

“Classic” character animation techniques

(Imagine)

~ R. Cory Collins

Character animators... What’s up with those guys anyway? They are always talking in another language or something. Saying things like, “This needs more squash on the hit,” or, “this needs more stretch...” or, “not enough anticipation...” What a strange lot these guys are, you might say.



Well, not really. Character animators, or creature animators as they are sometimes called, use specific techniques to add life to the creatures they animate. Much in the same way computer graphic modelers use specific techniques to build and surface their objects. Most of these animation techniques have been around for many years, developed by animators producing traditional two-dimensional cel animation.

This article will explain some of the language and techniques used by character animators. The “classic” animation techniques discussed in this article are:

- **Squash and Stretch**
- **Anticipation**
- **Overlapping motion**
- **Ease in and Ease Out**
- **Overshooting**

The techniques mentioned above are used to achieve the desired look or feel of the motions and actions of the characters that are being animated. The results may vary from extremely exaggerated and comical to ultra-realistic motions and expressions. Most of the principles of character animation are used to express a feeling of substance. It is a way of giving visual cues as to what the character is made of. They can also be used to convey a particular emotion or feeling to the viewer through the actions of a character.

Squash and Stretch

One of the fundamental techniques of character animation is known as squash and stretch. It’s one of the easiest ways to clue in your audience as to the makeup of a character. Squash and stretch can be used to show elasticity, or lack thereof. A simple example is the difference you see between dropping a rubber ball or dropping a bowling ball to the floor ([Figure 1](#)). If you hold up a rubber ball and drop it to the floor, you will notice that upon striking the ground, it will bounce many times; fairly high bounces at first, and losing altitude with each successive bounce. If you could slow down the action a bit, you could also see the elasticity of the rubber at work. Upon strik-



Figure: 1.

ing the ground, the ball flattens out laterally, hence the term “squash”. As it rebounds back up, it elongates in the direction of travel, or stretches, until it reaches the apogee and starts it’s downward path again (Figure 2) (AVI 1).

Now, if you try this experiment with a bowling ball, because of the nature of the material it is made of, you will get drastically different results. The bowling ball, being made up of much less elastic material, will fall, and have very few bounces after the initial hit on the floor. There will also be a minimum of squashing and stretching during the rebounds (Figure 3) (AVI 2).

Now, to apply this technique to a character, first you must determine what the character is going to be made up of. If it is a human being or animal, it will have a mixture of skin, muscle and fat, wrapped around a rigid skeleton of bones. The amount of each of these differing components will be a determining factor of how much squash and stretch should be

added in an action. If you have a creature with a large portion of it’s body made of bone, or hard material – something with an exo-skeleton perhaps, like a robot – you would need far less squash and stretch than a creature with a large portion of it’s body made from fat, like a rotund mouse character. Take for example the two characters jumping from a box to the ground. The robot, being covered with a steel shell, and the rotund mouse, whose body is made up of more elastic material, such as fat and skin. When the robot jumps, the only changes in shape will be at the joints, as they stretch out slightly. The steel shell keeps the limbs and body themselves from actually changing shape. When he lands, the shock is absorbed by the bending of the joints, and the shape remains the same, due to the shell’s in-elasticity.

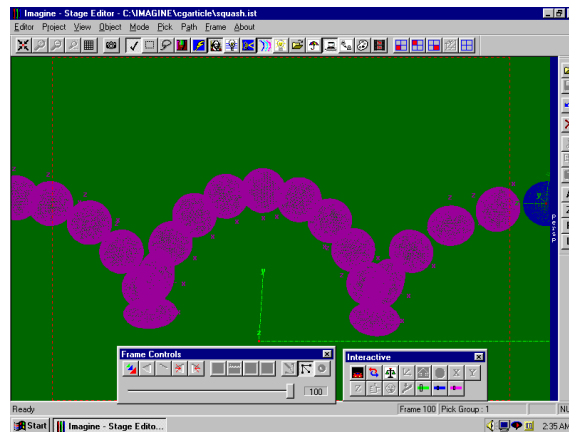


Figure: 2.

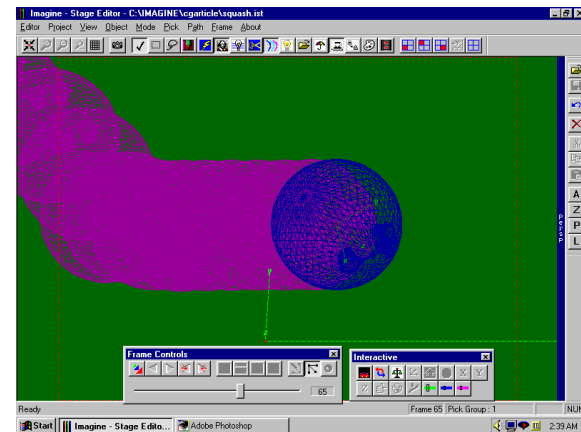


Figure: 3.

On the other hand, when the rotund mouse jumps up, his whole body will stretch toward the action, the muscles and fat following the extension of the skeleton. When he lands the entire body squashes down as the skeleton absorbs the shock, and the soft tissues continue toward the ground a bit with the momentum. Then the body will stretch back out to its original shape as the body comes to rest (Figure 4).

Another determining factor of how much squash and stretch to add would be the overall feel of the motion. What type of reaction do you want from your audience? An exaggerated amount of squash and stretch will look comical, and adding squash and stretch to something that would not

appear to be elastic would also garner shock, surprise, or laughter.

Squash and stretch techniques are also employed on the facial features of a character as it moves its head or talks. The lower half of the face will exhibit elasticity as the mouth forms the shapes for the sounds of speech. The

