

Intro:

December 2002 Update: Since first posting this material, I have adapted and grown in my own animation workflow and quality expectations. I wanted to reflect some of these lessons learned in this online article. Since it was first posted this article has been used in schools, universities and animation programs around the world. Additionally it has been noted as a resource for animators in animation studios and game companies and translated into a few foreign languages. In light of the responsibility of portraying information accurately, I have endeavored to update this article with the things I've learned since first writing it. You can see the updates in blue, as I've written here.

Over the past year or two folks have often asked me how I go about my animation. In recent months much interest has arisen in various internet circles regarding a method of animation that is called "pose testing" or "pose to pose".

I recall first trying my hand at this method of animating about 2 years ago at the suggestion of Rick May, and have found it to

be a huge help in forcing me to approach animation in a more structured way. This has allowed me to produce more animation

that is consequently stronger and more defined than anything I had done previously. As the years have passed I've come across

others who have tried this way of working and adapted some of their ideas and techniques.

In my circle of influence we have our own little way of approaching animation, and we call it "pop-thru" animation.

Sometimes I'll refer to it as organized keyframing. In an effort to try and share some insights into this method of computer animation,

I write this article/tutorial.

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Disclaimer:

This is not "my idea".

Many other folks have had a hand in the maturation of this method. The techniques I describe here are merely my adaptation of this approach.

And this technique is always evolving. I am absolutely positive that something I say here will not sit well with some animators.

Which is fine. This is NOT an effort to say that this is the ONLY way to animate in 3d, but it is certainly a USEFUL way to animate in 3d.

If I suggest something that you think is wrong or in error, or is a 'cheat' or sloppy, then please feel free to send me an e-mail outlining your thoughts. I'm still learning this craft we call animation, and I'm more than happy to hear other's thoughts on the subject.

Update: If you want to take your animation to an even higher level, you're going to have to do more than just the straight forward steps outlined in this article. The techniques employed here will yield OK results for TV or video quality work. For something along the lines of feature film level of work, your deadlines will allow you to spend more time in the final massaging of your motion, as well as exploring different possibilities with offsetting the motion of certain parts of your character. Not every body part moves the same speed, so the simplistic offsets and breakdowns employed in this article are going to leave you short of the goal in something as highly defined as feature film quality animation. So while this article does include some useful techniques, it is by no means the end of the conversation when it comes to producing high quality animation.

A Little History & A Basic Definition:

There has long been two general schools of approaching animation. Straight ahead and pose to pose. Straight ahead is what it sounds like: the animator just charges in and starts animating in a very stream of consciousness sort of way. This results in some genuinely inspired animation that flows extremely well. It also ends up in a lot of dead ends and wasted effort when

the animator realizes he's painted himself into a corner. Pose to pose animation is also much as it sounds,

The animator picks some seminal poses that, when timed correctly, capture the energy and direction of the shot.

The animator then will go and create these poses and hit the timings, working to deliver the shot with structure.

This often times ends up with some of the most powerful animation with very strong poses and tight timing, distilling the animation down to the very core of it's being. It also often ends up looking stiff and mechanical and very stilted when the animator isn't careful to think about keeping things alive.

Update: It needs to be said that the single greatest challenge to employing a pose-to-pose method as tightly as it is outlined in this article is that of keeping things from being too stiff. One of the greatest techniques for combating this stiffness is to break down your character's motion on an object by object basis. Starting from the hips out (the age old "layers" method) you need to look at your motion for arcs, consistency, hitches, glitches, force etc. By focusing on a single body part at a time, you force yourself to scrutinize every moving part of the body in order to work out all the kinks that a simplistic use of the pose-to-pose method can introduce. The second biggest challenge introduced by a simplistic use of the pose-to-pose methodology is a sense of everything hitting at the same time, or evenness. Simply offsetting the left arm a frame from the right does not significantly address the evenness issue. Instead you need to think more about what emphasis you want to place on which particular body part. It may serve the animation best to have a particular arm hit 12 frames before the rest of the body settles into a pose. Or it may serve it best to have the arm trail the rest by 18 frames. Or perhaps you want the head to lead the transition into a new pose and will start the head turning a good 10 frames before the torso follows. Or whatever. You have to think about the motion in a broader context than simply hitting a pose. Often the most powerful idea in animation is to choose a point of emphasis. Whatever doesn't ride along with the rest of the body is going to call attention to itself, and that is a very powerful technique that wasn't

