How Does Computer Animation Work?

***dovewings**: I'm writing an article on "how does computer animation work"*
***inkbug**: Oh Dear*
***dovewings:** :-)*
***inkbug:** will it help if I reminded you that 3D is just an illusion?*
***dovewings:** oh very good*
***inkbug:** In the end, all you see is a sequence of still images.*

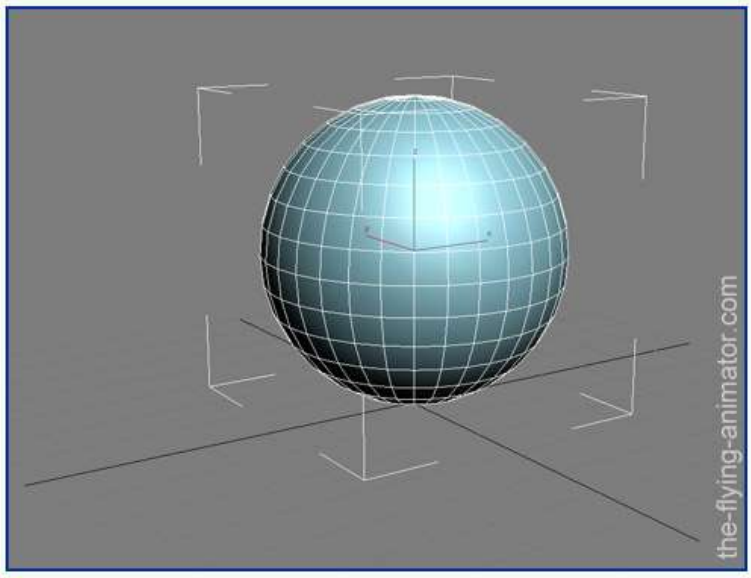
So how DOES computer animation work?

The animator uses a computer to generate a sequence of still images, that give the illusion of motion through three dimensional space when you play them.
You require a 3D animation software, such as 3DMax or Maya, and a good computer.

Instead of drawing every detail in the frame by hand, you draw every frame using a computer! The animator gives the software a set of parameters that describes how the elements should look and move, something along the lines of:

"At frame #1 (a point in time) place the ball at coordinates X1,Y1,Z1 (a point in space)."

"At frame #25 (1 second later) place the ball at coordinates X2,Y2,Z2 (a second point in space)."



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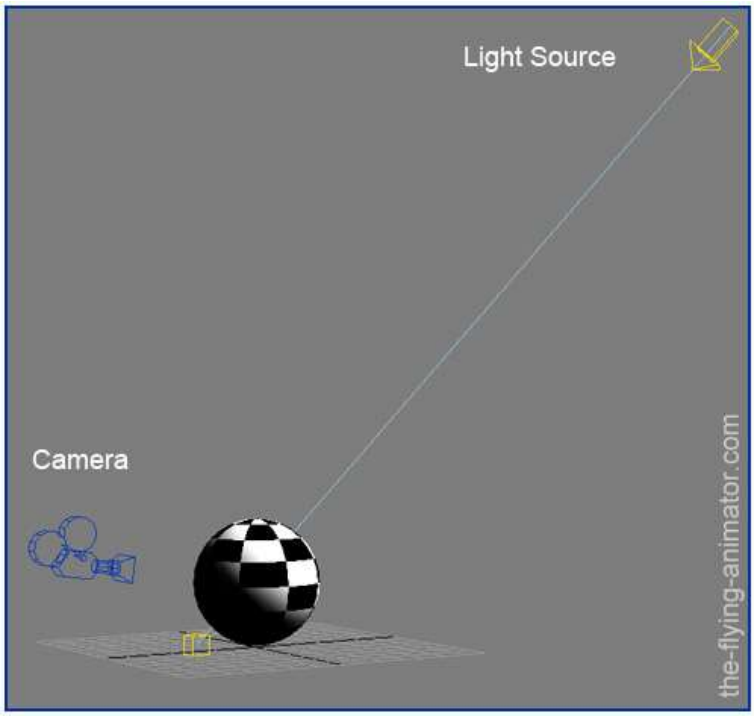
Screen shot from 3DMax: wire frame for a sphere in a three dimensional simulation

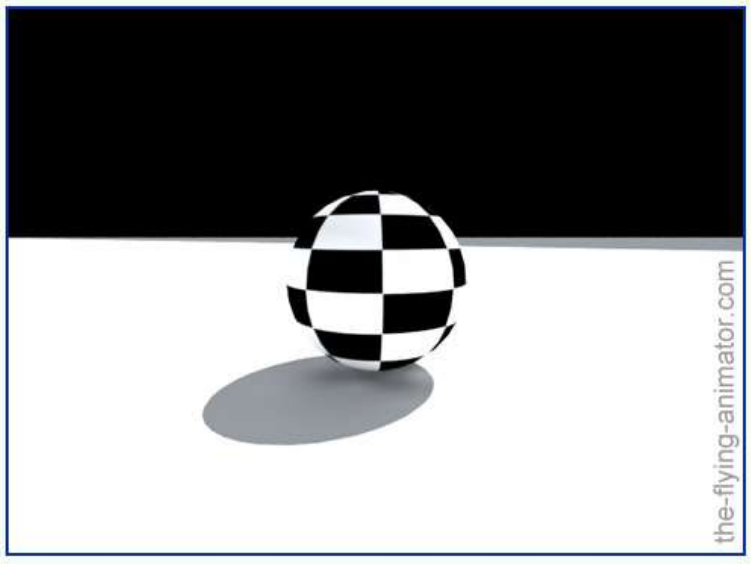
The animator also places a camera at coordinates X3,Y3,Z3 telling the software where to look at the scene FROM.
We also want a source of light to illuminate the scene:



Screen shot from 3DMax work panel: a ball in 3D space, a camera and a light source

When all the parameters are set, the computer then calculates two things (this calculation is called "Rendering"):

- The journey the ball makes from point 1 to point 2: Where exactly should the ball be at each of the 25 frames?
- How each frame looks from the point of view of the camera?



The rendered image

The end result is a sequence of 25 still images of a ball, moving incrementally across the screen. You play them on your DVD at the rate of 25 frames per second, and that, in a nut shell, is how computer animation works.

Does the computer save time and work?

First, let me clear up a serious misconception:

Computers DO NOT animate by themselves.
There is no "Make Animation" button!
(Nor is there the new invention - "Make GOOD Animation" button)

The computer really is JUST A TOOL.

More powerful than a pencil, obviously, but you still need an Animator to hold it.
Every time I meet someone and say I'm an animator, and they reply "Oh how lovely! A lot of work, animation, but the computer does it all for you now, doesn't it?"
I just go - like - AAAAAARRRRRRGHHHHHHHHH!!!!!!!
I just want to scream and yank my hair out!
Well, if I were thinking more clearly, I'd want to yank THEIR hair out!

Get real, people!
An animation software cannot animate a movie any better than a word processor can write a book.
It can copy and paste. It can align all the balls to one side, and number the pages or color all the balls blue with one click, but really, that's about it.

Sorry, I just had to get this out.
More to the point, computer animation can work for you, or you can work for it...

Things the computer can do for you

On a short, low budget, the computer can cut production times and costs dramatically, in comparison to traditional animation.

On a full scale production - nope, sorry.

Making a feature animated film is just as complex as it ever was, probably more.

The things a computer can do:

- Fill in the inbetweens (tweens, as they're called for short)
- Handle multiple characters and crowd scenes, like a whole army of Orks or bugs
- Create the perfect 3D illusion
- Simulate materials (getting better all the time)
- Simulate complicated lighting setups
- Integrate live-action with virtual images, from landscape back drops to explosions and stuff.
- Combine motion and performance of a live actor with an animated character (motion capture)

A CGI army in Lord of the Rings

Computer animation works for 2D animation as well. 2D can also be computer generated.

I feel that the boundary between 2D and 3D is getting rather thin. Ever since Beauty and the Beast waltzed under a 3D chandelier, they have been mixing up more and more.
And - I must say this again - 3D is really just an illusion, a flat image.
Our brain fills in the gaps.

Things a computer cannot do (2011)

Other than the obvious, like write a story, tell a joke or animate, these are the major buggers:

When tweening, the animator still needs to put in good keyframes, set motion arcs and set the spacing. If you let the computer do it alone, it all comes out mechanical and lifeless.
You would still animate complicated movements frame by frame if you want them to look good.
All things that are random or chaotic in nature are hard for a computer to simulate.
When Pocahontas stood on the edge of the cliff with her long hair blowing in the wind, Disney animator Glen Keane figured it out frame by frame, with pencil on paper. It takes a good animator to animate long hair, but a human brain can calculate how the strands rise and fall. But for Violet, The Incredibles' vanishing teenage girl, long hair was still theoretical until very late into the production. The TD (Technical Directors) at Pixar did figure it out but I think they sweated blood until they did.

The reason that hair, clothes and organic textures like skin and earth are so hard to do in CGI is this:

They need to looks and feel real - you can't cheat, because we KNOW what's it supposed to look like. It's 3D, and the illusion is powerful so we expect it ALL to look RIGHT.
If all of Pocahontas looks drawn in a certain way, and all the world around her speaks the same visual language, we're cool. We can concentrate on the story.

If the world looks very real and three-dimensional, but everything in it looks like it's made of plastic - you do Toy Story.
Until you manage to calculate the hair.

How does computer animation work - for animators

Honestly?
Look, if you are good at math, feel comfortable with Calculus and Boolean algebra, then by all means - dive into the programming and learn how to animate with numbers. You'll find a job in no time, I promise.

But you don't have to fully understand just how exactly computer animation works if you only want to animate.
Find a good rig from a good rigger, animate the character to life, and give it a soul and a spirit. Then, hand it over to the rendering people and come back a month later to see how it turned out. This is a sort of regression in animation, I think. Once upon a time, you drew the frames on paper, then captured them on film, and sent it to development, sometimes in another country. It could have taken 3 weeks to see how the animation turned out. It can take a similar time today - some movies take a day and a half to render a single frame!

Mostly when I think on how computer animation works, I'm just glad that it **does! LOL**
So long as it works and not breaks, I'm cool.

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