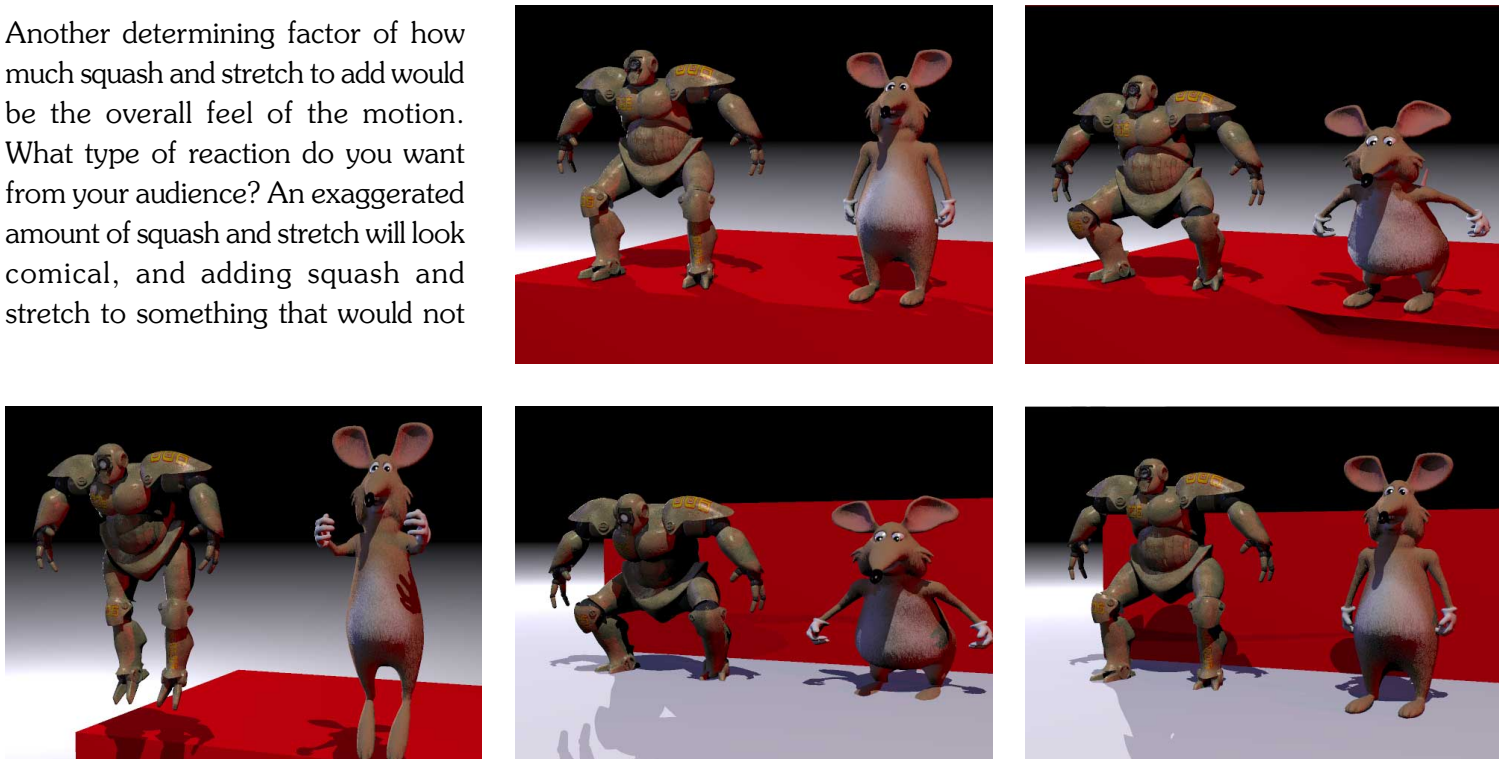


Figure: 4.

lips, cheeks and chin will need to move in, out, and up or down to follow the shape of the mouth. Eyeballs and eye sockets can be stretched toward the direction they are looking to enhance the feel of the motion. Movement of facial features is small in relation to movement of limbs so this technique livens up the face during animation (Figure 5).

Anticipation

When you are animating on a computer it is easy to lose the feel of weight and mass. After all, you can raise the Titanic with the click of a button, and a movement or two of the mouse. You can use the classic

technique of anticipation to bring back the feeling of mass or weight to your objects and characters.

An example of this principle applied to an object, is a man throwing a sack of potatoes into the back of a truck. You could have the man just move the sack toward the

back of the truck, but this would not convey a feeling of weight to the sack of potatoes. Instead, he will draw back first, away from the truck, and then heave the bag in the intended direction (Figure 6). This allows more distance to build up the speed necessary to throw the heavy bag far enough. The drawing back away before the



Figure 5.



Figure 6.

main action is known as “anticipation”. Looks like this theory works on a sack of potatoes, but how does it work on a character? Glad you asked...

Each part of your creature, the arms, the legs, the head and the torso, all have mass and weight. So when you raise a hand from the side of a character up to shoulder level, you should start by swinging the arm back slightly in anticipation of the motion. The same applies to a head turn. The head should swing the opposite direction first, then have the eyes point to the intended direction of travel, and finally the head will turn. Let the eyes blink, and the head dip down during the turn for a more natural look (Figure 7) (AVI 3). An example of whole body anticipation is when a character is standing still, then runs off stage. The legs should push the torso into the anticipa-

tion pose, with the arms following. Then, the character charges off in the opposite direction of the anticipation; sort of Newton’s Law of Physics for cartoons. The beauty of using this technique, as well as most of the classic character animation techniques is that it is something you add yourself. It really does not require any specialized software to add anticipation to your characters. Adding more or less anticipation for movement should be gauged by not only the intended mass or weight of an object, but also by what looks right to you, the animator.

Overlapping Motion

The principle behind overlapping motion is that not all of the separate joints or body parts involved in an action will leave or arrive at the place at the same time. A good example to illustrate this theory is that of a flag waving back and forth on a stick (AVI 4). As the stick follows its path, the flag will follow behind, with the attached end arriving first, and the trailing end arriving later, when the stick has continued on to its next destination. In the case of a human, watch how a baseball pitcher’s arm moves successively through a pitch. First, the arm will draw back in anticipation to the throw. Then, the shoulder will move forward, followed by the elbow,



Figure: 7.

then the wrist, and finally the hands and fingers (Figure 8). The major difference between the action of the flag and the action of the pitcher's arm is that of muscle. The flag is simply following the stick, but on the pitcher's arm, each successive joint is powered forward by muscles, and the rotation limited by the type of joint. Overlapping motion is also influenced by gravity and momentum as well.

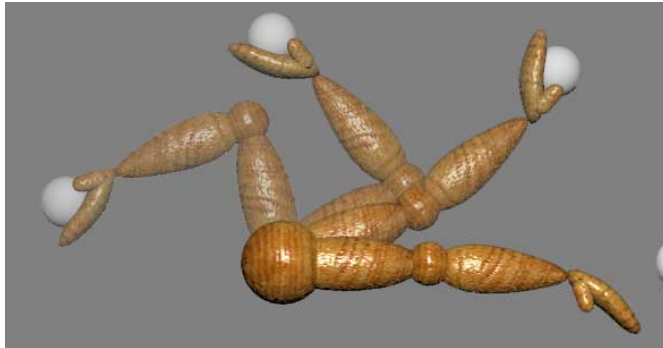


Figure: 8.



Figure: 9.

Note the arms on the jumping bunny. As the body dips down the arms move upward. As the legs propel the body upward, gravity drags down on the arms. See how the motion starts at the shoulders and works its way down to the hands. Overlapping motion is also expressed by the rabbit's ears, as the head moves back and forth, the ears follow (Figure 9) (AVI 5). Almost like the flag following the stick. Loose clothing would follow this same general rule. As with Anticipation, overlapping action requires no special software, only your eyes and your brain are necessary.

Ease In and Ease Out

In the world of computer animation, instant acceleration and instantly stopping on a dime is possible, but it just doesn't work like that in the real world. Since a character's body should appear to have weight, starting from a

standstill, any movement would have to accelerate a certain amount of time before reaching full speed, then when stopping, would decelerate a certain amount of time. This action is known to animators as Ease In and Ease Out. Imagine this scenario: A character is standing with arms at its side. The arms then rise to shoulder height and hold there a second before they are brought down, back to the sides. If

you were to animate this action over a sixty frame period at 30fps, it would go something like this:

- **Frame 1:** The arms at the sides.
- **Frames 2-5:** The arms start the movement up, moving a bit faster each frame.
- **Frames 6-10:** The upward motion remains constant.
- **Frames 11-15:** The movement slows a bit each frame until...
- **Frames 16-45:** Complete stop.
- **Frames 46-50:** Arms start to accelerate back down to...
- **Frames 51-55:** Constant motion.
- **Frames 56-59:** De-celeration over each frame.
- **Frame 60:** Complete stop.

The process of acceleration and deceleration as shown above could be plotted on a graph, measuring distance over time would look something like (Figure 10). This looks better than the "instant" movements, but more can be done. The resulting curve can be tinkered with by adjusting the number of frames for acceleration, constant speed and the easing out. You could take into consideration the effects of gravity on the character. It should take more effort to raise the arms than it would

to lower them. So, the acceleration would take more frames or time on the way up and the deceleration would take less. The trip back down would go just the opposite; it would take less time to reach full speed, using gravity, and more time to stop, as the arms would be fighting gravity (Figure 11). For even better looking motions you should have the hand "over shoot" the target position a small amount, before settling down in the intended pose. This technique adds a sense of flexibility to the joints. The same theory would apply to any limb of a character, the head during a turn, or even the entire body, when running or walking.

These animation techniques can be used to various degrees, dependant upon the intended look or feel of the actions of your characters (AVI 7). The use of exagger-

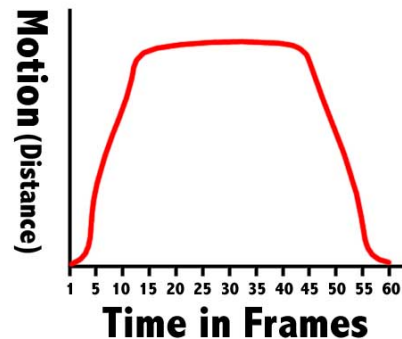


Figure: 10.

