Game Development with Unreal Engine 5

Learn the Basics of Game Development in Unreal Engine 5

Mitchell Lynn
Cliff Sharif

bpb

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www.bpbonline.com

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Dedicated to

Game Programmers, Application Developers and Game Designers,

who like to make the “Unreal” with “Unreal Engine 5”

-

About the Authors

Cliff Sharif (aka Emperor Katax) is programmer and digital artist. His first touch to digital content was with Commodore 64 and Amiga 500. He practiced early steps of programming multimedia and real-time application with these platforms and also touched first edges of digital art belongs to that era. Then he began his carrier with programming and digital art in 1998, by using Windows 98.

Cliff was an Unreal Tournament pro gamer and was involved with WCG international tournaments as team organizer back in 2004. Then after publishing his first book “Unreal Engine Physics Essentials”, he switched his main carrier on develop application with Unreal Engine. He was involved in develop, manage and design industry standard applications of Virtual Reality, Architectural Visualizations, Real-time midi-controlled visuals, and recently Virtual Production by using Unreal Engine with Blueprint and C++. He certified as “Unreal Authorized Instructor – UAI” by Epic Games in 2020 and after that his main focus went for teaching game programming and design with Unreal Engine to students around the world.

Mitchell Lynn is a programmer who has been playing videogames since before he could walk, he started out playing classics like DOOM and Quake on his Grandfather’s old hardware, and has continued playing through every gaming generation since. This experience has been extremely helpful to his progression and capability as a programmer.

After completing secondary education, Mitch decided to enter into the industry of creating the games that had occupied so much of his life. After a couple of years studying under Cliff to become a competent programmer, he entered the industry working on Virtual Reality simulation software, and then started

developing games, both of which using Unreal Engine. He specializes in data management-based programming, and is always happy to assist those interested in becoming a programmer themselves.

Preface

The Unreal Engine 5 is the latest game development engine released by Epic Games, and this book will cover the basic setup and usage of the engine, as well as provide and explain examples of how to create fundamental objects of a game.

After a quick review of mathematics used in game design, we go through Unreal Editor which is the main environment for debug and develop the application by using Unreal Engine 5. Then users will learn how to use programming skills in develop application by using unreal engine 5 templates and Blueprint visual programming language. This part will establish a base to discover and learn other parts of the engine in future chapters.

Users will learn create Actors which are fundamental game objects in the engine. Then we learn how to use data structures, im0plement event and event dispatchers, using interface, and handling users input data. We learn about shaders, Niagara particle system, Metasound and packaging the project by making practical examples with step-by-step instructions.

By the end of this book, user has an intermediate to advanced knowledge of how to use engine templates, and make standalone executable prototypes of games or interactive application using Unreal Engine 5.

Chapter 1 This chapter is for absolute beginners in game development. We learn about “Game Engine” and will focus on the Unreal Engine as an example of a popular and high-quality game engine which is the focus of this book. Then we go through the installation process and describe how to

customize the engine based on the user requirements. Also, we will learn how to use the Epic Games Launcher which is basically an interface to access Epic Games applications, of which Unreal Engine 5 is the latest one.

Chapter 2 Game developers need proper math skills for solving complex problems. An example could be calculation movement of 3D object in space, or calculating a target angle between 2 objects when they are pointing towards the player. Solving each of these problems requires knowledge of math which we learn in this chapter. Covering each aspect of the mathematical approach used in the digital world is not our goal in this chapter, but the user will go through the basics of math and follow the learning path to permit understanding more complex topics.

Chapter 3 This chapter will cover using the Epic Games launcher to open, update, or repair the engine, as well as how to use the marketplace. It will also cover the basic standard layout of the editor, how to modify the layout of the editor, where the important menus are located, their purpose, and how to use them, as well as explain useful hotkeys (and Reroute nodes), and skim through the project settings and plugins menus.

Chapter 4 Unreal Engine 5 uses a visual scripting language for making games and applications known as “Blueprint”. In this chapter users will learn the basics of blueprints, how to make and populate them in the scene and learn how to import mesh components into the game application and assign them in the blueprint. Also, users will learn how to use game engine resources by adding blueprint components to their blueprint object and basics of using physics. At the end, users learned basic knowledge of blueprint design before they learn coding in blueprints in the next chapters.

Chapter 5 By using previous knowledges from chapter 4, users will learn how to develop code in blueprints and make game objects. Also, users will learn about Unreal Engine 5 templates, and how to program user input to

the game character which meet learning more about Project Setting in the editor. Also, user learn how to change graphic setting of game in cases of rendering and light.

Chapter 6 Levels within UE5 consist of objects, (of which there are many types), and knowing these objects and how they function within the application, is essential for efficient & effective "Object Oriented" programming. We learn about game objects and materials in this chapter. Numbers of actor components that create game object in the game, can use materials. Material changes the appearance of the game object and can be simple or very complex.

Chapter 7 This chapter will cover the basic types of data (Ones that see regular use) used within Unreal Engine 5 (And programming in general), what each type is exactly, additional information about them, as well as their uses and benefits, with use-case examples. It will also cover how they can interact with each other (Pin splitting and conversions)

Chapter 8 Previously in chapter 5, users learned to use collision events to handle the collision. Now they will learn an advanced level of programming blueprints which is "Event Handling" and "Interface". We learn the "core knowledge" of communication between game objects in the engine which is essential for any scenario of applications development with Unreal Engine 5.

Chapter 9 There are a number of more complicated types of variables that aren't used as much as the simpler ones, but are arguably more important, as they are generally used for creating larger, core systems that the simpler variables are used within. We also cover how to use data for changing pos, in an animation Instance game object.

Chapter 10 This chapter will cover the more advanced aspects of game objects, including some other components with their functionalities/events (Projectile components, actor components, projectile components, movement components, etc.). It will also cover saving data to the system that game is running on, for future usage (Serialization), which is important for keeping track of player progress and their settings.

Chapter 11 In this chapter, users learn how to use the Unreal Engine 5 audio engine and develop audio code for the game. This feature is new in Unreal Engine 5 compare to previous versions of the engine. Also, users learn the basics of using Niagara which is a particle system simulator inside the engine to generate VFX effects. We explain a simple pipeline by a practical example, for using these features.

Chapter 12 Packaging a project is the last milestone of making any application by using Unreal Engine. There are numbers of options, with layers of details which are designed for packaging the application for different target machines. It basically takes time and research, to learn the best options for packaging your application, but we cover the main concept behind packaging and how the editor provides tools and resources on this. Also, users will learn how to avoid possible issues on packaging data.

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Table of Contents

1. What is Unreal Engine?

Structure

Objectives

History of Unreal Engine

Installing Epic Games Launcher

Conclusion

Points to remember

Multiple choice questions

Answers

Questions

Key term

2. Math for Game Design

Structure

Objectives

Basic mathematics

Boolean operator AND

Boolean operator OR

Boolean operator XOR

Boolean operator NOT

Using mathematics in programming game

Vector

Vector operator add

Vector operator subtract

Vector operators multiply and divide by scalar

Vector operator Dot Product

Mathematical functions

Math function: power

Math function: Pi

Math function: ABS

Math function: floor

Math function: cell

Math function: clamp

Math functions: sine and cosine

Math function: distance

Math function: normalized vectors

Conclusion

Points to remember

Multiple choice questions

Answers

Questions

Key term

3. Editor Basics and Epic Launcher

Structure

Objectives

Epic Launcher layout

Home

Store

Library

Unreal Engine

Marketplace

Library

Project Browser

Editor layout

Standard layout

Editing the layout

Layout menu

Common hotkeys

Important menu/window locations

File tab

Edit tab

Window tab

Level editor

Logs

Experimental

Layout

Tools tab

Build tab

Help tab

Project settings

Plugins

Conclusion

Points to remember

Multiple choice questions

Answers

Questions

Key terms

4. Using Blueprints

Structure

Objectives

What is a blueprint?

Design with blueprint

Blueprint components

Adding mesh to blueprint

Adding physics

Conclusion

Points to remember

Multiple choice questions

Answers

Questions

Key terms

5. Project Templates and User Interaction

Structure

Objectives

Using Templates in Unreal Engine 5

Adding user interaction to blueprint

Developing code in Blueprint

Simple collision detection

Making simple game assets

Conclusion

Points to remember

Multiple choice questions

Answers

Questions

Key terms

6. Game Objects and Materials

Structure

Objectives

Game objects

Classes

Inheritance

Variables

Components

Transforms

Events

Construction script

Beginplay

Tick

Endplay

Custom Events

Material Editor

Material nodes

Material instances

Material data

Material Parameter Collections

Dynamic Materials

Conclusion

Points to remember

Multiple choice questions

Answers

Questions

Key terms

7. Simple Data

Structure

Objectives

Variables in blueprint

Integers (Ints)

Integer 64

Floats

Doubles

Booleans (Bools)

Strings

Name

Text

Vector

Rotator

Pin splitting

Conversions

Conclusion

Points to remember

Multiple choice questions

Answers

Questions

Key terms

8. Interface and Event Handling

Structure

Objectives

What is the event in Unreal Engine 5?

Using event dispatchers

Using interface

Line Trace in blueprint

Casting in blueprint

Interface implementation in blueprint

Using physics (advanced)

Using physical gravity

Add physical force with impulse

Make physical behavior as material

Conclusion

Points to remember

Multiple choice questions

Answer

Questions

Key terms

9. Data Processing (Enum, Struct, Map, Data Tables) and Animation Instances

Structure

Objectives

Object-based variables

Enumerators (Enums)

Bytes

Enumerator editor

Structures (structs)

Structure editor

Nested structs

Arrays

Get

Remove

Add

Set Array Element

Clear

Length

Maps

Get keys and values

Find

Length

Clear

Contains

Is Empty and Is Not Empty

Data tables

Data table editor

CSV/JSON export

Data Table usage in blueprint

Does the data table row exist?

Get data table column as string

Get data table row names

Get data table row

Animation instances

Animation instance nodes

Get Anim Instance

Has valid animation instance

Play

Stop

Set animation

Set position

Get position

Is Playing

Play animation

Set Play Rate

Get Play Rate

Set animation mode

Get animation mode

Override animation data

Animation modes

Multi-variable type operators

Conclusion

Points to remember

Multiple choice questions

Answers

Questions

Key terms

10. Game Objects (Advanced) and Serialization

Structure

Objectives

Class defaults

Class settings

Changing inheritance

Interfaces

Setup

Returns

Usage

Tick settings

Replication settings

Serialization

Save game objects

User settings

Scalability

Input

Conclusion

Points to remember

Multiple choice questions

Answers

Questions

Key terms

11. Audio and Particles

Structure

Objectives

Using Niagara

Making Niagara emitter

Making Niagara system

Using audio

Making MetaSound

Conclusion

Points to remember

Multiple choice questions

Answers

Questions

Key terms

12. Packaging

Structure

Objectives

Platforms and licensing

Plugins

Conclusion

Points to remember

Multiple choice question

Answer

Questions

Key terms

Index

CHAPTER 1

What is Unreal Engine?

Along time ago, in order to make a video game, creative developers had to work hard and solve complex problems. They had to develop their own Game Engine , making assets, debug the application and release it with limited hardware variations in the market at that time. The Game Engine is an application for creating, debugging, and publishing a video game for target machines like PC, VR, mobile, and so on. After the release of Windows 95 by Microsoft, developers got standard framework and network tools for developing high-quality and multiplayer games, which led them to create more powerful game engines. At the same time, the game industry got massive support from hardware and software manufacturers, which not only increased audio and visual quality but also supported new gaming platforms and AR/VR gaming.

Today, a team of developers and designers with a creative mind have a number of game engines and massive resources from industry to begin their project. We will learn how to use Unreal Engine 5, which is one of the most successful game engines in the industry and has massive support from the community of game developers.

