Walks can embody every element of animation: physicality, attitude and emotion, appeal, and more. We’re going step by step (ahem) to create a solid walk technique that you can continue to build upon.
Walk Cycles

CREATING A WALK CYCLE is a fundamental skill for every animator. Whatever the medium--- film, video games, TV, etc.--- all depend on cycles in a variety of ways. Having a solid technique for creating a walk cycle will pay dividends time and time again, so we're spending this chapter looking at how to create them with minimal fuss. We'll also see how to easily fix some common issues that crop up, like knee popping and foot slipping.

I've always found walks to be a constant negotiation, because almost every part affects all the others. As you work through this chapter, keep in mind that you'll be going back to revise and tweak your work throughout the animating process. The files for this chapter are a general guide, but not a perfectly sequential progression, because that's not how animation works! Now step to it!
EVERY WALK has four core positions that create its foundation: contact, down, passing, and up. The first step is getting these positions keyed in the root, hips, and feet controls, and we can continue to build from there. Cycles are typically created in a layered style, where specific body parts are done before others. We'll be doing our initial work in stepped keys, although some animators prefer using linear or some other spline type from the start. This cycle will be an in-place one, where the character does not move forward in space, but rather walks as if he is on a treadmill. Towards the end of the chapter, we'll learn how to make him move forward in world space using the master control.

We're going to use AutoKey in our workflow. We'll set a pose on all controls on all the frames we need for blocking. Then AutoKey will automatically update them any time we make an adjustment to a pose, and we don't have to press $s$ every single time to set new keys. This saves tons of time and hundreds of keystrokes!

01_CorePositions.mb is the reference file for this cheat. The screen grabs have the right leg colored blue in the interest of clarity.

1. Open the Goon character and give yourself a 25-frame span in the timeline. This is a regular walk, so it will be 24 frames long with a pose set every 3 frames. We add an extra frame at the end to copy the first pose to so it will loop properly. Take both knee pole vectors and pull them out in front of the rig. This will prevent the knees from flipping.

2. f01 is the contact position. Rotate the hips in Y to around -10 and bring the left foot forward. Use the Heel Roll to angle it up and the Toe control to rotate the toes upward.

3. Pull the right leg back and use the Ball Roll attribute to rotate the heel up. Tweak the pose like above, keeping both legs straight. Select All controls and set a key.
How to Cheat in Maya

2 In the animation preferences, set the Default out tangent to Stepped. I've also turned on Auto Key.

3 Select the head and set the Neck Influence attribute to 0. Then select the neck and set Chest Influence to 0. The reason for this will be explained in detail in the head and neck section.

4 The only controls we'll be using right now are the root, hips, and feet. Switch to a side orthographic view.

5 Move to f04, select all, and set a key. Now auto key will set the key each time you adjust something on this frame. This is the down position, so move the root down in Y about -1.

6 This is an in-place cycle, so imagine he's on a treadmill. The front foot will plant and move backwards. Set the Heel Roll and Toe to 0 and move the foot back a bit.

7 The back foot is still on the ground, so it moves backwards also. Pull it back some, and also increase its Ball Roll attribute as the heel is pulled farther off the ground.

HOT TIP

The core positions will be found in some form in every walk. The type of walk and/or animation style will influence how they're posed and timed, but they will always be present.
The back foot is lifted in the passing position, so translate it up and forward. Set the Heel Roll to 0 and use Rotate X to get the angle here. Also use the Toe attribute to give a nice curve in the foot.

When doing these opposite versions of the poses, I like to flip back to the mirrored pose and make sure they line up as close as possible using the grid lines. This keeps things consistent and easier to adjust later. I'll also compare the values in the graph editor to make sure there aren't any huge differences.
The left foot is still on the ground, but the heel is starting to be pulled up. Move it back some more and adjust the Ball Roll to about 25.6. Remember to keep the leg straight.

Go to frame 10. Select All and set a key. This is the Up position, so pull the root up in Y to .6 and rotate the hips in Y to around 6.5.

Another tip for saving time is to copy the root poses over again, since those are the same regardless of the foot stepping. The root will be the same on frames 1 and 13, 4 and 16, 7 and 19, and 10 and 22. Use the MM drag technique in the timeline to quickly do this.

The right foot is now in front to take the next step. Adjust it using the Translates and Rotate X attributes.

Finally, to loop properly, the first and last poses need to be the same. Select all controls and go to frame 1. MM drag in the timeline to frame 25 and set a key.

Another tip for saving time is to copy the root poses over again, since those are the same regardless of the foot stepping. The root will be the same on frames 1 and 13, 4 and 16, 7 and 19, and 10 and 22. Use the MM drag technique in the timeline to quickly do this.

For every method of doing a walk, you can find the opposite approach that will work just as well. Never take any animation approach as the only way to do something.
WE HAVE THE BASIC FOOT POSITIONS and up and down for the body blocked in, so now it’s time to flesh them out a bit more. This section we’ll be working from a front view to get the weight pushing the hips up in Z rotation.

We’ll be using a technique of getting the extreme pose (the frame where a part is rotated or translated the farthest) in the viewport, then moving to the graph editor for the keys in between. This saves time and effort, and is also more precise, because we’re able to see the actual values of the keys instead of eyeballing it. There’s nothing wrong with eyeballing things, of course, but for cycles, especially walks, I find that precision in the blocking stage makes things much easier later. Once everything is working mechanically, we have more freedom to go in and make things more irregular and organic. 01_CorePositions.ma is the reference file for this cheat.