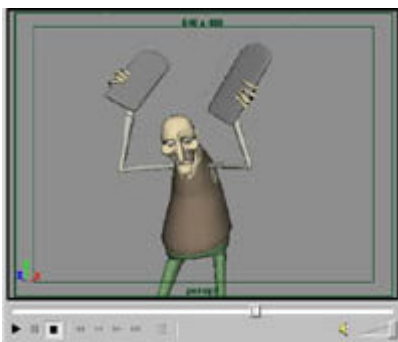
discussed in the original format of this article. Which is why I feel the need to address it here in an update.

In CGI animation, often times folks fall into two camps: realistic or "creature" animation and cartoony animation. Pose to pose, by it's strong nature, lends itself very well to cartoony animation, and straight ahead, due to it's fluidity lends itself very well to creature animation. But it would be a crime to say that there the boundaries lie and never shall they be violated. There's room for using a pose to pose approach in realistic animation, as long as the animator is careful to loosen things up enough in the end. And straight ahead animation works wonderfully for cartoons. Just watch some older Disney work to see this.

The term **pop-thru** is a stop-motion term that some of us have borrowed in CG. In stop-mo, there's not much of an "undo" feature, so the animator would often do a quick 'pop-thru' of their shot to get a sense for pose and timing. They may do this a few times, gradually revising their work until they felt they had the performance down fairly well. Then they'd go ahead and animate their shot with the puppet. In CG we're looking at doing things in a similar way. But the beauty of doing popThru in CG is that we don't need to treat these poses as disposable. Rather, we can use them as building blocks for our whole work, adding to them as we go until we at last have our animation.

The Project and My Motivation:

Here is the final version of the animation that we'll be studying after about 20 hours of work, including lipSync.



([moses08_final.avi](#); [indeo3.2](#); [cinepak avi](#); 2mb)

The clip is about 8.4 seconds long. That projects out to nearly 17 seconds of halfway decent quality animation per week. And that's one of my main areas of focus. The adage is true, The best animation you do is the one you finish. At work we have a production quota of 18.5 seconds of approved animation each week. For comparison our good friends

working on feature films often have quotas ranging from 4-9 seconds per week. In short, we needed to develop a way for myself and our team of animators to create alot of good footage quickly. Additionally we wanted to allow the director

the opportunity to see the thrust of the animation as soon as possible so as to reduce the number of fixes needed after the animation has been submitted for approval. Thus the main goals of this pop-thru method are to

- a. *animate quality footage as quickly as possible (it is a business afterall)*
- b. *provide the director a look at the animation as early as possible.*
- c. *A side benefit is the highly organized structure of the keyframe data, which I will detail later. Trust me, it's a huge help.*

First Things First:

It stands to reason that if you're going to use the "pose to pose" method, you need some poses. Click the thumbnail for a full size look at some thumbnail sketches I did before starting the animation.



[.jpeg](#)

There's some thought that your thumbs need to be locked down tight. That may or may not be true. I find it's good to not get too

attached to my thumbs, but to use thumb sketching as a stage of exploration. I'm not looking to define my animation exactly just yet.

What I am looking to do is explore different poses and different pose combinations. It's a lot quicker to explore things in pencil

than on the box. But I came up as a CGI animator. I have no notions about the computer being an inferior animation tool.

So while I'll explore on paper, I also allow myself freedom to not settle on things until I get to the computer.

