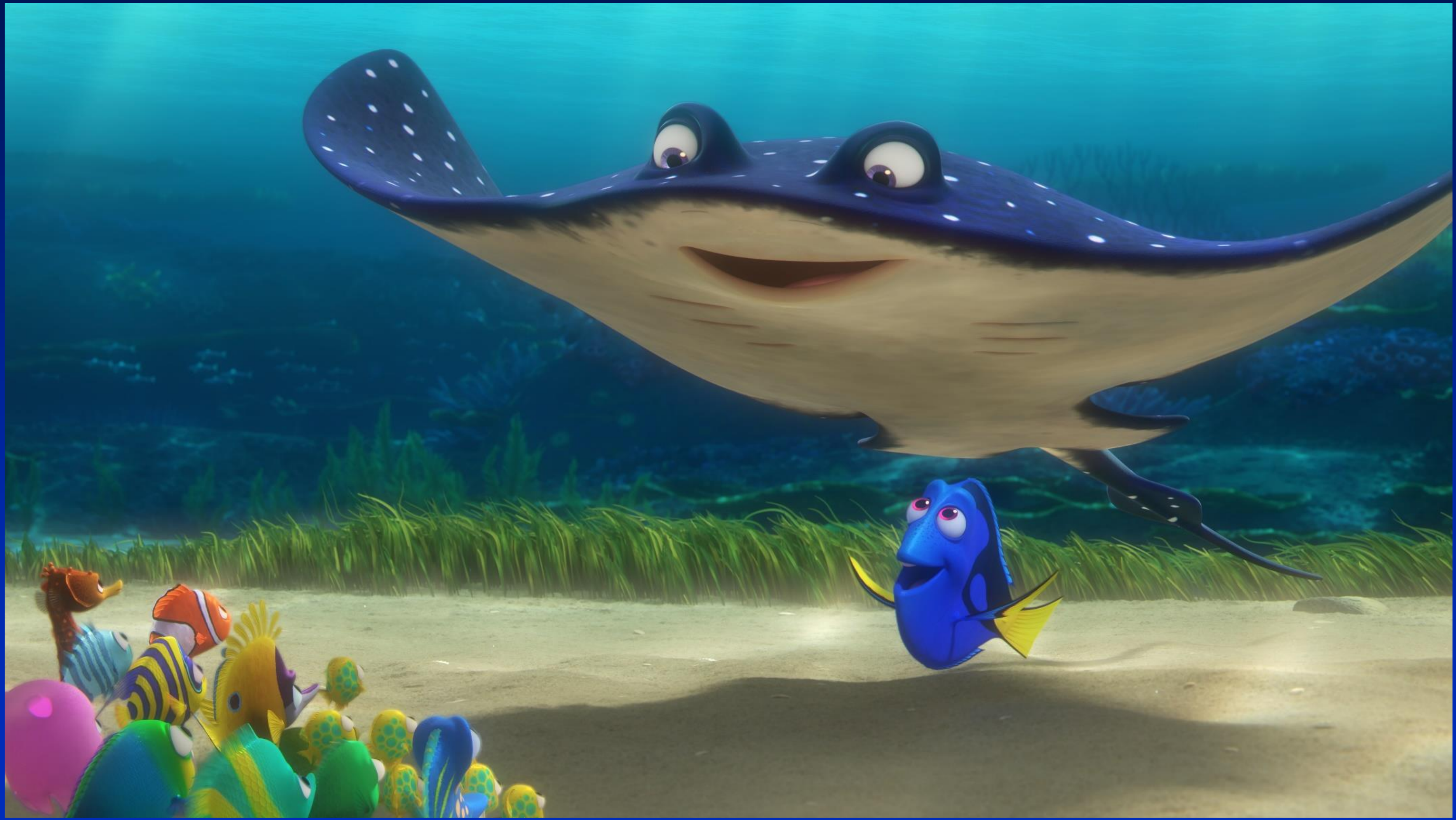
Lecture # 22

Luxo & Luxo Jr. 1986

Toy Story 1995

Inside Out 2015

Finding Dory 2016



3D Animation Pixar

Why do we need an animation production pipeline?

- Animated full-length features are huge endeavors
  - Up to 5 years from conception to final (2 years in production)
  - > 500 people involved
- Currently requires big budgets and big organizations
  - $ 100 M - $150M per movie
- Needs a very organized structure to bring the creative process from conception to final product

What is the animation production pipeline?

- Logical organization of the steps required to produce an animated feature film

- Every company has its own pipeline

- Every movie changes the pipeline
  - Requirements are changing
  - Save money
  - Increase the quality of the movie

Toy Story 3
Building a Single Frame

1 / SKETCHES There are 49,516 of these sketches in the movie's story reel.

John Lehrer. "How It's Done," Wired 18.06. http://www.wired.com/magazine/18-06

Building a Single Frame

2 / COLOR SCRIPTS The goal is to begin to define the style and lighting scheme of the frame (shot).

John Lehrer. “How It’s Done,” Wired 18.06. http://www.wired.com/magazine/18-06

Building a Single Frame

3 / PROPS Toys are positioned in the 3-D “dressed set.” The director can fine-tune the camera’s movement to best capture the action.

John Lehrer. “How It’s Done,” Wired 18.06. http://www.wired.com/magazine/18-06

Building a Single Frame

4 / LAST DETAILS The amount of labor spent on each character depends on its prominence in the final shot. Background toys are given simple textures and basic movements.

John Lehrer. “How It’s Done,” Wired 18.06. http://www.wired.com/magazine/18-06

Building a Single Frame

5 / FINALE Surfaces—walls, clothing, faces—are fed through rendering software that simulates light and shadow. An average frame takes more than seven hours of computing time to render. This one required eleven hours.

John Lehrer. "How It's Done," Wired 18.06. http://www.wired.com/magazine/18-06

John Lehrer. “How It’s Done,” Wired 18.06. http://www.wired.com/magazine/18-06

The simplified pipeline

- Many departments

Story	Art	Casting	Editorial
Modeling	Shading Texturing	Rigging	Backgrounds
Layout	Animation	Simulation	Effects
	Lighting	Rendering	

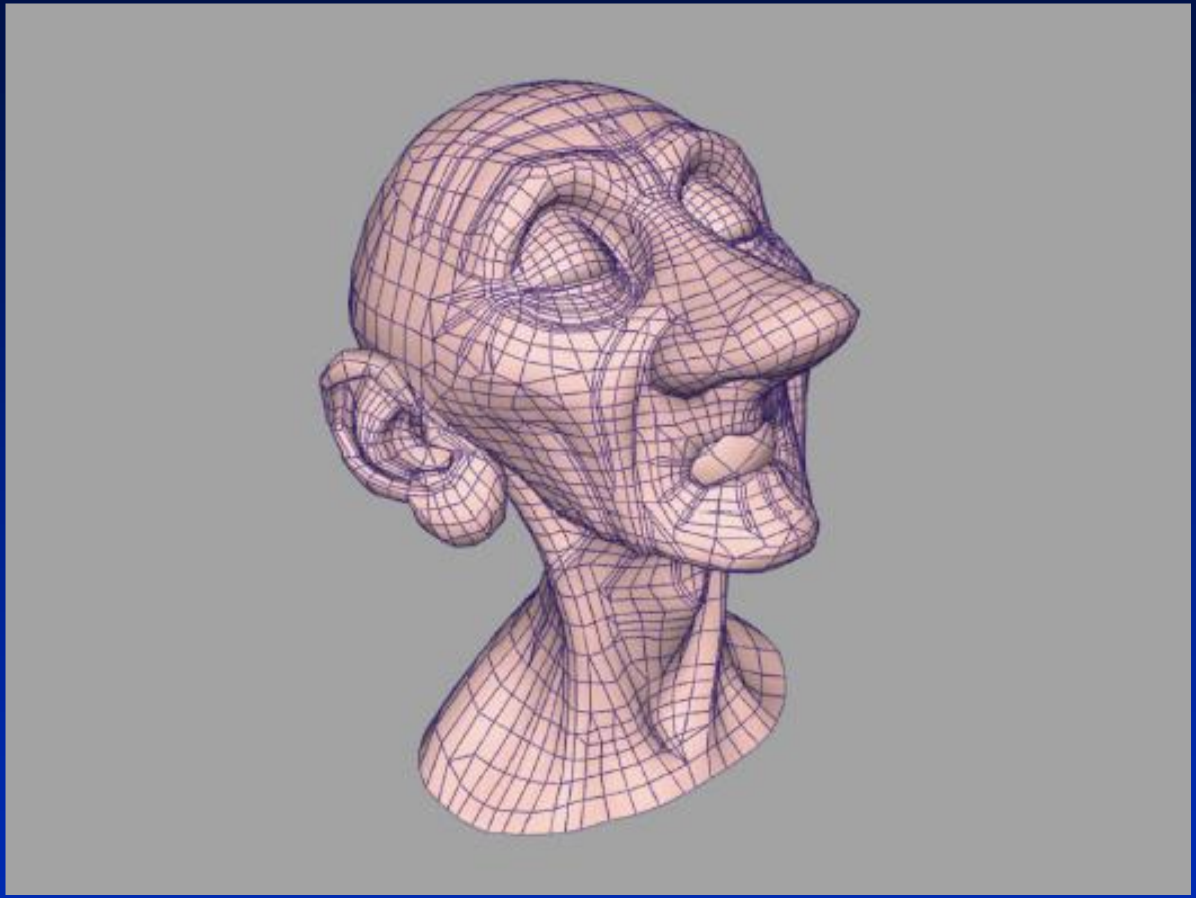
Jan Pinkava – *Storyboard*,

GERI'S GAME (Pencil)

PIXAR At the Museum of Modern Art, Disney Enterprises 2005

Jan Pinkava
– *Storyboard*,

GERI'S
GAME
(Pencil)



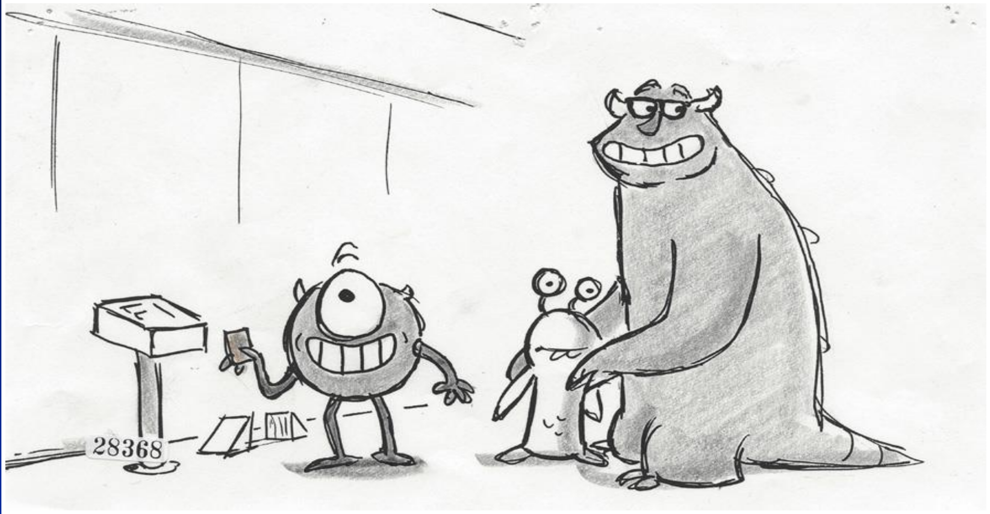
The control mesh for Geri’s head, created by digitizing a full-scale model sculpted out of clay.

