Modelado y Animación por Computador

Tema 2: Modelado

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Avances en la tecnología

Visual Milestones

El Arte de la Animación por Computador

Toy Story (1995)

- Primer largometraje realizado íntegramente en 3D. **Pixar & Disney Studios**.
- **Pixar:** creada por *George Lucas* y vendida eventualmente a *Steve Jobs*.
- Voces protagonistas: Tom Hanks y Tim Allen.
- Recaudó más de 350 millones de dólares.
- Solidez de la historia.

El Arte de la Animación por Computador

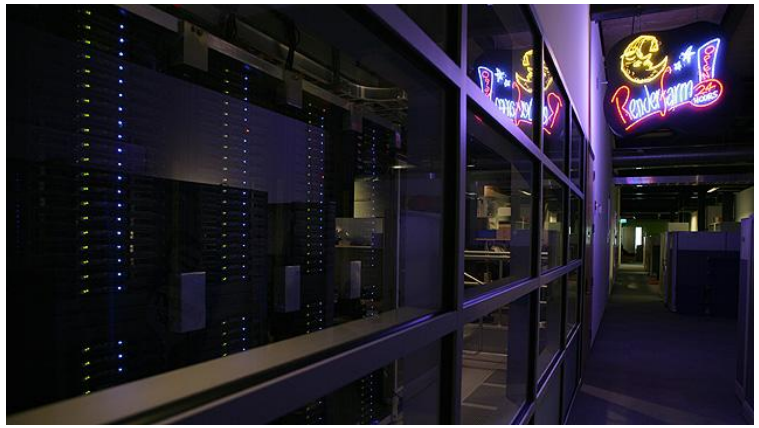
3D Computer Animation Studio

(Estudio de animación 3D)

El Arte de la Animación por Computador

Componentes básicos:

- Visión
- Plan de negocios y funciones
- Lugar de trabajo
- Personal creativo
- Personal producción
- Personal técnico
- Personal administrativo y comercial
- Software genérico
- Software propietario
- Potencia de procesamiento*
- Almacenamiento periférico
- Red de interconexión
- Equipamiento de entrada/salida



Pixar Render Farm

El Arte de la Animación por Computador

Tipos de software:

- Modelado superficies 3D
- 3D “rigging” y animación
- 2D/3D escáner
- Dibujo 3D
- Captura movimiento
- “Shading” y “rendering”
- Composición
- Edición
- Calibración del color
- Compresión archivos
- Rotoscoping*
- Web
- Animación 2D
- Dibujo 2D y retoque
- Gestor multimedia
- Backup
- Gestor de red

Rotoscoping: técnica utilizada para generar efectos especiales tales como “aura” sobre objetos (máscaras de contorno). El uso más clásico de “rotoscoping” fue en la trilogía original de *Star Wars*, donde se creó el efecto del sable láser (aura), a partir de un sable de plástico que manejaban los actores. Para conseguir el efecto, los editores trazaron una línea sobre cada fotograma donde aparecía el sable y lo retocaron generando el aura difuminada.

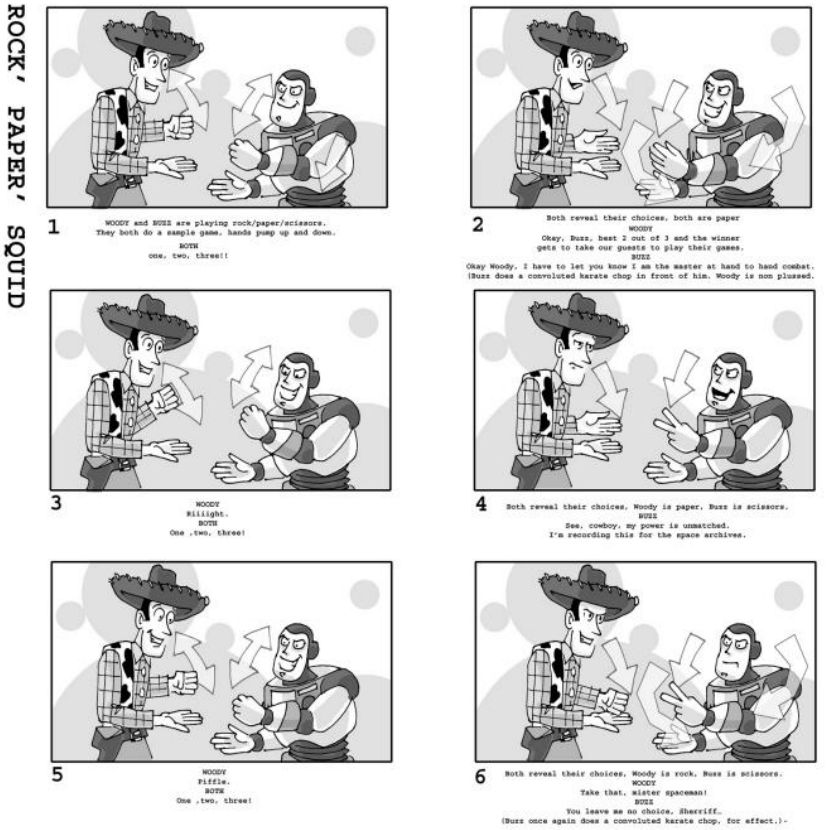
El Arte de la Animación por Computador

Equipo creativo (movie):

- Director
- Scriptwriter
- Production designer
- Visual effects director
- Art director
- Storyboard artist
- Producer

Equipo administrativo (movie):

- Executive producer
- Production assistant
- Production manager
- Director of postproduction
- Director of finance
- Production accountant



Storyboard Toy Story

El Arte de la Animación por Computador

Equipo de producción (movie):

- **Visual effects group**
  - Visual effects producer
  - Visual effects supervisor
  - Visual effects editor
  - Visual effects assistant editor
  - Visual effects coordinator
  - Stage technicians
- **Computer animation group**
  - Digital supervisor
  - Computer animation shot supervisors
  - Computer animators
  - Production coodinator
- **Modeling and lighting group**
  - Computer modeling supervisor
  - Modeling TDs
  - Lighting supervisor
  - Lighting TDs
  - Rendering wranglers
- **Computer technical support group**
  - CG department manager
  - CG software developers
  - CG technical assistants
  - CG systems support
- **Digital compositing and postproduction group**
  - Digital supervisor
  - Digital coordinator
  - Digital artists
  - Compositors
  - Digital transfer operator
  - Scanning supervisor
  - Scanning operators
  - Rotoscoping supervisor
  - Rotoscopers
  - Camera trackers
  - Digital output supervisor
  - Digital color timing supervisor
  - Negative cutter

El Arte de la Animación por Computador

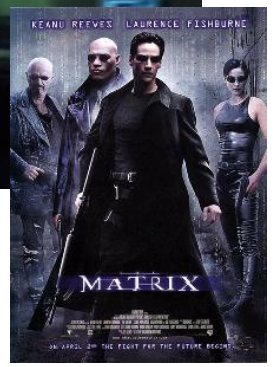
Películas con más influencia:

1. Star Wars 1977
2. Blade Runner 1982
3. 2001: A space odyssey 1968
4. The Matrix 1999*
5. Jurassic Park 1993
6. Tron 1982
7. King Kong 1933
8. Close Encounters of the Third Kind 1977
9. Alien 1979
10. The Abyss 1989
11. The Empire Strikes Back 1980
12. Metropolis 1927
13. A Trip to the Moon 1902
14. Terminator 2: Judgment Day 1991
15. The Wizard of Oz 1939
16. Who Framed Roger Rabbit 1988
17. Raiders of the Lost Ark 1981
18. Titanic 1997
19. Lord of the Ring: The Fellowship of the Ring 2001
20. Jason and the Argonauts 1963
21. E.T. the Extraterrestrial 1982
22. Toy Story 1995
23. Pirates of the Caribbean: Dead Man's Chest 2006
24. The Ten Commandments 1953
25. The War of the Worlds 1953
26. Forrest Gump 1994
27. Citizen Kane 1941
28. The Seventh Voyage of Sinbad 1958
29. 20.000 Leagues Under the Sea 1954
30. The Terminator 1984
31. Aliens 1986
32. Mary Poppins 1964
33. Lord of the Rings: The Return of the King 2003
34. Forbidden Planet 1956
35. Babe 1995
36. The Day the Earth Stood Still 1951
37. Lord of the Rings: The Two Towers 2002
38. King Kong 2005
39. Avatar 2009

El Arte de la Animación por Computador

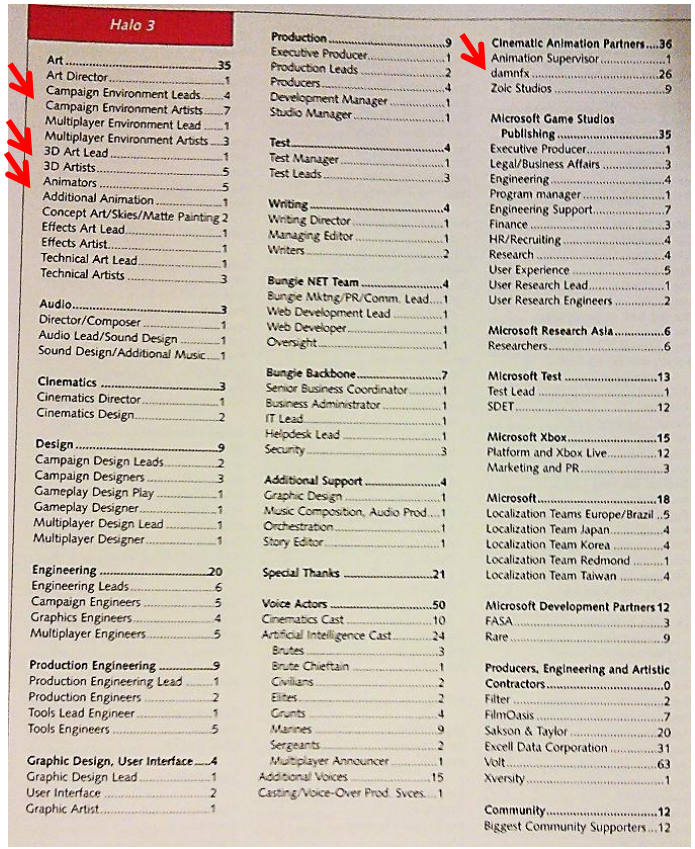
Películas con más influencia (The Matrix)

Bullet Time Effect



El Arte de la Animación por Computador

Equipo de producción (Halo3):



Halo 3

Art 35
Art Director 1
Campaign Environment Leads 4
Campaign Environment Artists 7
Multiplayer Environment Lead 1
Multiplayer Environment Artists 3
3D Art Lead 1
3D Artists 5
Animators 5
Additional Animation 1
Concept Art/Skies/Matte Painting 2
Effects Art Lead 1
Effects Artist 1
Technical Art Lead 1
Technical Artists 3

Audio 3
Director/Composer 1
Audio Lead/Sound Design 1
Sound Design/Additional Music 1

Cinematics 3
Cinematics Director 1
Cinematics Design 2

Design 9
Campaign Design Leads 2
Campaign Designers 3
Gameplay Design Play 1
Gameplay Designer 1
Multiplayer Design Lead 1
Multiplayer Designer 1

Engineering 20
Engineering Leads 6
Campaign Engineers 5
Graphics Engineers 4
Multiplayer Engineers 5

Production Engineering 9
Production Engineering Lead 1
Production Engineers 2
Tools Lead Engineer 1
Tools Engineers 5

Graphic Design, User Interface 4
Graphic Design Lead 1
User Interface 2
Graphic Artist 1

Production 9
Executive Producer 1
Production Leads 2
Producers 4
Development Manager 1
Studio Manager 1

Test 4
Test Manager 1
Test Leads 3

Writing 4
Writing Director 1
Managing Editor 1
Writers 2

Bungie NET Team 4
Bungie Mktng/PR/Comm. Lead 1
Web Development Lead 1
Web Developer 1
Oversight 1

Bungie Backbone 7
Senior Business Coordinator 1
Business Administrator 1
IT Lead 1
Helpdesk Lead 1
Security 3

Additional Support 4
Graphic Design 1
Music Composition, Audio Prod 1
Orchestration 1
Story Editor 1

Special Thanks 21

Voice Actors 50
Cinematics Cast 10
Artificial Intelligence Cast 24
Brutes 3
Brute Chieftain 1
Civilians 2
Elites 2
Grunts 4
Marines 9
Sergeants 2
Multiplayer Announcer 1
Additional Voices 15
Casting/Voice-Over Prod. Svces 1

Cinematic Animation Partners 36
Animation Supervisor 1
damnfx 26
Zoic Studios 9

Microsoft Game Studios Publishing 35
Executive Producer 1
Legal/Business Affairs 3
Engineering 4
Program manager 1
Engineering Support 7
Finance 3
HR/Recruiting 4
Research 4
User Experience 5
User Research Lead 1
User Research Engineers 2

Microsoft Research Asia 6
Researchers 6

Microsoft Test 13
Test Lead 1
SDET 12

Microsoft Xbox 15
Platform and Xbox Live 12
Marketing and PR 3

Microsoft 18
Localization Teams Europe/Brazil 5
Localization Team Japan 4
Localization Team Korea 4
Localization Team Redmond 1
Localization Team Taiwan 4

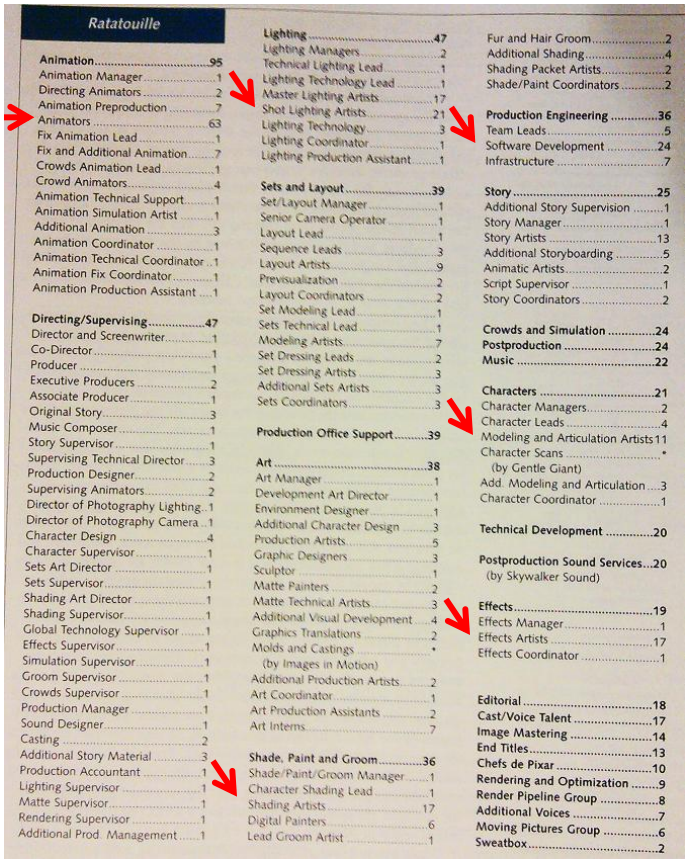
Microsoft Development Partners 12
FASA 3
Rare 9

