What Is Rigging in 3D Animation? Basics and How It Works

Three-dimensional (3D) computer animation can seem a lot like magic. How does a graphic artist's sketch of a character get transformed into a lifelike, 3D animation that's able to walk, crouch, jump, and use its limbs and hands as naturally as you or I can?

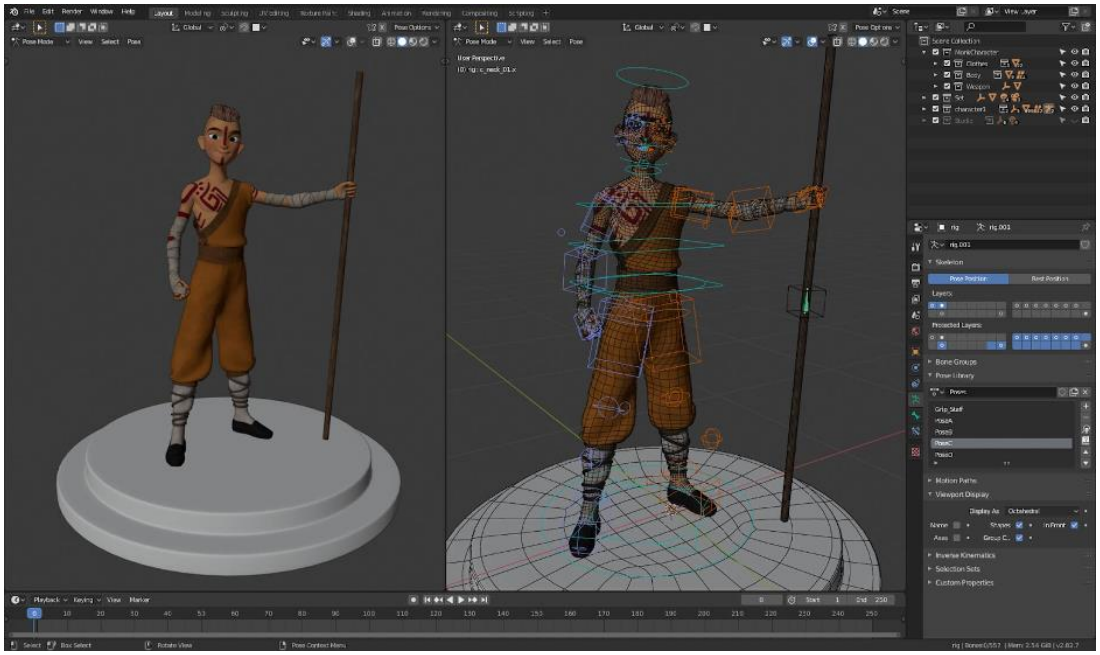


Image source: Kreonit

With 2D animation, motion is created frame by frame. Computers have since revolutionized animation, replacing hand-drawn frames with computer simulations that control how everything on screen moves: cloth, leaves on trees, and even hair.

But before a computer can take an artist's rendering of a character and bring it to life with motion, it has to go through an important phase: 3D rigging.

It's part art and part science. Here's a look at how it works.

What are 3D animation and rigging?

3D animation is simply the process of creating characters, objects, and even scenes or environments in a three-dimensional space. With 3D animation, designers can add more depth and realism to their creations than with 2D animation. It also makes it easier to achieve complex interactions like the

natural movement of water, fire, and wind—making final products more visually pleasing. In addition, 3D animations make it possible to abide by the natural laws of physics, texture, and lighting.

But before 3D animation is done, animators must first create rigs. Rigging involves creating bones or a digital skeleton that makes it possible to control the movement of characters and objects. For example, animators can control how characters run, how their hair, arms, legs, and other body parts move, and even their facial expressions.

Keep reading to understand the intricacies around rigging in 3D animation.

Key components of 3D rigging

Creating a 3D mesh, designing a skeleton, and finally incorporating the motion simulation and manipulation are the key components of 3D rigging.

The 3D mesh (skin)

In 3D animation, a mesh or skin is typically crafted using polygonal modeling, a technique where artists construct the character's form using interconnected polygons, usually triangles or quadrilaterals. This results in a wireframe structure, a kind of skeletal framework, that outlines the character's shape.