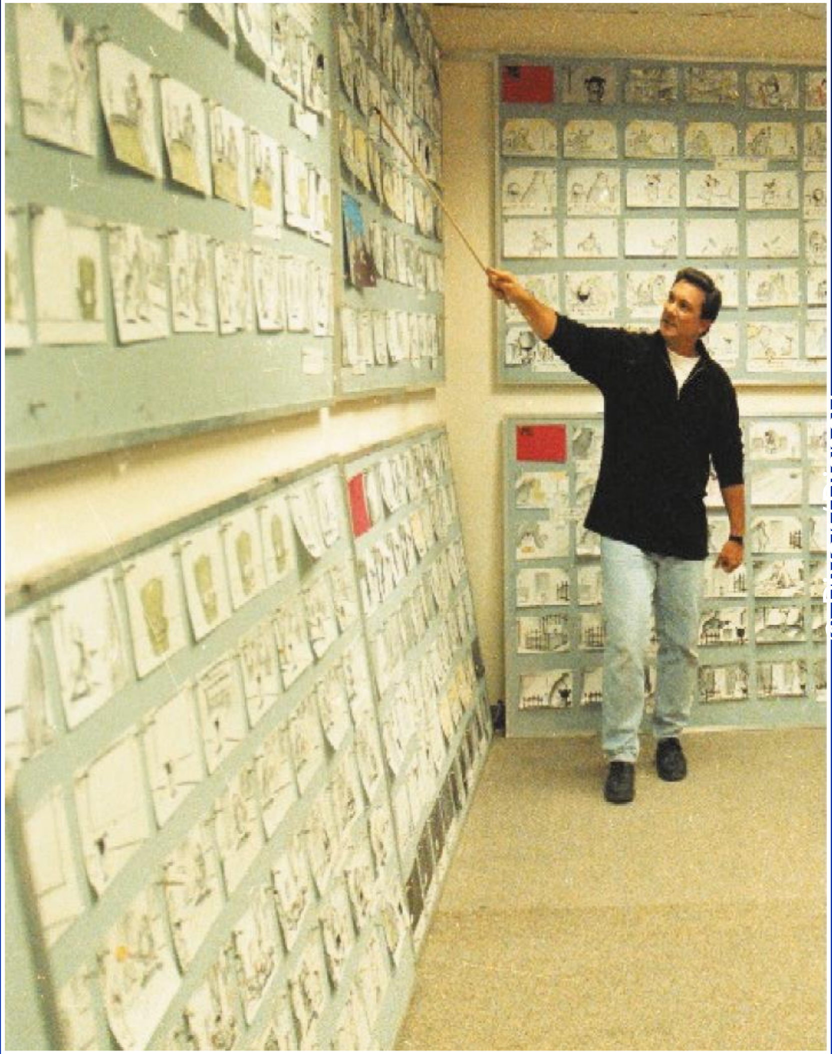
Subdivision surfaces

© Pixar/Disney

Video – Geri’s Game

Story Development





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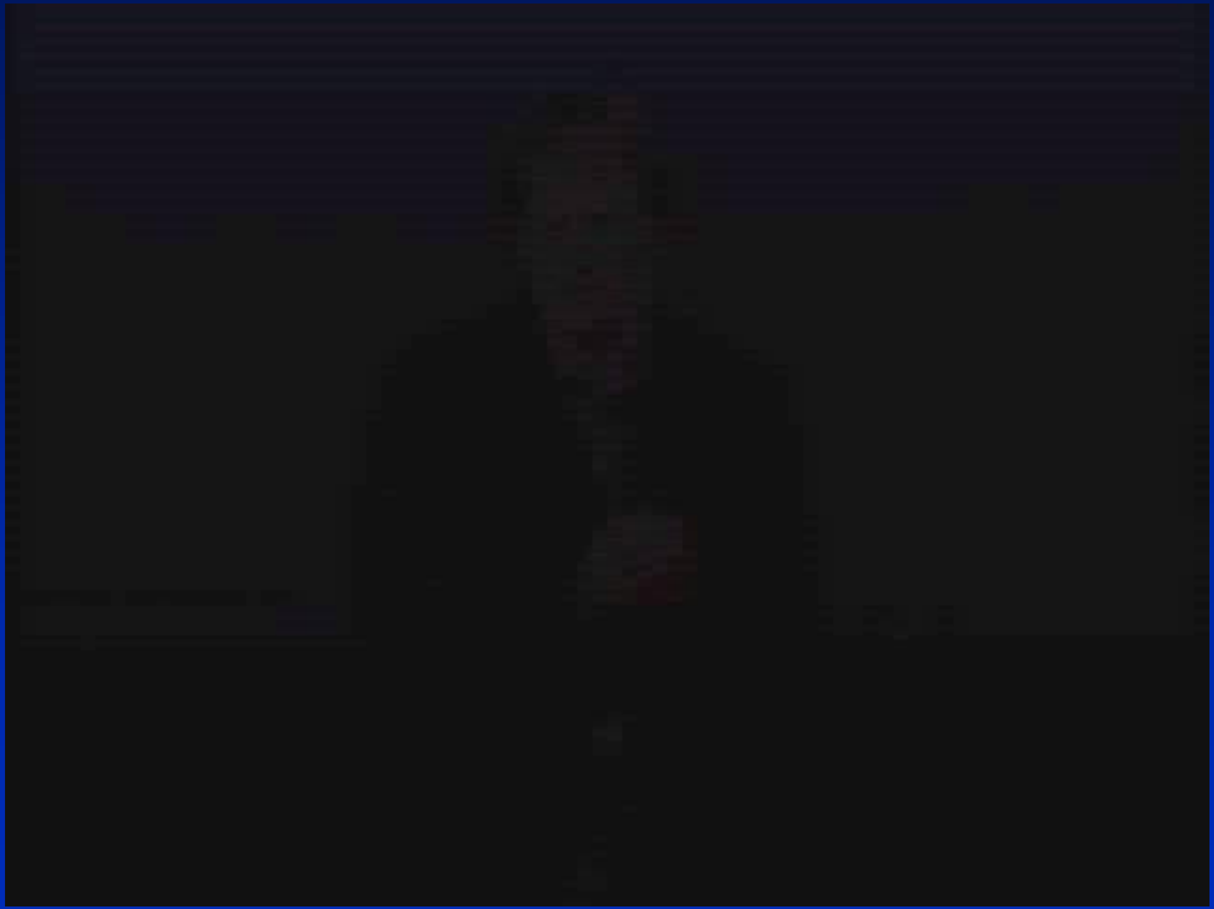
Story Pitch

- First time the story is publicly presented



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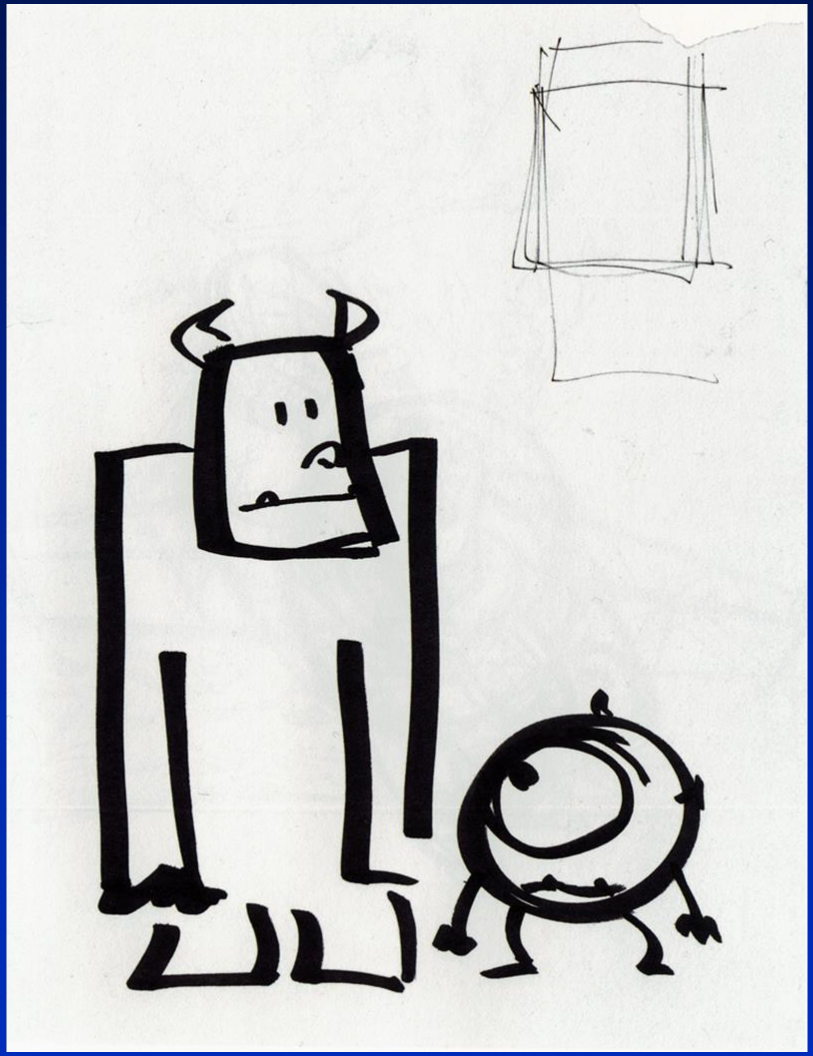
Art Development