Producers, Engineering and Artistic Contractors 0
Filter 2
FilmOasis 7
Sakson & Taylor 20
Excell Data Corporation 31
Volt 63
Xversity 1

Community 12
Biggest Community Supporters 12

El Arte de la Animación por Computador

Equipo de producción (Ratatouille):



Ratatouille

Animation 95
Animation Manager 1
Directing Animators 2
Animation Preproduction 7
Animators 63
Fix Animation Lead 1
Fix and Additional Animation 7
Crowds Animation Lead 1
Crowd Animators 4
Animation Technical Support 1
Animation Simulation Artist 1
Additional Animation 3
Animation Coordinator 1
Animation Technical Coordinator 1
Animation Fix Coordinator 1
Animation Production Assistant 1

Directing/Supervising 47
Director and Screenwriter 1
Co-Director 1
Producer 1
Executive Producers 2
Associate Producer 1
Original Story 3
Music Composer 1
Story Supervisor 1
Supervising Technical Director 3
Production Designer 2
Supervising Animators 2
Director of Photography Lighting 1
Director of Photography Camera 1
Character Design 4
Character Supervisor 1
Sets Art Director 1
Sets Supervisor 1
Shading Art Director 1
Shading Supervisor 1
Global Technology Supervisor 1
Effects Supervisor 1
Simulation Supervisor 1
Groom Supervisor 1
Crowds Supervisor 1
Production Manager 1
Sound Designer 1
Casting 2
Additional Story Material 3
Production Accountant 1
Lighting Supervisor 1
Matte Supervisor 1
Rendering Supervisor 1
Additional Prod. Management 1

Lighting 47
Lighting Managers 2
Technical Lighting Lead 1
Lighting Technology Lead 1
Master Lighting Artists 17
Shot Lighting Artists 21
Lighting Technology 3
Lighting Coordinator 1
Lighting Production Assistant 1

Sets and Layout 39
Set/Layout Manager 1
Senior Camera Operator 1
Layout Lead 1
Sequence Leads 3
Layout Artists 9
Previsualization 2
Layout Coordinators 2
Set Modeling Lead 1
Sets Technical Lead 1
Modeling Artists 7
Set Dressing Leads 2
Set Dressing Artists 3
Additional Sets Artists 3
Sets Coordinators 3

Production Office Support 39

Art 38
Art Manager 1
Development Art Director 1
Environment Designer 1
Additional Character Design 3
Production Artists 5
Graphic Designers 3
Sculptor 1
Matte Painters 2
Matte Technical Artists 3
Additional Visual Development 4
Graphics Translations 2
Molds and Castings ..... *
(by Images in Motion)
Additional Production Artists 2
Art Coordinator 1
Art Production Assistants 2
Art Interns 7

Shade, Paint and Groom 36
Shade/Paint/Groom Manager 1
Character Shading Lead 1
Shading Artists 17
Digital Painters 6
Lead Groom Artist 1
Fur and Hair Groom 2
Additional Shading 4
Shading Packet Artists 2
Shade/Paint Coordinators 2

Production Engineering 36
Team Leads 5
Software Development 24
Infrastructure 7

Story 25
Additional Story Supervision 1
Story Manager 1
Story Artists 13
Additional Storyboarding 5
Animatic Artists 2
Script Supervisor 1
Story Coordinators 2

Crowds and Simulation 24
Postproduction 24
Music 22

Characters 21
Character Managers 2
Character Leads 4
Modeling and Articulation Artists 11
Character Scans ..... *
(by Gentle Giant)
Add. Modeling and Articulation 3
Character Coordinator 1

Technical Development 20

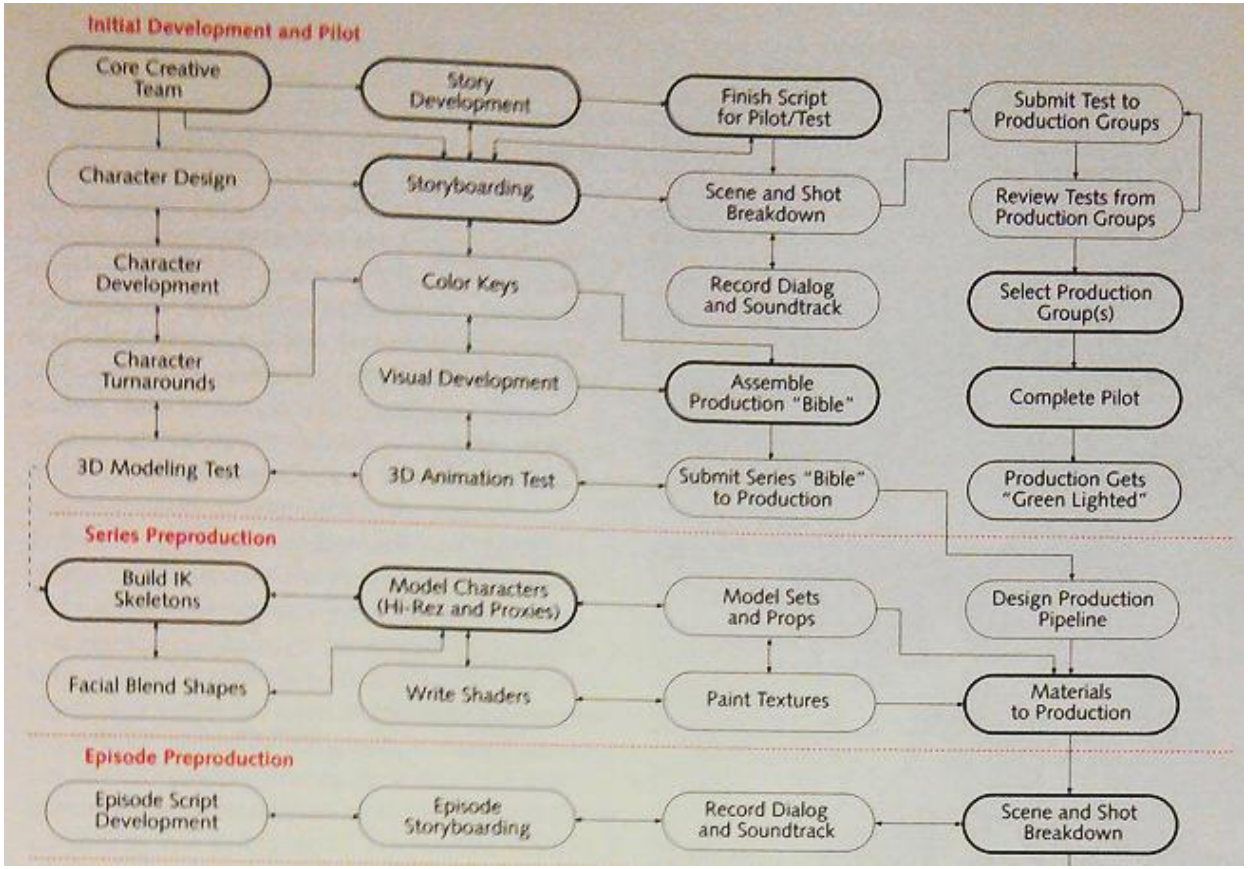
Postproduction Sound Services 20
(by Skywalker Sound)