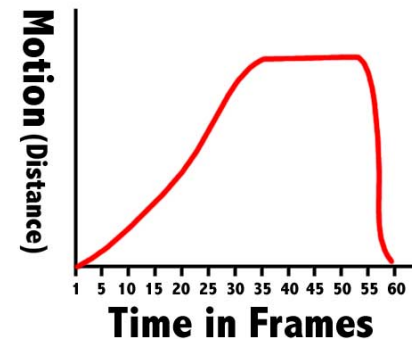


Figure: 11.

ated movements, and breaking the laws of physics can add a comical edge to the animation, or you can adhere to the laws closely and mimic real world motion.

Character animation tips for Imagine

Tools for Squash and Stretch

Using Imagine, there are several ways to add squash and stretch to your character. The first method is to use a deform tool to squash or stretch the object, then create the necessary states to animate. Load up the character and pose it as if it were landing from a high jump. Now add a deform tool from the Object–New–deform tool menu. An input box will pop up. This requester allows you to enter values for X, Y & Z, in Imagine units and the number of sections the tool will be divided into the three axis. Click okay for the default values of 3 sections. More complex shapes can be made using more sections for X, Y and Z values, but three will do for now. The deform tool will now appear in the

tri-view. Select the deform tool and move the axis to the lower front corner of the object to be deformed. Now, scale the tool LOCALLY on each axis until it covers the object (Figure 12). Go to select points mode. This is located under the Object–Select Menu. Using the lasso or Marquee Select tool, select all of the deform tool points and scale them down on the Z-axis. Now select only the middle points and scale them out in the X and Y axes (Figure 13). Go back to pick groups mode and pick the character object. Once the object to be deformed is selected, go to the Function–Deform tool command. A box will open with a tree view of the objects in the editor. Select the D-Tool 3.3.3 and hit okay. You should now see your object has squashed down in the Z-axis and out in the X and Y axes (Figure 14). You can now create a state for this, but be sure to check both shape and hierar-

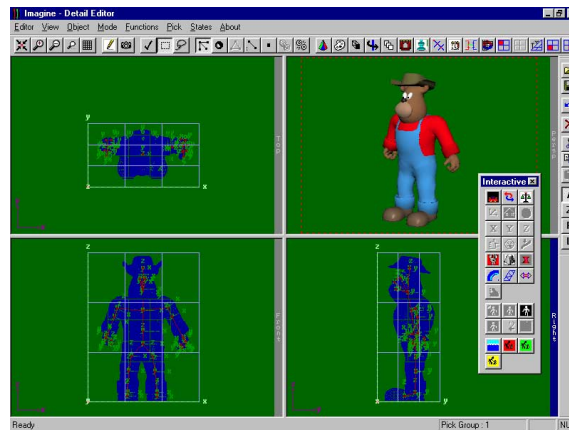


Figure: 12.

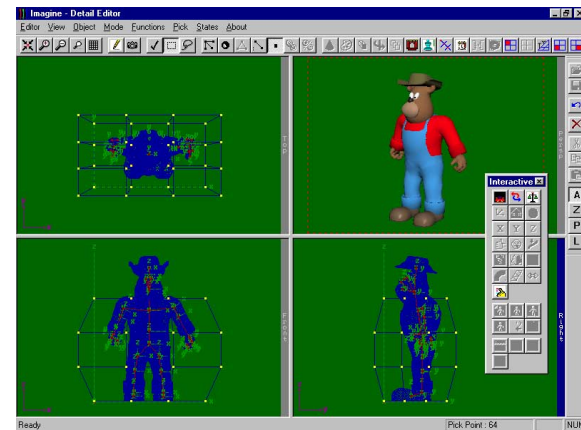


Figure: 13.

chy selections. The deform tool can be tailored to fit separate body parts if you want only squashing on, say, just the lower portion of the body, by adding more sections to the deform tool and only moving the points over the parts to be changed.

The second method I use in Imagine to squash and stretch features of a face is by using the magnet tool. This tool is used in drag points mode and is accessed under the Object-Magnet tool menu selection. In the Magnet tool dialog you can set the distance with the radius of influence input, and the shape by choosing cone, dome or bell shapes (Figure 15). This method is fairly easy; select the object, go to Drag Points mode, turn on the magnet tool, grab the cheek or brow (or whatever feature you wish to modify) and drag it out (Figure 16) (AVI 6). You can be more precise with the deformations by using select faces first and hiding all the faces that are not to be disturbed. This allows the manipulation of features that are close together, for instance moving just the top lip or the lower eyelid.

Tools for adding Anticipation, Overlapping motion, Ease in and ease out, and Overshooting

As I mentioned earlier, these properties can be used regardless of the software, as long as you have the ability to pose the character in the necessary states. In Imagine, bones are used to deform the meshed objects. The following are my favorite five, of the forty-four, bones rules for Imagine that were developed by Tim Wilson of Crestline Software. My thanks go out to Tim for com-

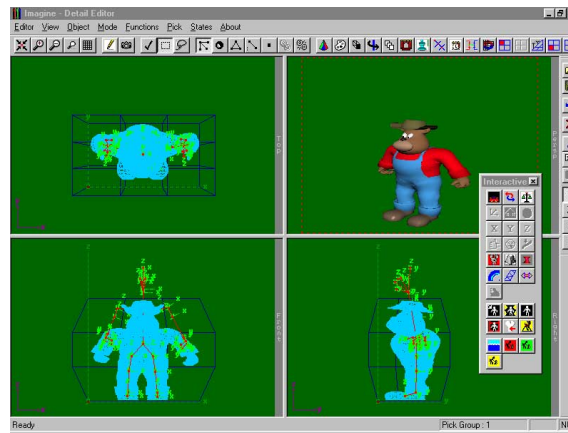


Figure 14.

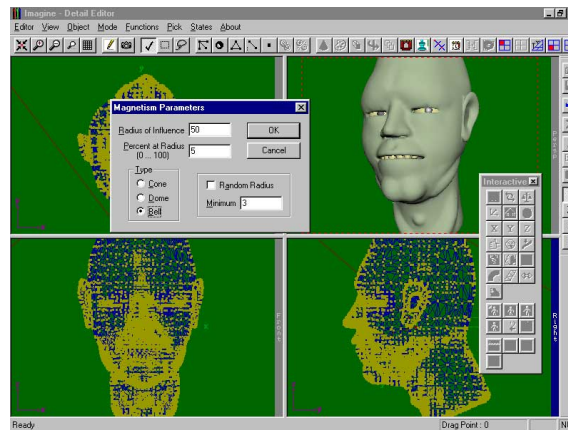


Figure 15.



Figure 16.

ing up with these rules and allowing me to print some here. The remaining rules can be found at <http://ourworld.compuserve.com/homepages/crestline/imagine.htm>. Please take a look, Tim will be glad you stopped by as well.

1. Design your Geometry and Bones to work together. You can't do either your modeling or your boning totally independently of one another. You will have to go back and forth between the two, until you come up with an optimum design for the geometry, and figure out the appropriate layout of the bones. Drawings will help, especially to locate articulation points in the model, and will make the job of building the skeleton easier.
2. When possible, each Bone should have its Z-axis pointed toward the child below it in the hierarchy. This is more of a guideline than a rule. Obviously if you are branching out from a back bone into two arms, you can't have the parent back bone pointing towards the next articulation in the spine, AND the shoulder joints as well.
3. The Small Bone Subgroup represents the area of the limb's geometry that you want to rotate **TOTALLY** when the joint is moved. (Just a note of clarification.

What the term 'Small Bone Subgroup' **ACTUALLY** means is the *small subgroup* for the bone, NOT, I REPEAT, NOT the *subgroup* for the small bone.... There are no *small* and *big* bones... What you are defining is a *small subgroup* and a *big subgroup* to GO WITH each particular bone.)

4. The Big Bone Subgroup includes the area of the limb that you want to rotate totally, PLUS the area of geometry that will bend when the joint is moved.
5. Just so you know, the Big Bone Subgroup MINUS the Small Bone Subgroup is the area where the geometry will bend, stretch or interpolate around the joint. Your bone should be roughly centered inside this area of interpolation.

A few tips I can add to these are:

1. Name the axis of each bone with something that represents its function. For example, the null axis used to rotate the arm at the shoulder should be named "shoulder" or "right shoulder". This will help clear up any confusion as to which bone is selected when the small and big faces subgroups are added. Simply select the axis, go to the Functions, Attributes menu (hotkey F7) and use the Misc. tab to name the axis.