When this 3D mesh is placed over the rig or skeleton, it aligns perfectly with the underlying bone structure. This harmonious interaction between the mesh and the rig enables the character to move in a lifelike and cohesive manner, with each polygon adjusting to mimic realistic movements.

For example, when a character lifts a hand, the skin mesh should also follow along—generating an illusion of movement and flexibility. A rigging artist can also apply different colors, textures, and lighting effects to a 3D mesh to achieve different goals.

Designers can also deform and manipulate the skin mesh for characters to perform actions like laughing, smiling, and other expressions.

The skeleton: bones, joints, and muscles

Before you animate a character, it needs to be rigged. Using interconnected bones, muscles, and joints, you use the skeleton or rig to control how characters

or objects move. A skeleton can feature a few simple control points or it can also quickly grow and become complex, depending on the character.

In 3D animation, the skeleton can be represented by lines or shapes that are interconnected via joints. In this context, joints are places where skeleton bones meet—and they control how different body limbs move. For example, a knee is an example of a joint when creating a rig for a human character.

On the other hand, muscles are mainly mimicked when creating the skin mesh. They are connected to the underlying skeleton to allow them to move as realistically as possible while obeying the laws of physics.

Motion simulation and vertex manipulation

Character movements are simulated by a computer based on the properties of the internal skeleton.

In 3D animation, each bone in a skeleton is connected to specific vertices on a 3D skin mesh. This means that when the bone moves, the skin, clothing, or even facial expressions are also affected. Animators can assign skin weights to different body parts—which will determine how much deformation occurs.

Animators also control character movement through forward and inverse kinematics. In forward kinematics, each bone in a skeleton can be manipulated independently to achieve different actions and poses. Inverse kinematics makes it easier to move a character's limbs, like legs and arms, realistically to specific predetermined positions.

The rigging process: step by step

Rigging is a highly complex but necessary step in the animation process. It allows a character's body to be articulated in a structured way. Without rigging, trying to animate a character would result in a very distorted, deformed mesh.

From initial modeling to weight painting, here are key steps in a rigging process.

Initial modeling and skeleton creation

Before a 3D model can be animated, it has to get a rig. Let's talk about this by thinking of a 3D character as a hand-sculpted clay model.

Once a model has been created by an artist, it's inanimate, stuck in its original position until you manually bend an arm or turn its head. You can imagine that creating motion by hand for a feature-length film would be extremely tedious.

To automate the process, computer animation programs allow animators to assign motions. For that to happen, animators have to transform characters from clay models into marionettes that can be manipulated. That's where 3D rigging comes in.

3D rigging creates a skeleton for a 3D model—all the bones and joints inside a character that give animation software vertices it can recognize.

Assigning bones and creating the rig

Each bone in a character skeleton is assigned properties and constraints, just like bones in a human skeleton.

For example, the bones can rotate, bend in certain directions, and even control the motion of other bones. Bones can be weighted so that they have more influence over other bones. A "master bone" can be set to control the center point of how a character moves.

Weight painting and vertex assignment

With software platforms like Unity and Blender, experienced animators can use drivers, morphs, kinematics, and weight painting, among other tools, to control nearly anything on a character—say, raising the left eyebrow for a curious look or raising both for a surprised look.

Through weight painting, animators can assign different values or weights to vertices on a skin mesh. This will influence their level of deformation from nearby bone structures, allowing 3D objects to move naturally or in any desired way. For example, Blender has the Weight Paint mode you can use to assign weights and visualize different values.

AI and machine learning in 3D rigging

Artificial intelligence (AI) is transforming the animation industry, enabling stakeholders to be more creative and productive. We discuss how AI can fit into your 3D rigging workflow.

Automating the rigging process with AI

AI-powered tools can perform repetitive and time-consuming tasks, allowing you to focus more on creative tasks.

In 3D animation, AI tools can analyze models and identify appropriate places to include skeletons or bone structures. These platforms can also assist in weight painting—specifically, in setting and adjusting skin weights—to ensure different parts move as intended.

AI also enhances the motion capture process, making it easier to imitate the movement of real human actors and map it to 3D rigs, allowing animation characters to move or act in a natural or human-like way.

Today's AI tools have been trained on vast amounts of datasets, including rigging best practices. As a result, they identify errors or incorrect logic applications in your project and provide tips to enhance your rigging process.

