

Tutorial – Particle Systems in Unity

In this tutorial we'll make three different particle effects using Unity's built in particles. Each particle system will be a different type of effect, so that you can see how particles can be applied in different use cases and get an idea of the flexibility and range of effects that are possible.

You're encouraged to use the instructions given here as a starting point. We won't be covering every module and option available, so please feel free to experiment with them!

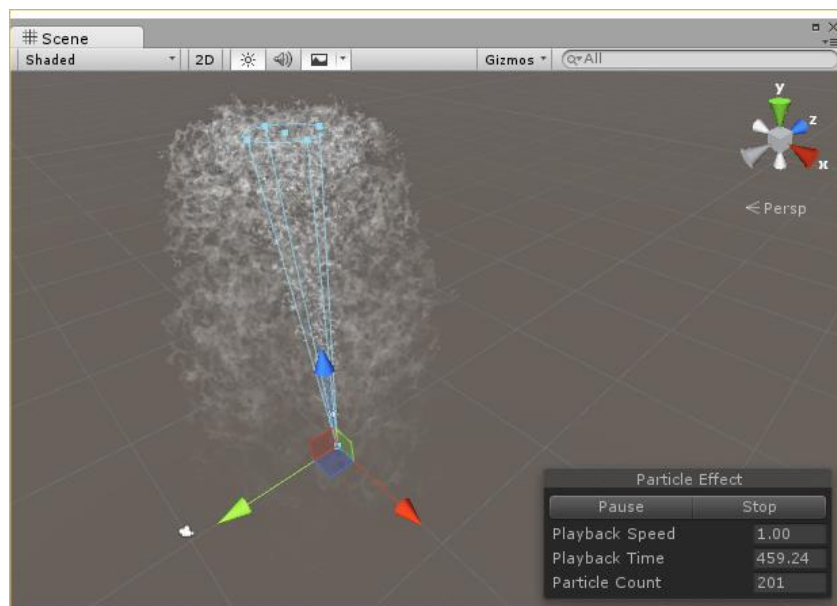
Activity 0 - Prepare our project:

Open Unity and create a new project.

Import the "ParticleSystems" asset package. You can do this either during the project's creation, or afterwards by selecting Assets -> Import Package -> ParticleSystems.

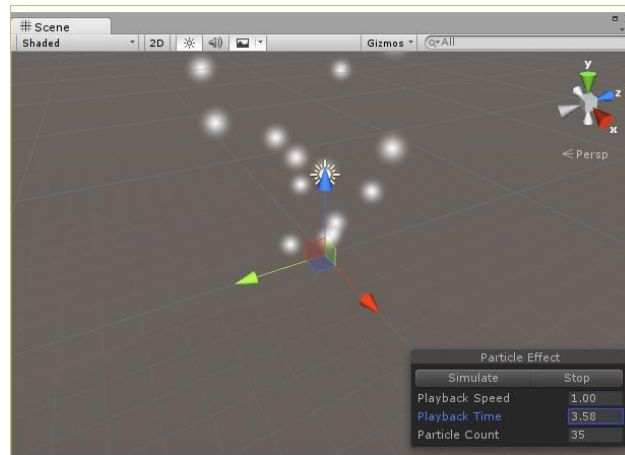
Activity 1 - Water Fountain effect:

For our first particle effect we'll create a simple water fountain.

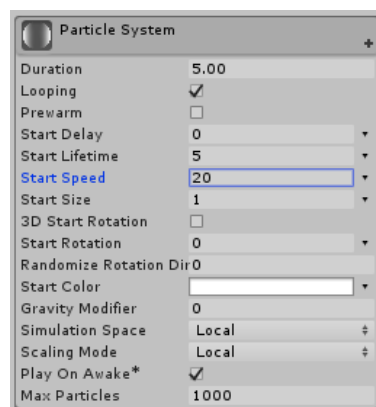


1. Create a new Particle System GameObject via GameObject -> Particle System. Position it at the origin of your scene.

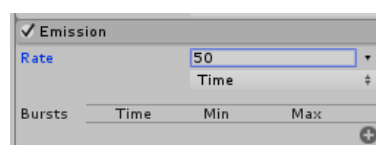
- Before we jump into modifying the system, take a moment to familiarise yourself with the Particle System preview controls in the Scene. When the Particle System GameObject is selected some controls appear at the bottom right of the scene view. These can be used to play, pause and stop the effect, change the playback speed and scrub the playback time.