1. Continuing with your walk cycle from the previous cheat, switch to a front orthographic view.

4. For blocking, I have the hips Rotate Z at 0 on the Contact positions (F1 and 13). Here is what your rotate Z curve should approximate in the graph editor.
2. We need to put some Z rotation on his hips to better communicate them pushing up from the weight on his planted leg. They’re at their highest on the Up positions, so go to frame 10, select the hips, and Rotate Z to 3.2.

3. Go to frame 22 for the other Up position and Rotate Z the opposite to around -3.2.

4. On frames 4 and 7, I use the Move tool and MM drag the keys to progress to f13’s Up position. Then do the same in the other direction on frames 16 and 19.

5. Playback the animation and the hips should now be rotating with the walk, being highest on the Up positions.

HOT TIP

The way you rotate the hips depends on a number of factors, including character design. On a more exaggerated style character, it could look better to rotate the hips up with the raised leg, instead of the planted one, because of how the body will read in motion.
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Body and Feet Side Motion

Next we move on to the sideways, or Translate X, movement of the body and feet. The body needs to shift to the side the character’s weight is on to keep him in balance. This also communicates that the character has weight and needs to compensate for it while moving. So we’ll stay in our front view and also be using the viewport to graph editor technique from the previous cheat.

Also, the feet tend to cross over at least a little in most walks. We’ll shift their planted positions inward, as well as swing them out when they’re lifted to start working in the arcs of the foot (which we’ll polish up later). Onward! 01_CorePositions.ma is the reference file for this cheat.

1. Select the body control. For blocking, I’m putting the side-to-side extremes on the passing positions (f7 and f19). On those frames, Translate X about 0.46 and -0.46, respectively.

4. Move the left foot’s Translate X curve to -0.4. It should look something like this on the character now.
The body moves through to those extremes, so again using the graph editor, I pull out the keys progressing to each one. Keep each side consistent, and don’t forget that frames 1 and 25 must be exactly the same to loop properly.

The feet arc outwards in Translate X when they’re in the air, so move the right foot out to -0.3 at f7 and -0.6 at f10.

The feet usually cross in front of each other a bit, so let’s move them inward. Select the right foot’s Translate X curve in the graph editor, and move it to around 0.4. Moving the curve is much faster than using the timeline. Also, keep an eye on the viewport to judge how far you’re moving things.

Do the same with the left foot, setting f19 to 0.3 and f22 to 0.6. Play back the animation and your walk should feel noticeably better.

HOT TIP
The amount the feet cross in front of each other can be influenced by the gender of a character. Female walks can have the feet almost lining up in a perfectly straight line, while a macho male walk would likely be much farther apart.
With the feet and body fairly well blocked in, let's focus our attention on the spine. I've hidden the arms in this example (the reference file also has a display layer for the arms on/off) so we aren't distracted by perfectly straight arms pivoting around the chest. The chest's Y and Z rotations are the opposite of the hips.

It's good practice to rotate the spine as a unit when blocking. Select all three controls, and rotate them together, getting as close to the pose you want as possible. Then rotate them individually if necessary for further tweaking. The reason for this is posing the individual spine sections is more time consuming, and can lead to strange results when splined. If you rotate the middle or lower sections noticeably more than the top (easy to not notice in blocking), the spine can move in an bizarre, alien way (can you twist your stomach with your chest perfectly still?) after you leave stepped keys. 02_CorePositions.ma is the reference file for this cheat.

1. Select the chest controls (all three of them) and go to frame 4. This is a Down position where we want the extreme for the spine's Rotate Y to be. Rotate all 3 in Y to 4.7.

2. I'd like to move the upper chest further, so select only that and rotate it to around 8.8. You can also do this in the graph editor if you prefer.

3. Rotate Z the opposite at f22, and then use the Graph Editor to pull out the keys between the extremes. Here is the general timing I used.

4. Rotate X is all that's left. In a side view at f7, rotate all three controls downward, and adjust the top spine control to taste.
Using our Move tool and graph editor technique, I now pull the keys to progress between the extremes at a timing/spacing I like. Do this for the Rotate Y of all three spine controls, keeping f1 and f25 the same value.

Our walk is shaping up nicely! We're almost done with blocking everything in.

Repeat the same process on the other side at f16, using the opposite values.

Add some Rotate Z to all three controls, using the same technique. The extremes will be at the Up positions, f10 and f22. At f10 I went to about 0.9.

At f10, rotate down in X just a bit further. Then repeat the same two poses at f19 and f22, respectively. Here are my Graph Editor curves for all three controls. Yours don’t have to be exactly the same, but they should be in the same ballpark.

Our walk is shaping up nicely! We're almost done with blocking everything in.

Don't be concerned with overlap through the spine joints at this point in the animation. Keeping all the controls keyed on the same frame for now will make it much easier to keep your animation under control.
THE ARMS ARE the next part to block in, and we'll start with the upper arm and work down to the wrist. I find it easier to do the arms using this layered approach, rather than posing the whole arm, because the isolation helps me figure out the drag and follow-through better. It's a good idea to put the overlapping action into your stepped keys as much as possible, because it communicates the motion better at this early stage and helps clarify the way the animation will end up.

There will usually be a lot of refining done on the arms later, but for now we just want things blocked in cleanly and working mechanically. The extremes for the arm poses will be placed on the Down positions, and we won’t worry about the fingers right now. This keeps everything as simple as possible.