Structure

In this chapter, we will discuss the following topics:

History of Unreal Engine

Installing Epic Games Launcher

Objectives

After studying this chapter, you should be able to install Epic Game Launcher and Unreal Engine 5, and you should know how to customize your installation. In this chapter, we will also go through a brief history of Epic Games and Unreal Engine and review some important titles there.

History of Unreal Engine

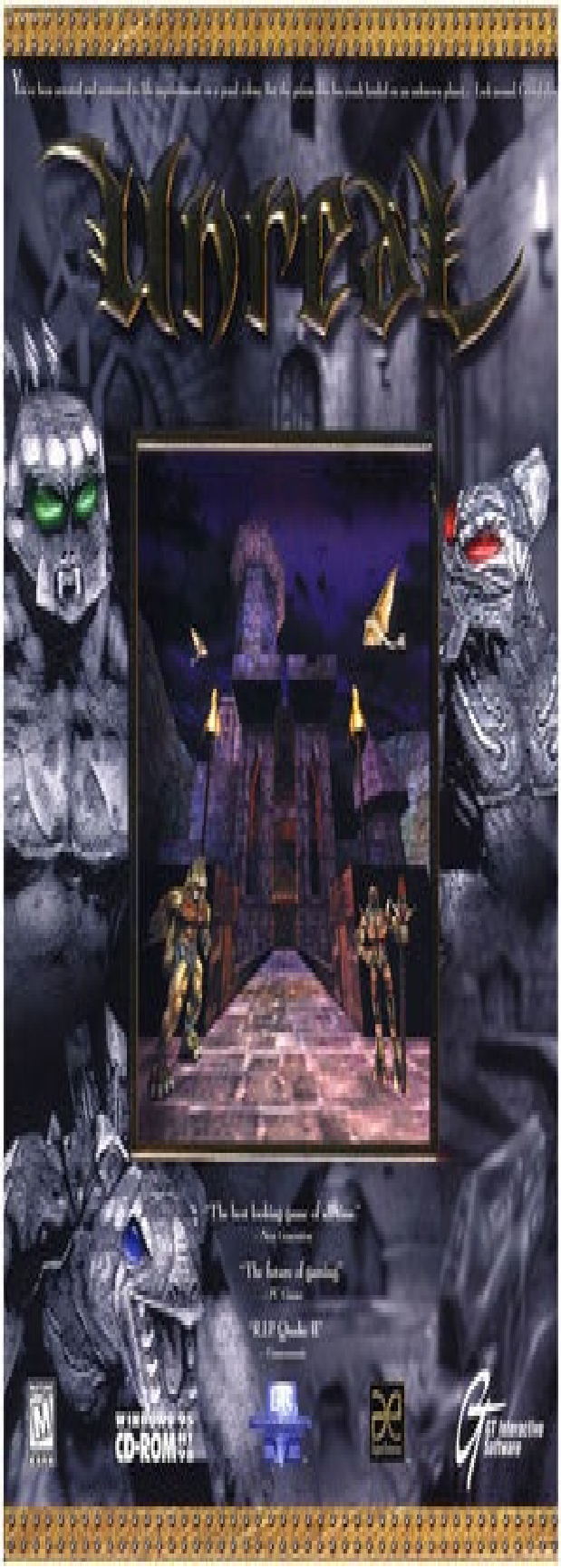
Everything began back in the late ’80s with Tim Sweeney from Maryland, when he returned home from work for holiday and turned on his IBM computer to play a video game, like he did when he was younger. He soon noticed that he is passionate about making computer games as a career, but it was an unusual decision and risky at the time. The game industry was so poor in terms of hardware and software and more importantly, lack of technical resources for making games was a serious problem for developing video games; however, none of these problems changed his mind.

Tim is one of the pioneers of the game industry like John Carmack from Id software (as you can see in Figure 1.1), who developed their own game engine from the beginning of their career. At the very beginning, he learned how to develop applications by using object-oriented programming methods, and then he developed his first game, known as ZZT, released for MS-DOS by 1991. It was a puzzle game with the modding ability. After that, he entered the game industry by opening his own company, Epic Game.

INDEPENDENT GAMES FESTIVAL
GAME DEVELOPERS CHOICE AWARDS

Figure 1.1: John Carmack and Tim Sweeney in GDCA 2017

In 1998, Epic Games released their first video game in the first-person shooter (FPS) genre called Unreal, and it got a lot of attention due to the quality of visuals in game, skeleton mesh animations, rendering techniques, audio effects, and rich game story. For making Unreal, they developed their own game engine with an editor to debug code and design game objects. By 1999, Epic Games released Unreal Tournament, which was a multiplayer first person shooter (FPS) game, and it was developed with same engine as Unreal (refer to Figure 1.2):


Unreal
"The best looking game of all time"
"The future of gaming"
"R.I.P. Quake II"
CD-ROM
GT Interactive Software

Unreal
TOURNAMENT
ALL NEW TEAM COMBAT FOR 1-16 PLAYERS
DOES NOT REQUIRE INTERNET ACCESS OR A 3D CARD

Figure 1.2: First series of FPS shooter games which released by Epic Games and developed by Unreal Engine

After the millennium, Epic Games put a massive push on the quality and flexibility of their engine and, they worked on supporting multiple platforms by the engine. That led studios and game developers to making several big titles in the industry, like Bioshock and Borderland, which brought massive marketing and support by the community of gamers and game designers.

The latest version of Epic Games game engine is known as Unreal Engine 5, and developers and designers have free access to the game engine for creating, designing, debugging, and publishing stand-alone game and non-game applications on multiple platforms and target machines like PC, Xbox, mobile, augmented reality, and virtual reality.

Now, let’s install and use Unreal Engine 5.

Installing Epic Games Launcher

Before using Unreal Engine, you must download and install an application, known as Epic Game Launcher. This application is designed to organize your game development environment, access to standard game assets, latest updates, and community news when you use Unreal Engine 5.

Let’s look at the steps for installing EPIC Games Launcher:

First, you need to make an account and profile in https://www.epicgames.com/, and then download and install the launcher. Then, open it and sign in to your Epic Games account from the launcher. You will have full access to Epic Games products, as shown in Figure 1.3, with Epic Games Launcher:

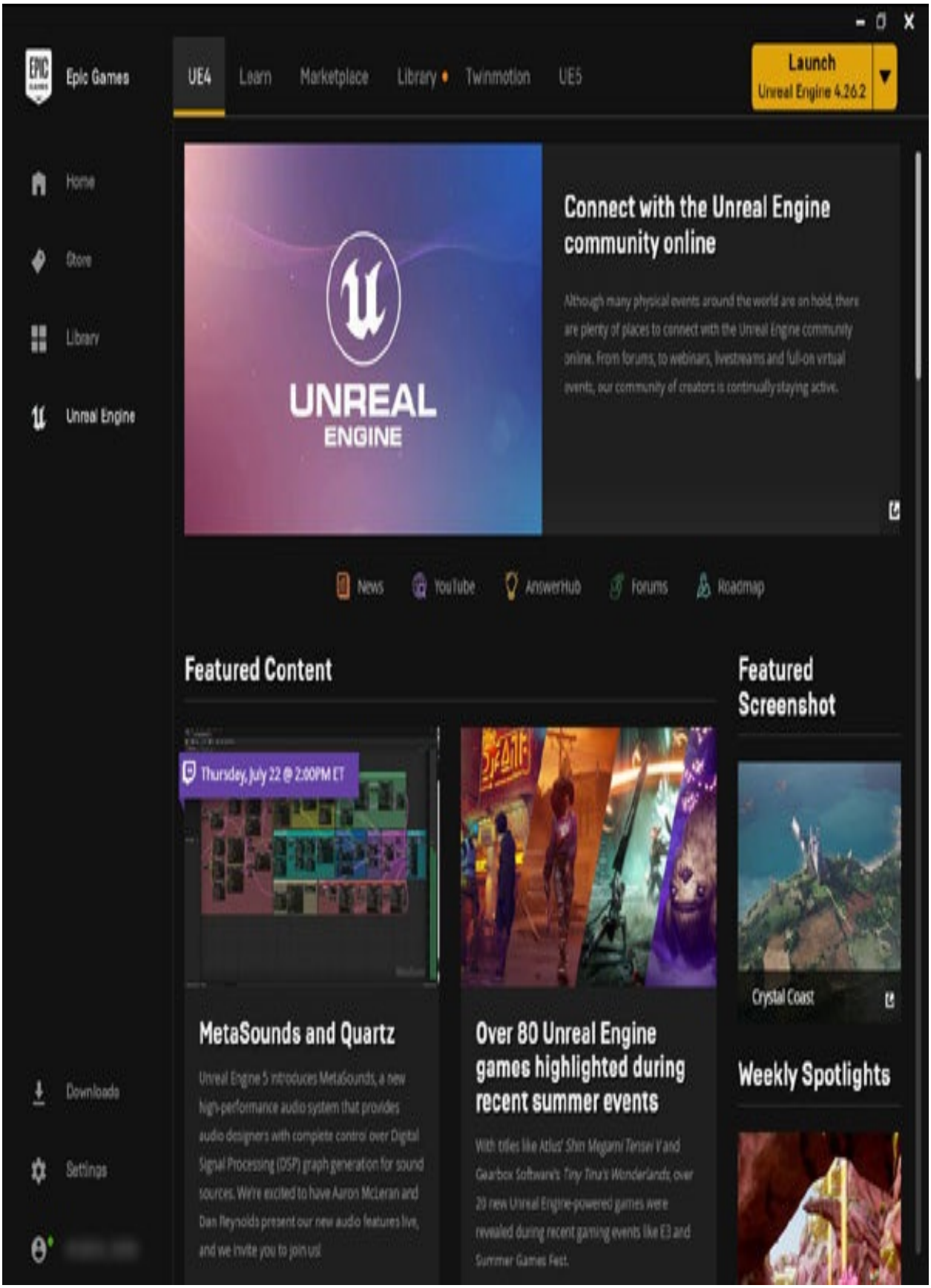

Epic Games
UE4
Learn
Marketplace
Library
Twinmotion
UE5
Launch
Unreal Engine 4.26.2
Home
Store
Library
Unreal Engine
UNREAL
ENGINE
Connect with the Unreal Engine community online
Although many physical events around the world are on hold, there are plenty of places to connect with the Unreal Engine community online. From forums, to webinars, livestreams and full-on virtual events, our community of creators is continually staying active.
News
YouTube
AnswerHub
Forums
Roadmap
Featured Content
Thursday, July 22 @ 2:00PM ET
MetaSounds and Quartz
Unreal Engine 5 introduces MetaSounds, a new high-performance audio system that provides audio designers with complete control over Digital Signal Processing (DSP) graph generation for sound sources. We're excited to have Aaron McLeran and Dan Reynolds present our new audio features live, and we invite you to join us!
Over 80 Unreal Engine games highlighted during recent summer events
With titles like Atlus' Shin Megami Tensei V and Gearbox Software's Tiny Tina's Wonderlands, over 20 new Unreal Engine-powered games were revealed during recent gaming events like E3 and Summer Games Fest.
Featured Screenshot
Crystal Coast
Weekly Spotlights
Downloads
Settings

Figure 1.3: Epic Games Launcher

To install Unreal Engine 5, click on the Unreal Engine tab in the launcher and then click on the Library tab on top; then, locate the ENGINE VERSIONS title and click on the plus-shaped drop box, as shown in the following figure:

Epic Games
UE4
Learn
Library
UE5
Launch
Unreal Engine 4.26.2
Home
Store
Library
Unreal Engine
ENGINE VERSIONS
GITHUB SOURCE
RELEASE NOTES
107.9 GiB
MY PROJECTS
Search Projects
Downloads
Settings

Figure 1.4: Navigate to Unreal Engine tab, click on library and add new engine version by clicking on the dropdown menu

The launcher will automatically add an icon that represents your engine version. You can add and install multiple versions of Unreal Engine on your system by customizing the engine's version, as shown in Figure 1.5:

Epic Games
UE4
Learn
Marketplace
Library
Twinmotion
UE5
Launch
Unreal Engine 4.26.2
Home
Store
Library
Unreal Engine
ENGINE VERSIONS
GITHUB SOURCE
RELEASE NOTES
107.9 GiB
4.26.2
4.25.4
5.0.0
4.18.3
Launch
Installed Plugins
4.24.3
4.27.0 Preview 2
4.24.3
4.23.1
4.22.3
4.21.2
4.20.3
4.19.2
4.17.2
4.16.3
4.15.3
MY PROJECT
Search Projects
Downloads
Settings

Figure 1.5: Select engine version from engine panel and install Unreal Engine 5

Here's the main reason behind this: imagine that you find a game asset or plugin from a marketplace or other source, which is not compatible with newer versions of the engine. In these cases, you can download the older version of the engine, which is compatible with your asset/plugin, and then migrate it to the new version and fix the possible issues. We will go through this in detail in the following chapters.