- Develop the look-and-feel of the movie
  - Characters and Sets
  - Follow it through production
  - Make the most of the *high-level* artistic decisions
- Traditional media
  - Sketches, Pastels, Sculptures
- Process
  - Start with real world objects
  - Develop the look: shape, colors, materials
  - Develop expressions and movements
  - For characters, sculptures are developed

Bob Pauley – Woody and Buzz, Toy Story (Pencil)

PIXAR At the Museum of Modern Art, Disney Enterprises 2005

Pete Docter – Sullivan and Mike (Marker)

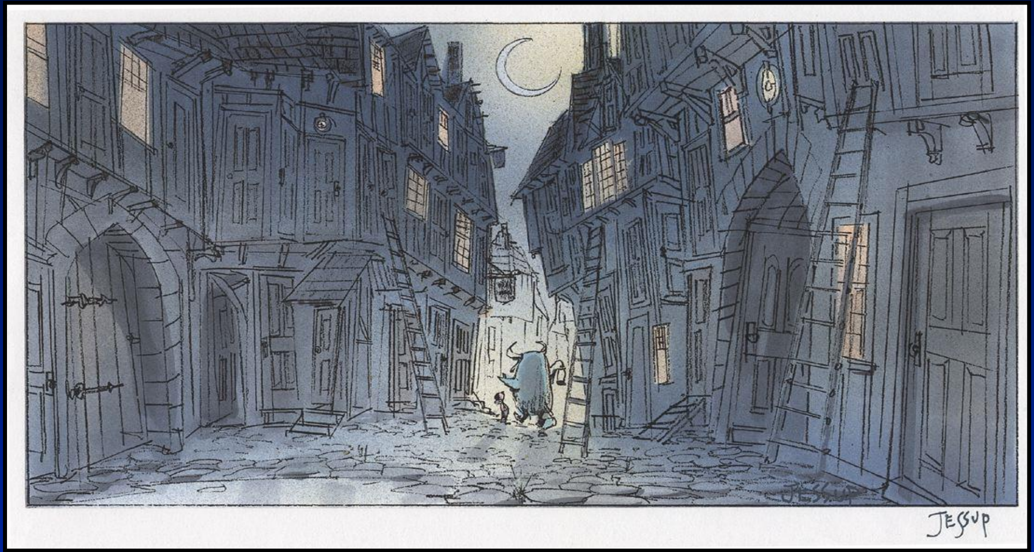


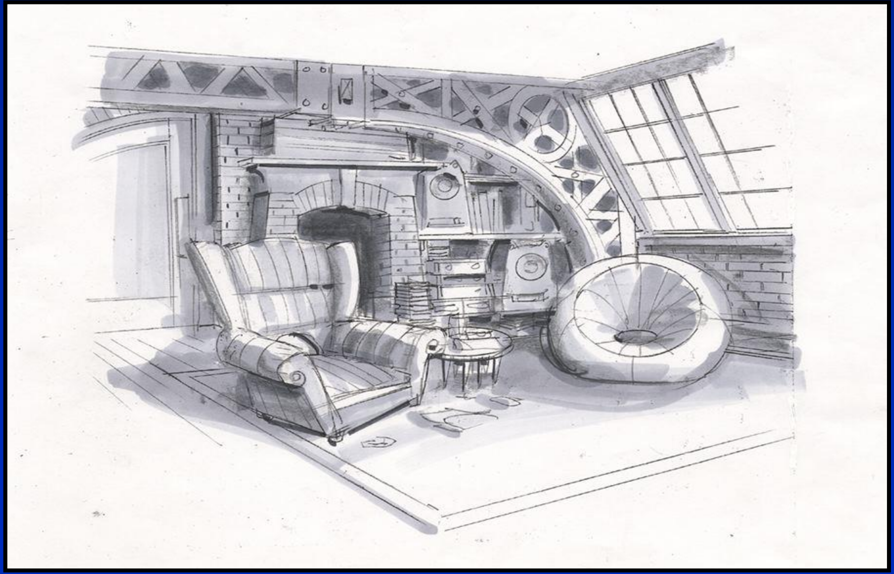
PIXAR At the Museum of Modern Art, Disney Enterprises 2005

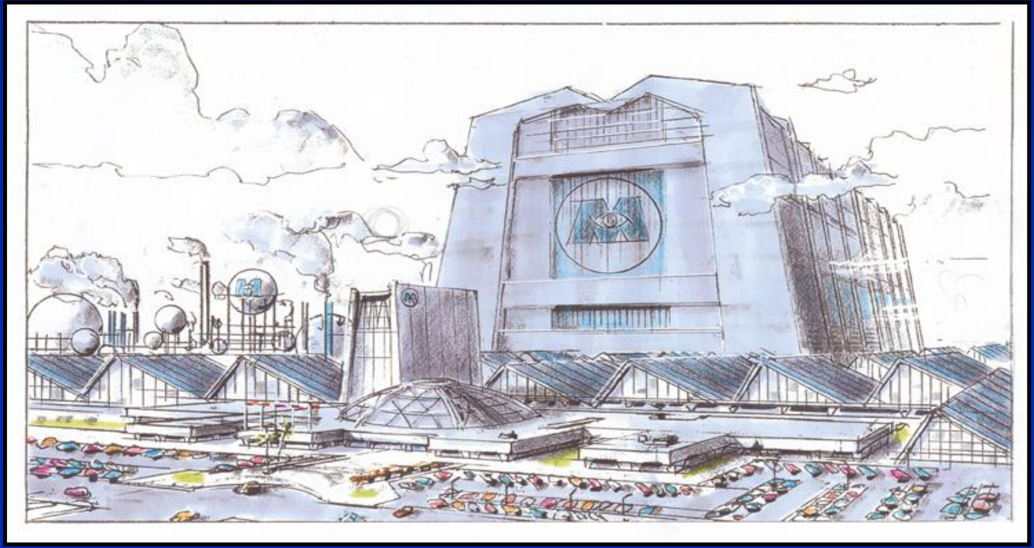
Art Development - Characters

© Pixar / Disney

Art Development - Environments







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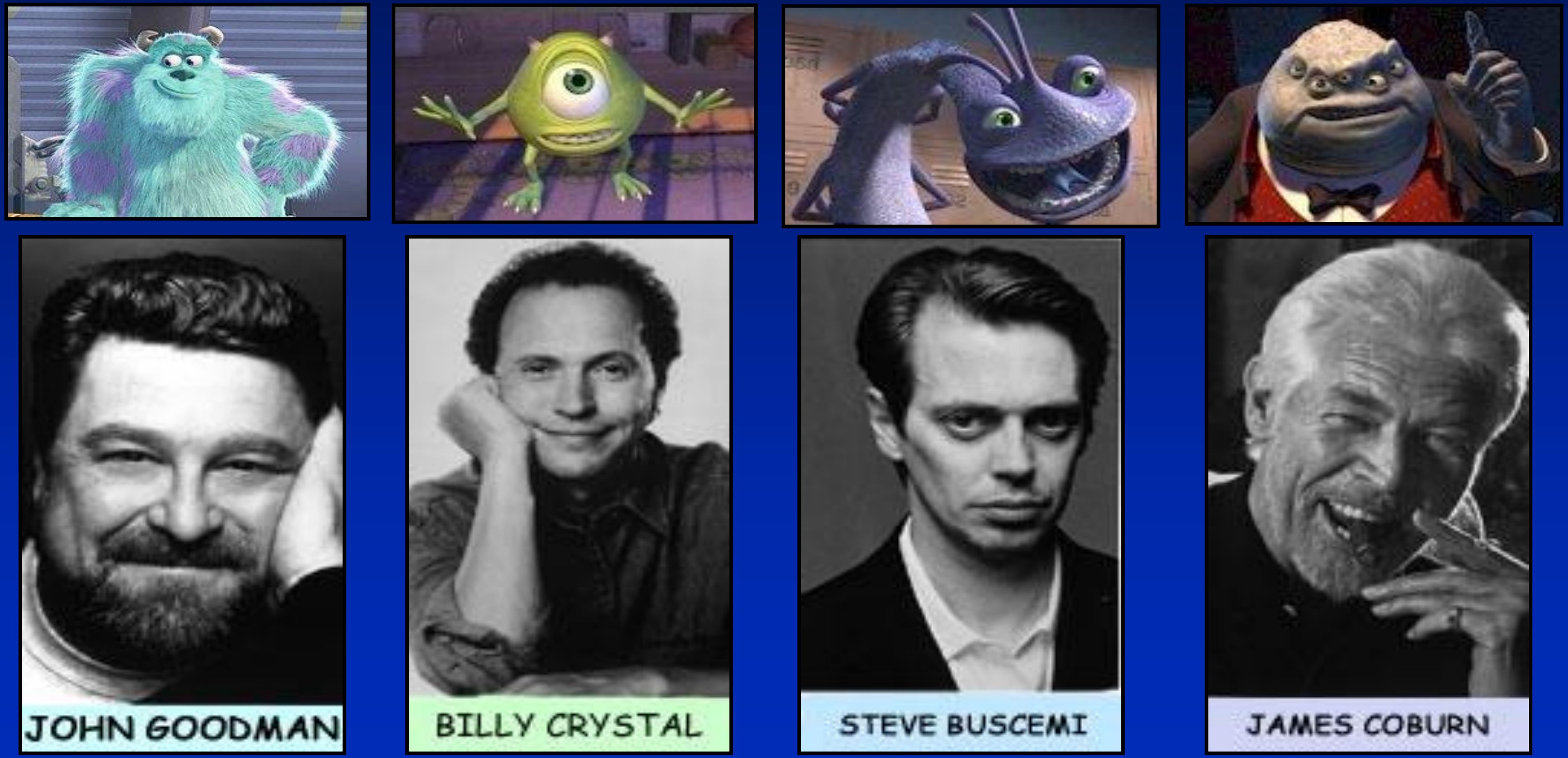
Casting

