RIGGING A VEHICLE IN MAYA

1. LOCATOR SETUP

- With your model in the scene, centered on the x and z axis, and sitting on the y axis, Rename the tires to *frontLeftTire*, *frontRightTire*, *backLeftTire*, *backRightTire*.
- Create 2 locator, rename them "*master*" and "*drift*", parent *drift* under *master*
- Create 4 locators, rename them to "*frontLeft*", "*frontRight*", "*backLeft*" and "*backRight*". Place them at the ground contact point for their corresponding tires. Parent the 4 new locators under *drift*
- Create 2 locators, rename them "*steerFrontLeft*" and "*steerFrontRight*". Match their Translation and parent *them to frontLeft* and *frontRight respectively*
- Create 4 locators, rename them "*orientFrontLeft*", "*orientFrontRight*", "*orientBackLeft*" and "*orientBackRight*". Match their Translation and parent *them to steerFrontLeft*, *steerFrontRight*, *backLeft* and *backRight respectively*
- Create 3 locators, rename them "*steer*", "*steerAim*" and "*offsetAim*".
- Place *steer* at the midpoint between *frontLeft* and *frontRight*, Parent it under *drift*. Parent *offsetAim* under *steerAim*. Move *offsetAim* some distance in front for *steer (Optional: Add annotation).*
- Select *master* and *steerAim*, Modify > Freeze Transformations.
- Select *frontLeft*, go to transform attribute > limit Information > Translate, limit the X and Z min and max to 0, Y min -5 (*Note: distance at which the tire ignores the ground*). Repeat for *frontRight*, *backLeft* and *backRight*
- Parent *frontLeftTire* to *orientFrontLeft*, *frontRightTire* to *orientFrontRight*, *backLeftTire* to *orientBackLeft* and *backRightTire* to *orientBackRight*.

2. CONSTRAINT SETUP FOR STEERING

- Select *steer* and *steerFrontLeft* in that order, Rigging > Constraint > Orient (default settings). repeat for *steerFrontRight*
- Select *offsetAim* and *steer* in that order, Rigging > Constraint > Aim (settings). Aim Vector only Z to 1, Constraint axis only Y.

3. CONSTRAINT SETUP FOR TIRE ORIENTATION

- Select *orientFrontRight* and *orientFrontLeft* in that order, Rigging > Constraint > Aim (settings). Aim Vector only X to -1, Constraint axis only Z
- Select *orientFrontLeft* and *orientFrontRight* in that order, Rigging > Constraint > Aim (settings). Aim Vector only X to 1, Constraint axis only Z
- Select *orientBackRight* and *orientBackLeft* in that order, Rigging > Constraint > Aim (settings). Aim Vector only X to -1, Constraint axis only Z
- Select *orientBackLeft* and *orientBackRight* in that order, Rigging > Constraint > Aim (settings). Aim Vector only X to 1, Constraint axis only Z.

4. BASE PLANE SETUP

- Create a *plane*, rename it to "*basePlane*"
- Move and snap each vertex on *basePlane* to *frontLeft*, *frontRight*, *backLeft and backRight* accordingly
- Move *basePlane* upwards to the midpoint of the tires
- Select *basePlane*, Modify > Freeze Transformation.
- Create cluster deformer for each vertex of *basePlane*
- Parent each cluster deformer under orient*FrontLeft*, orient*FrontRight*, orientB*ackLeft*, orientB*ackRight* accordingly
- Create a locator, rename it "*rivet*". Select the face on *basePlane* and *rivet* in that order, Rigging > Constraint > Point On Poly (default settings)
- Hide *basePlane*. Parent the car body under *rivet*
- Select *basePlane* and rivet, group them, rename group to "helpers".

5. ADD CUSTOM ATTRIBUTE TO MASTER

steerAimDistance float, min = 0, max = 1.
pathLength float.
tireDiameter float.

6. MOVING VEHICLE

- In the top view, create a curve using EP Curve Tool; from the center of the scene to some distance in front of the vehicle, rename this curve *drivePath*
- Select *master* and then *drivePath*, Constraint > Motion Path > Attach to Motion Path (settings). Set Time Range and Front Axis.

7. ROTATING THE WHEEL

- Create an animation expression on *master*, name the expression wheelRotate

```
frontLeftTire.rotateX =
frontRightTire.rotateX =
backLeftTire.rotateX =
backRightTire.rotateX = master.tireDiameter * 3.14159 * master.pathLength *
motionPath1.uValue;
```

- Determine the height of the tire by using Distance Tool, Create > Measurement Tools > Distance Tool. Input this value into the custom attribute tireDiameter on *master*.
- Determine the length of drivePath by using Arc Length Tool, Create > Measurement Tools > Arc Length Tool. Input this value into the custom attribute pathLength on *master*.

8. STEER FRONT TIRES

- Select *steerAim* and then *drivePath*, Constraint > Motion Path > Attach to Motion Path (default option)
- Go to the attribute editor for the *steerAim* motion path node, right click on the uValue and Break Connection.
- Create an animation expression on *master*, name the expression tireSteer

```
motionPath2.uValue = motionPath1.uValue + master.steerAimDistance;
```

- Adjust the steerAimDistance custom attribute on master.

9. ADDING BODY DYNAMICS

- Create 2 joints bone, rename *jointBase* and *jointTip*
- Move and snap *jointBase* to *rivet*
- Move and snap *jointTip* to *rivet* and move upwards to top of car body
- Create a curve using EP Curve Tool; with vertex snap on, click on *jointBase* and then *jointTip*, rename the curve staticCurve
- Parent *jointBase* and *staticCurve* under *rivet*
- Select *staticCurve*, FX > nHair > Make Curve Dynamic (default option)
- Parent the follicle group to *rivet*
- Select follicle, in the attribute editor adjust lock point to base
- Hide the staticCurve
- Parent other nodes to *helper*, rename newly created curve to *dynamicCurve*
- Go to Rigging > Skeleton > Create IK Spline Handle(option), uncheck auto create curve and uncheck auto parent
- In the scene viewed click on *jointBase*, *jointTip* and *dynamicCurve* in that order, then parent the newly created ikHandle to *helpers*
- Parent the car body to *jointTip*
- Select hairSystem, in the attribute editor dynamic properties, adjust bend resistance.

Note about Maya's dynamics:

- *It requires you set playback speed to Play Every Frame, Max Real-time*
- *It requires some frame to re-calibrate the simulation after scrubbing through the timeline.*
- *It doesn't evaluate properly in reverse play.*

Save the scene as carRig.

10. TESTING RIG

- Import or reference carRig scene into an environment scene containing the drivable geometry (ground) and a path for the vehicle to move along (*Note: all drivable geometry should be combined*)
- Move *drivePath* so that its ending point is close enough to the terrain's path starting point
- Select *drivePath* and terrain's path on that order, go to Modeling > Curves > Attach (options) uncheck keep originals
- Select the drivable geometry and then *frontLeft* in that order, Constraint > Geometry (default setting), repeat for *frontRight*, *backLeft* and *backRight*
- Determine the length of *drivePath* by using Arc Length Tool, Create > Measurement Tools > Arc Length Tool. Input this value into the custom attribute pathLength on *master*

Note: Increase and decrease the speed of the vehicle as it moves along the path by adjusting the animation graph of motionPath1 uValue.

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