Keep in mind that Unreal Engine 5 needs quality hardware features on your target machine to perform rendering and functionalities; so, double-check your system features before installing the engine. It is highly recommended to have more than 200-400 gigabit free space on local hard drives to avoid performance issues when you debug and run your game, when using assets, and when working with git technologies.

Here is list of recommendations and minimum hardware requirement for running Unreal Engine 5 and its standard sample projects on PC target machine:

Recommended hardware

Operating system: Windows 10 64-bit

Processor: 12-core Intel or AMD, 3.4 GHz or faster

Memory: 64 GB RAM

Video card/DirectX version: NVIDIA RTX 2080 or AMD Radeon 5700 XT

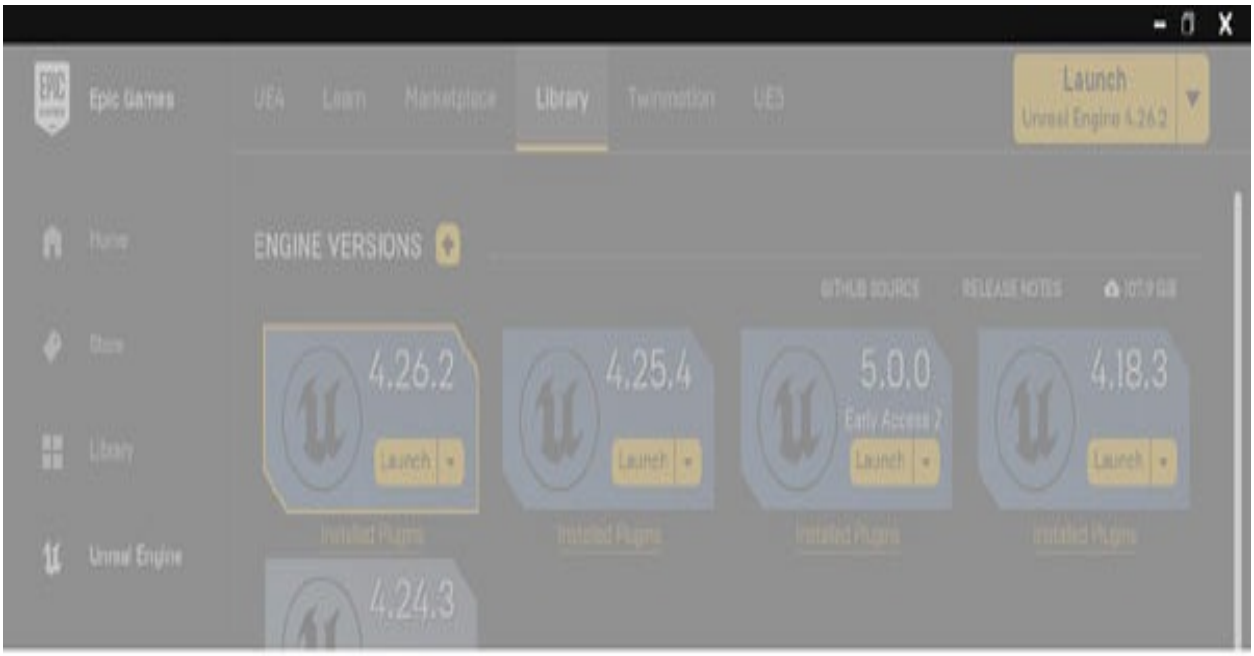
Minimum software requirements for running the engine or editor

Operating system: Windows 10 64-bit

Memory: 32 GB RAM

Video card/DirectX version: 8 GB of VRAM like NVIDIA GTX 1080 or AMD RX Vega 64

After you press Install for any version of engine, you will be prompted to customize the folder and path of your installation, as shown in Figure 1.6:


Epic Games
UEA
Learn
Marketplace
Library
Twinmotion
UE5
Launch
Unreal Engine 4.26.2
Home
Store
Library
Unreal Engine
ENGINE VERSIONS
GITHUB SOURCE
RELEASE NOTES
4.26.2
4.25.4
5.0.0
Early Access 2
4.18.3
4.24.3
Launch
Installed Plugins

Choose install location
Folder:
Browse
Path:
Options
Create Shortcut
Install
Cancel

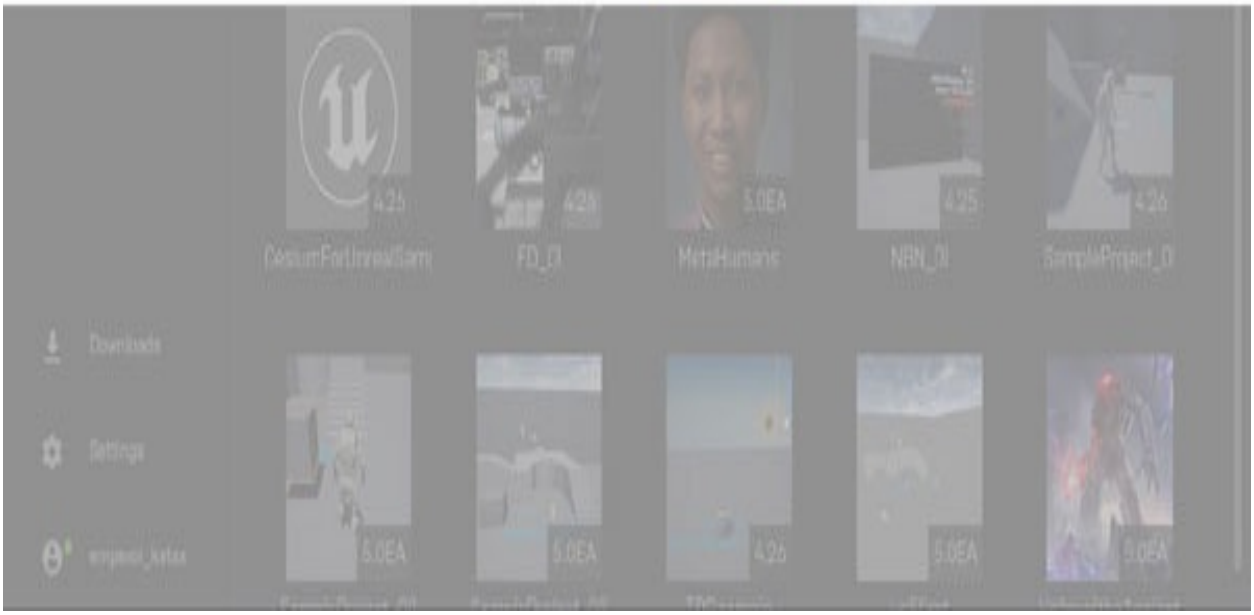

4.25
4.26
5.0EA
4.25
4.26
CesiumForUnrealSam
FD_0
MetaHumans
NBN_0
SimpleProject_0
Downloads
Settings
5.0EA
5.0EA
4.26
5.0EA
5.0EA

Figure 1.6: After pressing "Install", you will be navigated to the install page

Keep in mind that the Folder field represents a common folder that belongs to Epic Games applications. The Path field represents the folder of your selected engine version.

For example, Figure 1.7, as you see, has four different versions of engine plus Houdini and Unreal Tournament requirements, all located in the Epic Games folder, which is present in the Folder field on the installation page:

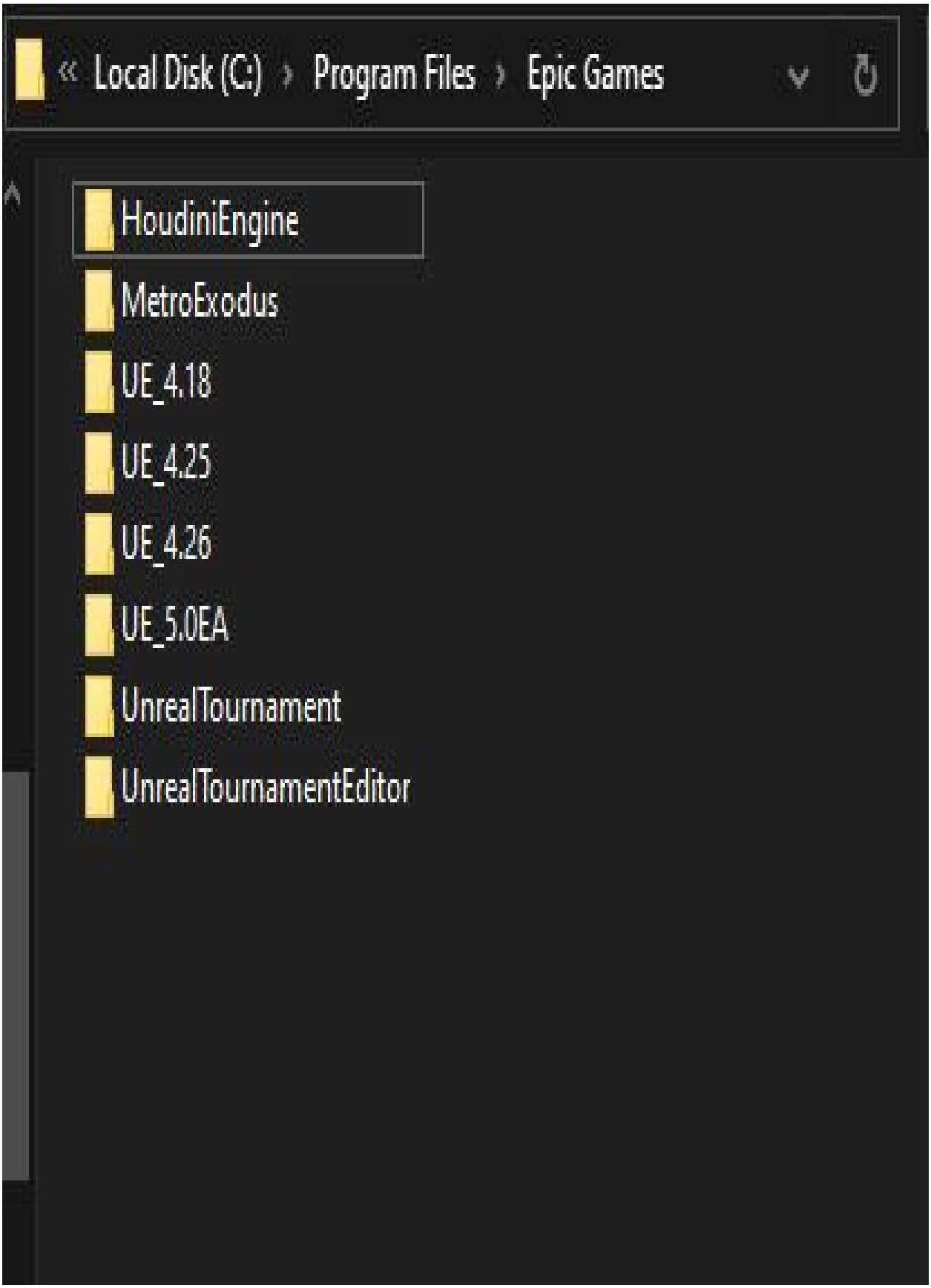

« Local Disk (C:) › Program Files › Epic Games
HoudiniEngine
MetroExodus
UE_4.18
UE_4.25
UE_4.26
UE_5.0EA
UnrealTournament
UnrealTournamentEditor