Effects 19
Effects Manager 1
Effects Artists 17
Effects Coordinator 1

Editorial 18
Cast/Voice Talent 17
Image Mastering 14
End Titles 13
Chefs de Pixar 10
Rendering and Optimization 9
Render Pipeline Group 8
Additional Voices 7
Moving Pictures Group 6
Sweatbox 2

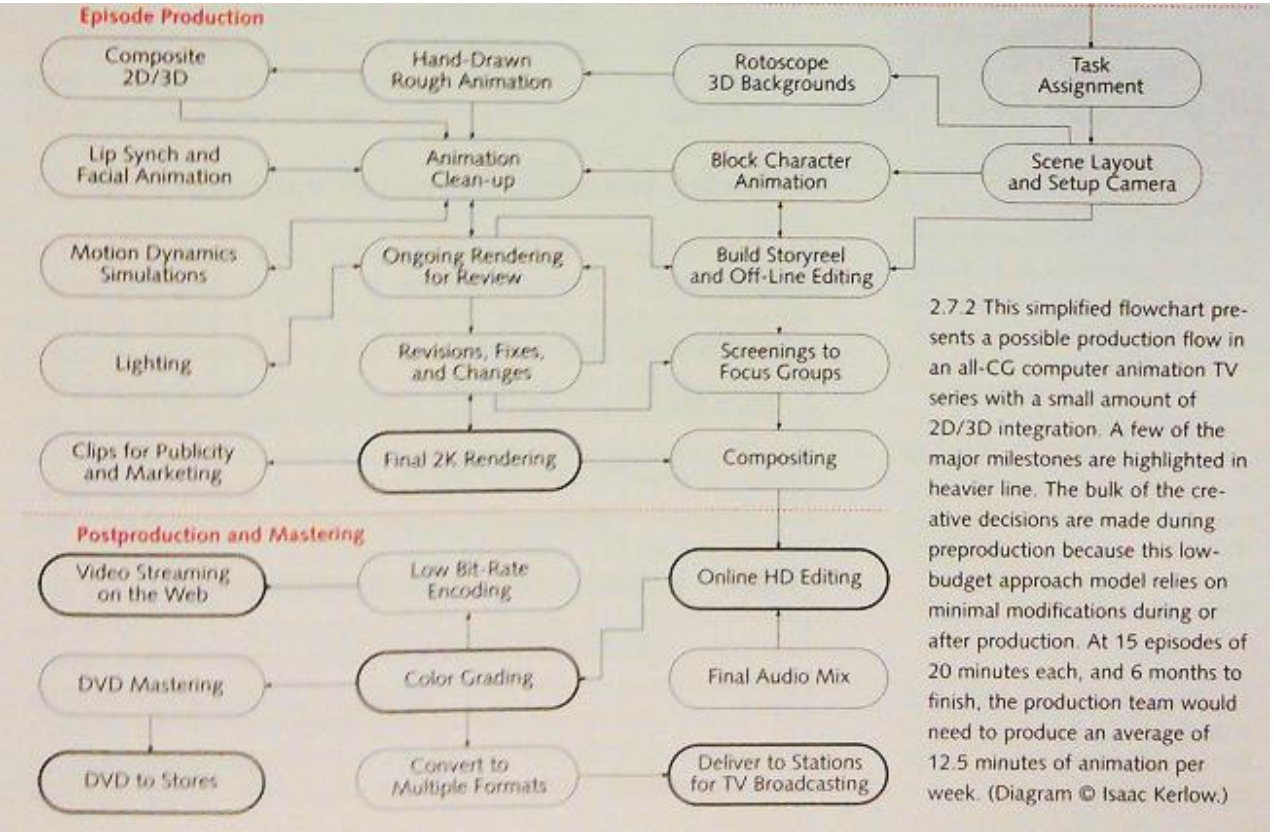
El Arte de la Animación por Computador

3D Production TV flowchart (I):



El Arte de la Animación por Computador

3D Production TV flowchart (II):



2.7.2 This simplified flowchart presents a possible production flow in an all-CG computer animation TV series with a small amount of 2D/3D integration. A few of the major milestones are highlighted in heavier line. The bulk of the creative decisions are made during preproduction because this low-budget approach model relies on minimal modifications during or after production. At 15 episodes of 20 minutes each, and 6 months to finish, the production team would need to produce an average of 12.5 minutes of animation per week. (Diagram © Isaac Kerlow.)

El Arte de la Animación por Computador

Proceso de producción en animación por computador:

- **Preproduction tasks:** grabación diálogos (scratch dialog) -> bases para animación caras
- **Storyboards:** unidades de producción, composición escenas, acciones y movimiento de cámara
- **Animatics, story reels, and previsualization:** acciones animadas simplificadas y previsualización
- **Modeling:** escena, personajes y elementos auxiliares…
- **Rough and final scene layout:** composición final de la escena
- **Rigging:** esqueletos internos (IK rigs)
- **Texture painting:** diseño de texturas complejas (material layers)
- **Character animation**
- **Effects animation and technical animation**
- **Review and approval or dailies:** trabajo de supervisión
- **Performance and live action capture on the set:** captura de movimientos de actores reales
- **Lighting and rendering:** iluminación -> posición luces, tipos, efectos… rendering -> shading, proc. textures
- **Rotoscoping and camera tracking**
- **Compositing, postprocesing, and final output**
- **Media asset management and technical support**

CGI Workflow example (behind the scenes)

https://www.youtube.com/watch?v=szJ9Ohi2FNo

Tema 2: Modelado

Transformaciones geométricas

Matrix representation 2D

- Representación de transformaciones 2D con una matriz:

$$\begin{bmatrix} a & b \\ c & d \end{bmatrix}$$

- Multiplicación de la matriz por un vector columna ⇔ aplicación de una transformación a un punto:

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} a & b \\ c & d \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} \qquad \begin{aligned} x' &= ax + by \\ y' &= cx + dy \end{aligned}$$

Transformaciones geométricas

Matrix representation 2D

- Transformaciones combinadas mediante multiplicación de matrices:

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} a & b \\ c & d \end{bmatrix} \begin{bmatrix} e & f \\ g & h \end{bmatrix} \begin{bmatrix} i & j \\ k & l \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix}$$

Las matrices representan la mejor forma de definir una secuencia de transformaciones geométricas de forma eficiente

Transformaciones geométricas

Matrix representation 2D

- ¿Qué tipos de transformaciones pueden ser representadas con matrices de 2x2?

2D Identity?

$$x' = x$$
$$y' = y$$

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix}$$

2D Scale around (0,0)?

$$x' = sx * x$$
$$y' = sy * y$$

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} sx & 0 \\ 0 & sy \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix}$$

Transformaciones geométricas

Matrix representation 2D

- ¿Qué tipos de transformaciones pueden ser representadas con matrices de 2x2?

2D Rotate around (0,0)?

$$x' = \cos\Theta * x - \sin\Theta * y$$
$$y' = \sin\Theta * x + \cos\Theta * y$$

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} \cos\Theta & -\sin\Theta \\ \sin\Theta & \cos\Theta \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix}$$

2D Shear?

$$x' = x + shx * y$$
$$y' = shy * x + y$$

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} 1 & shx \\ shy & 1 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix}$$

Transformaciones geométricas

Matrix representation 2D

- ¿Qué tipos de transformaciones pueden ser representadas con matrices de 2x2?