Enhancing realism: AI in muscle and skin simulation

AI tools contribute to realism in animation by simulating realistic muscle and skin movements. From their massive training datasets, AI platforms can simulate how muscles stretch and contract or affect other body limbs and apply these fundamentals to rigs, adding a more realistic touch to animations.

Examples of 3D rigging

Rigging systems are used to create lifelike movements in animated creatures, such as the one below.

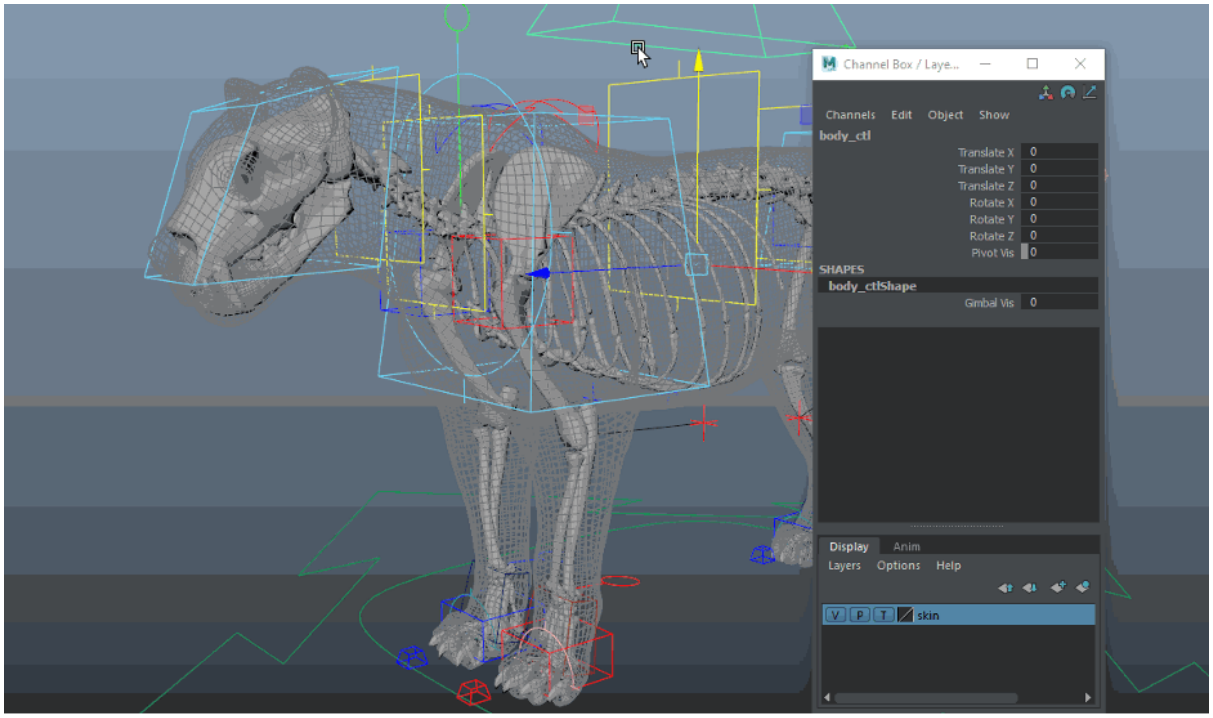


Image source: Paween Sarachan

Rigging is a widely used concept in different forums, including video games, films, marketing ads, and more. Below are some popular areas where 3D rigging has been exceptionally used.