Figure 1.7: Example of having different version of engine inside "Epic Games" folder

Each engine folder represents the Source of a specific version of Unreal Engine, and when you make a new project, the engine makes an exact copy of necessary files from this folder and makes a new folder and project for work in your selected path. We will go through this process in the following chapters, but keep in mind that any custom change in this folder and its contents may bring risk and instabilities to your project, so don't touch the contents of engine folders. Figure 1.8 illustrates the default folder structure of Unreal Engine 5:

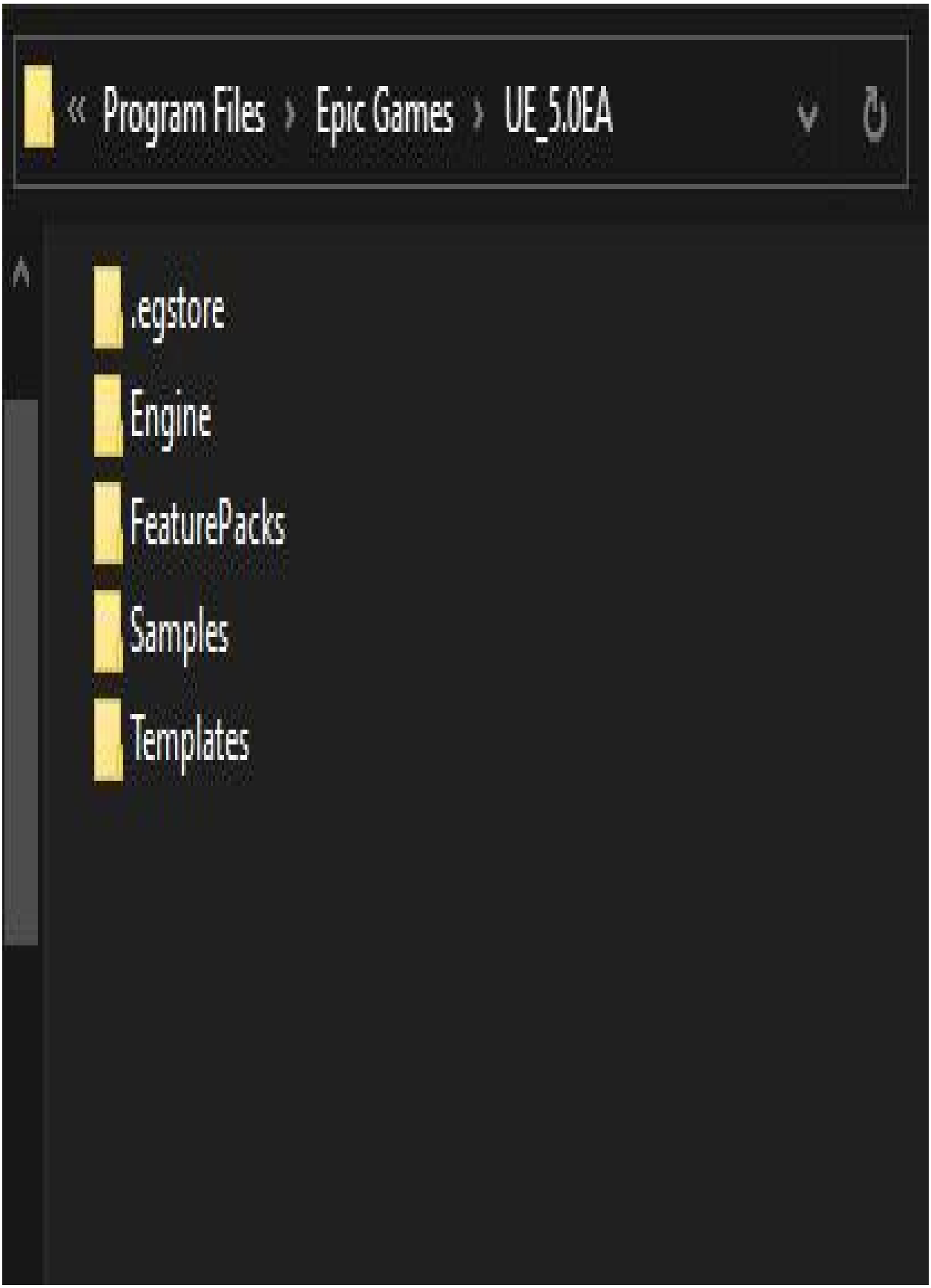
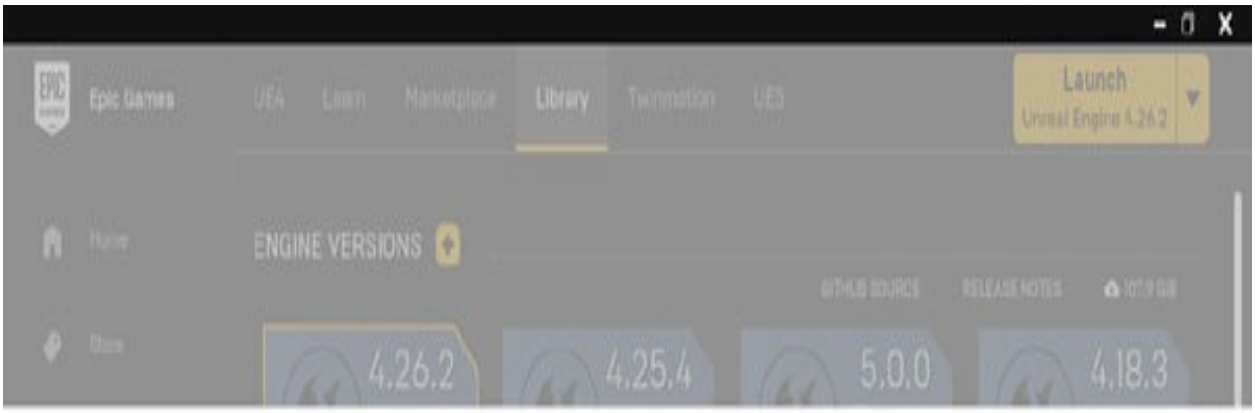
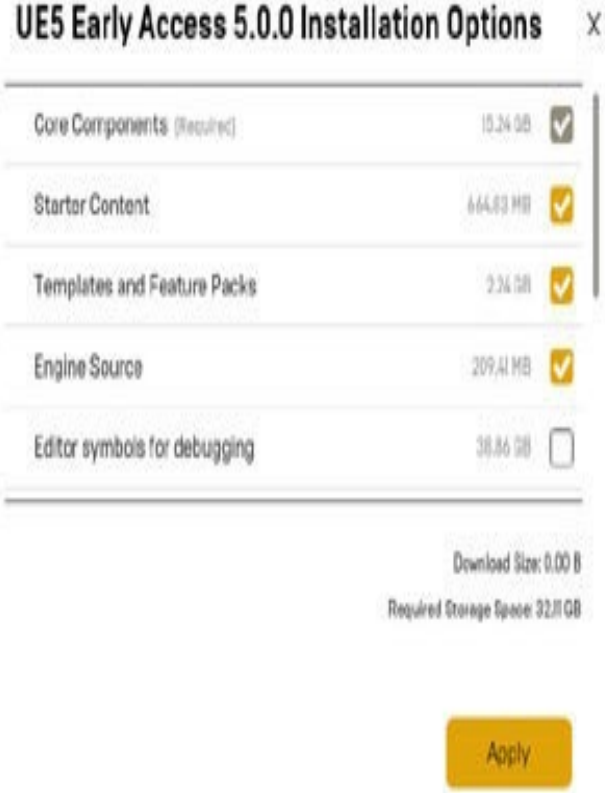

« Program Files › Epic Games › UE_5.0EA
.egstore
Engine
FeaturePacks
Samples
Templates

Figure 1.8: Unreal Engine 5 default folder structure

After you set the installation path, click on the Option button to navigate to the option page. In the page shown in Figure 1.9, you can customize your engine installation based on your project features. For example, if we have an Android device like a mobile phone, and our project is mobile game development, then the engine has to use a number of extra resources to compile and debug your game during development. So, you have to tick Android in the Target Platform section to get essential support for the engine. On the other hand, imagine that you have a simple PC project, and it doesn’t need Android support. Here, you can deactivate android support and save local drive space.


Epic Games
UE4
Learn
Marketplace
Library
Twinmotion
UE5
Launch
Unreal Engine 4.26.2
Home
Store
ENGINE VERSIONS
GITHUB SOURCE
RELEASE NOTES
4.26.2
4.25.4
5.0.0
4.18.3


UE5 Early Access 5.0.0 Installation Options
X
Core Components (Required)
Starter Content
Templates and Feature Packs
Engine Source
Editor symbols for debugging
Download Size: 0.00 B
Required Storage Space: 32.11 GB
Apply

Downloads
Settings
5.0EA
5.0EA
4.26
5.0EA
5.0EA

Figure 1.9: Unreal Engine 5 option page

There is a list of options on this page, which is as follows:

Core components: Engine native libraries, editor tools and essential components

Starter content: Premade multiple assets to help development and design prototypes

Template and feature packs: Provide numbers of premade templates based on your project like first person shooter or VR; we will grab and use the ThirdPerson template during this book to learn and debug our C++ code

Engine source: Complete source code of engine written in C++ programming language and accessible via Visual Studio or any C++ compatible IDE

Editor symbols for debugging: Add extra libraries and symbols for debugging

Target platforms: List of drivers of target machines

When you finish installing a version of the engine, you can always customize it at any time. As you see in Figure 1.10, you can click on the small arrow located on each engine panel and then click on Options from the dropdown menu:

Epic Games
UE4
Learn
Marketplace
Library
Twinmotion
UE5
Launch
Unreal Engine 4.26.2
Home
Store
Library
Unreal Engine
ENGINE VERSIONS
GITHUB SOURCE
107.9 GB
4.26.2
Launch
Installed Plugins
4.25.4
Launch
Installed Plugins
5.0.0
Early Access 2
Launch
Installed
4.18.3
Launch
Installed Plugins
4.24.3
Install
Options
Set Current
Create Shortcut
Remove
Verify
MY PROJECTS
Search Projects
Downloads
Settings

Figure 1.10: Customize game options after install engine

For example, imagine that you have to make a new project that supports HoloLens, and when you install the engine, you untick the HoloLens option there. In this case, you can tick the HoloLens in Target Platforms, and the launcher will automatically install the related resources.