2D Mirror over Y axis?

$$x' = -x$$
$$y' = y$$

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} -1 & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix}$$

2D Mirror over (0,0)?

$$x' = -x$$
$$y' = -y$$

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} -1 & 0 \\ 0 & -1 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix}$$

Transformaciones geométricas

Matrix representation 2D

- ¿Qué tipos de transformaciones pueden ser representadas con matrices de 2x2?

2D Translation?

$$x' = x + tx$$
$$y' = y + ty$$

NO!

Solo transformaciones lineales 2D pueden ser representadas con matrices de 2x2

Transformaciones geométricas

Matrix representation 2D

- Las transformaciones lineales son combinaciones de…
  - Scale,
  - Rotation,
  - Shear, and
  - Mirror

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} a & b \\ c & d \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix}$$

Transformaciones geométricas

Matrix representation 2D

- Traslación 2D representada con una matriz de 3x3:
  - Point represented with *homogeneous coordinates*

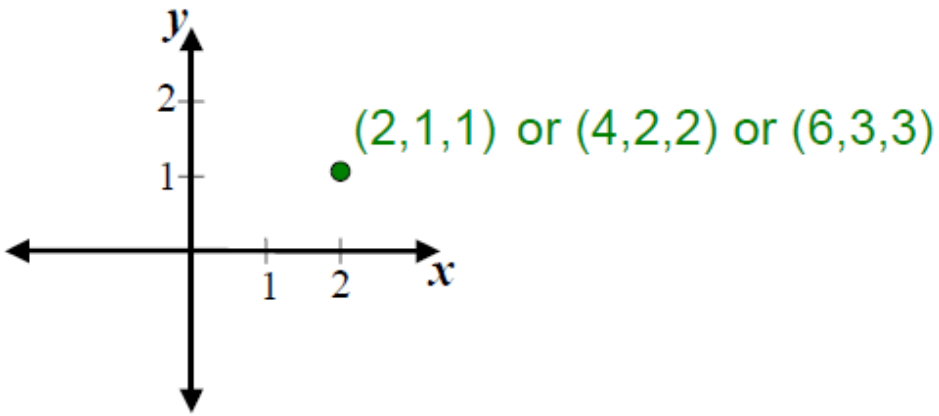
$$x' = x + tx$$
$$y' = y + ty$$

$$\begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & tx \\ 0 & 1 & ty \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

Transformaciones geométricas

Matrix representation 2D

- Adición de una tercera coordenada para cada punto 2D:
  - (x, y, w) represents a point at location (x/w, y/w)
  - (x, y, 0) represents a point at infinity
  - (0, 0, 0) is not allowed



Sistema de coordenadas idóneo para representar transformaciones

Transformaciones geométricas

Matrix representation 2D

- Transformaciones básicas 2D como matrices 3x3:

$$\begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & tx \\ 0 & 1 & ty \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

Translate

$$\begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} = \begin{bmatrix} sx & 0 & 0 \\ 0 & sy & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

Scale

$$\begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} = \begin{bmatrix} \cos\Theta & -\sin\Theta & 0 \\ \sin\Theta & \cos\Theta & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

Rotate

$$\begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} = \begin{bmatrix} 1 & shx & 0 \\ shy & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

Shear

Transformaciones geométricas

Matrix representation 2D

- Las transformaciones afines son combinaciones de…
  - Linear transformations, and
  - Translations

$$\begin{bmatrix} x' \\ y' \\ w \end{bmatrix} = \begin{bmatrix} a & b & c \\ d & e & f \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ w \end{bmatrix}$$

Transformaciones geométricas

Matrix representation 2D

- Transformaciones proyectivas…
  - Affine transformations, and
  - Projective warps

$$\begin{bmatrix} x' \\ y' \\ w' \end{bmatrix} = \begin{bmatrix} a & b & c \\ d & e & f \\ g & h & i \end{bmatrix} \begin{bmatrix} x \\ y \\ w \end{bmatrix}$$

Transformaciones geométricas

Matrix representation 2D

- Las transformaciones pueden ser combinadas mediante multiplicación de matrices:

$$\begin{bmatrix} x' \\ y' \\ w' \end{bmatrix} = \left(\begin{bmatrix} 1 & 0 & tx \\ 0 & 1 & ty \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \cos\Theta & -\sin\Theta & 0 \\ \sin\Theta & \cos\Theta & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} sx & 0 & 0 \\ 0 & sy & 0 \\ 0 & 0 & 1 \end{bmatrix} \right) \begin{bmatrix} x \\ y \\ w \end{bmatrix}$$

$$\mathbf{p}' = T(tx,ty) \quad R(\Theta) \quad S(sx,sy) \quad \mathbf{p}$$

Transformaciones geométricas

Matrix representation 2D

- La representación matricial es una forma eficiente de representar una secuencia de transformaciones:
  - General purpose representation
  - Hardware matrix multiply
  - Efficiency with premultiplication
    - » Matrix multiplication is associative

$$\mathbf{p}' = (T * (R * (S*\mathbf{p})))$$
$$\mathbf{p}' = (T*R*S) * \mathbf{p}$$

Transformaciones geométricas

Matrix representation 2D

- Precaución: el orden de las transformaciones influye

» Matrix multiplication is not commutative

$$\mathbf{p}' = T * R * S * \mathbf{p}$$

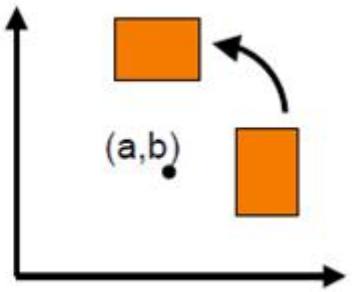
"Global" "Local"

Transformaciones geométricas

Matrix representation 2D

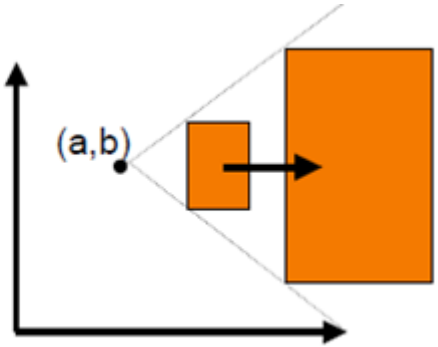
- Rotación Θ entorno a un punto arbitrario (a,b)
  - M=T(a,b) * R(Θ) * T(-a,-b)

The trick:
First, translate (a,b) to the origin.
Next, do the rotation about origin.
Finally, translate back.



- Escalado de *sx,sy* entorno a un punto arbitrario (a,b)
  - M=T(a,b) * S(sx,sy) * T(-a,-b)

(Use the same trick.)