2. Once you have developed a skeleton that works well for you, you can copy parts or all of the skeleton and paste it in another mesh. Then just use pick objects mode to move the joints to fit the new mesh and parent the mesh to the skeleton. Be sure to strip the skeleton of its states using the States, Strip Obj. command, before adding it to the mesh’s hierarchy.
3. When using Imagine’s Freeze and Constrain systems, try posing only one limb at a time by freezing it at the shoulder and hip joints, then use forward kinematics, or unconstrained motion to tweak out the pose.
4. When animating a complex character in the Stage editor using stage states, turn on the quick stage under the View, Stage settings menu. This will allow you to easily manipulate the skeleton with very fast re-draw rates. This makes it easier to flip through the frames using the Frame toolbar under the frame menu, allowing you to judge timing and track motion. One thing when using quick stage though, if you try a quick render, you’ll see nothing, as quick stage is actually just temporarily throwing away all the faces. You will have to actually use the renderer if you want to see a rendered version of the frame, or toggle off the quick stage when you are ready to start checking quick renders of individual frames.

Resources

The following books are excellent resources for character animation techniques. If you have a serious interest in character animation you should get these books.

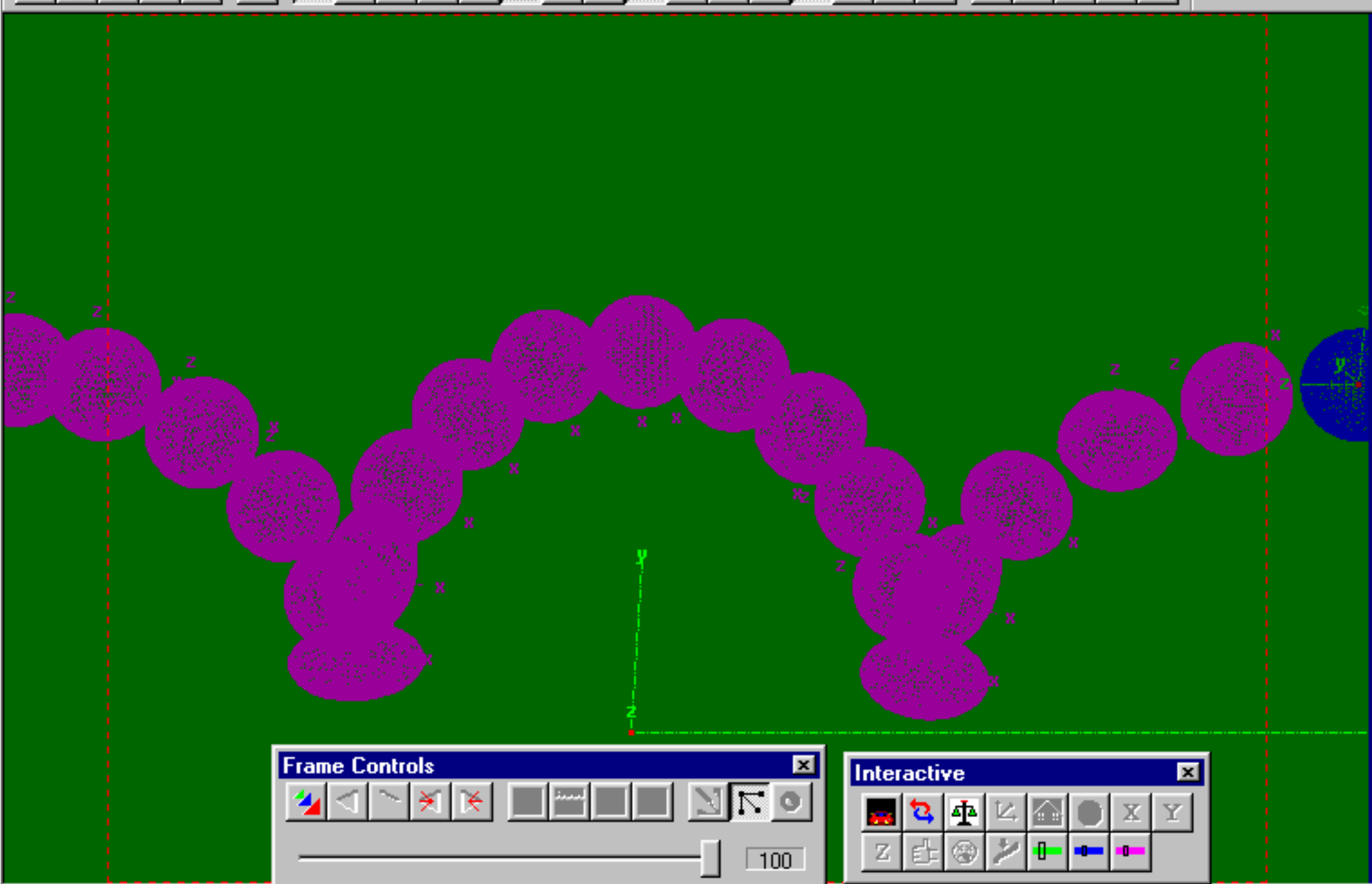
- The Illusion of Life: Disney Animation
by Frank Thomas, Ollie Johnston ISBN:0786860707
- How to Draw Cartoon Animation
by Preston J. Blair ISBN:0-929261-51-8
- The Animator’s Workbook
by Tony White ISBN: 0823002292

Biography

R. Cory Collins is a freelance 3D artist and animator who has been using Imagine since its early days on the Amiga computer platform. He has penned several articles on Imagine techniques for 3D Artist Magazine, and wrote the character animation chapter for Richard Foster’s I-Files, a complete resource of information on Impulse Inc.’s Imagine for Windows. He is currently working on creature design and animation for Eagle Film’s feature length sci-fi/horror movie, The Road, which should wrap-up production late this year. You can e-mail him at rccollins@alltel.net or visit <http://www.alltel.net/~rccollins>.







Frame Controls

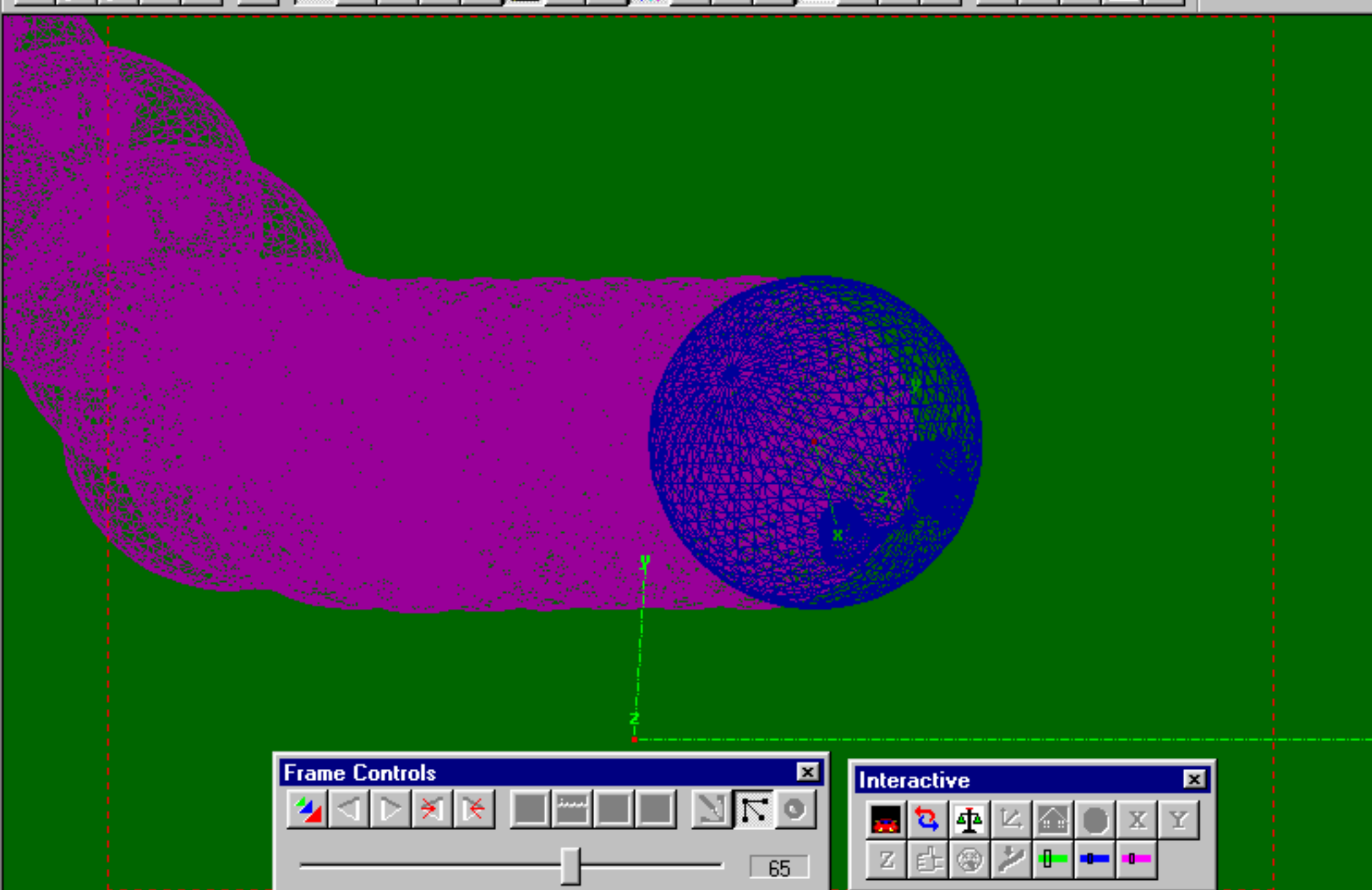
Navigation icons: first, previous, stop, next, last, and a play button.