03_CorePositions.ma is the reference file for this cheat.

1 Select the left upper arm control and in the Graph Editor pull down the Rotate Z curve to about -78. The arms are out in Z during the walk, but we’ll come back to that later. Switch to a side view to work on the Rotate Y.

2 At f04 is a down position. Since the left foot is forward, the left arm will be back. Rotate it in Y to 41 or so.

3 Now for the elbow. We’re going to be roughing this in, as the overlapping action is much easier to work on once we’ve gone to splined keys. At f01, rotate it forward in Y -27.

4 At f04 the lower arm is dragging behind the upper, so rotate it forward more in Y to -29.
Go to the Graph Editor and pull out the keys between the extremes to a timing and spacing that looks good to you. Here’s how I did it. Remember to keep f1 and f25 the same values.

3 The other down position is at f16, so go there and rotate the arm in Y to its forward extreme. I put it at -6.2.

4 Go to the Graph Editor and pull out the keys between the extremes to a timing and spacing that looks good to you. Here’s how I did it. Remember to keep f1 and f25 the same values.

5 At f07 the upper arm is now moving forward, but the lower still has momentum going the other way, which makes a straight arm. Rotate Y to -4.5.

6 The lower arm is still dragging at f10, and can’t go any farther (as this isn’t a cartoon-style walk), so we’ll keep it straight. Rotate Y to 0.

7 At f13 the lower arm now starts to move the other way. Rotate Y to -6.7.

HOT TIP
Think from the top down when doing any appendage that overlaps, like arms, tails, etc. The top section will always lead the rest. From that point, every section down will drag sequentially down the chain for some amount, which is determined by the style of the walk.
Blocking the Arms (cont’d)

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10. At f16, the lower arm continues in the same direction. Rotate Y to -7.8.

11. At f19, the upper arm starts back the other way, but the momentum keeps the lower arm going the same direction. Rotate Y to -28.

12. f22 has the lower arm dragging a bit more, but now ready to start moving back the other way. Rotate Y to -31.

16. At f10, the wrist is still dragging as the lower arm is just starting to change direction. Rotate Y to 10.7.

17. At f13, the wrist is now starting to move forward with the rest of the arm. Rotate Y to 7.6.

18. The wrist continues its direction at f16. Rotate Y to 3.1.
For this style of walk, we don’t want the wrist too floppy. I’m keeping it straight, except when it drags at, and right after, the extremes. At frames 1, 4, and 25 the wrist Rotate Y is at 0.

Keep the wrist the same at f22. We now have the left arm roughly blocked in. Repeat these poses for the right arm, except with opposite extremes: the right arm will be forward with the left foot, and vice versa.

Since we need f1 and f25 to be the same, key the lower arm’s Rotate Y at f25 the exact same value you have at f1. In my case it’s -27.25.

At f19 the arm is moving back but the wrist is still going forward. Rotate Y to -14.

At f07 the arm is moving forward, but the wrist is still dragging. Rotate Y to 9.5.

Don’t sweat the small stuff! Keep fingers for later once the arm is splined and working mechanically. The more you have going on, the more confusing things will be.
The final segment of the blocking phase is getting the head and neck moving, and then we'll be ready to start refining this walk into a fully animated one. These two parts are pretty straightforward, as they basically overlap the spine. However, getting just the right amount of head overlap for the walk you're doing is important for the entire body to feel organic. Like I stated before, in a walk everything affects everything else in some way. That's what makes them challenging (and fun).

We're also going to be using the head in Master space. On the Goon Rig the attribute is called "Neck Influence" on the head and "Chest Influence" on the neck. Other common names I've seen on rigs are "Global" and "Align." Some rigs you turn this on, although the Goon Rig you actually turn it off (set to 0), setting the neck to have no influence on the head and the chest to have no influence on the neck. By doing this, you are making the head and neck independent of the body. Normally rotating the neck and/or spine will rotate the head along with it, but in Master space, the head will stay facing its current direction until you actually rotate it. This is great for a walk cycle, because it saves you TONS of counter-animating. Otherwise, every time you rotate the chest, you'd have to rotate the head back to its original position. Very time consuming and annoying! 03_CorePositions.ma is the reference file for this cheat.

1. For a quick demo, go to perspective view and go to f01. On the neck control, set Chest Influence to 1, and on the head, set Neck Influence to 1. The head position will probably change when you do this.

2. Rotate the chest in Y and notice how the neck and head simply follow, as if they were all one piece. This is because the influence of the chest is at 1, or 100%. Undo all of these steps.

6. Repeat the same values in Rotate X at f22.

7. At the positions before those poses, I'm going to do an ease-in. At f7, rotate the neck in X to 22.7 and the head to 4.9. Repeat at f22.
3. Set the head and neck influence at 0, and rotate the chest in Y again. Now the head maintains its current angle, as the rig is automatically countering any rotations you do in the chest. Undo everything you just did.

4. Switch to side view. We’re going to only work on the Rotate X for the head and neck. Since the down position happens at f4, the spine follows at f7, and the head/neck will move down at f10 for the overlapping action.

5. At f10, rotate the neck in X to 24.8. Then rotate the head in X to 6.2.

8. At f04, the head is back. Set rotate X to 0 for the head and 14.5 for the neck. Repeat at f16.

9. Set the remaining pose at frames 1, 13, and 25. I set the Rotate X on the neck to 17.1, and the head to 3. Here are my Graph Editor curves. And that’s it! We’ve now blocked in the walk and are ready to start refining the animation.