The drop-down menu also has following options:

Set Current: Select this version of engine as the default version to launch, which will be represented at the top-right side of your launcher screen, as shown in Figure 1.11:

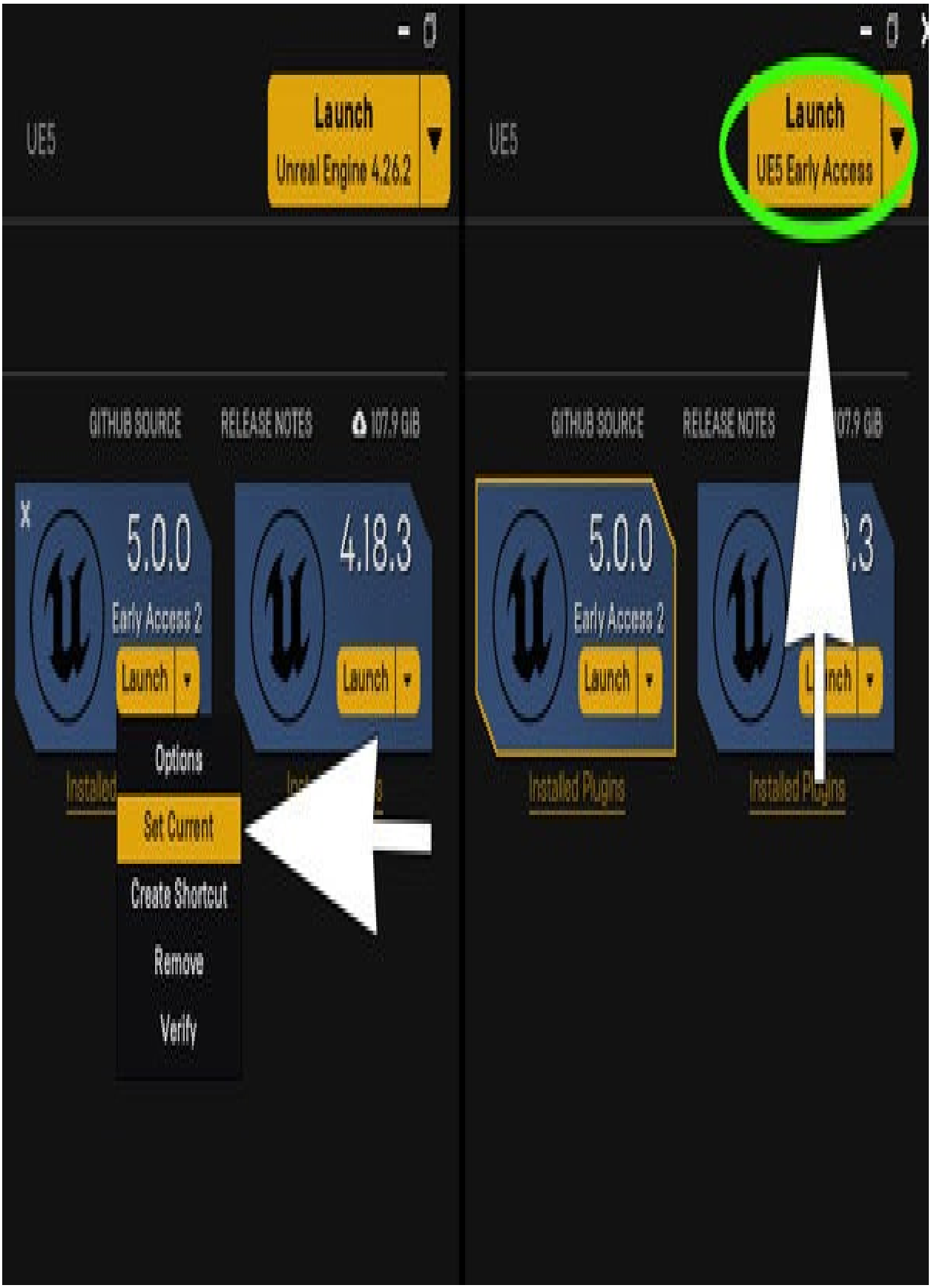

UE5
Launch
Unreal Engine 4.26.2
GITHUB SOURCE
RELEASE NOTES
107.9 GIB
5.0.0
Early Access 2
Launch
4.18.3
Launch
Options
Set Current
Create Shortcut
Remove
Verify
UE5
Launch
UE5 Early Access
GITHUB SOURCE
RELEASE NOTES
5.0.0
Early Access 2
Launch
Installed Plugins
Installed Plugins

Figure 1.11: Set engine version as default for launch

Create Shortcut: Make a shortcut of this version and add it to your desktop for a quick launch.

Remove: Uninstall the engine with all its components.

Verify: After installation, you can verify your installed file in case of custom changes to the local source or missing files.

Conclusion

During the past decades, Epic Games had a massive impact on the industry in the case of designing and developing video games on multiplatform. They created their own game engine, known as Unreal Engine, and released it as a free application to download and use by the public. The qualities and multi-platform approaches of their game engine resulted in brilliant video games and huge support by game designers and programmers after the millennium. The Unreal Engine 5 is the latest version of Unreal Engine, which has a major improvement on mesh processing, dynamic lights, and audio programming. For using it, check your system preferences, make an account in Epic Games online portal https://store.epicgames.com/en-US/, and then install Epic Game Launcher. This application is designed to organize and support your game design projects with Unreal Engine. From the launcher, you can install a number of versions of the engine and also customize their options.

We will go through making projects and using game templates in the next chapter.

Points to remember

By default, you can use Epic Game Launcher to install multiple versions of Unreal Engine.

You can customize and remove each version of Unreal Engine by using launcher menus.

Multiple choice questions

How can you add or remove versions of Unreal Engine on my computer?

Using Epic Game Launcher and navigating to the Library tab

Using Epic Game Launcher and navigating to the Marketplace tab

Using Visual Studio Installer and navigating to the Workflow tab

Using Epic Game Launcher and navigating to the Unreal Engine tab

Answer

a

Questions

Is that possible to install multiple versions of Unreal Engine and use them on the same machine?

As a default installation, how much space do you need on your hard drive to install Visual Studio and Unreal Engine together?

Key term

Epic Game Launcher is the application that installs and customizes engine versions and gives access to other Epic Game online services like Marketplace. You have to make an account and profile through Epic Game home page, i.e., https://www.epicgames.com/, before using this application.

CHAPTER 2

Math for Game Design

Making computer games meet using programming skills invents a harmony of visuals and sound effects, which interact with players based on their inputs. Players can interact with games via keyboard and mouse or any other controllers like VR set or console. Everyone knows that player interactions with game is a human factor, so as a beginner, they may have numbers of mistakes, like randomly/accidently clicking on buttons or pushing the wrong button. After a player becomes an expert in a game, their interaction with the game gets more mature and accurate on time. So, how we can make a bridge between human input as a player and the video game we designed in order to make a good gaming experience for player either as a beginner or an expert? What is the secret of making a harmony of visuals and assets that supports the Fun of gaming?

The answer is hidden in two main factors of the game: the quality of design and the efficiency level of the code. In this chapter, we will go through essential knowledge of mathematics, which any game developer needs to develop code for game. Mathematical approaches are an important part of any game development. They can support game mechanics, tune shaders, and increase performance. Mathematical functions and procedures are involved in creating material, playing animation, running special effects, supporting logics in inventory system, simplifying user interactions, calculating delays, and much more. Having advanced knowledge of mathematics and numeric in programming will always give accurate results and efficient qualities in any video game project.

Structure

In this chapter, we will discuss the following topics:

Basic mathematics

Using mathematics in programming game

Vector

Mathematical functions

Objectives

After studying this unit, you will learn the basics of mathematics in game development by going through numeric and Boolean data types and learn how and where to use mathematical operations on these basic data types. After this, you will learn how to use Vector and its operations and formulas, which is great knowledge on each game development scenario. At this stage, you are ready to learn more complex mathematical topics and as planned, you will learn essential knowledge of Trigonometry and functions related to it. Unfortunately, there is not enough space in this chapter to cover all aspects and details of Trigonometry, but we will cover a good base for your future research and studies on this important topic in math and game development.

We will also cover distance and normalize at the end of this chapter.

Basic mathematics

Each data in computer needs space in the memory to store its value, and it must be connected to a variable in your code in order to accessed it`s values by your application. On each game application, you will find numbers of variables that are responsible to store various kind of data or better say, Data Type in memory. There is a long list of data types in Unreal Engine 5, and we will cover most of them and their relation to variables over the following chapters, but for now, we like to get an overview on mathematical procedures, so let’s focus on numeric and Boolean data types that are commonly used for making variables in order to perform mathematical operations and functions in game.

The Numbers are represented by numeric data types, and the Booleans are represented by Boolean data types. A variable made from a numeric data type is simply a signed number, and you can use it for making health bar of player, damage of player weapon, enemy distance from others or the color values of friendly unit’s armor. All these examples use a signed number to present data to player.

A variable made from Boolean data type represents True and False and that’s all! These two values (true and false) are commonly used to present binary logic of game, like decision-making, or switch between different tasks, for example, turn on night vision view from the main menu in a shooter game or defuse bomb in counter strike (as shown in Figure 2.1) and win the round. All these are examples of using a Boolean variable to switch or activate relative functions in the game:

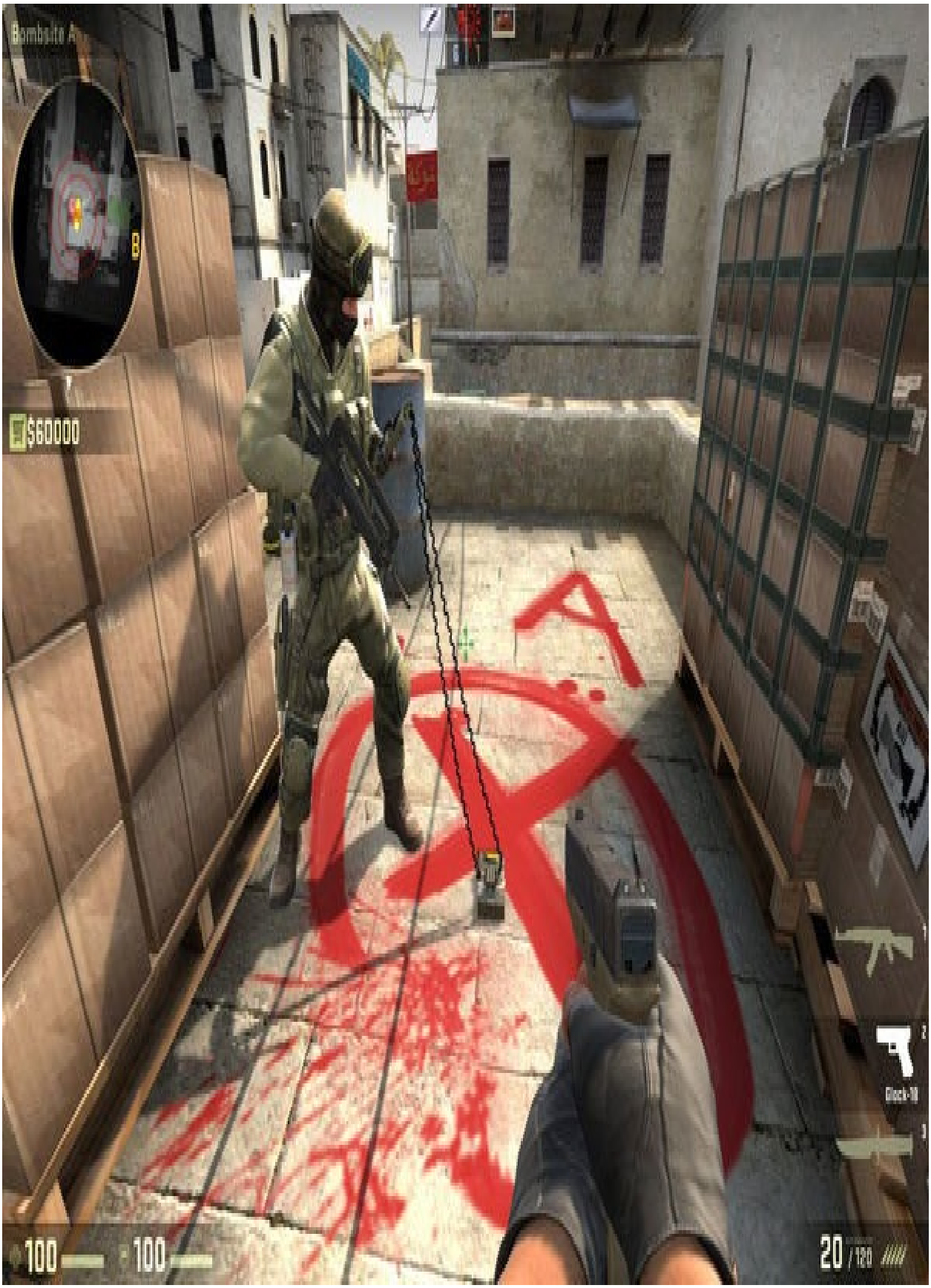

$60000
100
100
20 / 120
Glock-18

Figure 2.1: Defuse bomb in Counter Strike is basically a Boolean procedure that affects the state of the game

As we mentioned, numeric data types are simply numbers. They are implemented by three main data types in Unreal Engine 5: Integer, Float, and Byte. Integer variables are whole numbers and can be positive, negative or 0; examples are 12, -7, and 4000. Float numbers are like integers but also have an attached decimal value; examples are 0.025, 7.44, and -5.4. Numbers like 2.0 and -4.0 represent float numbers because they have an attached decimal value, which is .0. Byte variables can hold a positive whole number between 0 to 255; examples are 0, 64, 110, so numbers like 400 or -2 can NOT be implemented and hold by Byte data type.