I think the computer can be a valid place for structured, focused exploration. It is, after all, only a very expensive pencil. Animators who don't feel comfy on the box may disagree. That's OK. God still loves you and I'm trying my best to. :o)

An interesting practice in some 2d animation circles is to work through your thumbs, and then put the thumbs away in a drawer and never refer to them again. The main thinking behind this is to keep yourself from becoming a slave of your thumbs,

cutting off those serendipitous gems that arise when the juices are flowing while you're hip deep in the performance.

It's this kind of thinking that I tend to follow when doing my thumbs. Thumbs are great servants, but hard masters.

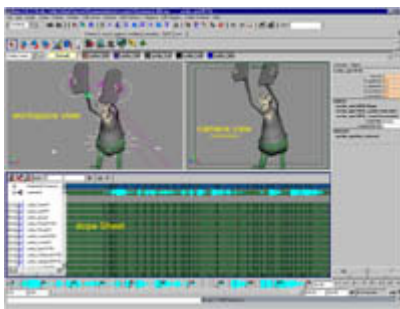
Anyhow, you can see how I broke down the dialog trying to find the energy of the delivery, marking out breaks. Then I just tried a

bunch of different things seeing what I liked and didn't like. Then I kinda set that page aside and got on the box to see what

worked best in the situation I was in.

Second Things Second:

Here's a quick look at my animation set up using A/W Maya. I like to be able to have a window to toodle around in, as well as a locked down "look through the camera" view so I can check my arcs, lines of action and silhouettes. And I'm also a big fan of the dope sheet.



[\(workflow.jpg\)](#)

A few words about the dopesheet...

While I came up as a CGI animator, my training has had a pretty strong traditional bent. I like the clarity of one frame=one drawing

with key drawings defining what the inbetweens will do. The dopesheet is a great way to see just keyframes for objects. No fCurves or channel curves to deal with. I'm looking at just keys and time.

This is a key component (pun intended) of what I like to call **organized keyframing**.

What is Organized Keyframing?

Just what it sounds like. The goal is to arrange all your keys in an easy to edit, easy to read fashion.

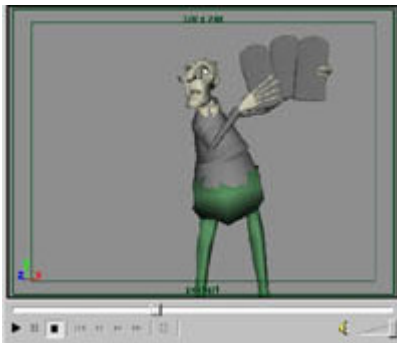
The one draw back of straight ahead animation is that keys tend to end up all over the place. As time goes by and the work progresses,

the keyframes get messier and messier to deal with. Need to shuffle a pose at the director's request? Fine. But which keys define that pose?

What if you did fCurve bias editing to get that particular ease in that he liked? Now the difficulty lies in finding the keys and editing the fcurves again. With popThru pose to pose, much of this difficulty is bypassed.

The First Pass:

Have a look at this first pass popThru animation.



([moses01_pop.avi; indeo3.2, cinepak, 900k](#))

This is where I settled on the basic poses that I wanted for this animation. I had my fCurves with zero inbetweening. In Maya it's called a stepped key. In Hash it's a held key. Most programs have this feature. It will hold the keyframe all the way until the next keyframe, where it 'pops' to the new pose in one frame. Thus the name "pop-thru animation". There's no messy or ugly inbetweening to deal with just yet. Right here, in this simple popping pose test I know the basic

components of my animation right up front. Pose and timing. I can show this to my director and get immediate feedback about

my pose choices and my timing. He can tell me if he likes where things are headed or not. He can tell me if the acting choices are what he wants or not. Right here, in this very first look on the computer, are the building blocks of my entire animation, all achieved within a few hours of work.

Look at this screen grab of the dopeSheet....



([dopeSheet.jpg](#))

Notice that all the control objects for my character are keyed ALL ON THE SAME FRAME. See how organized it is? I'm treating each

keyframe as a piece of paper. In traditional animation for each keyframe you draw the whole character, so I pose the whole character here.