- Voices have to match your characters



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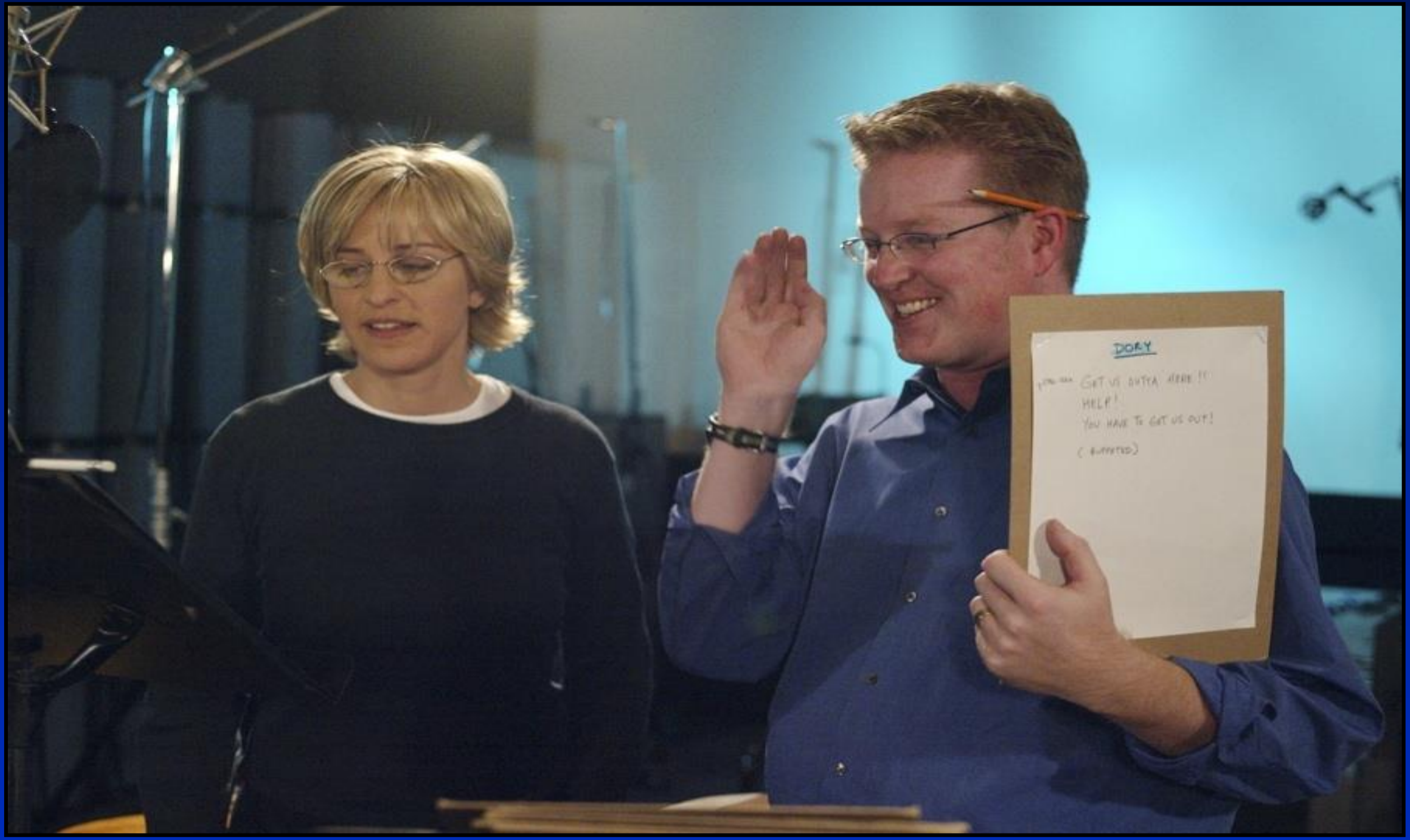
Dialogue Recording

- Useful for animation reference



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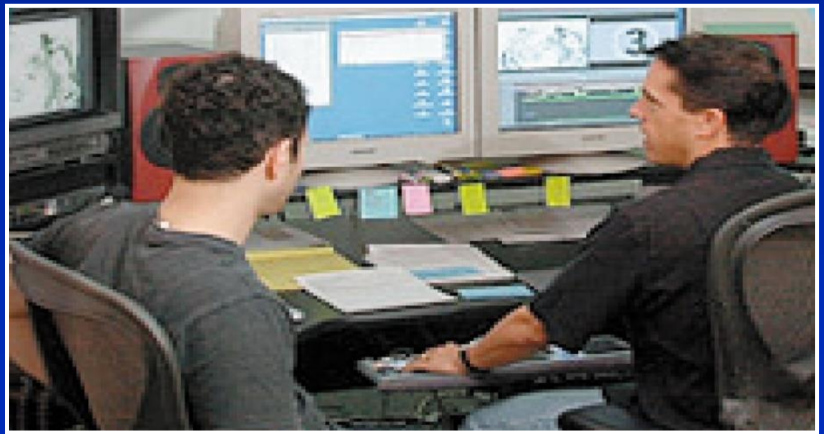
Editorial

- The keeper of the flow
  - Study the timing of actions in the movie
- Manage the editing of the movie
  - Prepare the various releases
- Similar to a traditional studio



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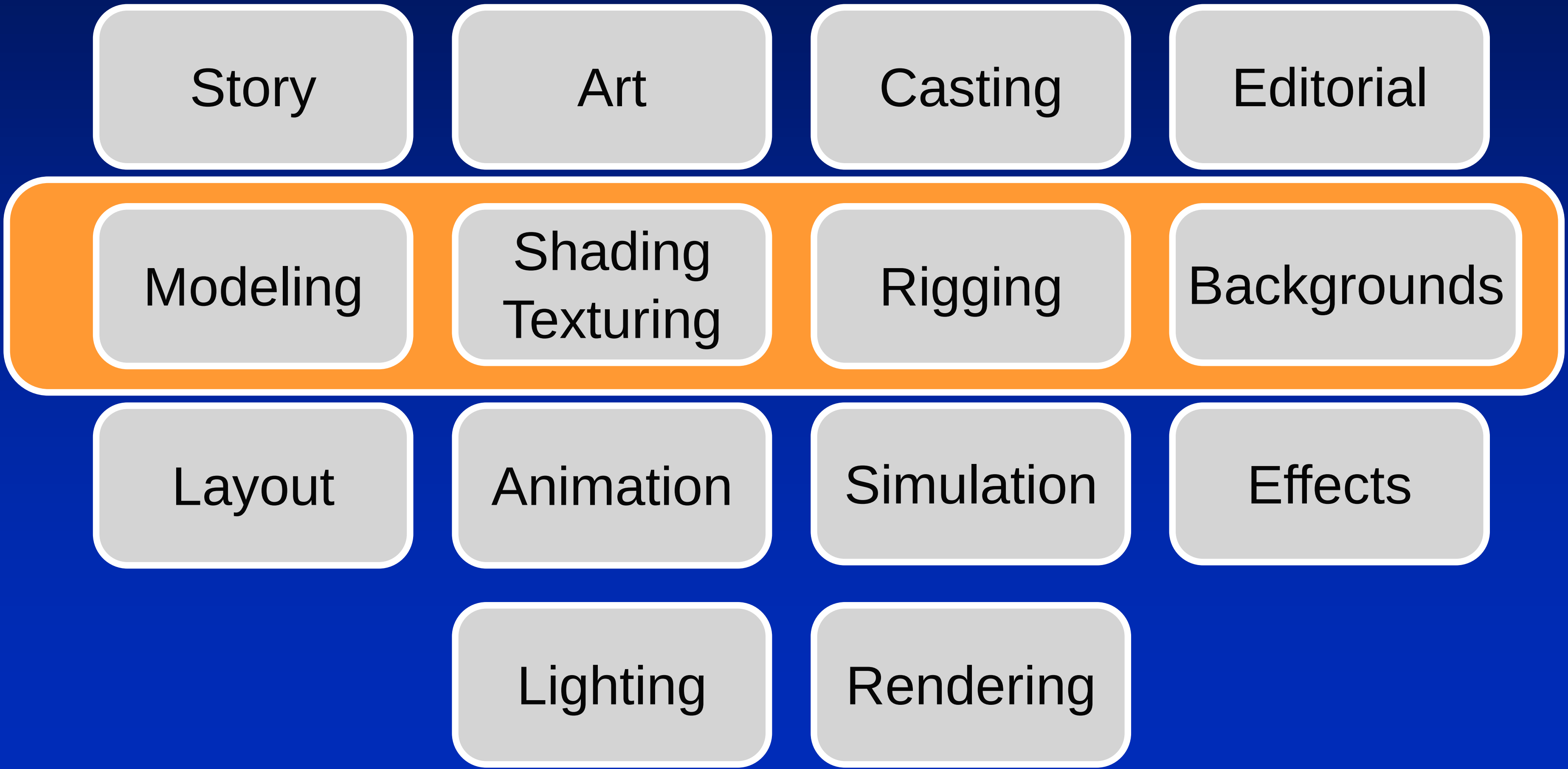
The Simplified Pipeline