HOT TIP
If you’re having trouble getting something to look right and are getting frustrated, try deleting the animation on that part and starting over. It may sound painful, but it actually can make things much better. It’s easier to see how to fix something when it’s 100% wrong, rather than only 10% wrong.
Before we spline, let's make sure there are keys on every control, as it's possible to miss a few in blocking. Select All controls, and go to f01.

Select all the curves, and press the Pre and Post Infinity Cycle buttons in the Graph Editor. These tell Maya to loop the curves infinitely before and after to make a continuous cycle.

Now that we've blocked in all the major body movement, we're in a good place to start refining the animation. We'll move out of stepped keys and into splined curves, where Maya interpolates between the keys. That's a fancy way of saying it fills in the frames between where we set our blocking keys. A good portion of computer animation is editing these Maya-created in-betweens to make them less perfect and exact (as computers are so good at that), and more organic, imperfect, and alive.

A very important ritual in splining your stepped keys is ensuring that every control has a key at every frame we blocked in a pose. It's easy to miss some in the blocking process, and if you spline without ensuring this, you can create a lot of extra work for yourself later. So first we'll use some hotkeys and double check that we've keyed everything before we move to spline mode. 04_Splining.ma is the reference file for this cheat.

Press \( \text{S} \) to set a key on all the controls. Then use the \( \text{>key} \) to advance to the next keyframe at f04. Set another key, and continue through f25, setting keys on each frame that keys currently exist.

In the graph editor menu, go to View > Infinity. You'll see dotted lines on each side of the curve representing the looping.
3 With all controls selected, open the graph editor and select all of the curves.

4 Press the Plateau Tangents button to convert to splined curves. Plateau does a respectable job of flattening extreme keys and smoothly transitioning in-between keys, making a good starting point.

7 Playblast your animation and your walk should be fairly smooth. There will be some very minor hitches but overall everything should be moving fine. If not, undo the splining and make sure you have a stepped key on every control at every blocking frame. This is much faster than dealing with it later in spline mode.

HOT TIP
Plateau tangents work well, but even better is using an auto-tangent script. This script will go through your curves and place a flat tangent on every extreme and a spline tangent on every in-between. Check out Michael Comet’s website at www.comet-cartoons.com for a fantastic auto-tangent script, as well as a ton of other fabulous tools.
With the curves now splined, we can really get things going. We’ll start by refining the body control. When using a layered workflow, it’s extremely important to always start with the foundation and work your way up from there. Since the body control is the center of the character’s gravity, everything branches from there, and that’s what we’ll work on first. The legs will follow, since they are dependent on the body’s movement, and form the physical base of the walk.

I’ve chosen this approach because everything else, like the spine, neck, head, and arms, all get their reference of movement from the body. It doesn’t make sense to work on them yet, since they will change based on what you do with the body control. Always base a layered workflow from the character’s center of gravity, and work your way up from there.

It bears repeating that we’re now knee deep in the organic part of animating that is impossible to accurately represent in a step-by-step succession. These next few cheats will introduce the techniques for refining your own walk, but ultimately use your judgment and intuition, as that’s the only way to learn how you animate.

I’ve created some display layers to hide the upper body to focus on the parts I need with minimal distraction. 05_Refining.ma is the reference file for this cheat.

1 I’ll start with the up/down of the body. Select the body and focus on the Translate Y curve in the Graph Editor. We’re going to be doing all of our adjustments in the graph editor since it’s faster and more precise than doing them by hand in the viewport. Be sure to keep an eye on your viewport while you’re making the changes, so you can see how altering the curves affects the character.

4 A walk is a controlled fall, so let’s adjust the keys travelling down at f01, f11, and f25 a bit lower. Now he’s getting to the up position a bit faster and holding there longer, and then moving to the down position faster.
At f07 and f19, I want his body to ease into the up position so things don't feel so even. Select those keys, press w for the Move tool and MM drag them up to around 1.5.

The ends of the curve are flat, but looking at the dotted infinity lines before and after our curve, they should be smooth since they aren't extremes. Select the two end keys and press the Spline Tangent button. You can also adjust the keys' tangent handles manually if you like.

We can push these timing changes even further. Let's add a frame on the way up to make it hang even longer, and take one away from the way down to make his weight drop faster. We won't change the number of total frames, but rather shift the keys we've already set to different positions. Select all the keys except the two down positions.

Work from the base of the body down. First get the body control working, then the legs, then the spine, and everything else afterward. The core of the body influences all the other parts.
With the Move tool (W) MM drag the keys over 1 frame. This will offset his up position 1 frame over from the rest of the keys. The body will now have a nicer bounce instead of a regular sine wave type motion. Right now it's a subtle difference, so feel free to experiment with the placement of the keys and find something that you like.

This is what the original Translate X curve (sideways movement) looked like for me...
When offsetting keys or changing timings for a cycle, remember to keep the number of frames for each curve exactly the same, in this case 25. If you shift either the beginning or end key, move the other one also. For example, if you shift the first key one frame to f02, you’d also move the end frame to f26, as f02 to f26 still totals 25 frames. 

Try your hand at the side-to-side motion of the body. Switch to a front view to see the Translate X movement more clearly.

...and this is what I ended up with. Ease ins and outs at the extremes, a smooth transition between them, and shifting the entire curve over 1 frame to offset the motion from the rest of the body.