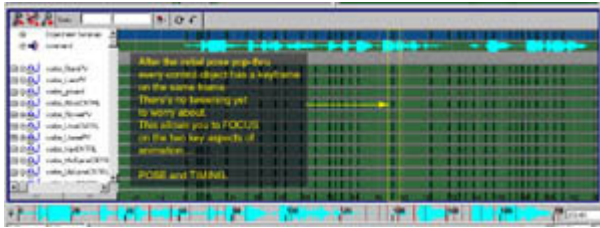
Nice and easy to edit the keys around if I or the director feel an action is happening a little too slow or fast. Or if a particular pose

needs revision, I can do it all at once and key everything. By keeping everything very organized I can quickly make changes without having

to re-interpret my previous work. Again, we're looking at two main things here: Pose and timing. Pose and timing are KING.

Every other aspect of animation is secondary to pose and timing. No amount of follow through or overlap or anti-twinning or secondary action

or fancy flesh simulation and dynamic fat jiggling is going to overcome bad poses and poor timing. With pose and timing you convey emotion, weight, energy, power- the very core of animation is locked up in pose and timing. So until we're happy with these two things, we don't do anything else.



(pop02_Dope.jpg)

The Second Pass:

Update: It's at this point that I wish to offer an alternative methodology than what was originally discussed in this article from this point forward. Originally I discussed how you would go from the initial pose timing to adding things like breakdowns and anticipations and moving holds and the like. While that is still a viable method, it has its difficulties which I will address later. An alternative way to proceed from this point is to mix metaphors. Start pose-to-pose, then switch to straight ahead. Choose your poses strongly at the outset, block them in for timing purposes to hit whatever accents you deem as worthy of the emphasis. Then rather than blocking in your anticipations, breakdowns overlaps and moving holds in an "all or nothing" fashion as originally outlined in the article below, you switch to a straight ahead mindset. Now your poses and their timing can still be used as an early sign off for your director and for yourself, but you then work from the beginning of your shot in a straight ahead fashion to reach those pose milestones. How you get there is open to the fluidity and freedom of interpretation that straight ahead allows for, but your animation still has definition, direction and an overarching sense of design to it. This combination of work flows is a powerful technique that can serve your work in immensely.

Now, the first crack at my pop-thru was pretty rough. There's a few things lacking. Like breakdowns on transitions, and defining the inbetween arcs. Since again I've got a pretty well established "traditional" brain, I can think of my breakdowns and arcs without having to see the tweens yet. Here's the second preview animation with some of these things added.



(moses02_popedited.avi, indeo3.2; cinepak; 1000k)

Notice there's a little more definition to the action. The arm sweeps have some arc, the end part where he says "Ten! Ten commandments!" has some anticipation and transfer breakdown keys added. Also, I've blocked out my moving holds. I do this by generally estimating how long I want a movement to take. Again, I add these new keys with just held frames with zero inbetweening by the computer. Already we're starting to see how things are fleshing out very quickly.

Sidebar on How To PopThru Your Moving Holds:

Let's say the a character hits a pose on frame 10 and from my first pop thru I find that I like that he hits his next pose on frame 24. There's 14 frames in there between these 2 poses. Now I know I want that action where he hits pose 24 to be fairly quick- let's say 5 frames.

So I count back 5 frames from 24 and know that the END of my hold for the pose on frame 10 will occur on frame 19. (read that again slowly if you didn't get it.)

I could just dupe the frame 10 key at 19 to get the boundary of my hold established, and in my first pass I usually will. But in this second pass I went a little further. I slightly adjusted the pose, settling into it. This is called a moving hold. Most computer animators are familiar with the concept of a moving hold. When a CG character stops dead and doesn't move,

it just dies for some reason. So we have the pose move slightly as it's held for the duration.

So as a matter of course I add that in my second popThru pass, so I can get a better feel for how fast or slow my transition moves are.