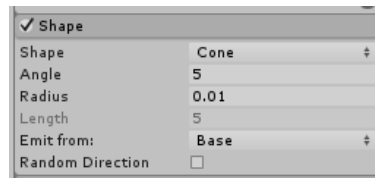
- Name your Particle System's GameObject something like "Tutorial Fountain".
- Ok, let's start shaping our Particle System into our desired fountain. The existing particles aren't moving as quickly as we'd expect for a fountain. Speed them up by setting "Start Lifetime" in the base Particle System settings to 20.



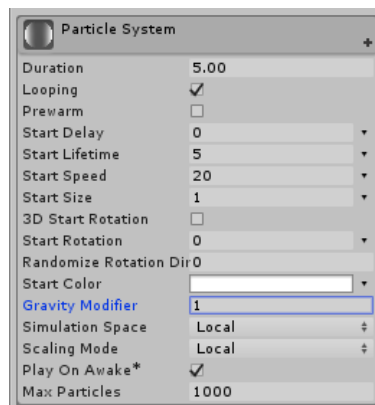
- A fountain should emit a constant stream rather than occasional dots. Open the "Emission" module, and set "Rate" to 50. The "Rate" controls how many particles are emitted by the system each second.



- The particles are spread out more than we'd expect for a fountain, so open up the "Shape" module. The default "Cone" shape works well with some modified properties. Set "Angle" to 5 and "Radius" to 0.01.

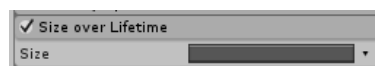


- Water coming out of a fountain should be effected by gravity. The easiest way to do this is to return to the base Particle System settings and set "Gravity Multiplier" to 1.

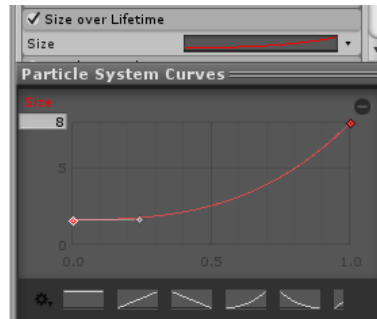


Broadly speaking your fountain should be taking shape now.

- Water coming out of a fountain tends to disperse over time. We can emulate something like this using the "Size over Lifetime" module. Enable that module by ticking the small circle to the left of its label, then open it by clicking the label.



9. You won't see any effect, because it works with a curve which we haven't configured yet. Click on the gray bar to the right of "Size" to open the Curve Editor, which will appear at the bottom of the Inspector. In the Curve editor, first set the maximum size in our curve by setting the number at the top left to 8. Then, modify the curve until it looks similar to the image below. This makes our particles grow over their lifetime, especially in the second half while they are falling back to the ground.

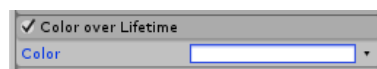


You can modify the curve by:

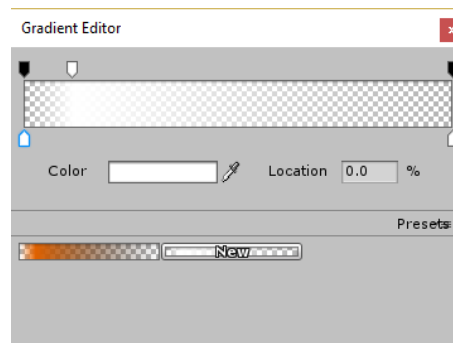
- Dragging the key points, which are represented by the red dots on the curve.
- Right-clicking to change the properties of the selected key point.
- With some property settings, dragging the gray handle(s) on the selected key point.
- Double-clicking on the curve to add a new key point.

You should now see that your particles grow in size after they are emitted.

10. As the water spray disperses it should also get more transparent. We can emulate this with the "Color over Lifetime" module. Enable and open that module as you did for the "Size over Lifetime".