Transformaciones geométricas

Matrix representation 3D

- Misma idea que las transformaciones 2D
  - Homogeneous coordinates: (x,y,z,w)
  - 4x4 transformation matrices

$$\begin{bmatrix} x' \\ y' \\ z' \\ w' \end{bmatrix} = \begin{bmatrix} a & b & c & d \\ e & f & g & h \\ i & j & k & l \\ m & n & o & p \end{bmatrix} \begin{bmatrix} x \\ y \\ z \\ w \end{bmatrix}$$

Transformaciones geométricas

Matrix representation 3D

$$\begin{bmatrix} x' \\ y' \\ z' \\ w \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \\ w \end{bmatrix}$$

Identity

$$\begin{bmatrix} x' \\ y' \\ z' \\ w \end{bmatrix} = \begin{bmatrix} sx & 0 & 0 & 0 \\ 0 & sy & 0 & 0 \\ 0 & 0 & sz & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \\ w \end{bmatrix}$$

Scale

$$\begin{bmatrix} x' \\ y' \\ z' \\ w \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & tx \\ 0 & 1 & 0 & ty \\ 0 & 0 & 1 & tz \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \\ w \end{bmatrix}$$

Translation

$$\begin{bmatrix} x' \\ y' \\ z' \\ w \end{bmatrix} = \begin{bmatrix} -1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \\ w \end{bmatrix}$$

Mirror over X axis

Transformaciones geométricas

Matrix representation 3D

Rotate around Z axis:

$$\begin{bmatrix} x' \\ y' \\ z' \\ w \end{bmatrix} = \begin{bmatrix} \cos\Theta & -\sin\Theta & 0 & 0 \\ \sin\Theta & \cos\Theta & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \\ w \end{bmatrix}$$

Rotate around Y axis:

$$\begin{bmatrix} x' \\ y' \\ z' \\ w \end{bmatrix} = \begin{bmatrix} \cos\Theta & 0 & -\sin\Theta & 0 \\ 0 & 1 & 0 & 0 \\ \sin\Theta & 0 & \cos\Theta & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \\ w \end{bmatrix}$$

Rotate around X axis:

$$\begin{bmatrix} x' \\ y' \\ z' \\ w \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos\Theta & -\sin\Theta & 0 \\ 0 & \sin\Theta & \cos\Theta & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \\ w \end{bmatrix}$$

Transformaciones geométricas

Global deformations

- Alan Barr, SIGGRAPH '84
- A 3x3 transformation matrix affects all vertices
  - P'=M(P)P
- M(P) can taper, twist, bend…

¿SIGGRAPH?

Transformaciones geométricas

SIGGRAPH

SIGGRAPH (short for **S**pecial **I**nterest **G**roup on **GRAPH**ics and Interactive Techniques) is the name of the annual conference on computer graphics (CG) convened by the ACM SIGGRAPH organization. The first SIGGRAPH conference was in 1974. The conference is attended by tens of thousands of computer professionals. Past SIGGRAPH conferences have been held in Los Angeles, Dallas, New Orleans, Boston and elsewhere across the United States.

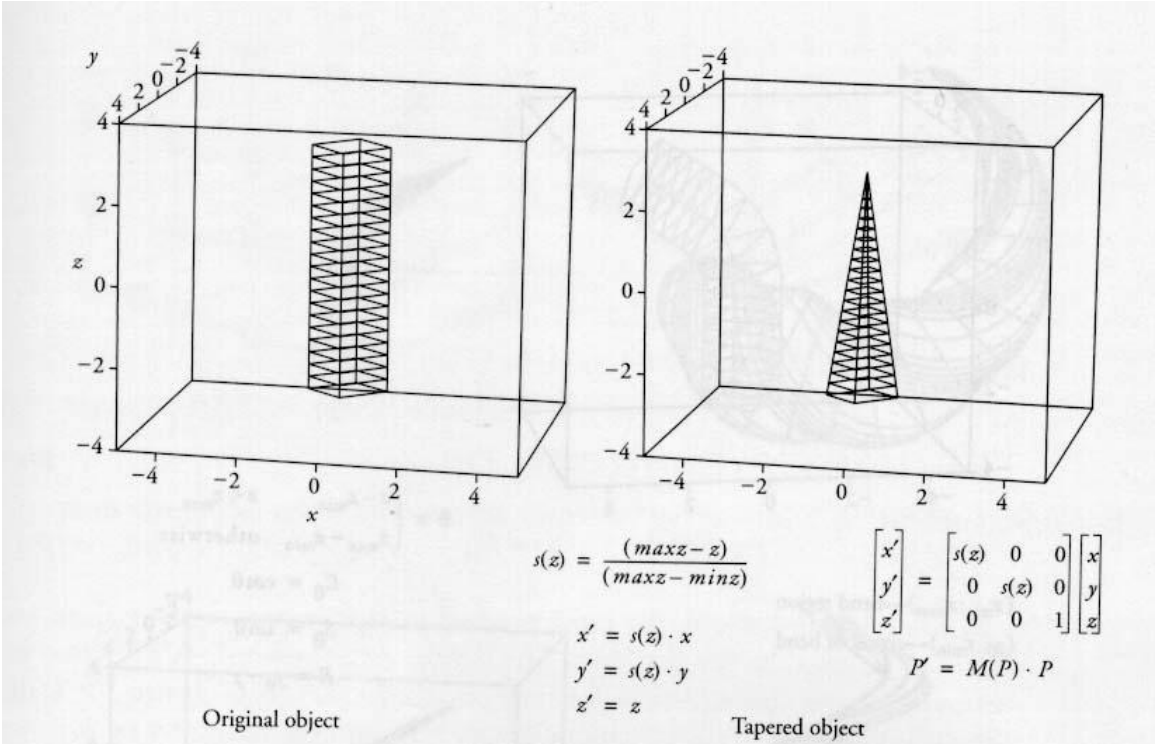
http://www.siggraph.org/s2014/

http://www.youtube.com/watch?v=GJ5L0zkTkB4&list=PLUPhVMQuDB_avy_6-qmDg5R-0pwCYvTt4&index=4