Refining is a great place to use Animation Layers to try out different approaches and ideas. See Chapter 11 for more on using this amazing feature.
We’ve roughed in the hips’ Y movement, now let’s tighten it up some. Currently they have some flat sections in the curve and the spacing makes the movement a bit jerky.

The hips are one of the most important things for conveying weight, and go a long way in defining the attitude of the walk. Since we’re doing a standard walk cycle, things won’t get too crazy, but it’s good to exaggerate them a tiny bit, even if the style is more real or naturalistic. I believe that not pushing the hips’ movement can make an animation feel kind of light and mocap-ish. If you’re doing a personality walk, pay very close attention to the hips, as they will be a central element in making it feel right. A female walk, for example, can be almost completely sold with the hip swing. 05_Refining.ma is the reference file for this cheat.

Like the Y curve, the Rotate X curve has some spacing issues. The ending key tangents also flatten out, which will add a slow-down in the movement we don’t want.
On f10 and f22, adjust the keys for a nicer ease in. On f01 and f25, and f13, tweak the keys so we don’t have perfectly flat tangents. Subtle tweaks like this will add up to make everything feel more organic and loose.

Switch to a front view to work on the hips’ Rotate Z. For this walk, the hips over the planted foot will be pushed up from the body’s weight.

5 Around f10 and f22, I adjusted the surrounding keys to ease in and out. This is so the hip stays in the up positions longer while the weight is on his leg. Select the keys on each end and click the Spline Tangents button so they move smoothly through the cycle when it loops.

6 Some animators don’t use much (or any) rotate X on a vanilla walk. I did a little bit and it works fine for now with how it splined. Here’s what I came up with. Feel free to adjust yours as you see fit.

HOT TIP
I’ll say this once more about the hips, as it can be a contested issue among animators. Depending on the style of the walk and the design of the character, the hips can work differently. If the character lifted his legs higher when walking, it could work better to have the hips Rotate Z go up with the leg that’s in the air. But it all depends. Be open to finding what communicates the character best, as there are never any 100% of the time rules in art.
In any walk, the feet can have a lot of subtlety, more than they may appear to at first glance. A step can seem like a simple movement, but when we study it closely, the little details that we can put into our animation really make it come to life. From the overlap and drag of the toes, to the peeling off the ground, to the drag and swing in the air, all of these things differentiate a functional walk from an appealing one. While we could probably use half of this book to talk about feet, let’s look at the vital things we’ll need to transform these simple splined feet to ones that are really going somewhere. 05_Refining.ma is the reference file for this cheat.

1 Right now the feet are taking three frames to go from contact with the ground to planted. This is too long and makes him feel like he’s stepping very softly.

4 Now the foot snaps down over 1 frame, adding to the feeling of weight. It’s still a bit mechanical, though, so let’s add some overlap with the toe.
2. On each foot, select the key on the Heel Control attribute that is at 0 immediately after being raised. In this example, it’s f04 on the left foot and f16 on the right.

3. Drag them over 2 frames so the transition happens over 1 frame.

4. Adjust the curve for the Toe attribute so it is still up the frame the foot plants on the ground, and then have it go down the frame after. Repeat with the other foot.

HOT TIP
For a walk that was very quiet or sneaking, you would probably want the feet to plant over more than one frame to give the feeling of light stepping and caution.
I adjusted the timing and smoothed out the top to give the motion a nice slope. It starts lifting a frame earlier at f15 and gets to the ease in key at f20. Now we have a smooth lift, slight hang, and nice drop in the step.

The Translate Y curve looks a little clunky with the flat tangents at the peak. This creates an awkward arc in the step’s path of action.

Once the heel starts peeling off the ground, have it keep peeling until the foot comes off the ground. The curve should keep travelling and not plateau, which will make it look stuck and mechanical.

Use the Toe attribute to add some drag on the toes as the foot travels through the air.
When it hits the contact position, I made the keys at f13 and f25 linear. This makes a hard in, as the foot is stopped by the ground and doesn’t slow down before landing.

The lifting foot can have a slight drag using the Rotate Z, which helps add to the weight.

One of the tricky parts when using both Rotate X (when the foot is in the air) and the heel roll (when it’s on the ground) is getting the transition to not look jerky. The key is to overlap them. Experiment until you get a smooth motion.

Some slight Rotate Y and Z on the contact position also adds some nice detail.

While you’re working with the feet you may notice the knees popping. It’s tempting to fix them now, but it’s far less work to wait until the end when everything is working. Making other adjustments in the body is likely to affect the knees and put you back where you started.
As we work on the spine, it's helpful to think of the Rotate X motion working its way up from the hips through the head. The chest can't rotate forward until the waist does, and so on up the chain. If we keep this principle in mind while we work on the upper body, it will go a long way toward loosening everything up and making the walk feel weighty.

We'll be sure to work with all three axes. As a general guide, the chest and hips rotate in Y inverted from each other. For the Y rotation, I'm going to have the chest be the base of the arm swing movement and therefore lead the waist in that direction. We'll also have some subtle compression with the Rotate Z. As you work on the spine, I would definitely recommend looking at video reference and studying books like *The Animator's Survival Kit* by Richard Williams.

The Rotate X for the head will also receive some attention, and for a nice touch we'll add some squash and stretch to the whole spine at the end. walkFinal.ma is the reference file for this cheat.
I moved the entire curve up so the rotation forward is more pronounced. Then I smoothed out the flat sections so it drags back smoothly, and snaps forward with each step.