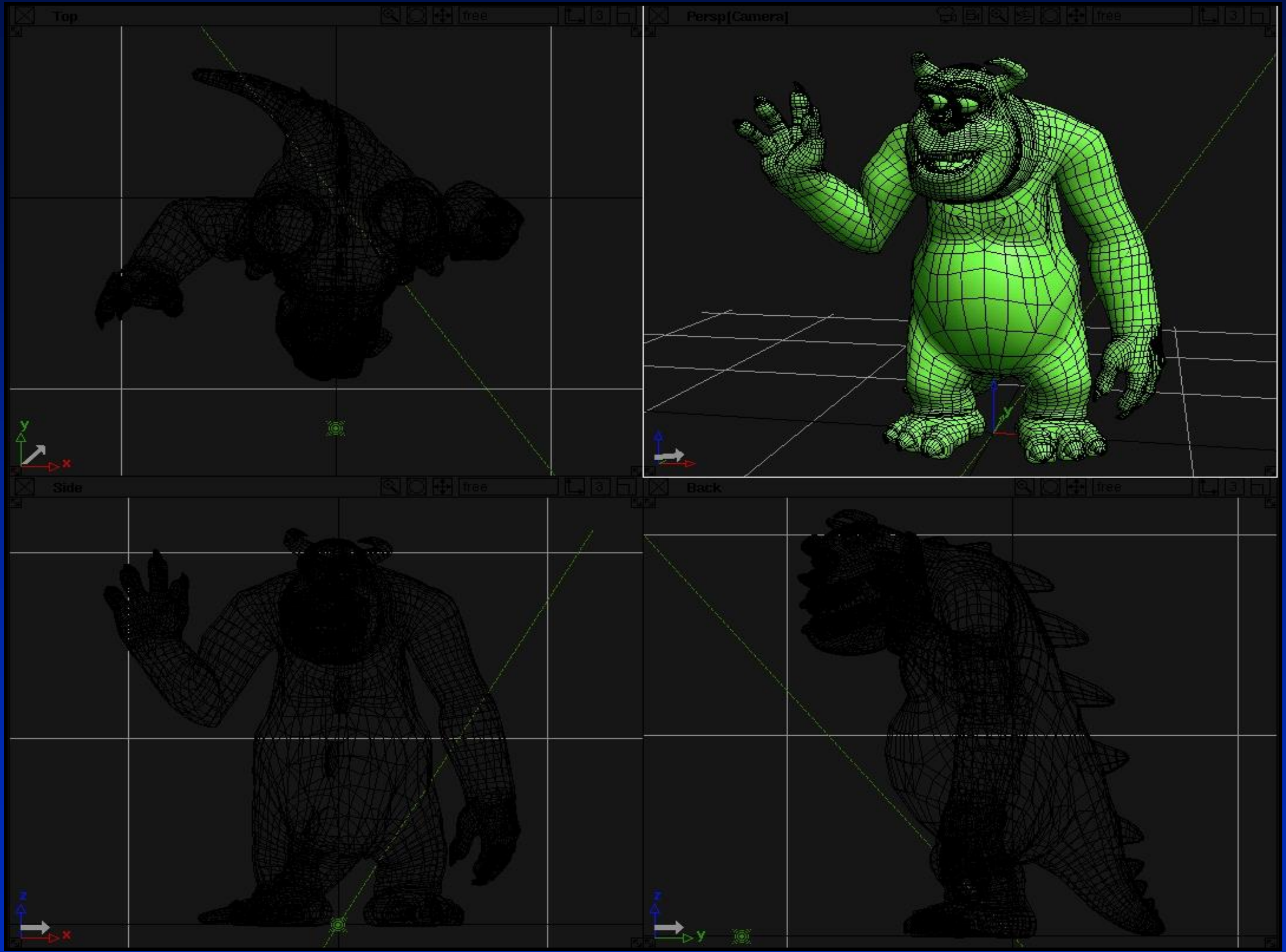
- Characters and Sets



Modeling

- Defines the shape
- Process
  - Starts with art data
    - Drawings
    - Sculptures (sometimes scanned)
  - Recreate geometry in the modeling environment
- Models have to
  - Look good – to please the eye
  - Be functional – to fit in the pipeline
  - Work when deformed – for animation

Character Modeling



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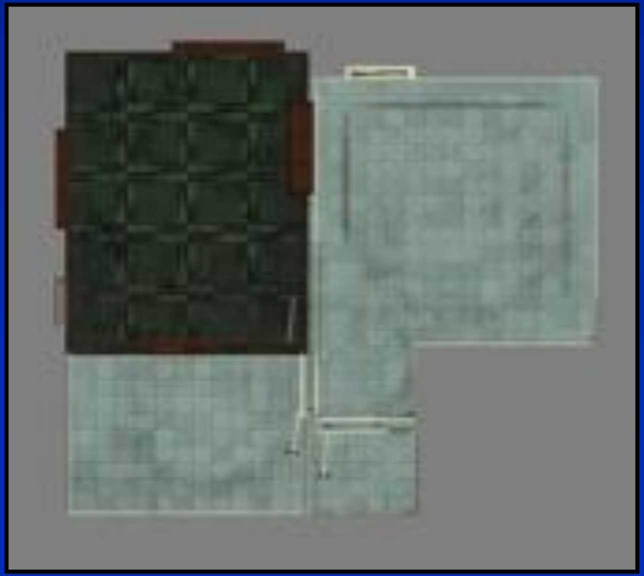
Environment and Prop Modeling



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Shading/Texturing

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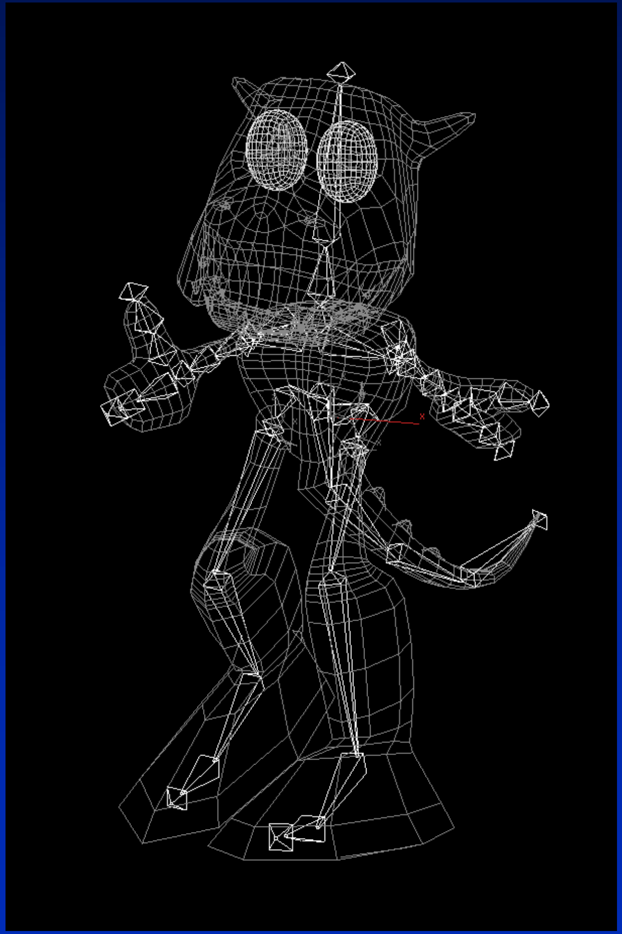
Character Rigging

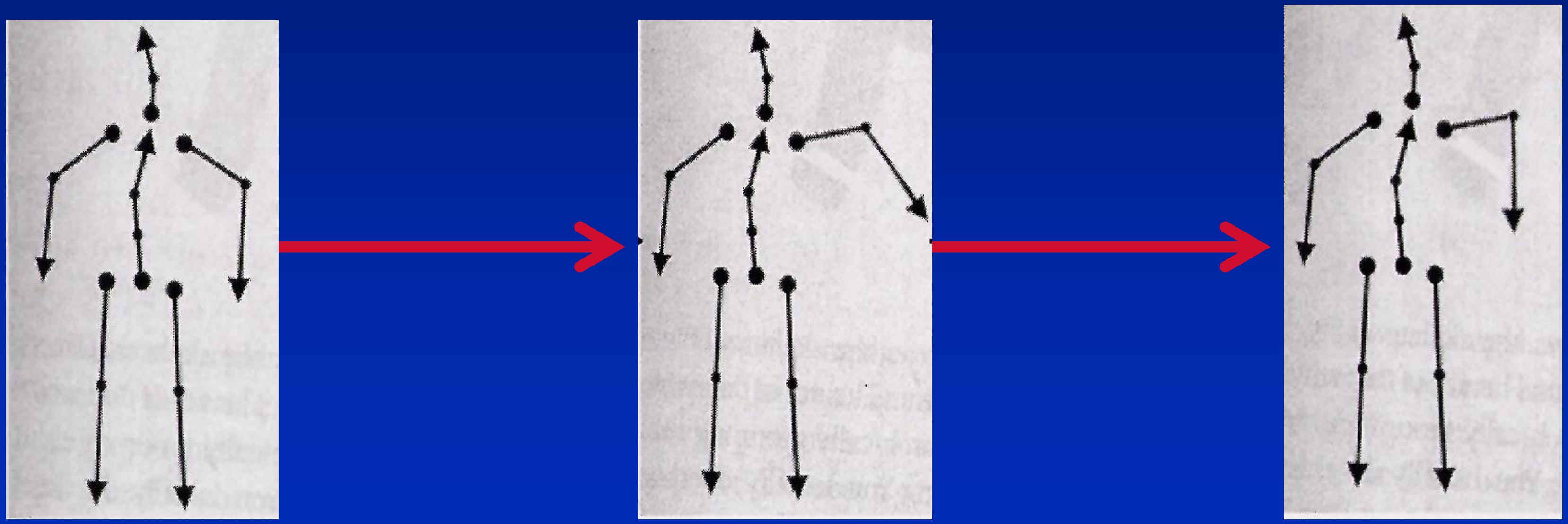
- Prepares a character for animation
  - Defines the deformation of the shape
    - Shape changes when the character moves
  - Defines controls for animators
- Process
  - Start with art data
  - Work with animation to test the look and controls

Rigging



Computer Skeletal Animation

- **Moving your hand with Forward Kinematics**
  - Involves individually rotating each joint in order to get the hand to a specific location



  - To move hand, must first rotate whole arm, then rotate lower arm

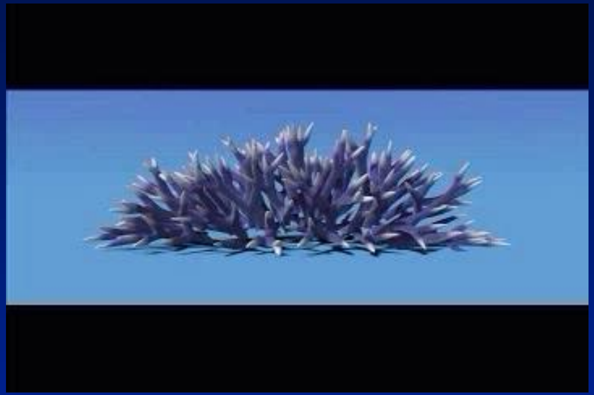
Computer Skeletal Animation

- **Moving your hand with Inverse Kinematics**
  - Position of the hand determines the position of the arm joints