All integer, float and byte data types have basic operators for add, subtract, multiply, divide, and modulo, which are described in Table 2.1:

Name	Sign	Output result
Add	+	Add two values with each other
Subtract	-	Subtract one value from another
Multiply	*	Multiply two values
Divide	/	Divide one value by another
Modulo	%	Return the remainder or signed remainder of a division

Table 2.1: Basic Numeric operators

Boolean data types are simply accepting True and False as value, and they are implemented by just one type known as Boolean. Sometimes these values are referred to 0 (stands for False) and 1 (stands for True), which are numeric representations of a Boolean data type. Boolean data types have a number of operators, which are shown in Table 2.2. These operators are easy to learn, but as a beginner, you have to understand when and how they can be used to simulate the logic of your game. We will go through simple examples of basic Boolean operators used in Unreal Engine 5:

Name	Output result
NOT	Returns the logical complement of the Boolean value
AND	Returns the logical AND of two values
OR	Returns the logical OR of two values
XOR	Returns the logical eXclusive OR of two values

Table 2.2: Basic Boolean operators

Boolean operator AND

This operator returns True if both comparisons are True, as shown in Table 2.3:

Variable A	Variable B	Output Result
True	True	True
True	False	False
False	True	False
False	False	False

Table 2.3: Boolean AND operator

Imagine that you are designing logic for a space simulation game. As you know, each human logically needs Air to breath and Water to drink to stay alive. So, how can we develop such a logic in our game by using Boolean? First, imagine that Air and Water are two Boolean variables like A and B, which can hold True or False as value. Now, if A is True, it means we have Air, and if it is False, it means we don't have Air, and it is the same for Water with variable B. Now, let's make some logical rules:

No Air and no Water = Player cannot survive

No Air and enough Water = Player cannot survive

Enough Air and no Water = Player cannot survive

Enough Air and enough Water = Player can survive

Now, let us replace Air and Water with variables A and B, and simplify our logic:

A is False and B is False = Cannot survive

A is False and B is True = Cannot survive

A is True and B is False = Cannot survive

A is True and B is True = Can survive

As you see, the AND operator is the best match to simulate this logic in the game.

Boolean operator OR

This operator returns True if at least one comparison is True, as shown in Table 2.4:

Variable A	Variable B	Output Result
True	True	True
True	False	True
False	True	True
False	False	False

Table 2.4: Boolean OR operator

Imagine that you are designing the logic for a city-building strategy game. Each city has a unique building that supplies electricity. This building needs either water or gas as the main resource to generate electricity. In case of having no water and gas together, the building cannot supply electricity. So, again, how can we develop such a logic in our game by using Boolean? First, imagine that Gas and Water are two Boolean variables like A and B that can hold True or False as value. Now, if A is True, it means we have enough Gas, and if it is False, it means we don't have Gas, and it is the same for Water, which is represented by variable B. Now, let us write some logical rules:

No Gas and no Water = Building cannot produce electricity

No Gas and enough Water = Building can supply electricity

Enough Gas and no Water = Building can supply electricity

Enough Gas and enough Water = Building can supply electricity

Now, let us replace Air and Water with variables A and B, and simplify our logic:

A is False and B is False = No electricity

A is False and B is True = Having electricity

A is True and B is False = Having electricity

A is True and B is True = Having electricity

As you see, the OR operator can simulate this logic for the building in the game.

Boolean operator XOR

This operator returns True if at least one comparison is True, as shown in Table 2.5:

Variable A	Variable B	Output Result
True	True	False
True	False	True
False	True	True
False	False	False

Table 2.5: Boolean OR operator

A very simple example of using XOR to simulate logic is to check the possibility of pregnancy between two individuals based on gender type. Assume that variable A and B are two individuals; here is the logic:

A is male and B is male = pregnancy is NOT possible

A is female and B is male = pregnancy is possible

A is male and B is female = pregnancy is possible

A is female and B is female = pregnancy is NOT possible

So, simply like the previous example, you can assign True and False to represent gender and then use XOR to simulate pregnancy logic based on gender in any application.

Boolean operator NOT

This operator returns the inversed value or opposite response of a Boolean variable. This means if a Boolean variable is True, the NOT operator will change it to False and if it is False, this operator will switch it to True, as shown in Table 2.6:

Variable A	Operator	Output Result
True	NOT	False
False	NOT	True

Table 2.6: Boolean NOT operator

Using mathematics in programming game

As you know, each video game has a number of 2D or 3D assets in the scene. These assets follow logical or physical rules to move, rotate, and affect other objects in the scene when the player runs the application and plays the game. Mathematics is a vital part of this experience because by using it, developers can address physical properties of each asset and control logical procedures during game play. So far, we learned about numeric and Boolean variables, and the operators belong to each group. These variables are the fundamental elements of special kinds of objects and functions that we like to describe and review in this section. By using these functions and objects, you can simulate geometric calculations, physics, and mechanics in your game. These objects and functions are common in all game development technology, so using Unreal Engine, Unity or CryEngine, you can use similar objects and math functions to develop your game.

An example of mathematical object is matrices, which is a rectangular arrangement of numeric or Boolean data types into rows and columns. Matrices are useful to solve linear equations and geometric conversions. Another example is a very common mathematical object known as Vector, which is made by numeric data types and wildly used in game development. Figure 2.2 represents 3 x 3 matrices called A on the left, which has 9 members, and there is a vector on right side, called B, that looks like an arrow:

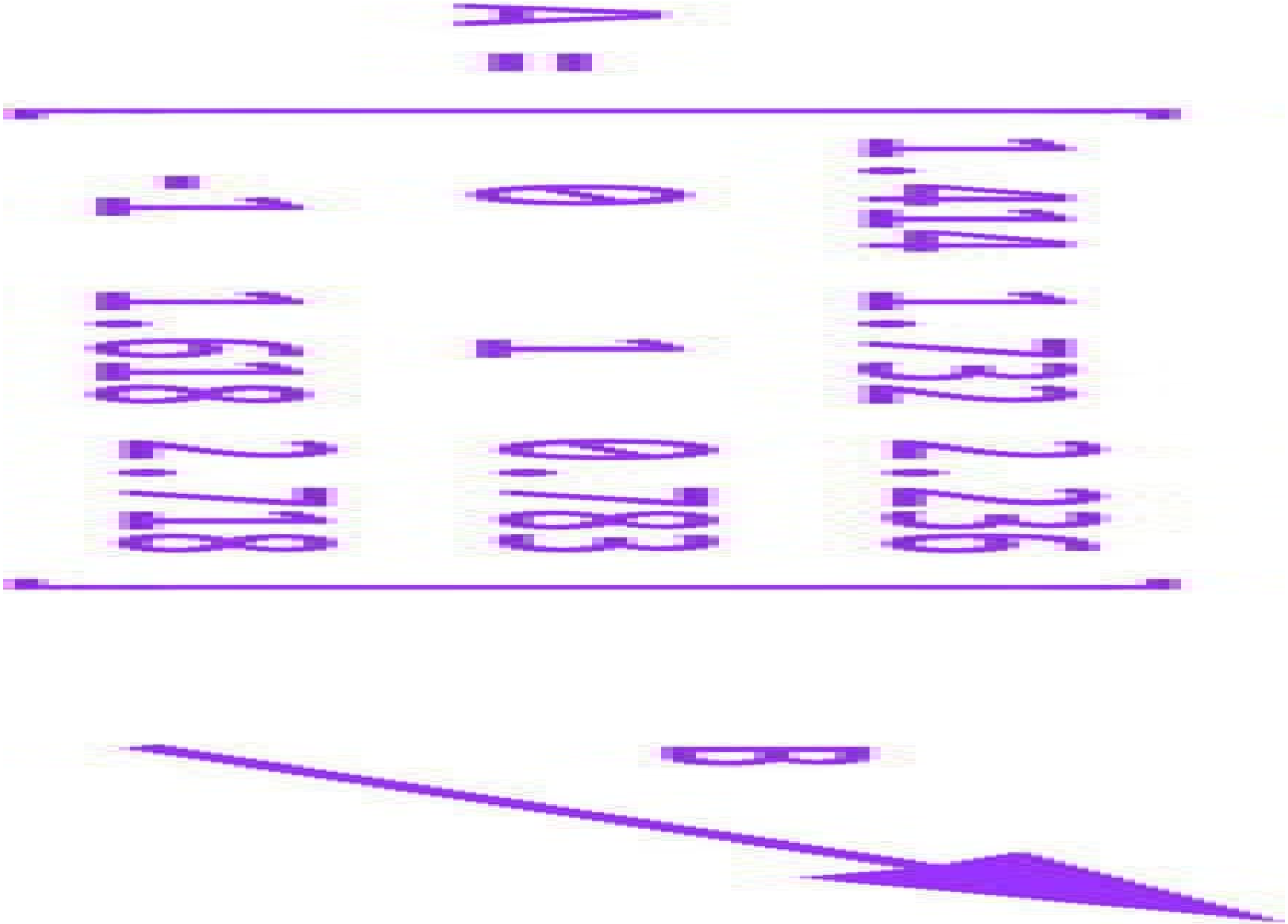


Figure 2.2: Left-representation of Matrices (Right -representation of Vector)

Vector

Vector is one of the most important mathematical objects used in each game application to commonly represent location, direction, or velocity of an object in the game scene. Each vector always has two informative factors: direction and magnitude or size. You can imagine a vector as a directed line with one start point, and an end point with an arrow, as shown in Figure 2.3:

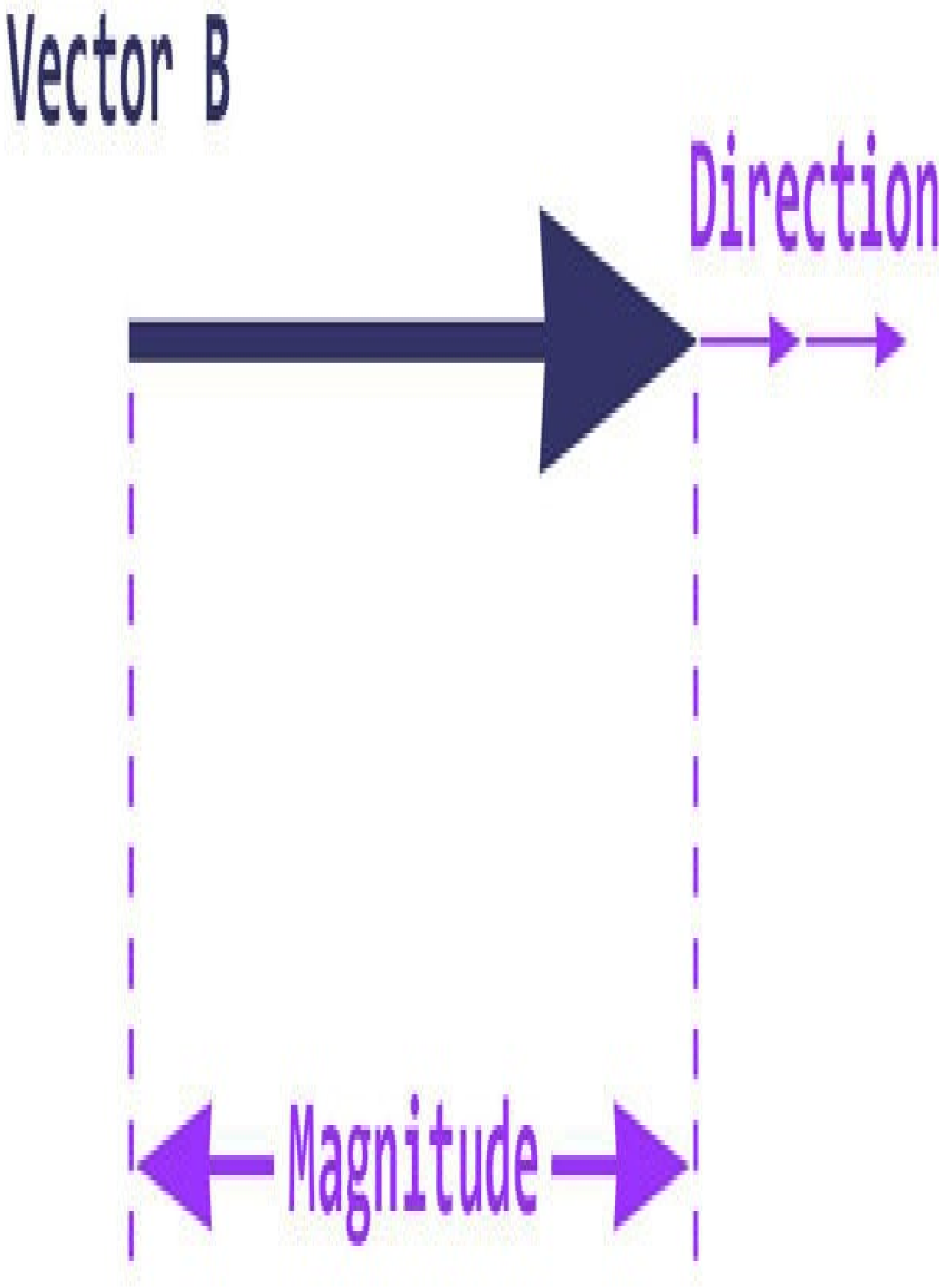

Vector B
Direction
Magnitude

Figure 2.3: Vector B magnitude and direction

In nutshell, vector is like an array made of two or more numeric data types, which are known as Vector's Elements. Each vector element can be defined as a variable of Int, Float, or Byte numeric data type. Unreal Engine 5, supports vector variables in three variations, which are shown in Table 2.7:

Vector type	No. elements	Representation	Magnitude
Vector 3	3	(x,y,z)	$\sqrt{x^2+y^2+z^2}$
Vector 2	2	(x,y)	$\sqrt{x^2+y^2}$
Vector 1	1	(x,y,z,w) or (r,g,b,alpha)	$\sqrt{x^2+y^2+z^2+w^2}$

Table 2.7: Vector variables support in Unreal Engine 5

Vector 2 has two elements and is used in 2D calculations to present numeric values of X and Y coordination's of an object in the scene. Figure 2.4 shows an example of using vector 2 to present location of 2D game objects:

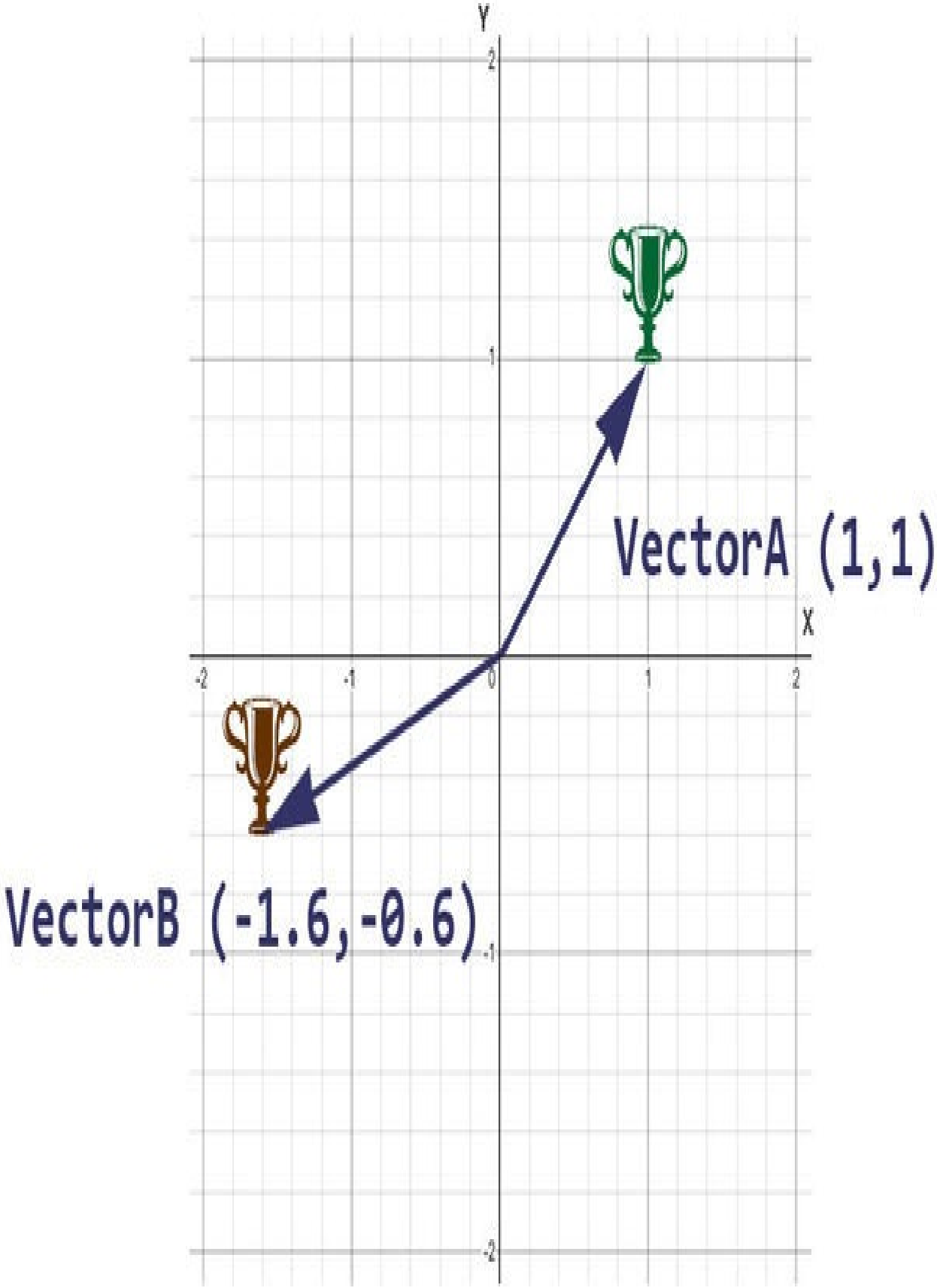

Y
X
2
1
-1
-2
-2
-1
0
1
2
VectorA (1,1)
VectorB (-1.6,-0.6)

Figure 2.4: Green cup is located at X = 1 and Y=1 and Brown cup is located at X=-1.6 and Y=-0.6 in a 2D map. Vector A uses these values as its elements to presents 2D location of the object. Follow the same rules, Vector B (-1.6, -0.6) shows the location of Brown cup at X=-1.6 and Y=-0.6.

Vector 3 has three elements and is used to present 3D coordination of geometrics objects in the scene. Figure 2.5 shows a 3D representation of a point in the space:

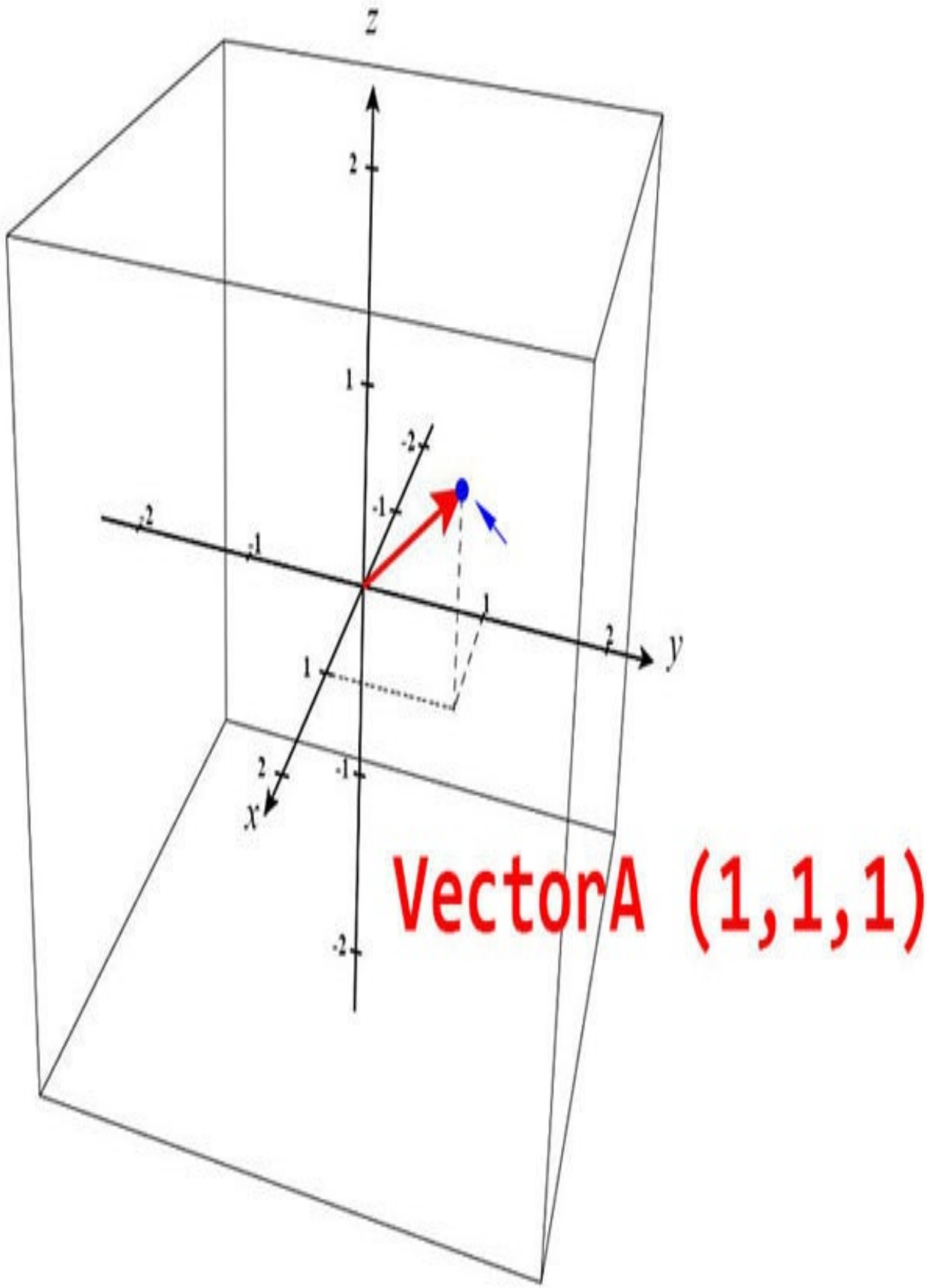

z
y
x
VectorA (1,1,1)

Figure 2.5: Blue dot is located at X = 1 and Y=1 and Z=1. Vector A uses these values as its elements to presents 3D location of the object. So, Vector A (1, 1,1) shows the location of the Blue dot at X=1 and Y=1 and Z=1.