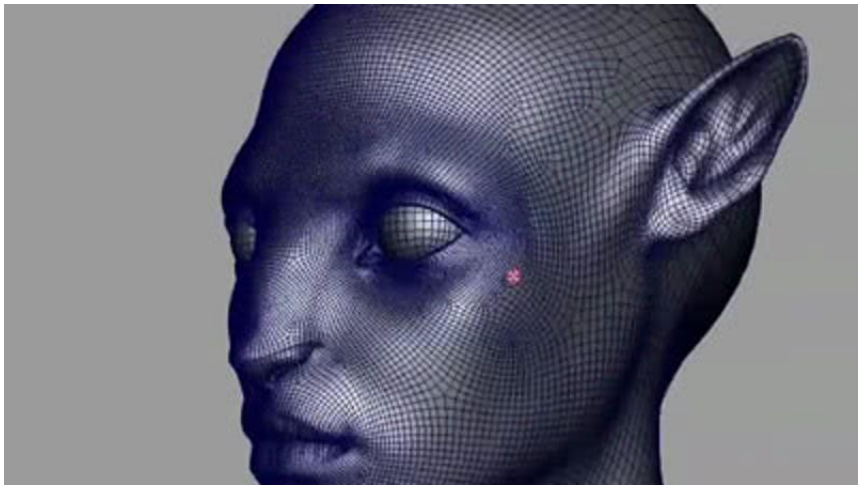


Image source: Media Division

- Avatar. This film used a performance capture technique to map a wide range of movements and actions of real actors to animated characters. As a result, the characters moved and behaved in a realistic and believable way.

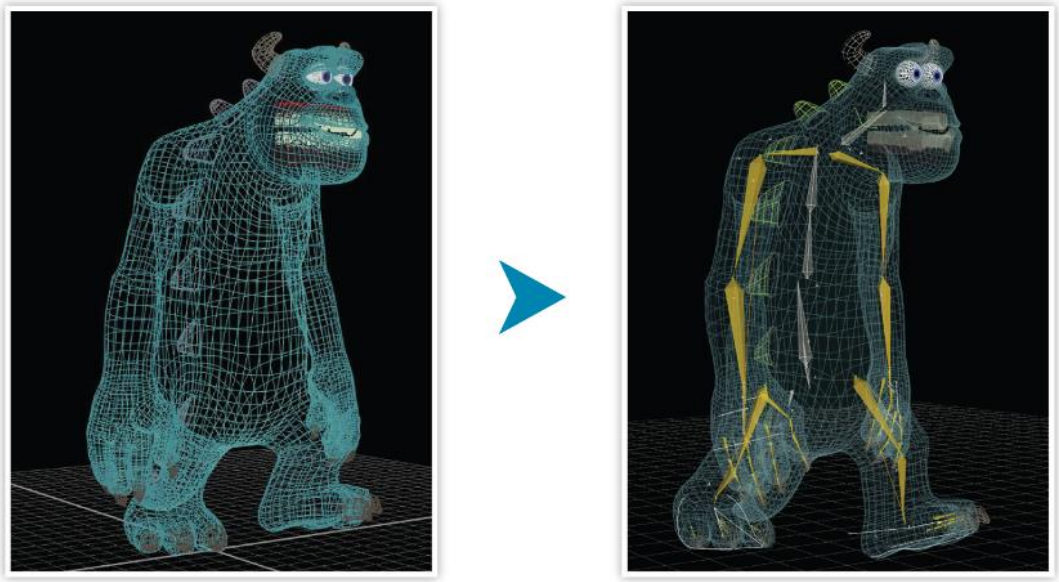


Image source: The Science Behind Pixar

- Monsters Inc. Pixar's movies, such as "Monsters Inc.," use advanced 3D rigging techniques to bring their characters to life. The rigging process in these films allows characters like Sully or Mike Wazowski to move in expressive and emotionally engaging ways.