The Third Pass: Linear is as Linear Does

Now that I've defined my poses and timing even more in my second popThru pass, adding arc and transition breakdowns as well as defining

my moving holds, I'm ready to see what the computer thinks about it. So in my fcurve editor (graph editor in Maya-speak) I change all

my keyframes to have a linear interpolation. This means there's no ease in or ease out from keys, it's just going from one to the next

in a straight fashion. Computers loves this phase. It feels so...CG!

Here's a look at the above animation switched to linear...



[\(moses03_linear.avi; indeo3.2, cinepak, 2mb\)](#)

Not bad, but certainly not good either. Here I can see a few things that I didn't see in my pop-thrus. One being the transition on

"has given unto you" is way too slow. The second being the hand rotations are pretty ugly and the arcs need more definition in places.

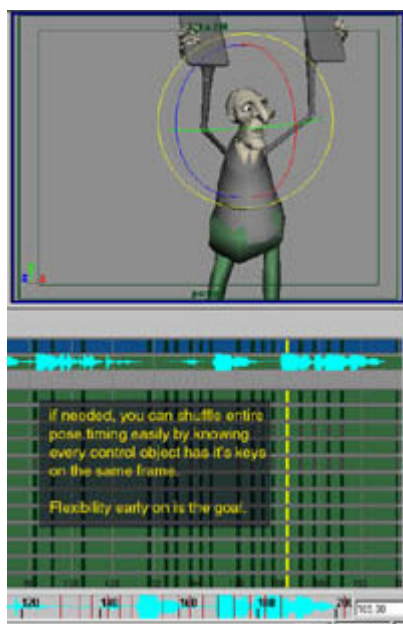
There's also a few little things about the pose timings that I'd like to adjust, especially in the part where he looks down at the

dropped tablet. That moving hold moves a bit too much. So I make a note of every thing I want to fix and I fix it.

This is a good habit to get into: find everything wrong that you can, note it and fix it. THEN do another preview.

The temptation is to twiddle each thing in detail and preview every fix as you're making it. But that can just eat your day away waiting for preview animations trying to fix one little thing instead of fixing them all at once, then previewing and working in more detail afterwards.

So anyhow, here's a look at some of the things I did to tighten stuff up after seeing my first linear pass...



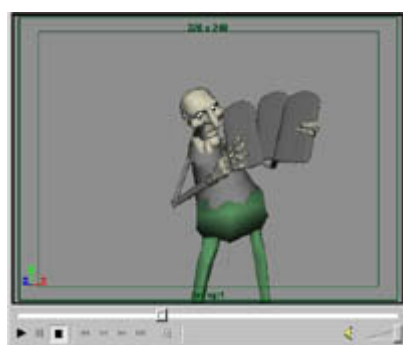
_jpeg



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Fourth Round: Hey, this looks sorta like *animation*!

Here's my next pass after cleaning up some of the junk my first linear pass revealed to my eyes...



(moses04_LinearCleanUp.avi; cinepak, 2mb)

At this point I've pretty well nailed the core of my animation. I like the poses, I like the speed of the transitions, I like the arcs, the breakdowns.

Generally I'm ready to start loosening things up.

Remember I mentioned earlier on that pose to pose animation can tend to look stiff and robotic? Well, this fourth pass is just that:

good timing, good poses, but a little dead, a little stiff. Here's where the rest of the '12 rules" comes into play (or not). We need to loosen things up a bit, to let it breathe and live some more.

Now lots of folks have different ways to loosen up their work. I'll share what seems to work for me. It helps me put out good animation at a pretty decent clip (which my employer appreciates, and my kids benefit from. After all, I gotta make a living, and being good AND fast is a nice combo in a tough animation market). I have some shortcuts and tricks that I use that may make some animators gasp in horror. That's cool. Whatever works for you. Having said that, here's some things I like to do...

Offsetting Keys:

Update: As I noted above, the simplistic means of keyframe offsets as explained originally in this article are insufficient to handle the area of emphasizing a particular aspect of your animation. While this step does loosen up some movements, to really get a greater sense of fluidity to your motion you're gonna have to dig a little deeper and harder to find the right combination of offsets and eventually keyframe deletions. With that in mind, the original technique outlined below is good for that "gotta get it done" quality of animation that a lot of us are paid to produce.