  - Because all parts of the arm are connected, if hand moves → arm moves

Backgrounds

- Creates sets out of props
- Prepares a stage for acting



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The Simplified Pipeline

- Movement

Story	Art	Casting	Editorial
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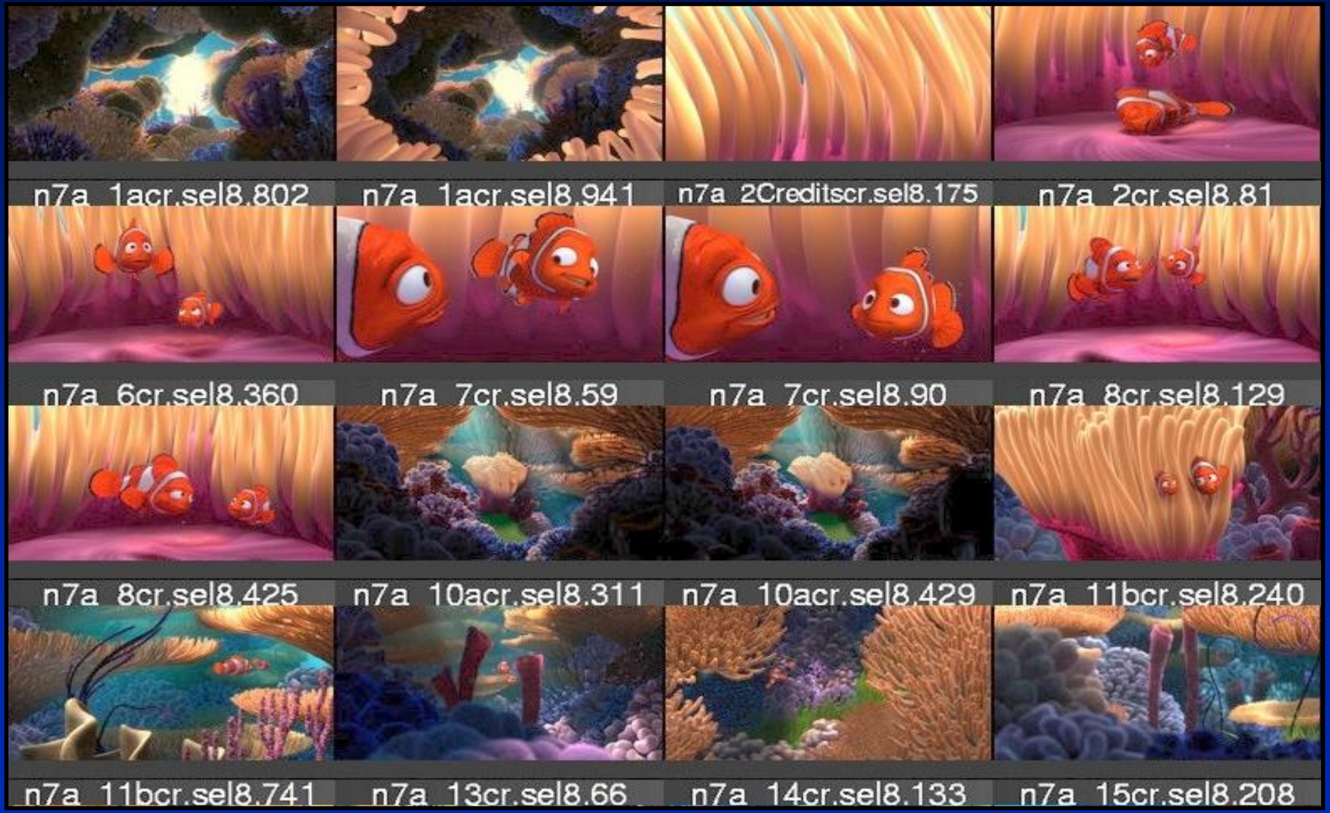
	Lighting	Rendering	

Layout

- Defines the camera
  - Starting position
  - Framing – which objects are seen
  - Movement
- Defines basic object positions



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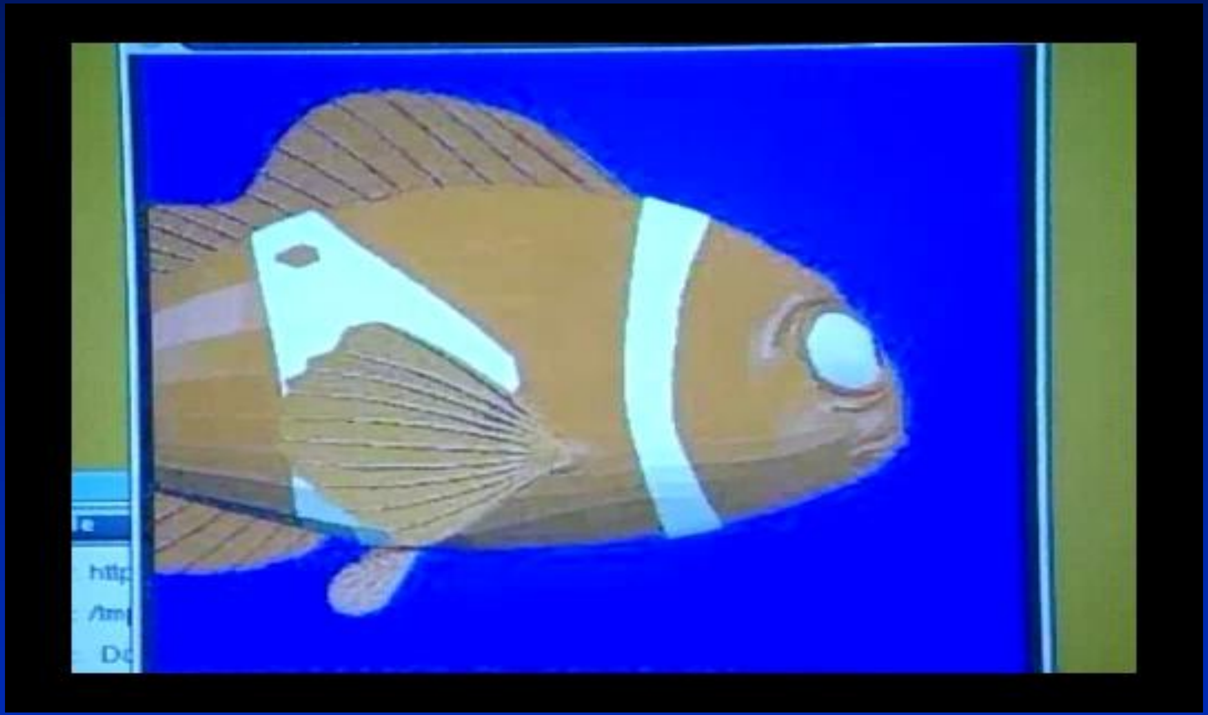
Animation

- Keyframed animation
  - Movement is specified by changing individual controls on characters at various frames
  - Used by Pixar and DreamWorks
- Motion capture
  - Movement is recorded using live actors
  - Used by Sony Imageworks, Weta
- Very time consuming!
  - Requires big budgets and long development times
- Today it is the biggest distinction between large studios and smaller ones

Animation



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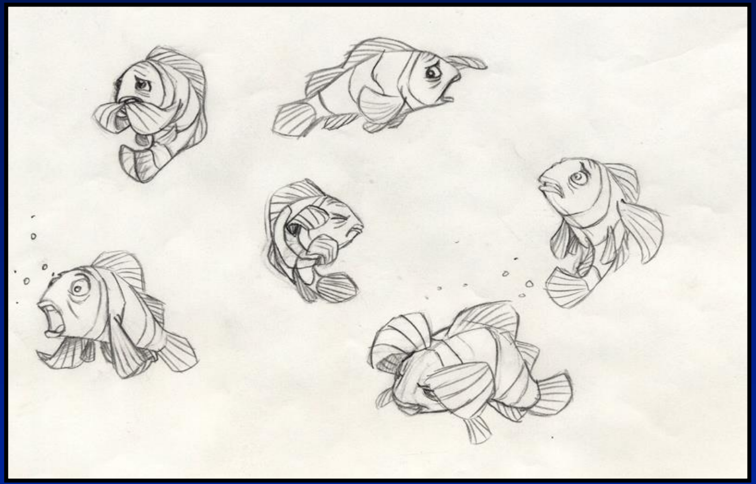
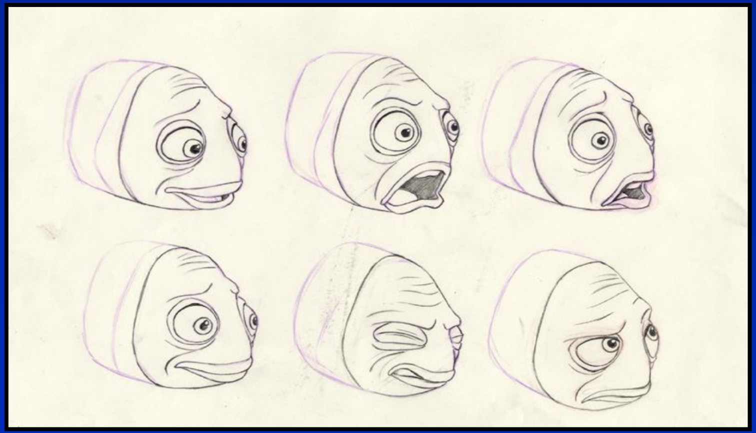
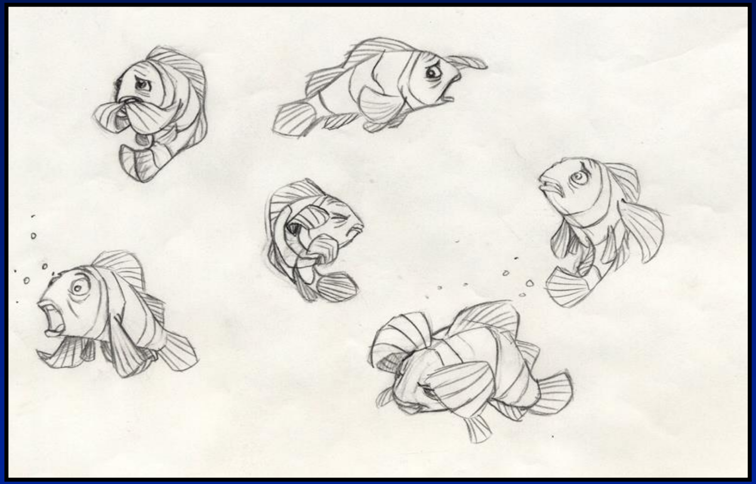
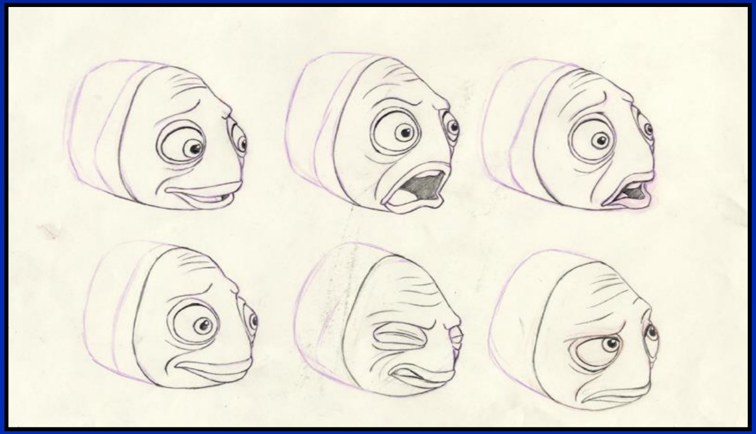