Timeline slider with a value of 100.

Interactive

Buttons for various interactive features: a red car icon, a circular arrow, a balance scale, a house, a sphere, and X/Y axes.

Buttons for Z, a thumbs up, a globe, a hand, a green bar, a blue bar, and a pink bar.





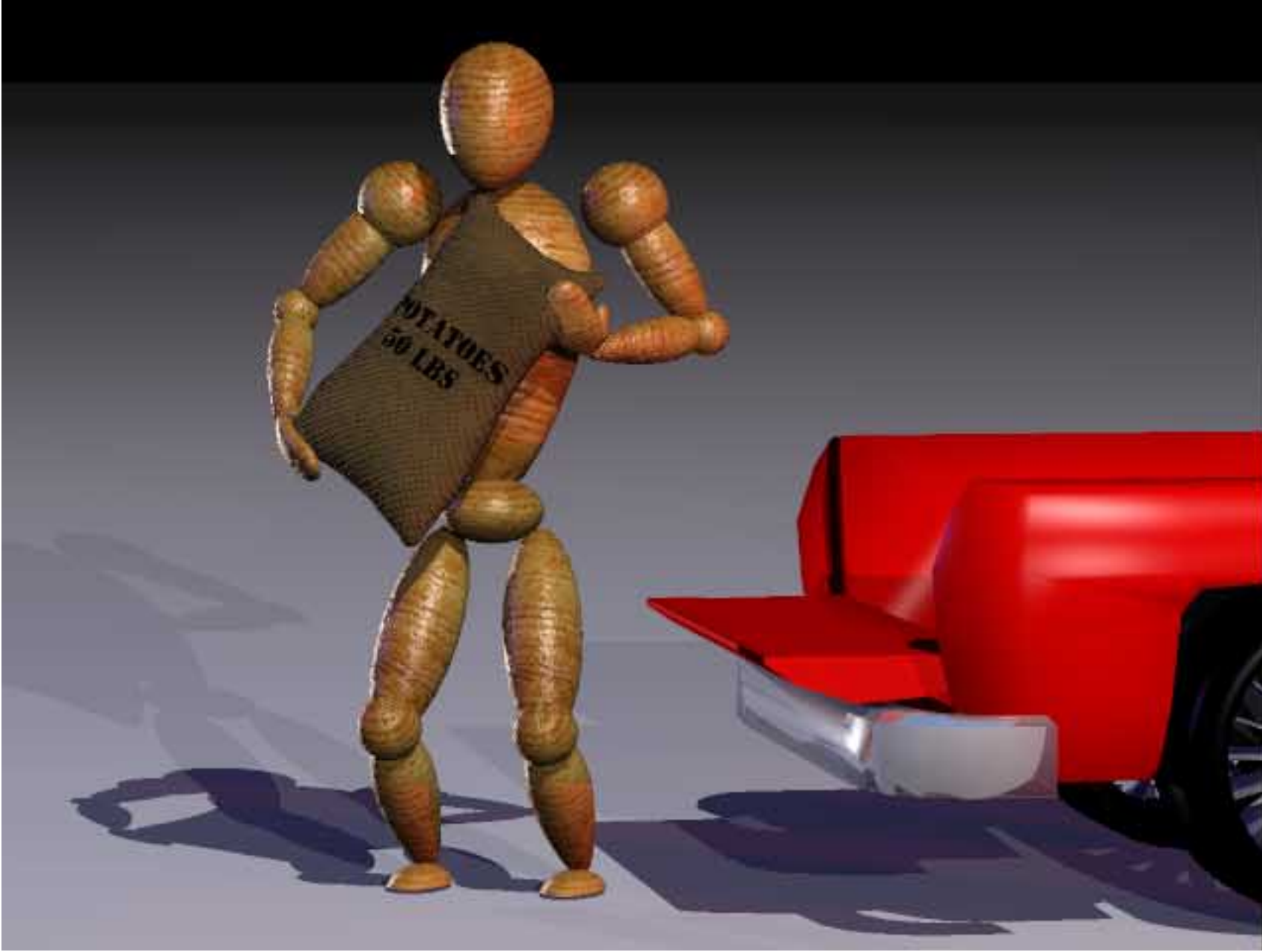




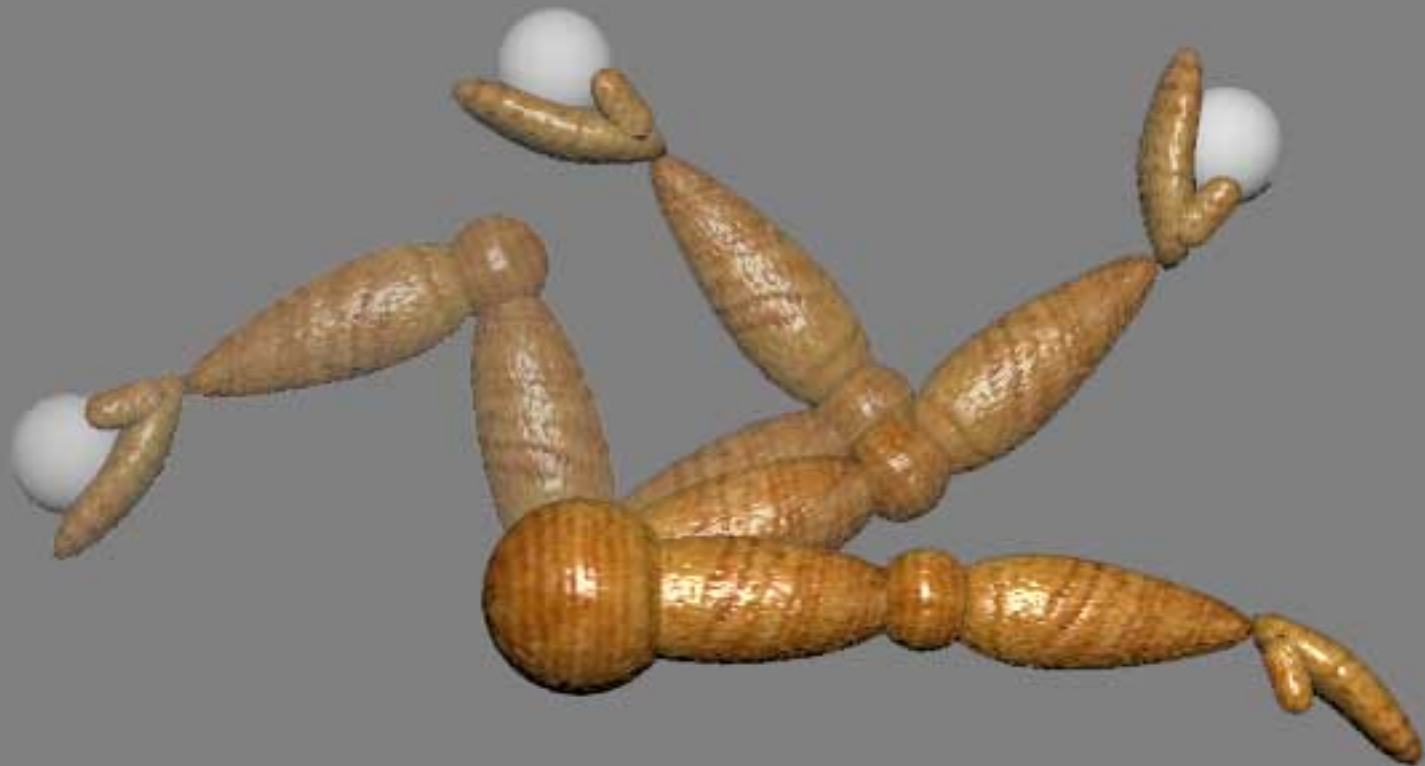






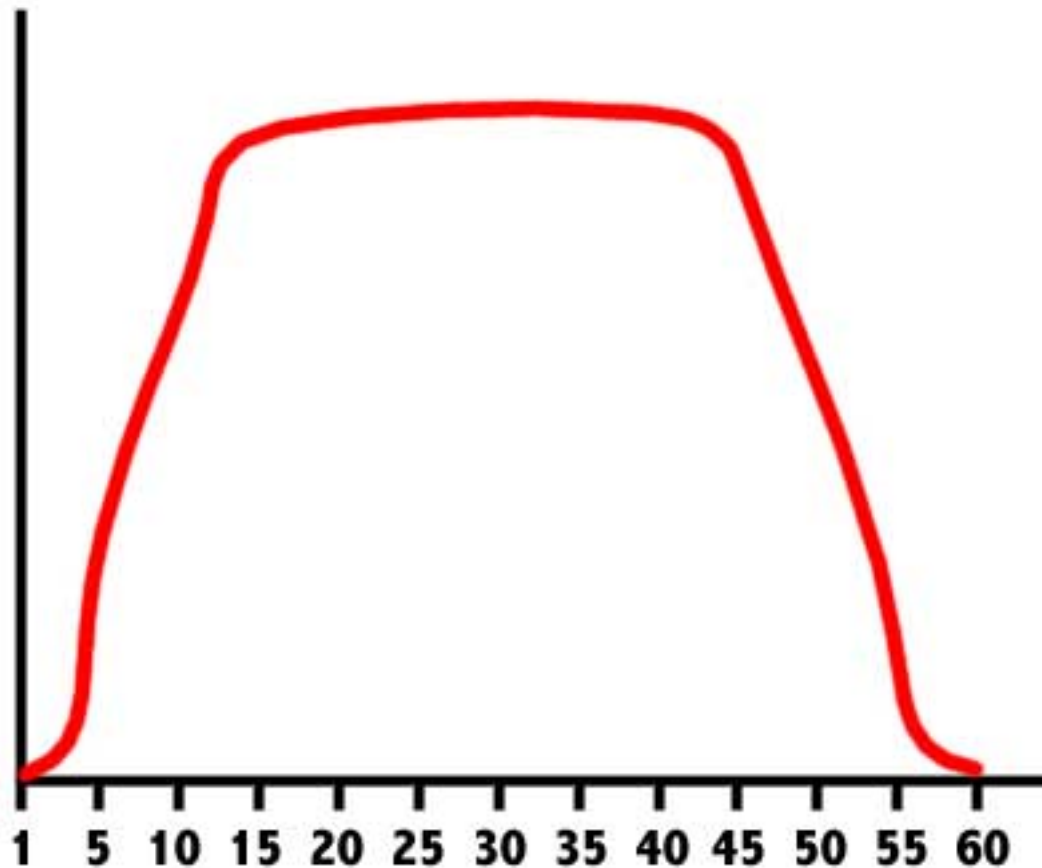






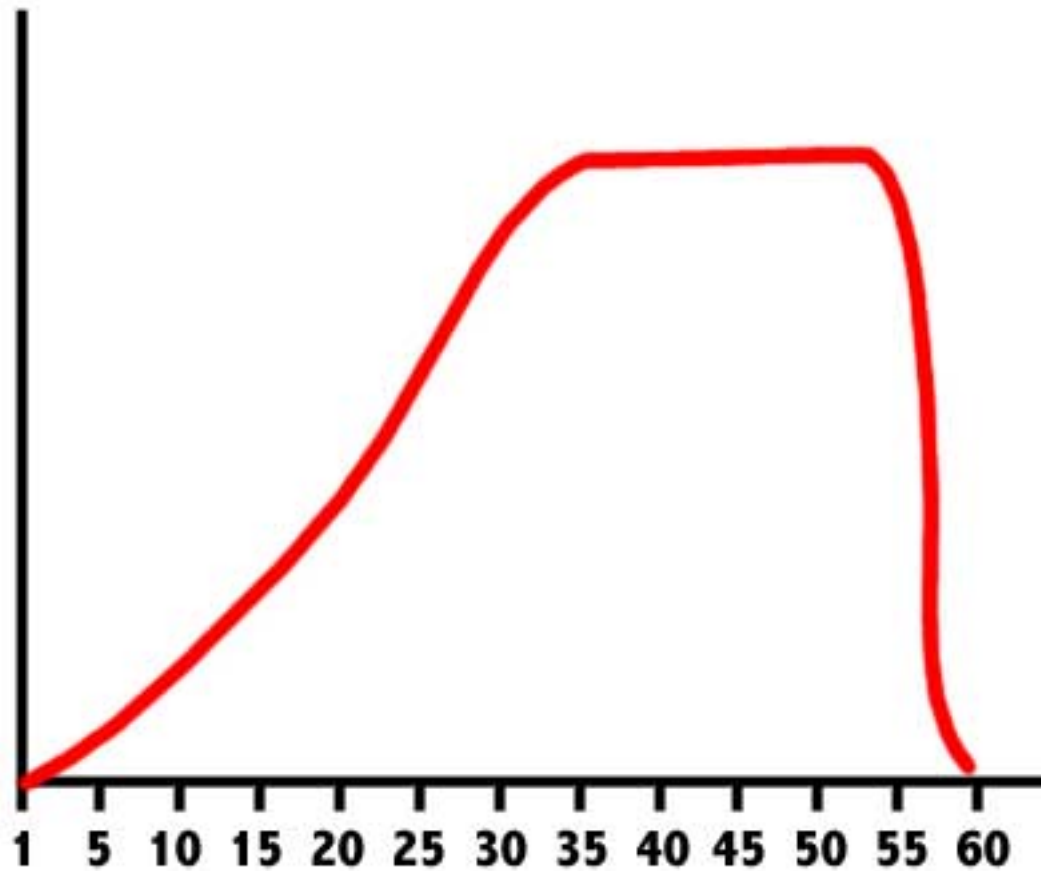


Motion (Distance)