For the Rotate Y I’m going to make the chest lead the rest of the spine, as it will be the base of the arms’ swinging motion. To start, the curve from blocking needs a lot of clean-up.

Smooth the tangents, adjusting the ease ins/outs and compressing the entire curve a bit. Then move the curve one frame earlier since the chest leads the ribs and waist in Rotate Y.

Clean up the ribs and waist Rotate Y curves. I put the extremes of the ribs 1 frame behind the chest, and the waist 2 frames to keep everything from moving too perfectly.

Getting the overlap just right takes time. Remember that you may have to rotate something backwards to get the drag right before it starts moving in the direction it’s being pulled in. Simply offsetting the curves will rarely get you the motion you need.
Continue to work with the spine’s Y rotation until you’re happy with it. Make the chest and hips complementary in their movement, as well as where they hold around the extremes.

Switch to a front view to work on the Rotate Z. For this walk, I’ll make sure the spine will compress into a slight C shape with the planted foot side.

The head will move back quickly at f04, then down quickly to f07, where it slowly starts to reverse direction until f13 where the cycle starts again.

Once you’re happy with the spine movement, adding a bit of squash and stretch in the spine can be the touch that really makes the walk feel weighty and organic. On the main body control there is a stretch attribute.
10 Continue the refining process by cleaning up the Rotate Z curves until you're happy with the movement.

11 Moving on to the head, think of the wave principle we used when doing the spine Rotate X, just more pronounced. The head will rotate back and down quickly from the body's weight hitting the down position, and slowly rotate until the next drop in the body snaps it downward.

14 Use the body's Translate Y as a reference point. When it starts downward, the spine will continue to stretch a couple frames before starting to squash. The curves in the screenshot have been normalized (made the same proportion visually only) for clarity.

15 After the body hits the lowest down point, the squash will continue a couple more frames before going back to normal. Work with the stretch curve until you're satisfied with the animation.

HOT TIP
The spine and head are more elements that will vary widely depending on the walk. Depending on what you're doing, things like the rotation directions can be opposite of what a regular walk needs. Always experiment. With cycles you can simply select curves and drag them halfway in either direction to see how the opposite looks.
The final parts we need to refine are the arms and hands. I’ve saved them for the end because their movement is almost completely based on the body. When doing the overlapping action for the arms, it helps to think of how a pendulum works. The upper arm leads the forearms and wrist. Once the upper arm changes direction, the forearm must keep going in its current direction for a few frames before following the upper arm. The same principle continues through the wrist and fingers.

We also need to add some rotation in X and Z to keep the arms from feeling robotic or locked on a track. To finish, we’ll add some rotation in the shoulders and some bounce from the body’s up and down to loosen the walk up even more.

walkFinal.ma is the reference file for this cheat.
2 First I'll clean up the Rotate Y curve. It's fairly even, so I'll delete some extraneous keys and add ease ins and outs to the extreme keys as a starting point.

3 I also shifted the curve earlier one frame since the upper arm will be leading the rest of the arm. Here's the curve after refining and checking in a playblast.

4 Continue the refining process for the forearm's Rotate Y curve, using the upper arm's curve as a reference. For my walk I had the forearms overlap the extremes by 4 frames.

6 Use the forearm's Rotate Y curve as a reference for the wrist's Rotate Y. I ended up putting the wrist's extremes 2 frames after the forearms and making the ease in and outs tighter. Refine the wrists to a point that looks good to you.

7 Switch to a front view to work on the Rotate X and Z. The upper arm's Rotate Z will control how the arm swings out, which I'll make more pronounced as the arm goes forward than back.

HOT TIP
Using other curves as reference for the ones you're working on is very helpful, but don't get too focused on them. In the end what matters is what you see in the viewport, and working only in the graph editor will end up making everything look the same and lifeless.
I made the arm swing out more as it travels forward than back. The curve is very similar on each direction; the difference is done mostly with ease ins and outs.

Add some Rotate X as well, mainly in the wrist. There's a subtle rotate outward when the hand is back, and inward when it's forward.

To finish we'll add overlap in the fingers. Make all of them offset from each other, but not necessarily in perfect order, to make them feel more organic.

When the arms are travelling forward, the fingers compress together from the drag.
10 Moving to the shoulder, I refined the Rotate Y to work with the upper chest, just offset by a few frames.

11 Put a pronounced drop in the shoulder using its Rotate Z, offset a couple frames from the body’s Translate Y, which I used as a reference point.

14 The fingers will separate again as they get dragged back with the arm.

15 Mirror the animation on the right arm and our walk is almost complete!

HOT TIP
A good approach to making things like fingers organic is making sure nothing is offset the exact same way. It’s easy in computer animation to make everything the same amount apart. Change up the number of frames, the amount of ease ins and outs, and the order to get more lifelike movement.
**Fixing Knee Pops**

When it comes to polishing a walk, we will invariably need to fix popping in the knees. When you watch the animation, you’ll probably notice some jerkiness, jiggle, or pop in this area, particularly around the foot contact frames. Knee pops are a by-product of using IK legs, and it’s essentially just a problem of spacing. The knees will have too far a gap between frames from the IK leg trying to figure out where they go based on the body and foot positions. They can also pop if we have something like a perfectly straight leg for only one frame. It generally takes 2 frames for a pose to be felt by the viewer, and just 1 frame of straight into a bent knee will feel like a hitch in the motion.