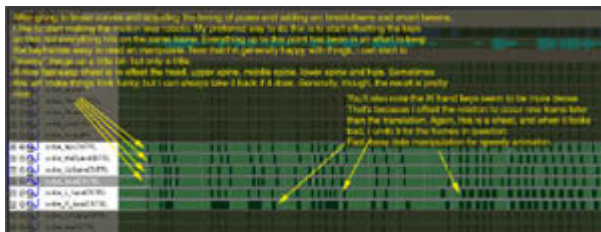
One nice and easy way to get some loosening up is to not have everything hit on the same frame, which is contrary to everything I have said so far.

But that organization served it's purpose and now it's time to back off from that rigidity. Up to this point, we have hit our poses solid.

Every part of the body comes to hit the pose at the same time. That's not natural. So we need to shuffle things a bit.

Here's a look at some dopeSheet

screen grabs that show how I like to do this...



[jpeg](#)



[jpeg](#)

I'll grant you that my approach is a bit formulaic, but again, we're working outwards toward our goal, from organized structure at

first into disorganized life in the end. So for offsets I'll shuffle my head from my spine and my spine from my hips to have the

torso of the body sorta flow into a pose. Depending if I want the motion to lead with the hips or the head will determine which

way I'll offset my keys. Sometimes I'll shuffle some keys and things will look awkward for a certain pose or transition.

That's OK, I can shuffle them back for that spot. It's a cheap way to get rid of that robotic feel of pose to pose.

I'll offset the hand's rotation to occur a frame after the hand hits in place. Now this is assuming an IK arm set up (as I used here).

Since the hand controls where the arm will swing as well as the hand rotation, it's a good idea to break this up so it looks less like a marionette being pulled by the wrists. A lot of folks don't like using IK arms. I used to hate 'em, but got used to

making them look OK after some work. I know Rick May is a fan of the IK arm, for those keeping score at home. As far as I can

tell the key to having IK arms look decent seems to be in good breakdowns, careful observation of arcs and offsetting hand rotations

from IK handle translation. If I were using an FK arm, I'd offset the lower arm a frame from the upper arm and the hand a

frame from the lower arm, allowing the arm to have a sort of unfolding overlap, the "successive breaking of joints" kind of feel.

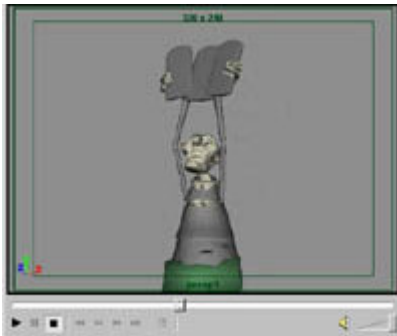
Again, with IK I'll do it with breakdowns and offsets. In general, anyways. Again, where it looked funky

I'd step back and not do it there. These are just cheats, not rules. The only rule is the animation: does it look good?

If yes, then the cheat is good. If not, then the cheat is evil.

Oh, one more thing, I offset both arm animations to get rid of twinning in my pose hits. Just in case anybody cares.

Here's what it looks like after all that offsetting and shuffling....



[\(moses05_offset.avi; cinepak, 2mb\)](#)

Smoother, but not quite loose enough for what I'd like this to be. By the way, this is about as loose as it gets for us at work.

After this I'd be ready to run a smoothed fcurve spline filter on the curves and be on to lipsync and grabbing my next assignment.

The style of our show is pretty tight, which fits the deadlines. For my own stuff at home I sometimes like to explore loosening things up a bit more.

Kill Mr. Roboto!

Here's where things get a little less formulaic for me and I start to rely on experience and a good eye for animation. The deleting of keys.

Many a young animator struggles with having too many keys. Especially if they're just going straight ahead. After awhile they

don't know what they're looking at anymore (at least I didn't back then). The solution for me was to key smartly. But in the pose to pose

world, the problem is it can be TOO organized, things can be too structured. What's needed is some good old fashioned editing.