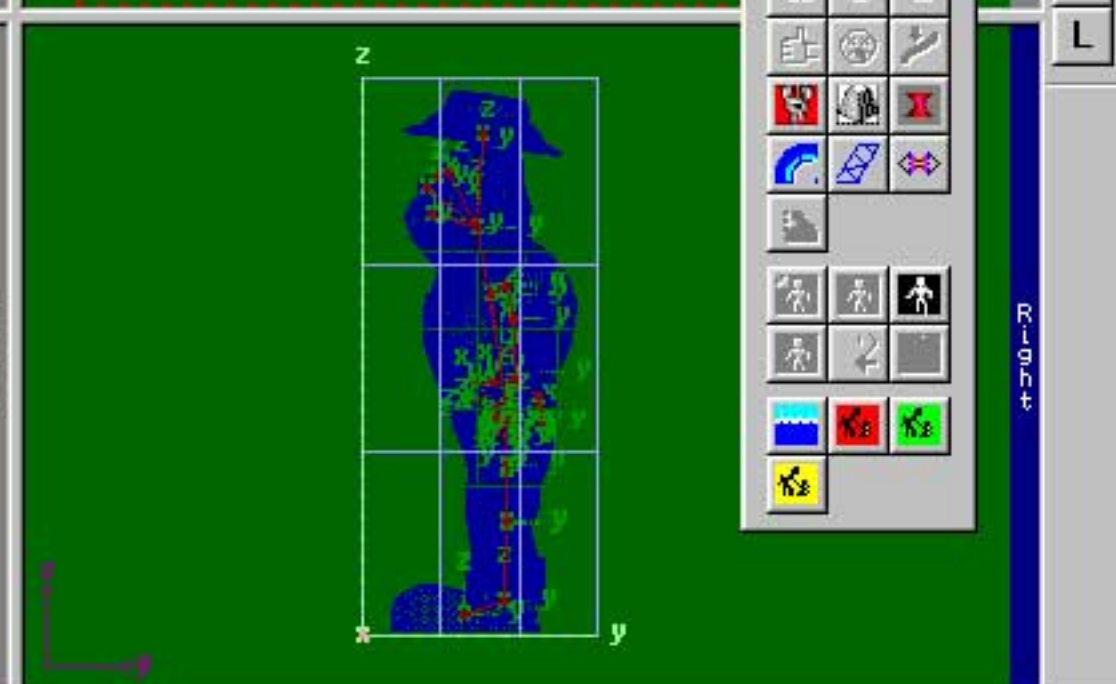
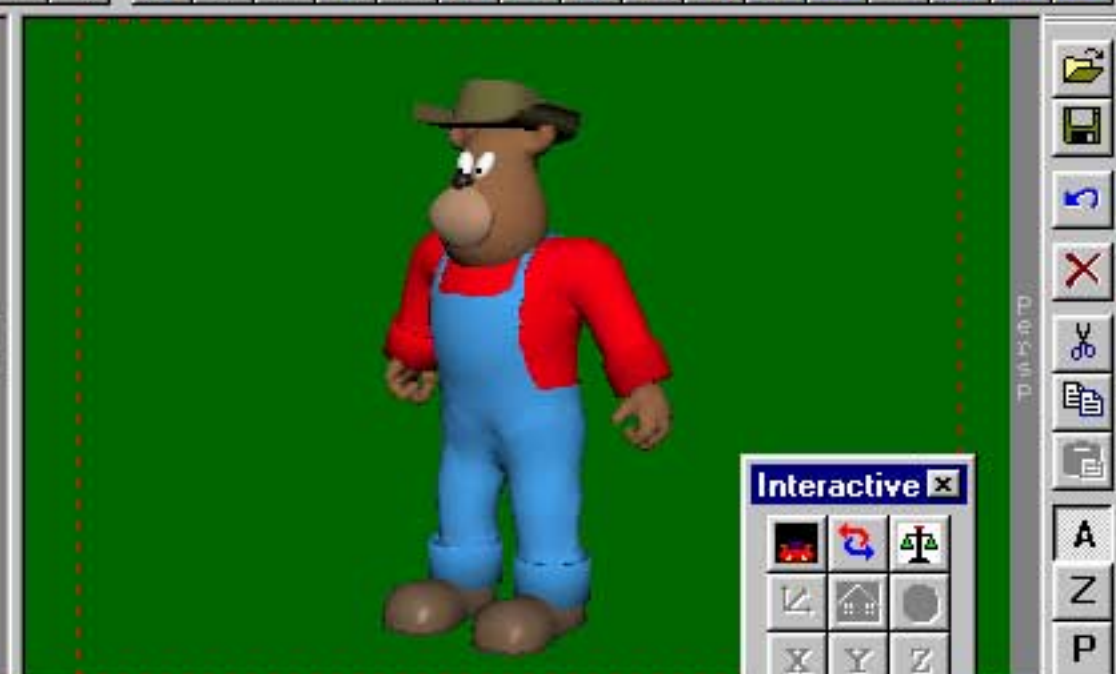