Transformaciones geométricas

Global deformations

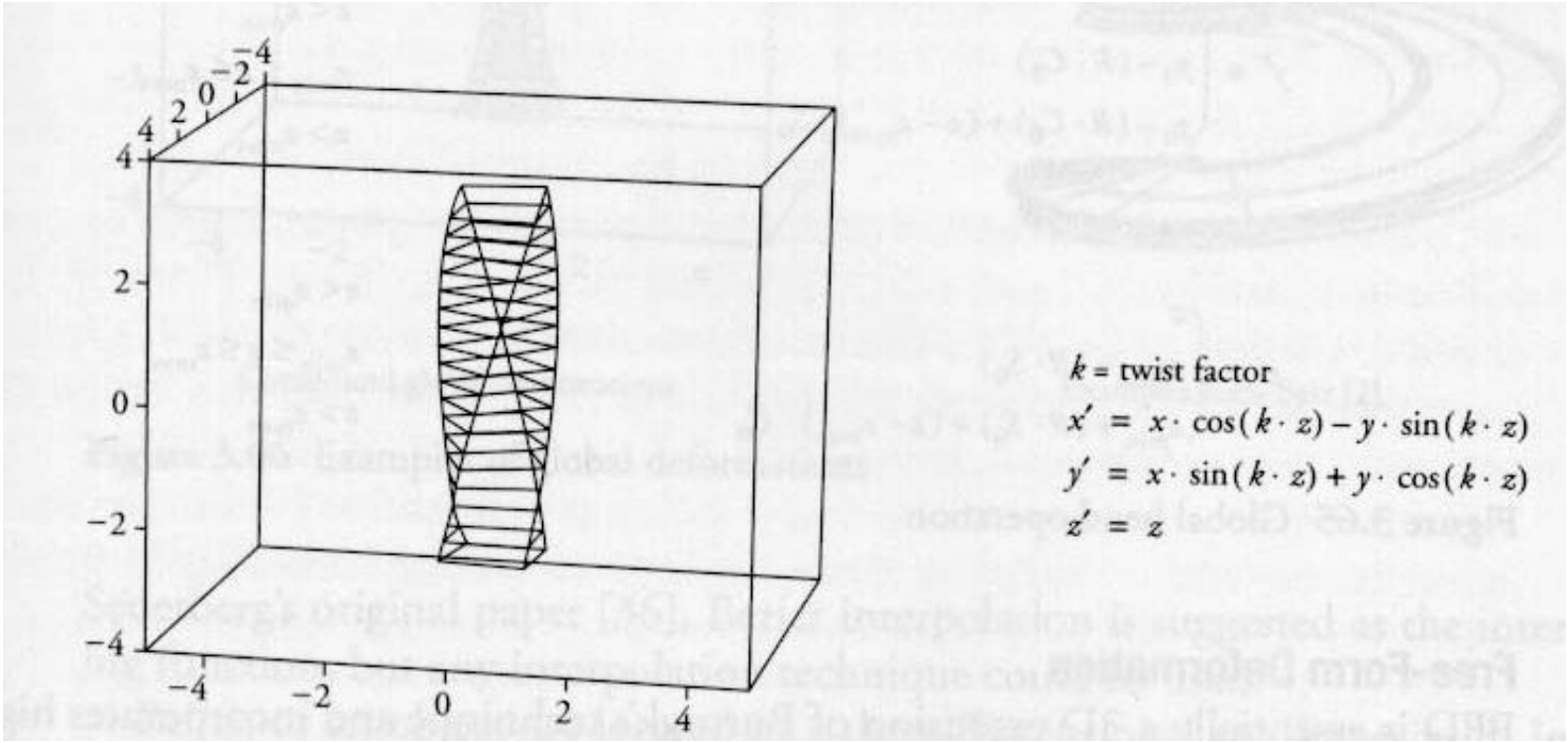
Taper



Transformaciones geométricas

Global deformations

Twist



k = twist factor

$$x' = x \cdot \cos(k \cdot z) - y \cdot \sin(k \cdot z)$$
$$y' = x \cdot \sin(k \cdot z) + y \cdot \cos(k \cdot z)$$
$$z' = z$$

Transformaciones geométricas

Global deformations

Bend

$(z_{min}: z_{max})$—bend region

(y_0, z_{min})—center of bend

$$\theta = \begin{cases} z - z_{min} & z < z_{max} \\ z_{max} - z_{min} & \text{otherwise} \end{cases}$$

$$C_\theta = \cos\theta$$

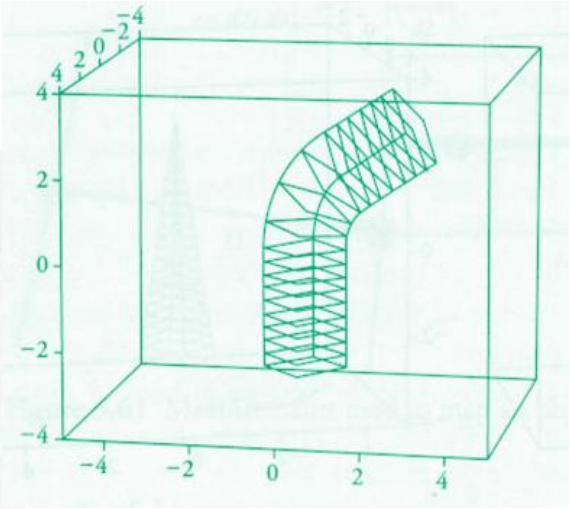
$$S_\theta = \sin\theta$$

$$R = y_0 - y$$

$$x' = x$$

$$y' = \begin{cases} y & z < z_{min} \\ y_0 - (R \cdot C_\theta) & z_{min} \le z \le z_{max} \\ y_0 - (R \cdot C_\theta) + (z - z_{max}) \cdot S_\theta & z > z_{max} \end{cases}$$

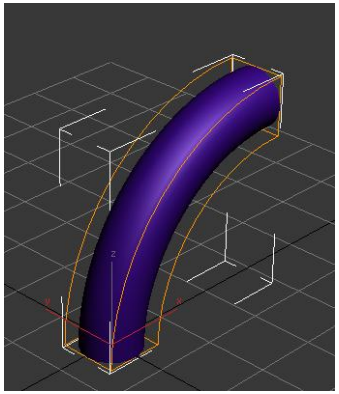
$$z' = \begin{cases} z & z < z_{min} \\ z_{min} + (R \cdot S_\theta) & z_{min} \le z \le z_{max} \\ z_{min} + (R \cdot S_\theta) + (z - z_{max}) \cdot C_\theta & z > z_{max} \end{cases}$$

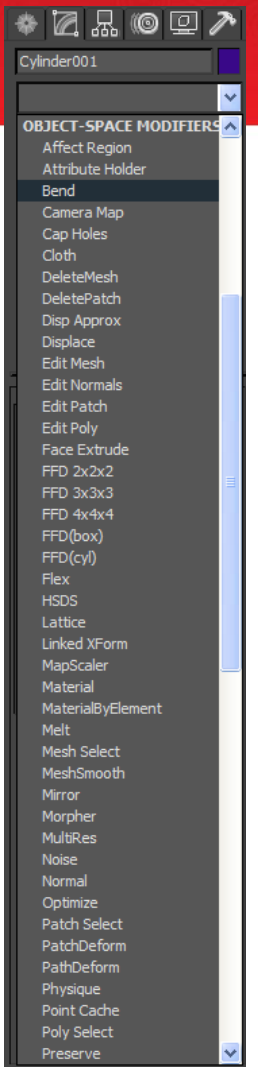


Transformaciones geométricas

Modifiers

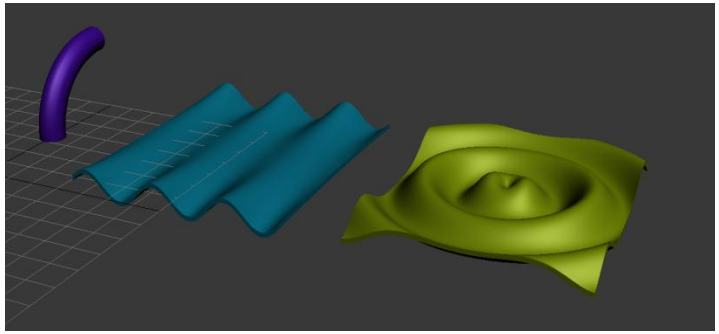
3D Studio Max





- Bend
- Taper
- Twist
- Spherify
- Noise
- Ripple
- Skew
- Squeeze
- Strech
- Wave