I try and look at the spine mostly. I found that alot of the rigidness in my work comes from the spine being too tight. So I'll go in there and shuffle things around, deleting keys and some breakdowns here and there. I'll also try having a lower spine control not settle into the pose until almost near the end of the hold. Sometimes I'll have the head take longer, or somesuch. This is the massaging part of animation that is very difficult to define as a step or a process. So here's a look at a close up of the dope sheet and the corresponding animation change that goes with the edit.



[.jpeg](#)



[moses06_deleteSmooth.avi, cinepak, 400k](#)

It's a very subtle effect, but when you do this for the whole shot, it really starts to loosen things up and defeating that robotic feel.

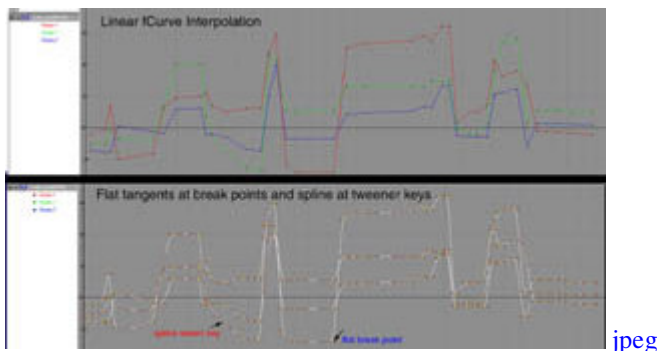
And remember, this is still all with linear keyframes. There's no ease in or ease out from key to key.

The plus side of this is that when the time comes to start adding ease in and out by switching the fCurves over to spline interpolation and then filtering the tangencies, you're not in for any surprises. Oh, one last thing here: I took the time to really tweak the whole hip/weight transfer flow in the part where he kicks the fallen tablet out of the way. This again is something that you just need to use your animator's eye to spot and fix. This is the place where I try to address anything that really needs fixing, before going into spline curves.

F-Curves, away!

Now I'm ready to switch the fCurves from straight linear interpolation to a spline interpolation with edited/filtered curve tangencies at the keyframes.

Here's a quickie peek at the curves for one control object...



What this is going to do is really smooth out alot of the remaining jerkiness of the animation. Pose hits have ease to them,

transition breakdowns have some flavor besides straight through. There's no surprises here, I'm not really adding anything

new, but I'm taking what I already have and applying this neat smoothing to it all. It's like icing on an already pretty tasty cake. The trick is to not violate the extremes as they have been defined already. Spline interpolation by default tends to overshoot the holds, really making things sloppy. So I try and keep the holds pretty tight with a minimum of overshoot,

while the keys in the middle transition areas are pretty smooth. Now if I wanted, I could go through each control object and

delete select keys in the middle of curve transitions to make things smoother, and I may yet do that for this piece.

Generally

if I want to loosen things up even more I'll do it in the fCurve editor by deleting some frames along the curve that are hitching the motion a little bit.

Still, if you want the absolute best animation you can get, then that's a step worth taking in my opinion. Like I said,

I didn't do that for this piece as it is seen here.

Update: The statement directly above is especially true when you want to get even finer, more natural motion. In taking your work from serviceable to excellent in quality, you're going to spend at least half your time in the finessing of the keys and curves. Yes you can produce OK animation by doing everything up to this point, but you'll be leaving the work short of all it can be by not going the final mile. You can expect to spend 50% of your time on the last 15% of the animation to bring it to a level of excellence. Now if your producer/employer states that the budget doesn't support that level of quality, then you'll have to leave that undone and live with what the preceding efforts give you as far as results. But for your own work at home or for your portfolio and personal growth I highly recommend spending the time it takes to generate the absolute best animation you're capable of. Employing that level of discipline will best serve you in the end.

Here's the motion with the spline ease curve interpolation...