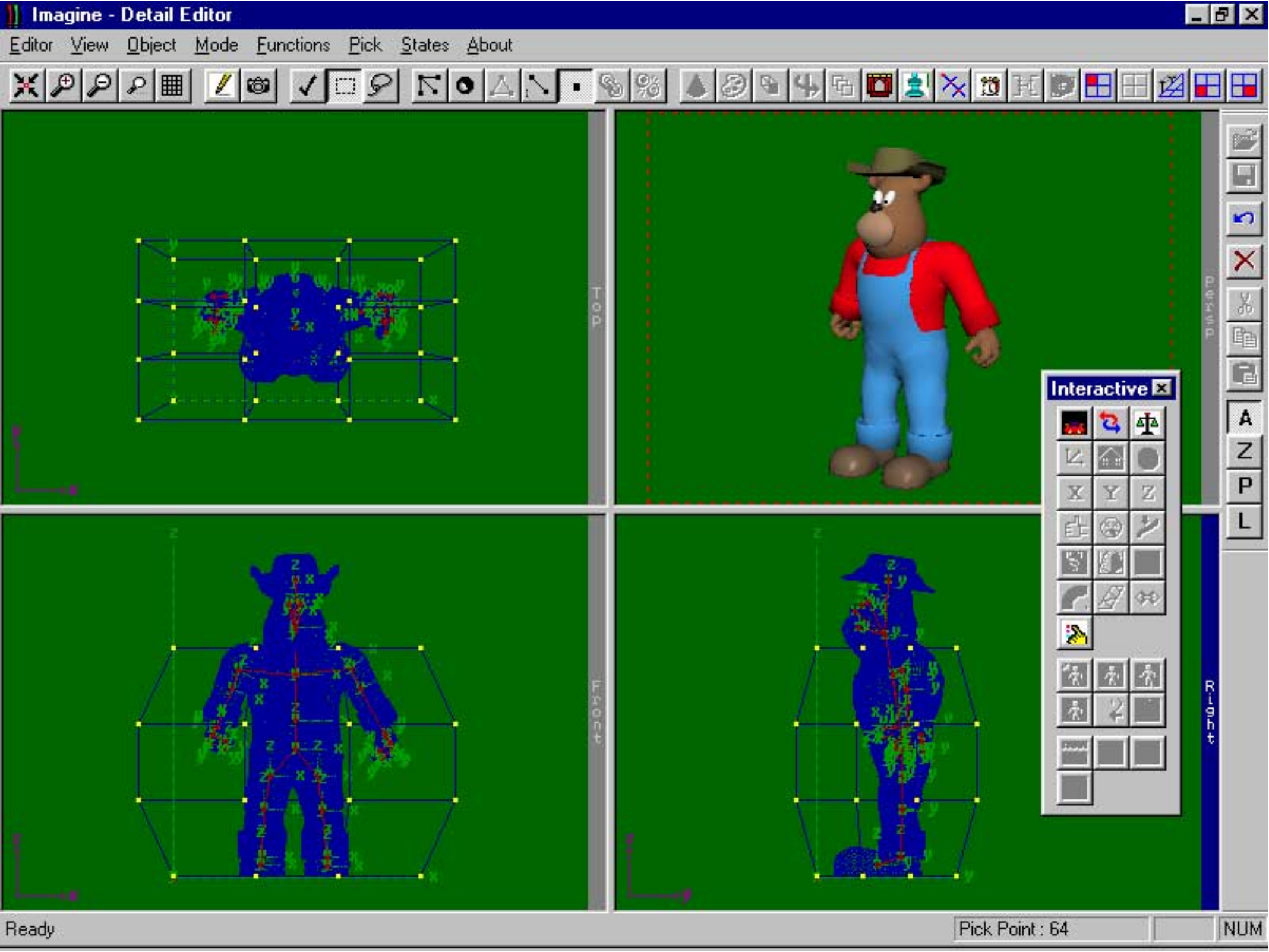
Time in Frames

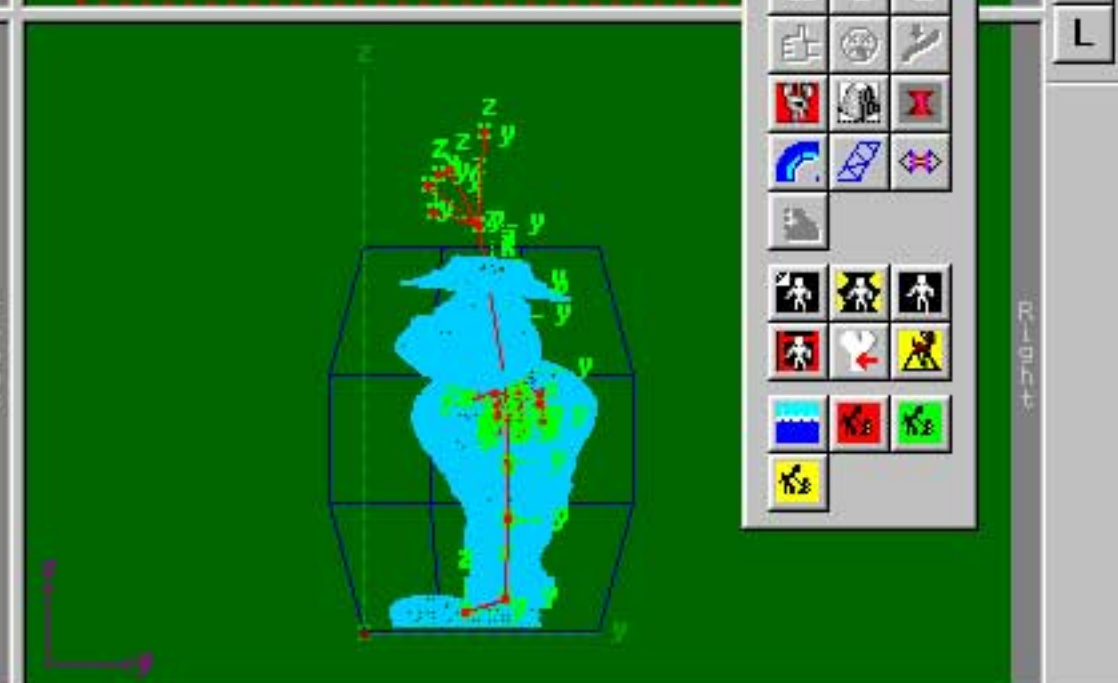
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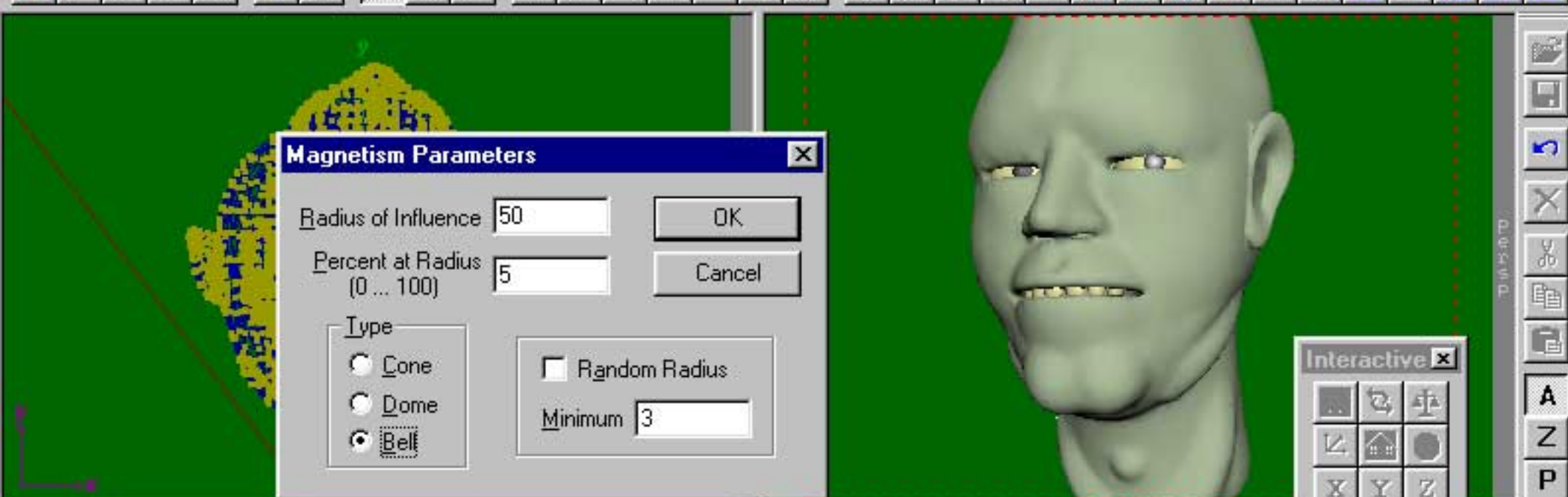


Time in Frames









Magnetism Parameters

Radius of Influence

Percent at Radius (0 ... 100)

Type

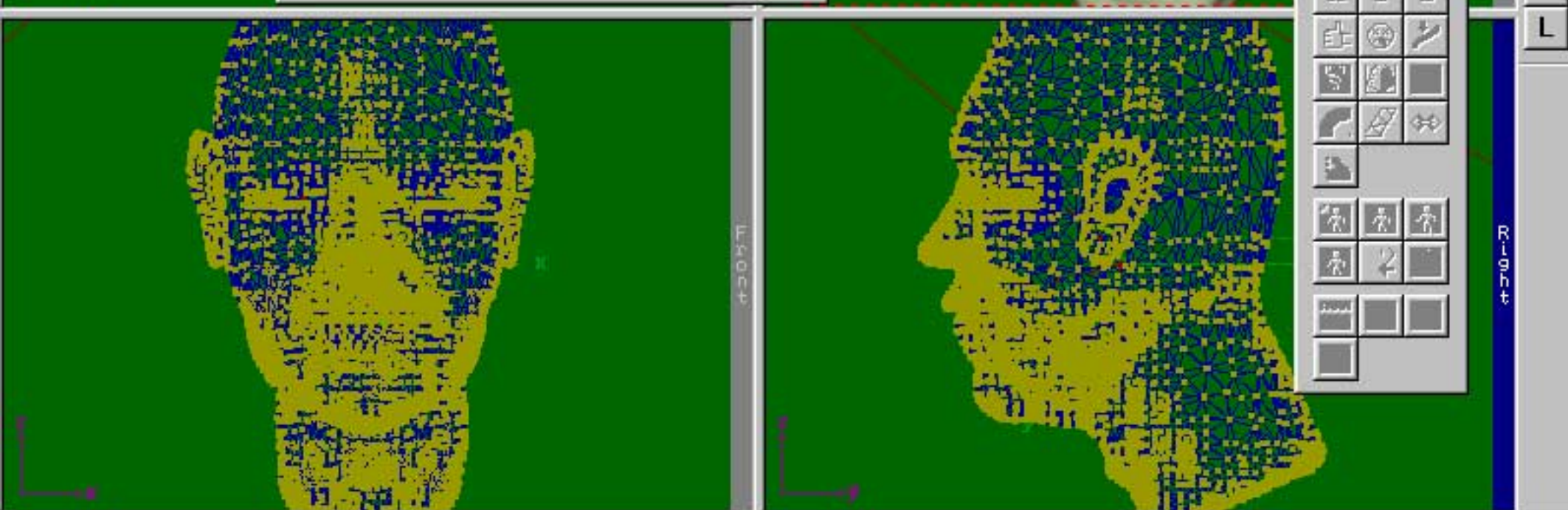
☐ Cone

☐ Dome

☒ Bell

☐ Random Radius

Minimum



Interactive

Grid of interactive tools for manipulating the magnetism map, including zoom, pan, and specific magnetism editing tools.