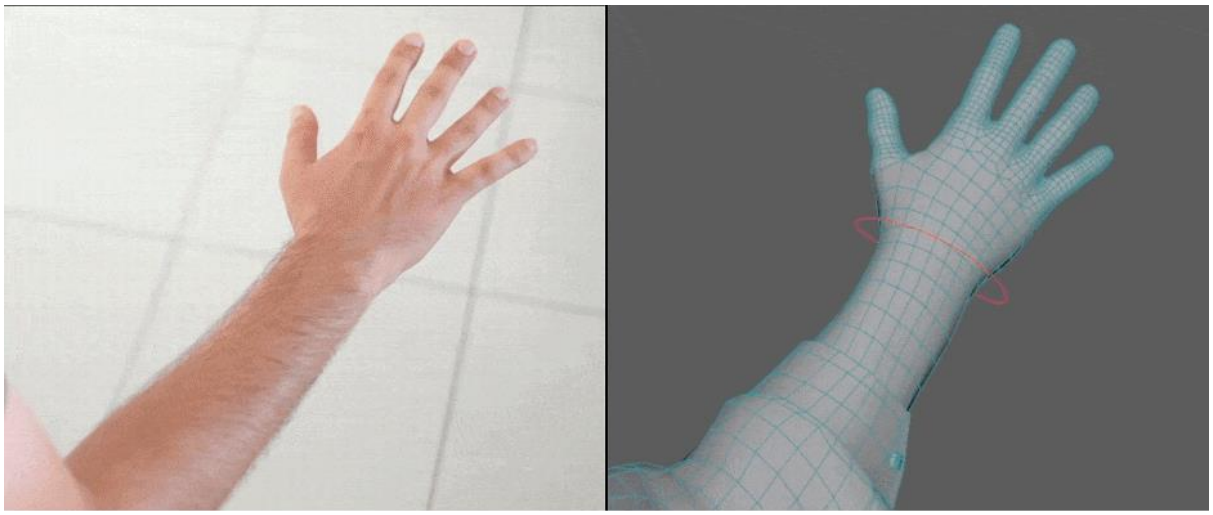


Image source: Vajont VR Devblog

- Virtual reality (VR) experiences. In VR environments, 3D rigging is crucial for creating immersive and interactive experiences. Characters or avatars in VR games and simulations are rigged to respond to player movements and actions, enhancing the sense of presence in the virtual world.

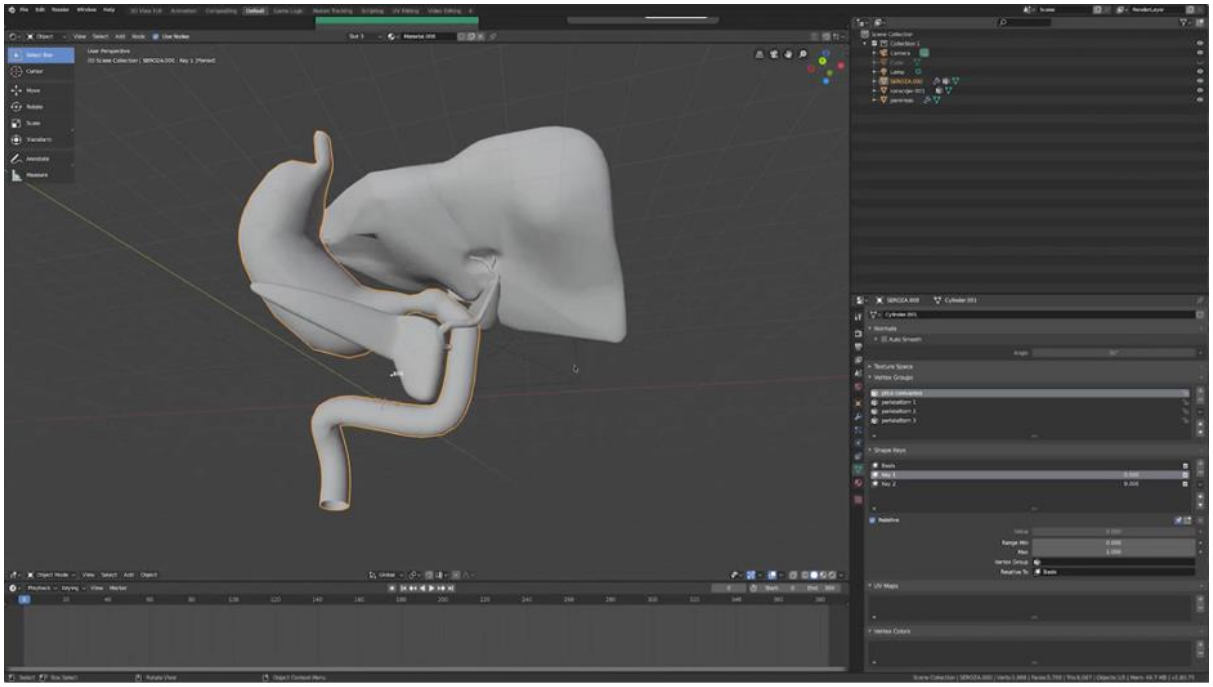


Image source: 3D Blendered

- Educational software and simulations. 3D rigging is used in educational software to create realistic models of the human body, animals, or machinery. These models help in understanding complex concepts through interactive visualizations.