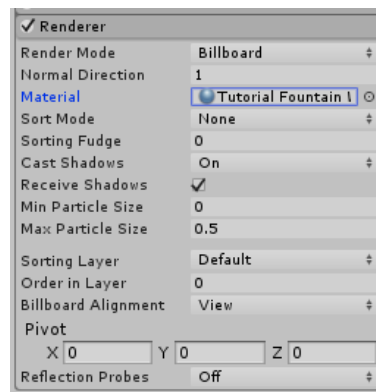
11. Once again there is no effect until we change the configuration. This time, click the white bar labelled "Color", and the Gradient Editor will appear. Modify the gradient until it looks similar to the image below. This causes our particles to quickly fade in at the start, instead of "popping" into existence. They then fade out slowly over their lifetime, during which they are also growing - so it looks like they're dispersing as the water spreads out.



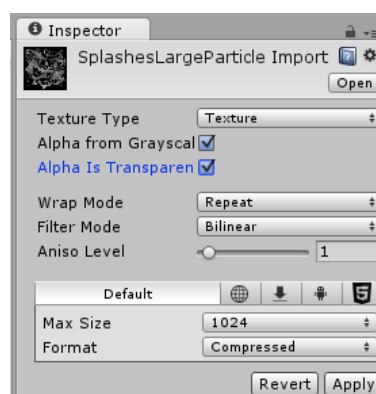
To modify the gradient:

- Click just above the gradient display bar to add a key point for the alpha value, which controls how transparent the particles are.
 - Click just above the gradient display to add a key point for the colour value.
 - Drag any key point left or right to change its time.
 - Press "Delete" on your keyboard to remove a key point.
 - With a key point selected, you can change its value or location in the gradient with the controls under the gradient bar.
12. Now that we can see our particles fading out, return to the base Particle System settings and modify the "Start Lifetime" value so that the particles are fully faded out at about the same height as the emitter.
13. You might notice that the particles are very bright near the top of the fountain. This is because the default particle material uses additive blending, which isn't ideal for a fountain. Also, we'd like to have some texture rather than just white puffs. Thankfully, the ParticleSystems package has supplied us with some textures we can use. Start by creating a new material, called something like "Tutorial Fountain Water".
14. In your Material, set the shader to "Particles / Alpha Blended".
15. In your Material, for the "Particle Texture" property select the "SplashesLargeParticle" texture.

16. Select your Particle System again, and open the "Renderer" module. Set the "Material" property to the one you just created.

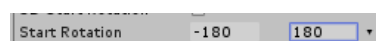


17. You'll immediately notice that our particles now all have big black squares around them. This is because the provided texture isn't set up for use with additive blending, and we're using it with alpha blending. We can fix this in its Import Settings. Select the texture file in your Project panel so that its Import Settings show in the Inspector. Tick the box labelled "Alpha from Grayscale". A new tick box will appear labelled "Alpha is Transparent", tick this as well. Then click "Apply".



Alternatively, you may make a copy of the texture file (using Explorer in Windows or Finder on a Mac) and modify the properties of the copy instead. This will preserve the original texture's settings for use in the example particle systems from Unity.

18. Now, return to our material and change the "Tint Color" from grey to white. Leave the alpha value at its default.
19. Lets return to our base Particle System settings again, and take a look at "Start Rotation". You'll notice that some settings have a small arrow to the right of their value. This indicates that they can accept different types of values. Lets change "Start Rotation" to use the "Random Between Two Constants" type. Then set the first value to -180, and the second value to 180. Now our particles each emit with a random rotation, which helps reduce visible patterning in the particles.