[moses07_spline.avi, cinepak, 2mb](#)

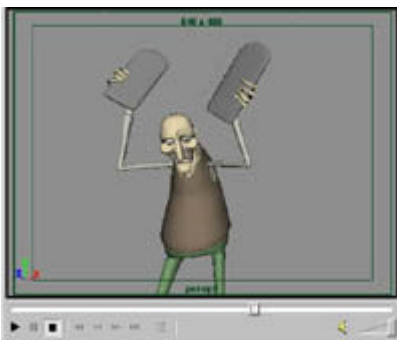
The animation of the body is pretty much done here. Like I said, I could go in and tweak it more. Since this is a personal clip and not for work, I may. That's the nice thing about personal pieces, no deadlines and no quotas. Well, sometimes no

deadlines. I did 3.25 minutes of animation in 7 weeks for my short film "Lunch".

As you can see, THAT had a deadline and this method helped me meet it. :o)

The Final Result (well, final enough anyway)

And one last look at the final with lipsync and eye/facial animation....

[moses08_finalLipSynced.avi](#)

I'd go into the eye and lipsync animation, but that's another subject in and of itself. Suffice it to say, there's some little cheats I use there as well, but nothing earth shattering.

Comparison Shopping

For the ultra curious, I have made a side by side comparison of the preview animations as they progressed. The way it works is this:

pop1 vs. pop2

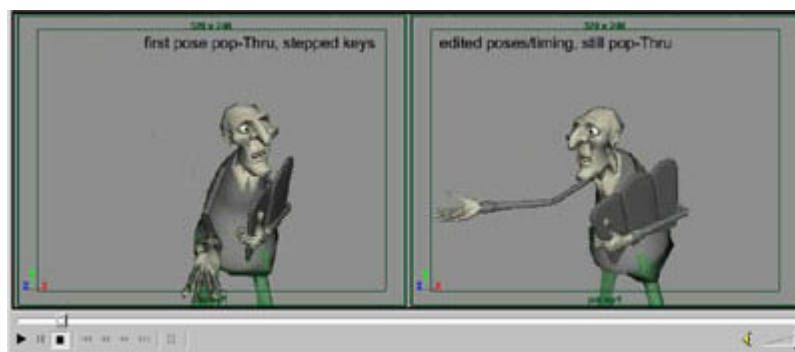
pop2 vs. Linear

Linear vs. Cleaned Up Linear

Cleaned Up Linear vs. Linear Offset

Linear Offset vs. Splined Curves

Splined Curves vs. Final Animation



[mosesProgress.avi \(DivX required\)](#)

So there you have it, one guy's way of working through animation. As stated earlier, I'd welcome any feedback or discussion.

Sharing techniques and methods can only help us all. I don't pretend to be the world's greatest animator, nor to impose that

my way is the right way. But folks have expressed interest and I figured it couldn't hurt to open up my brain and share some

of how I work to get my job done and still try and make halfway decent looking stuff.

Thanks for stopping by and taking the time to go through all of this.

Update: I've since taken some time to bring this clip more in line with some of the improvements I have mentioned in my updates. To view this animation with even more time spent in finessing it, [click here](#). It's better, but still not probably what I would call great or excellent.

Special Thanks:

To those who's feedback has made my stuff better through the years:

Mike Comet, Mark Behm, Rob Dollase, Ron Smith, Tim Lannon, Rick May, Chris Bailey, Victor Navone, Doug Dooley,

Ethan Hurd, Angie Jones, Steve Talkowski, John Goodman, Julian Love, Bear Weiter, Wes Houghton and a host of others I'm probably forgetting. Thanks also to my wife Kim, bless her heart she puts up with me and this silly idea of being an animator for a living. Poor girl could have married a dentist....

About the author:

Keith Lango is an assistant director/animation director for the "3-2-1 Penguins!" children's video series produced by Big Idea Productions in Chicago, IL. Keith has also produced/directed a number of award winning short films

and has been an avid student of the art, craft and profession of animation since 1993.

He also hopes to age well like a fine cheese.

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