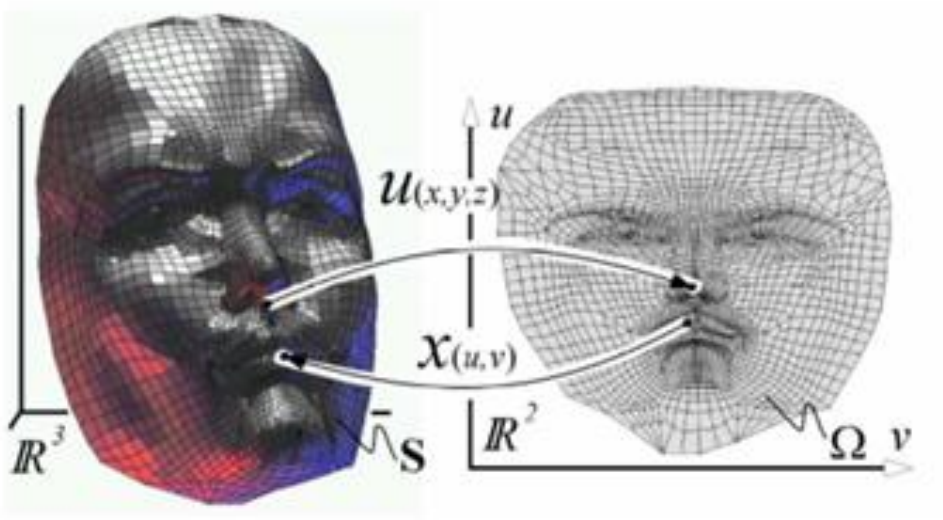
Object-space modifiers



Transformaciones geométricas

Polygonal Mesh Processing. **Analysis.**

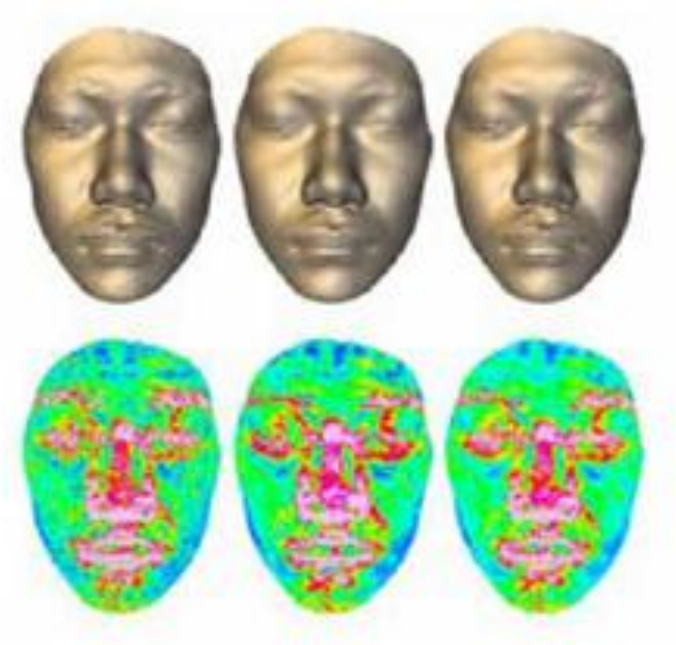
Parametrization



Transformaciones geométricas

Polygonal Mesh Processing. **Analysis.**

Diferential geometry



Transformaciones geométricas

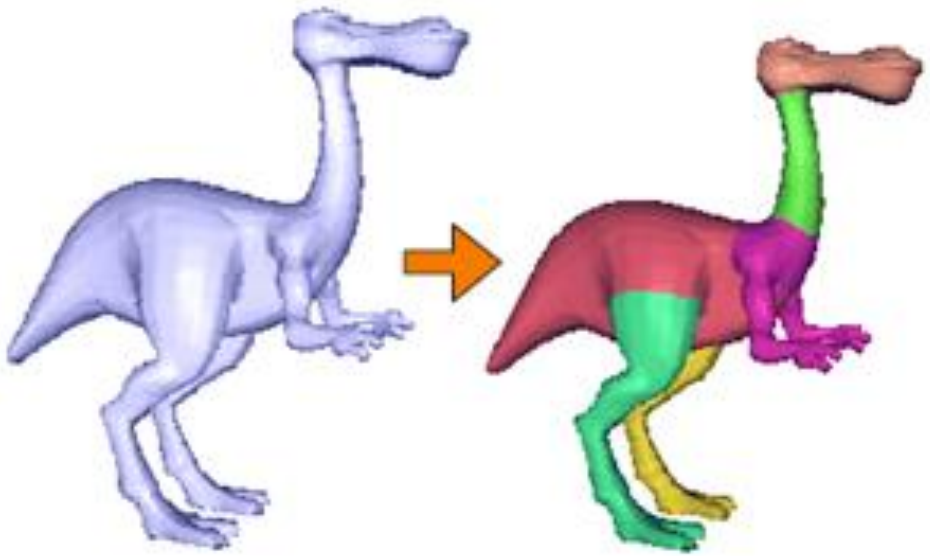
Polygonal Mesh Processing. **Analysis.**

Feature detection

Transformaciones geométricas

Polygonal Mesh Processing. **Analysis.**

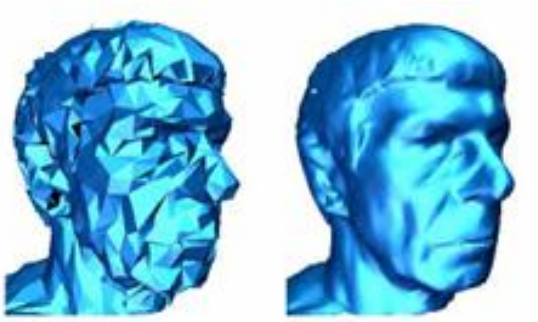
Segmentation



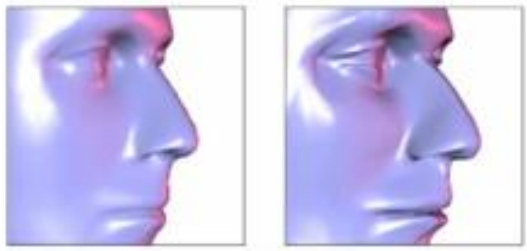
Transformaciones geométricas

Polygonal Mesh Processing. **Editing.**

Smoothing, sharpening, deformation, etc.



Smoothing

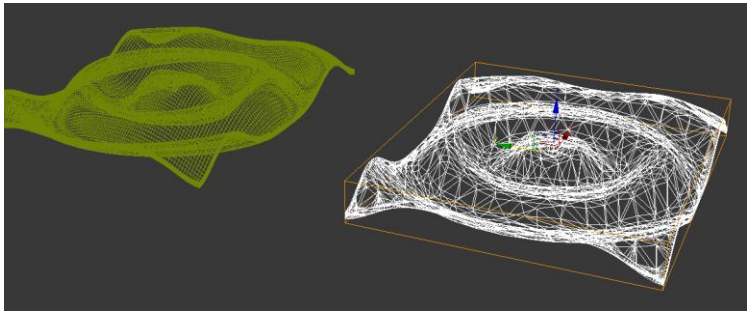


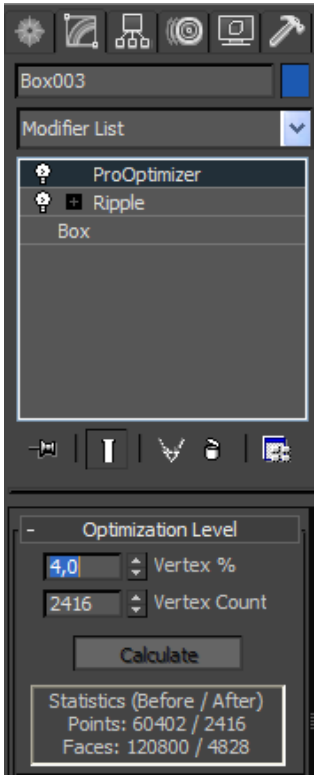
Sharpening

Transformaciones geométricas

Modifiers

3D Studio Max





- Cap holes
- Mesh smooth
- Optimize
- ProOptimizer
- Smooth
- Turbo smooth
- Welder

Object-space modifiers