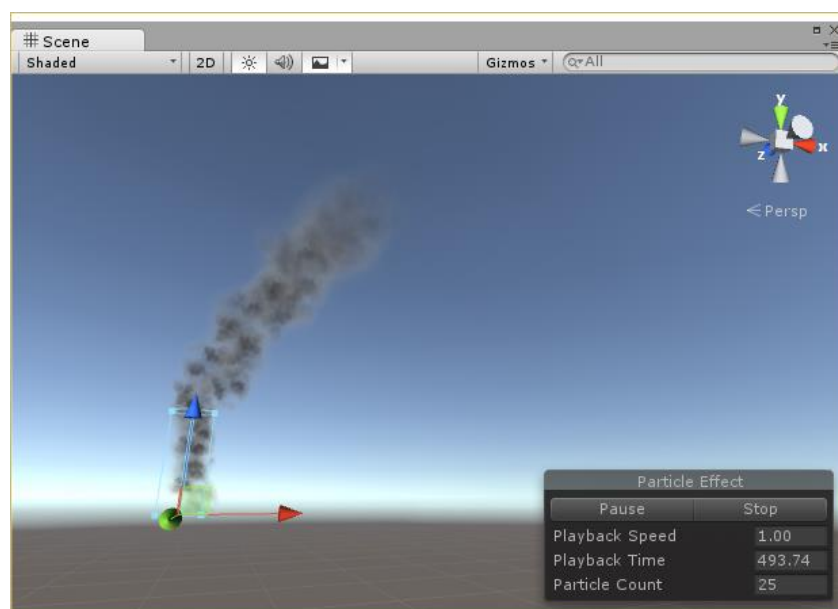


20. Scroll to the bottom of the Particle System Inspector and un-tick the "Resimulate" box, so that you can properly see the effects of changes to the Transform. (See the tooltip for details.) Then, in the base Particle System settings find the property called "Simulation Space". Experiment with the difference between the "Local" and "World" settings, by selecting each and moving and rotating your particle system to observe the effect. When might you want a Particle System to work in Local vs. World space? What do you think is most appropriate for your fountain?
21. Also in the base Particle System settings, experiment with the "Prewarm" setting by changing it and then using the Start and Stop controls for the Particle System in the Scene view. When might you want a Particle System to be prewarmed? What do you think is most appropriate for your fountain?
22. Your fountain should now look very similar to the one shown in the image at the start of the activity. Feel free to tweak any settings to taste.

Activity 2 - Smoke effect:

Our second effect will be of smoke, rising into the air as if from a large camp fire or similar.

You should be getting used to navigating between modules and finding properties now, so these instructions will be a little less detailed. Don't hesitate to ask for help if you need it!



1. Create another new Particle System in your scene. Call it something like "Tutorial Smoke". Place it a short distance from your fountain so you have some room to work.
2. In the "Shape" module use the "Cone" shape again. Set the "Angle" to 0 so that the smoke rises straight upwards, and set the "Radius" to 1 so that it emits from a larger area compared to our fountain.
3. Use the "Color over Lifetime" module again so that our smoke fades in quickly at the start, then fades out over the remainder of its lifetime. Only change the alpha values. Leave the colour as white, as the Material will take care of the color.

4. Create a new Material for your smoke. For its shader select "Particles / Alpha Blended". For its texture select "ParticleCloudBlack". Set your Particle System's "Renderer" module to use this Material. Modify the Material's colour to taste.
5. Use the "Size over Lifetime" module to make your smoke grow over time. As a starting point you can try a curve starting at around 2.0 and ending at around 10.0, but feel free to use anything you like.
6. We can emulate some wind using the "Force over Lifetime" module. Enable it, set "Space" to "World", and add small values to the X and Z components to taste.
7. Use the "Rotation over Lifetime" module to add some extra movement within your smoke. Remember that you can change the type of the "Angular Velocity" property.
8. That's the basics all in place. Feel free to look over and tweak the Particle System settings to taste. Particle lifetime and the emission rate are especially relevant to the smoke effect.
9. In the base Particle System properties you'll find a setting called "Max Particles". Ideally this number should be set to the lowest value where your system won't run out of particles. For our smoke this is easy to calculate:

$$\text{Ideal Max Particles} = \text{Emission Rate} \times \text{Start Lifetime}$$

For my Particle System's settings this results in a Max Particles of 25. Using a higher number than you need doesn't have a visual effect on the Particle System, but it does use extra memory which can add up if you're using many Particle Systems. If the number is too low then you will get periods where the system stops emitting.

If you're wondering why Unity doesn't calculate this for itself, the answer is that because we can emit particles or change their properties via script there's not enough information here to do that. For instance, we might want to allow some additional particles here

(Go ahead and also do this for your fountain.)