Animation





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fish acting.comp.85

Simulation

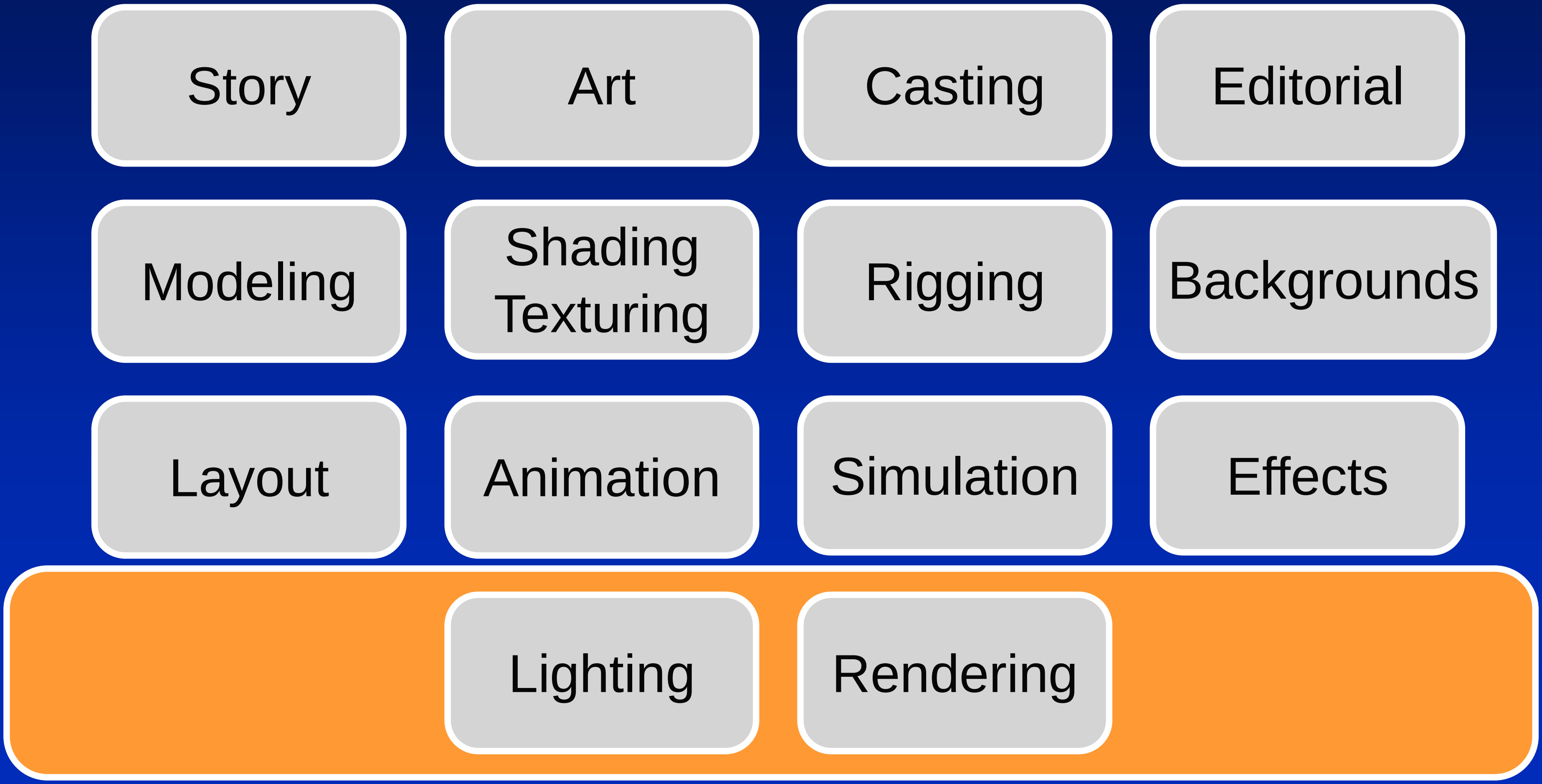
- Not possible to animate everything
- Physically-based animation
  - Movement is computed to simulate physics
- Applications
  - Humans: hair, cloth, skin
  - Natural media: water, fire, smoke
  - Special effects: explosions

Effects

- Natural media: Water, Fire, Smoke
- Weather: Snow, Rain, Wind
- Special effects: Explosions, Morphing
- Encompasses modeling, animation and shading

The Simplified Pipeline

- Final images



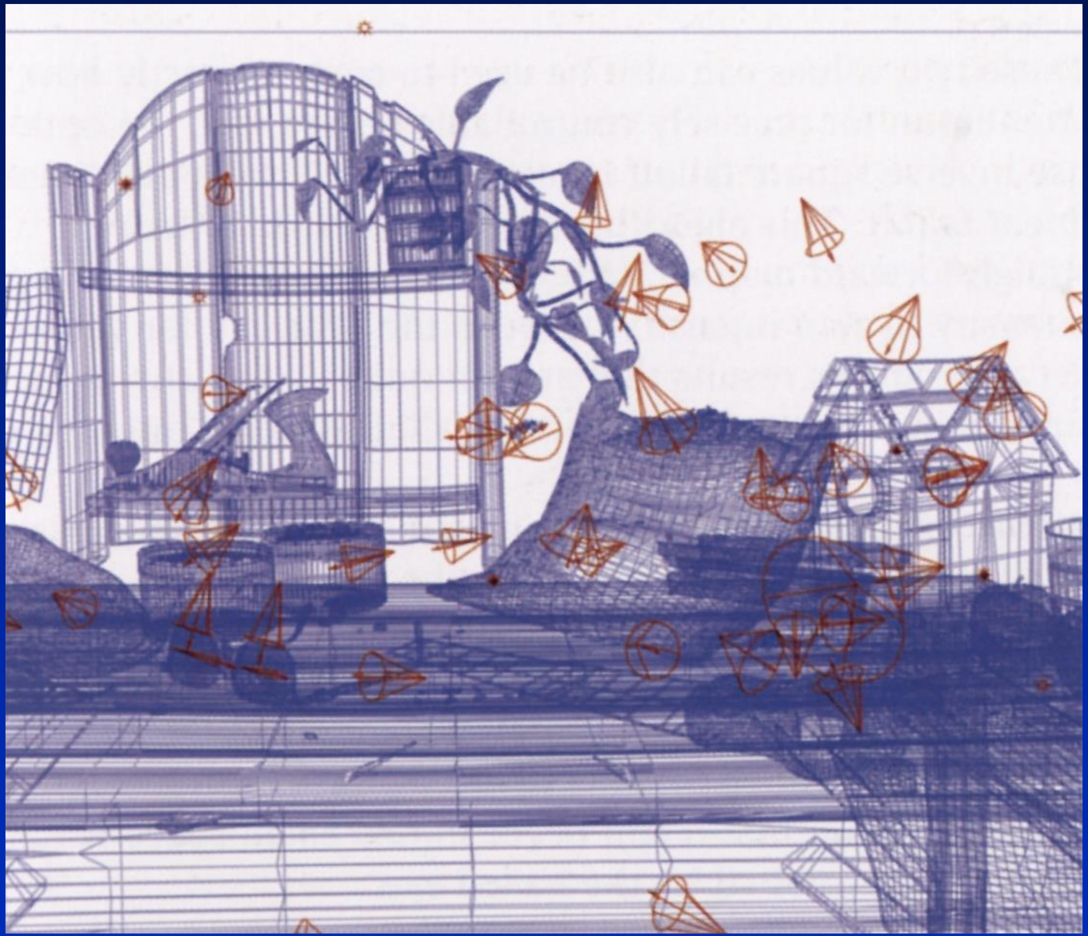
Lighting

- Defines scene illumination
- Process
  - – Study real world footage
  - – Study material/light interaction
    - > Simple materials: plastic, woods, etc.
    - > Complex materials: metals
    - > Characters: skin, hair
  - – Start with art images
  - – Add and change lights to obtain the final picture

Lighting

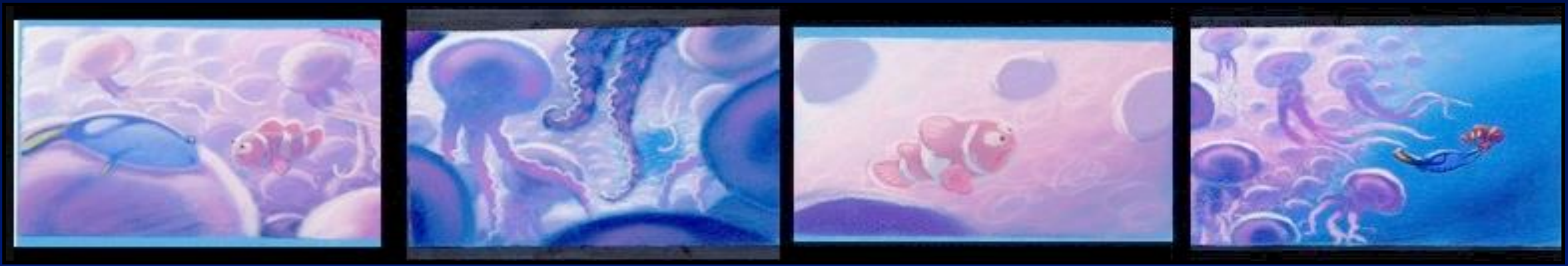
Darren Brooker. “Essential CG Lighting Techniques,” 2003 .