All of this is remedied using the Stretch attribute on the foot control. Because the body and feet are working the way we want, we don’t need to mess them up just because of the knees. So we’ll simply adjust the stretch in small increments, shortening or lengthening the leg frame by frame to put the knee where we want it. Since it will only take small amounts of stretch to accomplish this, the change of length in the leg won’t be noticed.

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1. Open KneePops.ma. On frames 2 and 3, we have a spacing issue in the left knee. There’s a large gap between them, making it pop when the animation plays.

4. Now on those frames we have a smooth motion in the knee.
2. On the foot control, select the Stretch attribute's curve in the Graph Editor, hold  i  and MM click to insert keys on frames 2–6. Often when using this technique, you must adjust the stretch on surrounding frames to make it look good.

3. While watching the viewport, adjust the keys to smooth out the spacing on the knee from frames 2–6.

4. There's also a pop in the rear leg that we should fix. Add keys to the Stretch attribute on the surrounding frames and smooth out the knee spacing.

5. Now the knee is smooth on the back leg as well. Continue to smooth out the knees until all pops are fixed.

HOT TIP
Save this stretch technique for the very final stage of your walk. Check the arcs of the feet and body and make sure they're exactly how you want them. Double check that the peel-off is working and that everything else is finished. If not, you are adding yet another element into the complex mix and can create a lot of frustration for yourself.
Translating the Walk Cycle

This is it! With the walk finished we're now ready to make this in-place cycle actually move forward. The cycle itself will remain inplace, but we can figure out the amount to translate the root controller forward to create the illusion of walking. For each frame his feet slide back, the root control (which moves the entire character) moves forward the exact amount to counteract and make the foot appear to stay on the ground.

To get this to work properly, we need to do some slight adjustments on the Translate Z curves of the feet, along with some basic math. While the feet are translating backwards, they need to be linear splines, which make each frame the exact same value. Ease ins and outs change the amount the foot is moving back from frame to frame, and will make the feet slip when the root control moves. Now, grab your calculator! walkTranslate.ma is the reference file for this cheat.

1. Select the left foot. The foot contacts at f01 and travels back through f16. Select all Translate Z keys from frames 1–16.

2. Change them to linear tangents, and delete any keys between f01 and f16. This ensures that these 16 frames are all exactly the same value apart.

3. Delete any keys between f13 and f28 and make those two keys linear tangents. Make sure that f13’s value is 4.916 and f28’s is -9.008, just like the other foot.

4. Select the root control and set a key on it at f01 and f02.
Cycle with Offset makes the root translate forward .928 each frame to infinity, and now our character is walking through the viewport.

We need to figure out the value of each frame. f01 is 4.916. f16 is -9.008. Adding them for the total distance is 13.924. That divided by 15 frames is .928. So the feet travel back .928 units each frame.

The other foot needs to match that amount per frame and it makes things simpler if both feet have the same starting value (4.916). However, the curve itself ends while in the middle of traveling backwards.

On the root's Translate Z curve, enter .928 as the value on f02. Then select the curve and go to Curves > Post-Infinity > Cycle with Offset.

Cycle with Offset makes the root translate forward .928 each frame to infinity, and now our character is walking through the viewport.
HOW DO YOU APPROACH FINDING THE BEST ACTING CHOICES FOR A CHARACTER?

This to me is the hardest part of the job. The thing with acting choices is that they are very subjective in nature. There are so many ways to approach a shot. Any or all of them could be right and what one animator thinks works might not land for someone else. And who knows. Maybe the director is so clear on his/her vision, I don’t need to make any choices at all! But if it’s up to me, I start by listening to the audio track over and over (and over) again. My goal here isn’t necessarily to envision the whole shot and lock it down. Instead I’m trying to establish a handful of strong poses that really define the performance to act as anchors for the shot. I appreciate that there are a lot of animators out there that like to act out and thumbnail the whole shot from the get-go, but I find that by dropping in just a few poses, I get a much more organic workflow. My end result is never what I first envisioned because I allow the shot to evolve. So although this is the hardest part for me, it’s also the most rewarding when I really see the shot come to life.

WHAT’S THE MOST CHALLENGING SHOT YOU’VE EVER WORKED ON AND WHY?

This is a tough one. I feel like any shot can be hard in some way or another. But I’m going to go with a shot that was done for the extended Spider-Man 2 DVD. The shot was initially meant to be about 30 seconds of intense fighting between Spider-Man and Doc Ock, and although it was subsequently broken up with new camera angles, I still remember it as one big challenging shot. Here’s why.
First, the initial concept was to have a fairly static camera moving along the side of the train. How does this make the shot hard you ask? The static camera meant I had nowhere to hide. The shot had to look realistic and the choreography had to be exciting because I wasn’t going to benefit from some generous camera shake or big moves to conceal shoddy animation.

Secondly, the choreography. The trick with these fight shots for me was making sure I got the audience to look exactly where I wanted them to look. I guess that doesn't sound too hard, but if you have a bunch of tentacles moving around, you can get yourself into trouble fairly quickly because your eye will jump around in all directions. When Ock grabs Spidey's hand, for example, I made sure the tentacle reared up and held a strong silhouette before grabbing while the foot tentacles waited for their mark so to speak. Only when I got a read on the tentacle grabbing the hand did I move the foot tentacle down onto the train. And only then did I rear up the right tentacle to grab the other hand. Essentially, the challenge was to find the balance between keeping it exciting and ensuring the action was clear and readable. I need to guide the audience on where to look so they can absorb the action on a first pass.