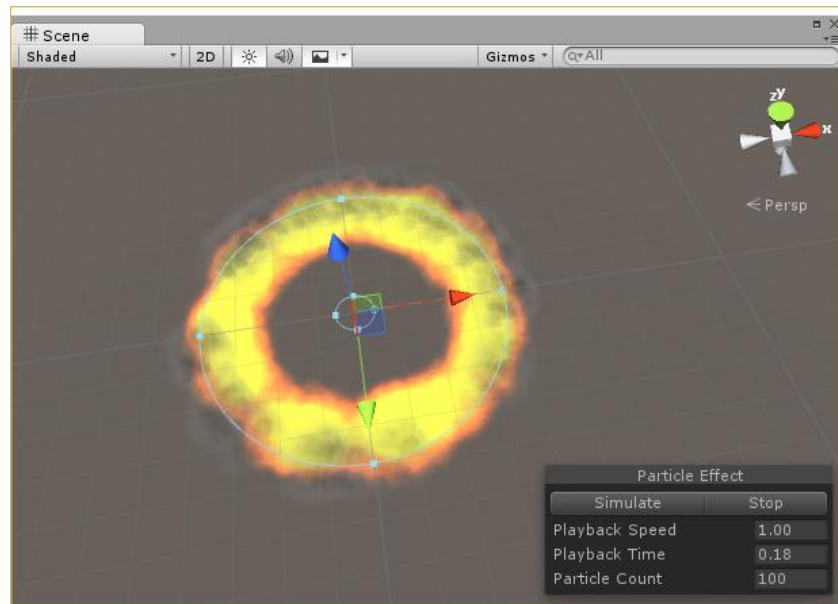
10. Should your smoke be simulated in Local or World space? Make an appropriate selection in the base Particle System properties.

Activity 3 - Cartoon Explosion:

Our third effect will be a cartoon-styled ring explosion. This effect will be different from the others in two ways.

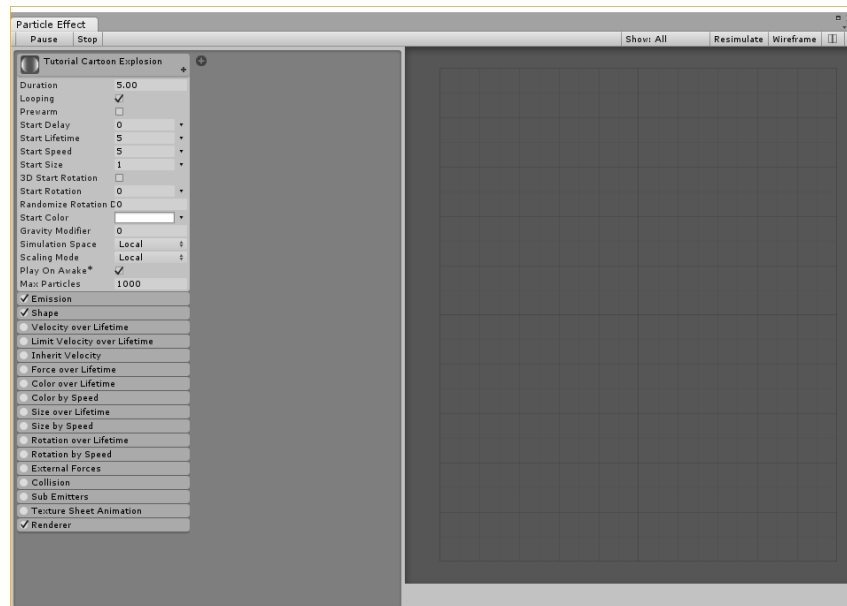
First, where the fountain and the smoke are continuous looping effects, the explosion will be a once-off effect with a distinct end.

Secondly, the explosion will be made up of two distinct Particle Systems working together to make a single, combined effect. As such, we will use the Particle Editor to create this effect.



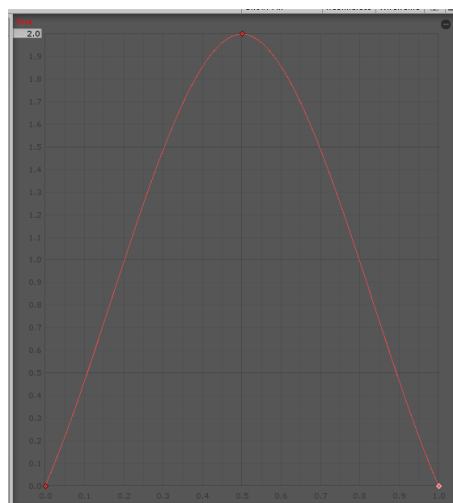
1. Create another new Particle System in your scene. Call it something like "Tutorial Cartoon Explosion". Place it a short distance from your other Particle Systems so you have some room to work.

2. In the Particle System Inspector, click the button labelled "Open Editor...". This will open the Particle Effect window.