Lighting



Darren Brooker. "Essential CG Lighting Techniques," 2003 .

Lighting



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Lighting

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Particulate Matter

Surge and Well

Caustics

Murk

Reflection Refraction

Rendering

- Compute the final images

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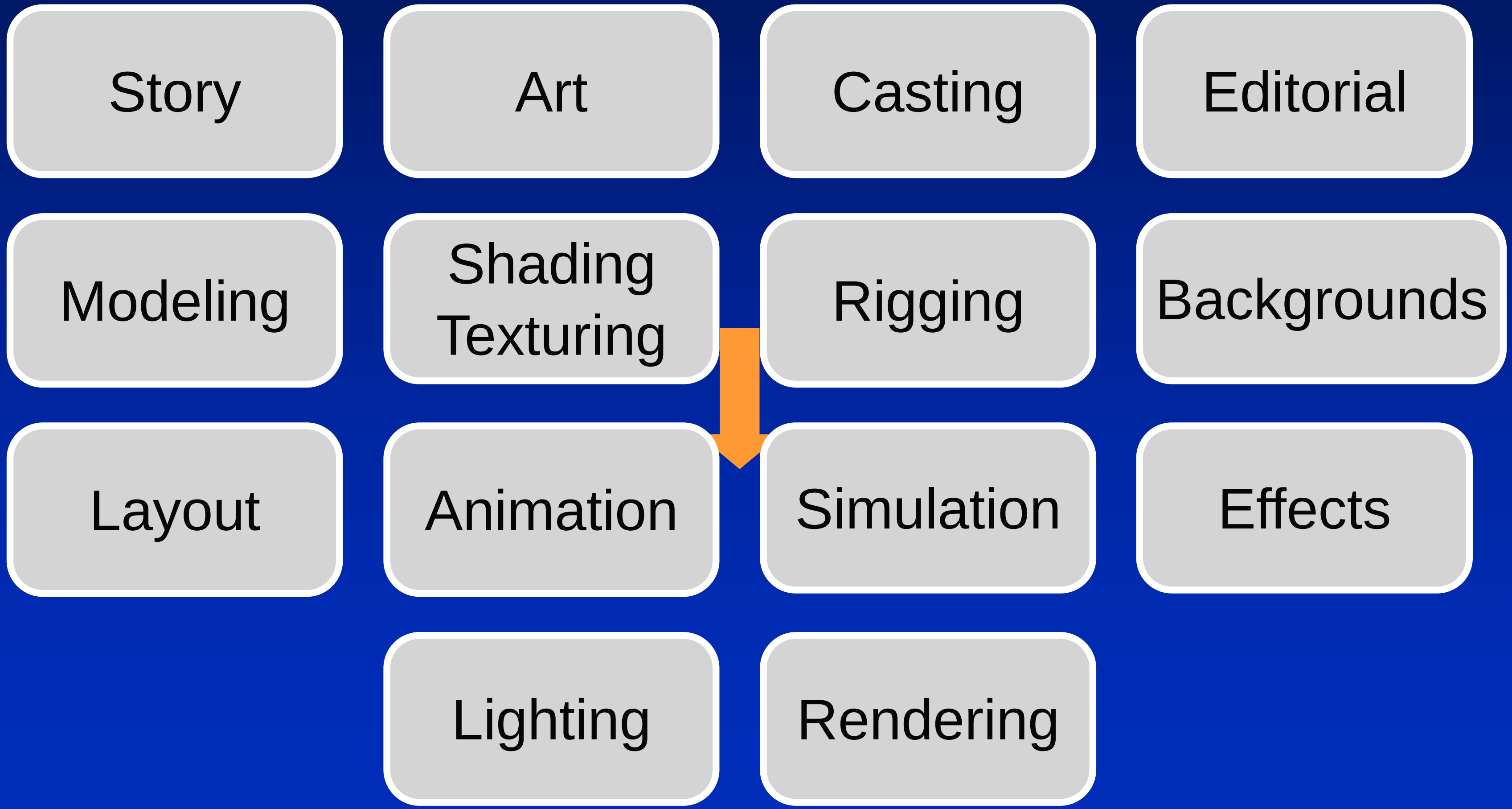
The Simplified Pipeline

- Vertical hierarchy too



Shot Progression

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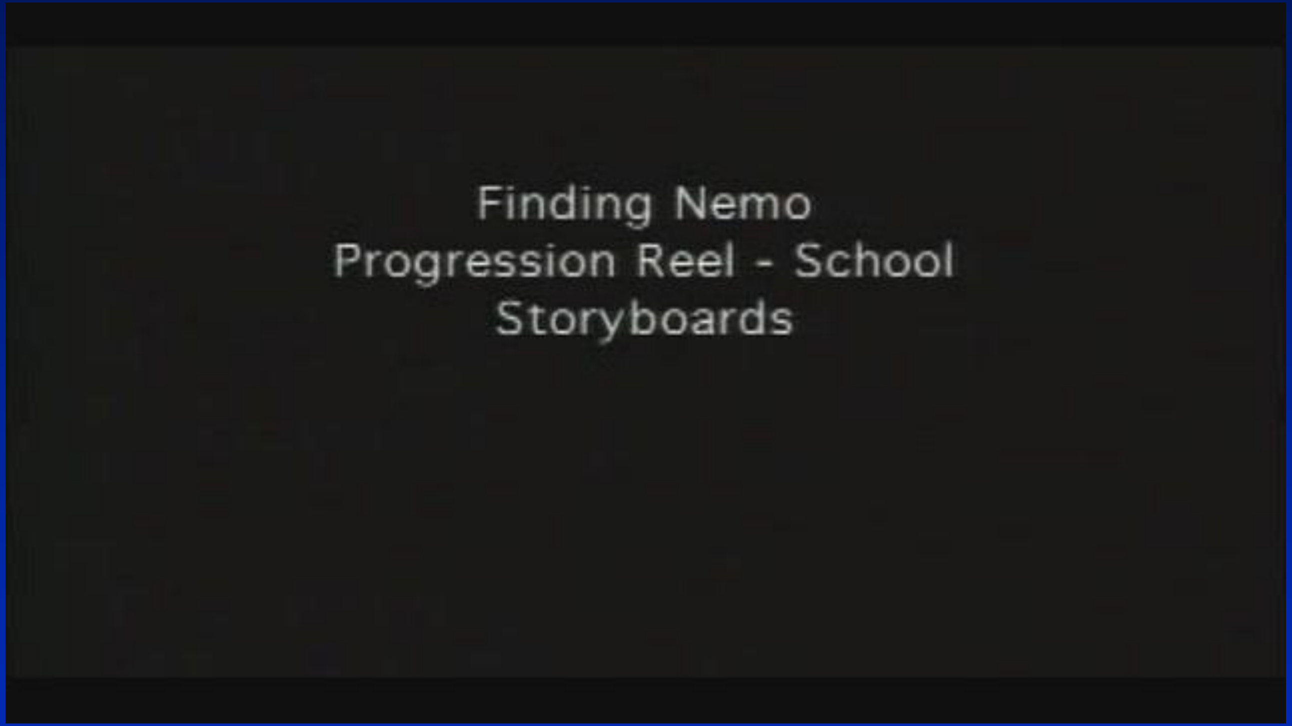
Shot Progression



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Nemo_Progression_School.comp.85

Should one go into the computer animation industry today?

Pixar Approximate Employee Distribution

Creative

Story: 60

Art: 70

Layout: 40

170

Production

Layout: 40

Anim: 150

TD: 150

GT/FX: 100

Lighting: 120

Editorial: 30

Post: 60

650

Technology

Research/Tools: 170

Renderman: 25

195

2011
1,200 employees

Success depends on a good story!

‘Coco’ Scores Another Strong Thanksgiving Debut for Disney

$71M opening weekend

Pixar's Coco 2017

Success depends on a good story!
But production is a big risk!

Computer Animation Theater Gross Revenues (U.S.) as of 11/2016

Rank	Title (click to view)	Studio	Lifetime Gross / Theaters		Opening / Theaters		Date
1	Finding Dory	BV	$486,295,561	4,305	$135,060,273	4,305	6/17/16
2	Shrek 2	DW	$441,226,247	4,223	$108,037,878	4,163	5/19/04
3	Toy Story 3	BV	$415,004,880	4,028	$110,307,189	4,028	6/18/10
4	Frozen	BV	$400,738,009	3,742	$243,390	1	11/22/13
5	Finding Nemo	BV	$380,843,261	3,425	$70,251,710	3,374	5/30/03
6	The Secret Life of Pets	Uni.	$368,384,330	4,381	$104,352,905	4,370	7/8/16
7	Despicable Me 2	Uni.	$368,061,265	4,003	$83,517,315	3,997	7/3/13
8	Inside Out	BV	$356,461,711	4,158	$90,440,272	3,946	6/19/15
9	Zootopia	BV	$341,268,248	3,959	$75,063,401	3,827	3/4/16
10	Minions	Uni.	$336,045,770	4,311	$115,718,405	4,301	7/10/15

Boxofficemojo.com

End