Thirdly, the tentacles. Need I say more?

The fourth element was the cloth. Although I didn’t have to animate Doc Ock's jacket and vest, I still had to give the cloth team enough room to work their magic once my animation was done. What this meant was making two characters appear to be grappling and fighting, but in terms of the actual geometry, they could never touch. So when Spidey is straddling Ock and pulling him up by the collar, he isn’t actually sitting on the geometry, nor is he grabbing the collar. It all had to be cheated to camera. Think of it as WWF wrestling. They look like they are fighting, but they never really hit each other. Take that wrestling fans! Essentially, it’s another layer to manage as you try to get a hard shot out the door.

Finally, I have to say the schedule. It was short! I never really felt I had enough time to begin with, but when they changed the camera angle for two sections, it got even crazier trying to rework the animation! Still, I think it all worked out. Hopefully you have a copy kicking around to check it out.

WHAT IS YOUR TYPICAL WORKFLOW FOR A SHOT?

That depends on the style of animation. If I’m doing a realistic visual effects show, I tend to work straight ahead. Pose to pose just doesn’t work when for me when I’m trying to assess whether a character has the appropriate amount of weight or velocity,
etc. I need to see it in motion all the time to know whether or not the speed accurately represents real-world physics. Consequently, the question I constantly ask myself while I’m animating is “Does this look real?” Seems like an obvious one, but it forces me to look very critically at my work. I think it’s possible to get romanced by a cool pose or some fancy choreography, but if it doesn’t look realistic, and I’m meant to be animating something from the real world, then I get a big old fail on the shot.

For a character like Spider-Man, I always approached him like he was a stunt double. That meant no shortcuts where I would allow myself to say that he has super-human speed because he has super-human strength. If he moves too fast, he looks light. For a swinging shot, I start by animating his overall body mass and some rough key poses. The goal is to simply get him moving at the correct speed. Only when I was satisfied with that would I move onto finessing the key poses, transitions, and in-betweens required to bring him truly into the real world. The final polish stage is where I will throw in all the texture for the shot. Texture might be a slight body adjustment or a little shake on a leg to break up the smooth feel of the shot. Think of a gymnast on a beam. Usually, they do very small adjustments with their limbs so their core can stay balanced. In addition to breaking up the shot, it also provides some more real-world detail that can really take your shot to the next level.

For a character shot, I work a bit differently. As I mentioned earlier, I spend a lot of time in the beginning simply listening to the audio performance and imagining what the character could be doing. Eventually, certain acting choices become very clear to me and that’s where I start. I don’t worry about blocking the whole shot with breakdowns because I personally like to allow the shot to evolve as I’m working. Simply put, throwing in a few solid posing choices and playing them with the audio track always opens new and unexpected avenues for me to pursue while animating the shot. For all of us, getting started is often the hardest thing to do because that blank canvas can be pretty intimidating. So dive in with as few poses as possible needed to define the broad strokes of the performance. Even two or three will be fine. Then allow your shot to grow.

One thing I don’t do at this stage of a character shot is worry about facial poses or lip sync. There are two main reasons for this. First, bad lip sync distracts me and I know that if I try to block something in, my focus will constantly drift into the smaller confines of the face. But perhaps more important is the idea that you can really sell the emotional feel of a shot with good facial poses. Just by having a sad face on a default pose will make the audience read the character as sad. By not including the expressions, I’m forcing myself to make the body poses convey as much of that
emotion as possible. If I can sell the emotional state of the character without facial poses, then I know that when I do finally get to the face, the shot will just get that much stronger.

Once I get a strong pass of key poses and breakdowns, it’s time to convert my shot from stepped mode to spline. It’s always painful, but I try to manage my suffering. The first thing I do is break up the shot up into manageable chunks. You can usually find a beginning and an end to a specific action or perhaps a line of dialogue. I’ll key all on either side of that chunk, convert to spline, and leave the rest stepped. By doing this, I never get overwhelmed by the amount of massaging I need to do. Baby steps. When I’m satisfied with the first portion, I’ll move on to the next section and so on. Once this phase is done, I should have a pretty solid timing and performance pass with the addition of facial expressions and basic lip sync. Then, just like I do with my visual effects work, I layer in the texture. Essentially, I always layer from broad action to detail work with the idea that my detail work should improve an already successful shot. I never want to use facial work as a crutch for weak body and performance choices. Rinse and repeat.

WHAT DO YOU FEEL ARE THE MOST COMMON PITFALLS FOR BEGINNING ANIMATORS?

I think the biggest thing for me is that beginning animators try to cram too much into their shots. Quantity does not equal quality. This creates a couple of issues. Firstly, the shot gets a little muddy and the audience is unclear where to look, or the actions all feel rushed. But the larger issue is how hard the shot becomes to troubleshoot. By jamming all those ideas into your 5-second shot, how do you assess what’s working and what isn’t? What do you strip out to make the shot sing? So, I recommend layering up. Start with the basic concepts you are most attached to and then add the texture as you see fit.

LOOKING BACK, WHAT WOULD YOU HAVE DONE DIFFERENTLY AS A STUDENT?

I learned to animate the old-fashioned way with a pencil and paper. My issue was that I wasn’t a fantastic artist. If you throw in my need to keep things on model, what you got was a student spending way too much time on the minute details of a character and not the broader elements of motion and performance. So if I could do it all again, I’d throw away the model sheets and animate with a grease pencil. Make sure your work is loose!