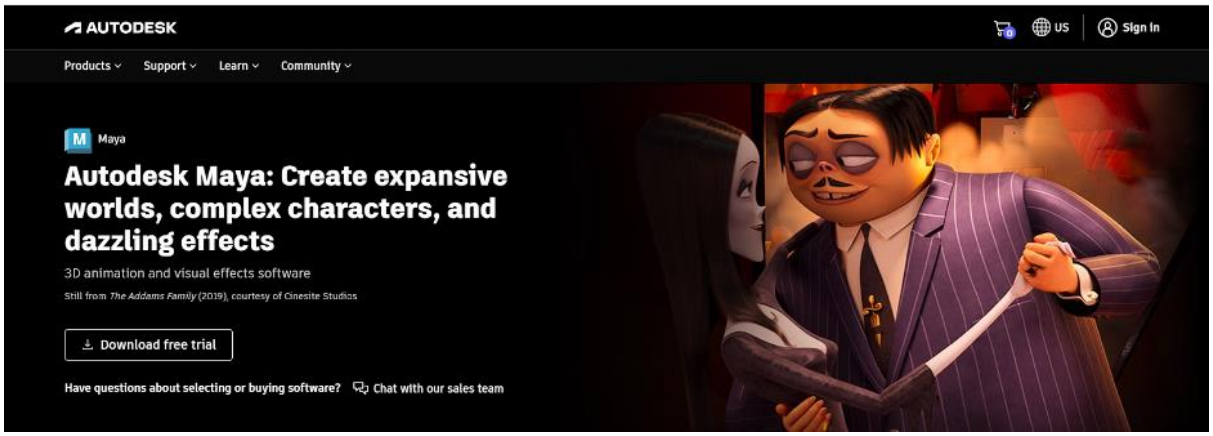
Image source: Thangs

- Marketing and advertising mascots. Many brands use animated mascots in their advertising campaigns. These mascots are often 3D models that have been rigged to perform various actions, like dancing or interacting with products, making them appealing and memorable to consumers.

Top rigging software tools

From Autodesk Maya to Cinema 4D, we discuss the top rigging software that you can integrate into your animation workflow.

Autodesk Maya



Autodesk Maya is a comprehensive platform used for complex rigging, rendering, facial animation, character modeling, skeletal animation, creating 3D effects, and simulations. It's used by special effects (also called FX) artists, riggers, animators, and 3D modelers in a wide variety of industries spanning from gaming to film.

Features:

- Ability to create complex skeleton structures for different characters
- Enhanced skinning tools
- Transfer rigs from one character to another with similar skeleton structure
- Polygonal modeling

Pricing:

You can purchase Maya via subscription or through flexible payments:

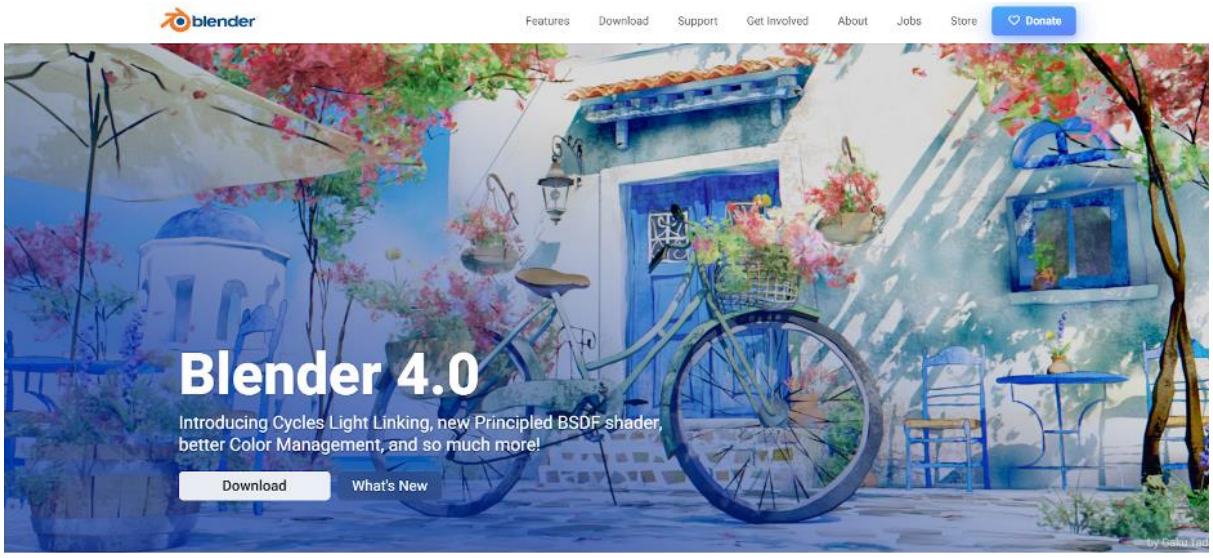
Subscription:

- $235 per month
- $1,875 per year
- $5,625 paid every three years

Flexible payments:

- 100 tokens for $300
- 500 tokens for $1,500

Blender



Blender is open-source software that helps artists and animators create complex characters, graphics, vectors, and visual effects. Apart from its intuitive interface, experienced creators can also write Python scripts and use them in 3D modeling, character rigging, and animation. Blender has a huge community support network, allowing you to access valuable learning resources and tutorials.

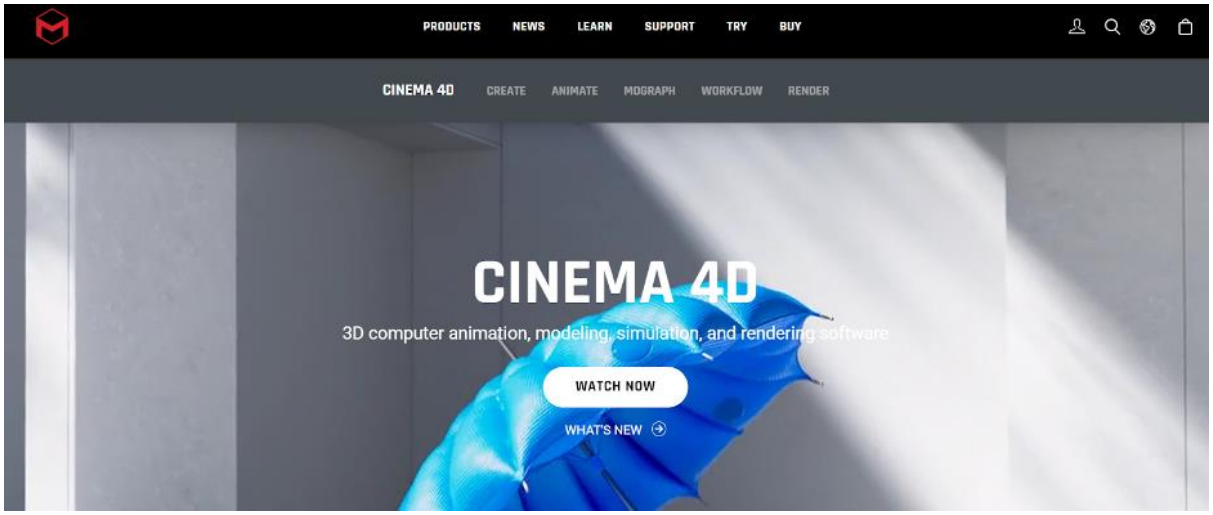
Features:

- A robust animation toolset
- A simple weight scale and painting tool for assigning different weights to digital bones
- Automatic skinning—which leads to realistic movements
- Bone layers and colored groups facilitating better organization
- Control objects easily by setting constraints
- Motion paths allow you to control character movement easily

Pricing:

- Available for free, donations accepted

Cinema 4D



Cinema 4D is a professional tool that performs numerous tasks in the 3D animation pipeline, including sculpting, character design, modeling, and rigging. Apart from built-in features, Cinema 4D also supports different integrations, including from popular apps like Adobe After Effects and Photoshop.

Features:

- Parametric, volume, and polygonal modeling
- Body paint 3D for adding textures to models
- Car rig templates
- Toon rig to animate cartoon characters quickly
- Provides a huge library of resources you can import and use in a project

Pricing:

- Maxon One for $99.91 per month or $1,199 billed annually
- C4D +Redshift for $81.91 per month or $983 billed annually