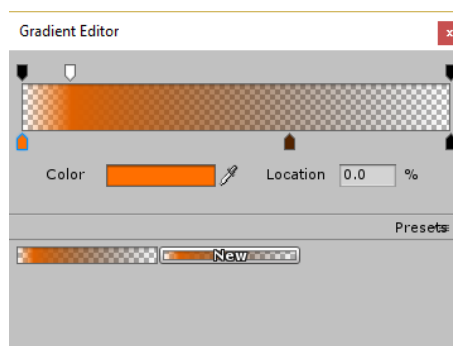


3. Set the Particle System's "Duration" to 3.
4. Set the Particle System's "Start Lifetime" to 0.33. Note that it is useful to set a low Playback Speed in the Scene view when working with short particle effects.
5. Set the Particle System's "Start Speed" to be a random value between 20 and 25.
6. Set the Particle System's "Max Particles" to 100.
7. Unlike our fountain and smoke effects the explosion should not constantly emit particles. In the Emission module, set "Rate" to 0. Then, add a "Burst" at time 0.0, with "Min" and "Max" emission values both set to 100. By doing this we are telling the system to emit all of its particles immediately at the start.
8. The Cone shape isn't particularly effective here. In the "Shape" module change to the "Circle" shape instead, with "Radius" of 0.5 and "Emit from Edge" ticked. We should now have the basic ring aspect of our explosion.

9. Use the "Size over Lifetime" module so that the particles start with a size of 0, expand to a full size of around 2, and then shrink back to 0 again. You will need to add a key point to your curve to achieve this. Note that you can work with a larger version of the Curve Editor which is visible in the Particle Effect window. Your curve should look similar to this:



10. Create a new Material for your particle effect. Use the "Particles / Additive" shader and the "ParticleFirecloud" texture. Set your Particle System's "Renderer" module to use this Material.
11. Use the "Color over Lifetime" module to fade your particles in and out, and also to apply a changing colour over their lifetime. Start with a bright orange, and change to a dark brown and then black as they fade out. Here is an example of what your gradient may look like:



12. Use the "Limit Velocity over Lifetime" module to dampen the speed of the particles over time. Use a "Speed" property of 1 and a very low "Dampen" value or around 0.1.
13. Now we have the flame component of our effect in place, it's time to add some smoke. We're going to do this by adding a child Particle System. Do this by pressing the small "+" button that you will find next to the top of your existing Particle System's properties in the Particle Effect window.
14. In your Hierarchy view, take note that this has created a child GameObject with a ParticleSystem component underneath your original Particle System object. Rename this to something appropriate, such as "Tutorial Cartoon Explosion Smoke".
15. Set the smoke Particle System's "Duration" to 3, "Start Lifetime" to 2, "Start Speed" to 0, and "Max Particles" to 32.

16. In the smoke Particle System's "Emission" module, set "Rate" to 0, and add a burst of 32 particles at time 0.
17. In the smoke Particle System's "Shape" module, set "Shape" to "Circle" and tick "Emit from Edge". Then, tweak the "Radius" until it roughly matches where the flame particles faded out.
18. Enable the smoke Particle System's "Velocity over Lifetime" module, set "Space" to "World", and set the Y component to 2. You may also set X and Z component values to taste.
19. In the smoke Particle System's "Renderer" module, set the "Material" to the same material we made for our other smoke Particle System.
20. Enable the smoke Particle System's "Color over Lifetime" module. Configure the gradient's alpha so that the particles fade in quickly, then fade out over the duration of their lifetime.
21. Enable the smoke Particle System's "Size over Lifetime" and configure to taste. You could use a starting value of 2 and an ending value of 4 as a starting point.
22. Enable the smoke Particle System's "Rotation over Lifetime" and configure to taste.
23. Tweak the smoke Particle System's "Start Delay" property so that the smoke appears as the flames begin to fade out. Note that small changes can make a big difference here.
24. The basics are all now in place. Feel free to tweak to taste, and experiment with anything we might not have covered.
25. For testing purposes, we've left the "Looping" property on both of Particle Systems ticked. Now that we're nearly finished, un-tick both of these. Note that now you need to press the "Simulate" button in the scene view to see your effect previewed. Also note that when you press "Simulate" for the parent effect it's children also run.