Vector 4 is heavily used in Shader programming. Each element of this vector represents a color: R for Red, G for Green, and B for Blue. The last element of Vector 4 represents alpha or transparency. Figure 2.6 is an example of using vector 4 to create a color in material in Unreal Engine 5; we will cover this in detail in the following chapters:

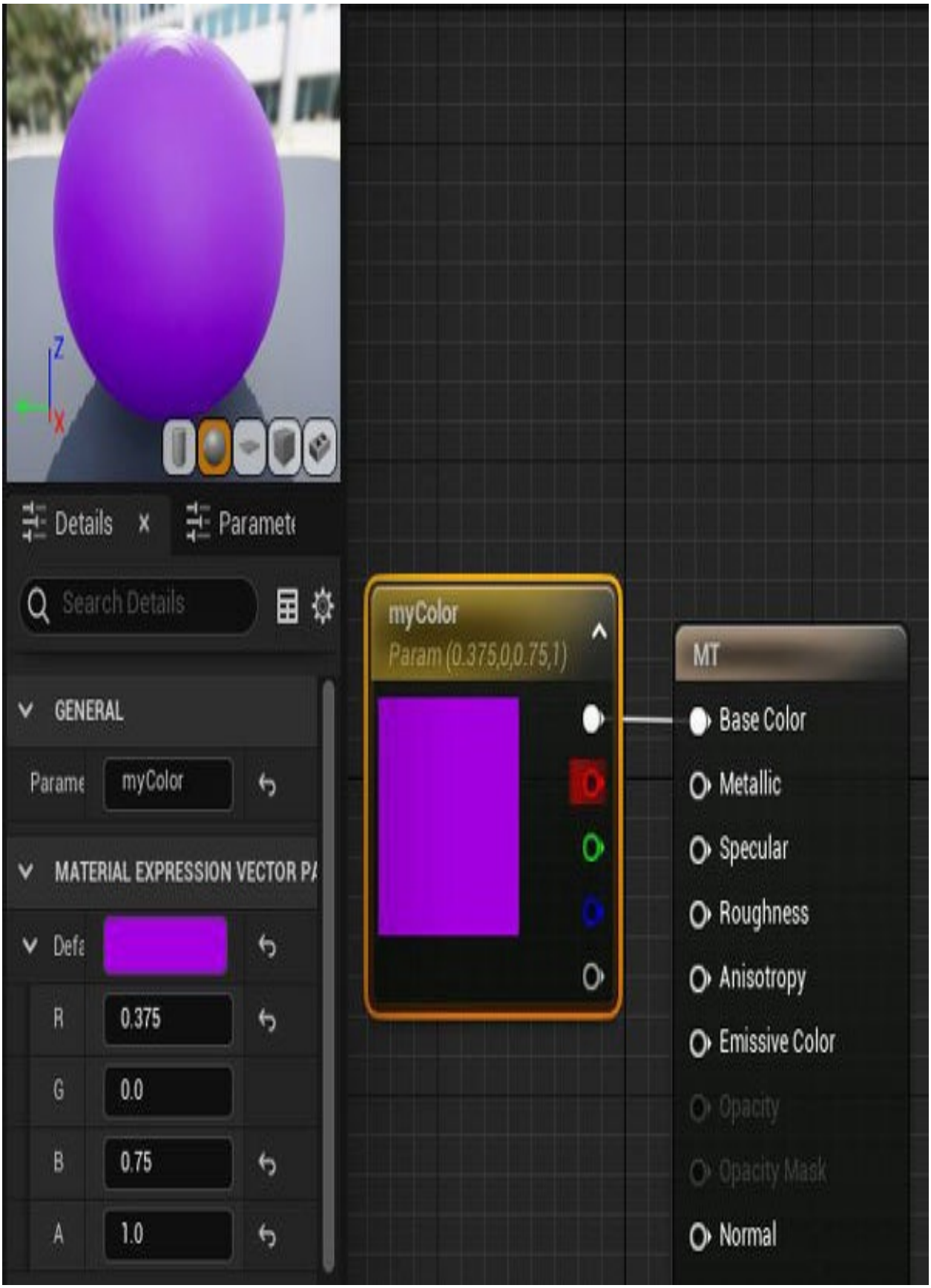

Details
Paramete
Search Details
GENERAL
Parame
myColor
MATERIAL EXPRESSION VECTOR PA
Defa
R
0.375
G
0.0
B
0.75
A
1.0
myColor
Param (0.375,0,0.75,1)
MT
Base Color
Metallic
Specular
Roughness
Anisotropy
Emissive Color
Opacity
Opacity Mask
Normal

Figure 2.6: Using a Vector 4 variable (myColor) with (0.375, 0.0, 0.75, 1.0) as element, which are addressing Red, Green, Blue, and Alpha channels to create material color in Unreal Engine 5.

You can use math operators on vectors like numeric data type. All types of vectors support operators add and subtract like numeric data types, and you can use operator multiply and divide on a vector to multiply or divide it by scalar value. In addition, vectors have one unique operator known as Dot Product, which is commonly used in shader code and creating VFX functions. Now, let's go through each operator and explain how they work.

Vector operator add

For adding two vectors, you need to add similar vector elements with each other. Assume that vector A (2, -4) and vector B (8, 6) represent x and y of two locations in the scene. Now, if you like add these two vectors, you need to add X elements with each other and the same for Y elements, so A + B = (2 + 8, -4 + 6) = (10, 2).

Vector operator subtract

For subtracting two vectors, you need to subtract similar vector elements from each other. Let’s use the previous example: consider vector A (2, -4) and vector B (8, 6) of two locations in the scene. Now, if you subtract these two vectors, you need to subtract X elements from each other, and the same for Y elements, so A - B = (2 - 8, -4 - 6) = (-6, -10).

Figure 2.7 shows a visual representation of add and subtract two vectors in a 2-dimensional map:

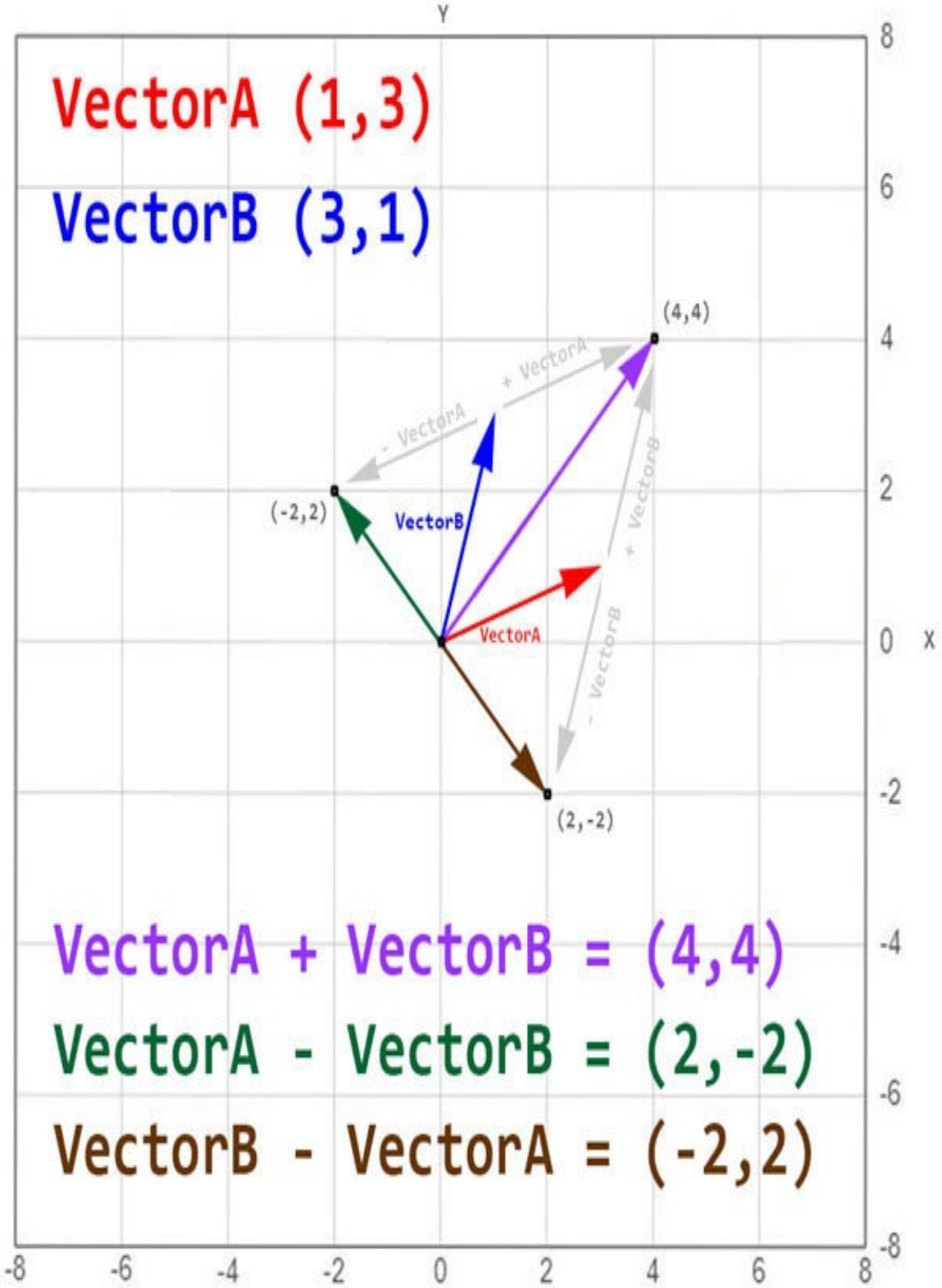

VectorA (1,3)
VectorB (3,1)
(4,4)
+ VectorA
- VectorA
(-2,2)
VectorB
+ VectorB
VectorA
- VectorB
(2,-2)
VectorA + VectorB = (4,4)
VectorA - VectorB = (2,-2)
VectorB - VectorA = (-2,2)
Y
X
8
6
4
2
0
-2
-4
-6
-8
-8
-6
-4
-2
0
2
4
6
8

Figure 2.7: Visual representation of add and subtract operation on two Vector 2

Vector operators multiply and divide by scalar

For multiplying a scalar value to vector, you need to multiply it to each element of vector. Imagine that Vectors A (2, -4, .5) represent x, y and z of a 3D object in the scene. This object has a distance from origin of map (remember that vectors have magnitude and direction), now we like to move it in the same direction. So, you can multiply or divide each element of vector by a scalar number and change the magnitude of vector. For example, if we multiply Vector A by 10, it means we move the object to a new location far from first one, and the new location will be as follows:

$$10 \times \text{Vector } A = (10 \times 2, 10 \times -4, 10 \times .5) = (20, -40, 5) \text{ new coordination.}$$

Now, to move the object closer to the origin, you can divide it by a scalar, and it works like multiplying. For example, if we like to bring the object 100 times closer to the origin, we can divide each element of vector by this number:

$$\text{Vector } A / 100 = (2/100, -4/100, .5/100) = (.2, -0.040, .005) \text{ new coordination}$$

Vector operator Dot Product

The Dot Product is a scalar value that is simply a number. Assume that Vector A and Vector B are locations of two items in a 2D map, as shown in Figure 2.8. Now, we can calculate Dot Product by multiplying similar elements of each vector and adding them to each other with the following formula:

$$A \cdot B = Ax \times Bx + Ay \times By = \quad = \quad \times \quad + \quad \times$$

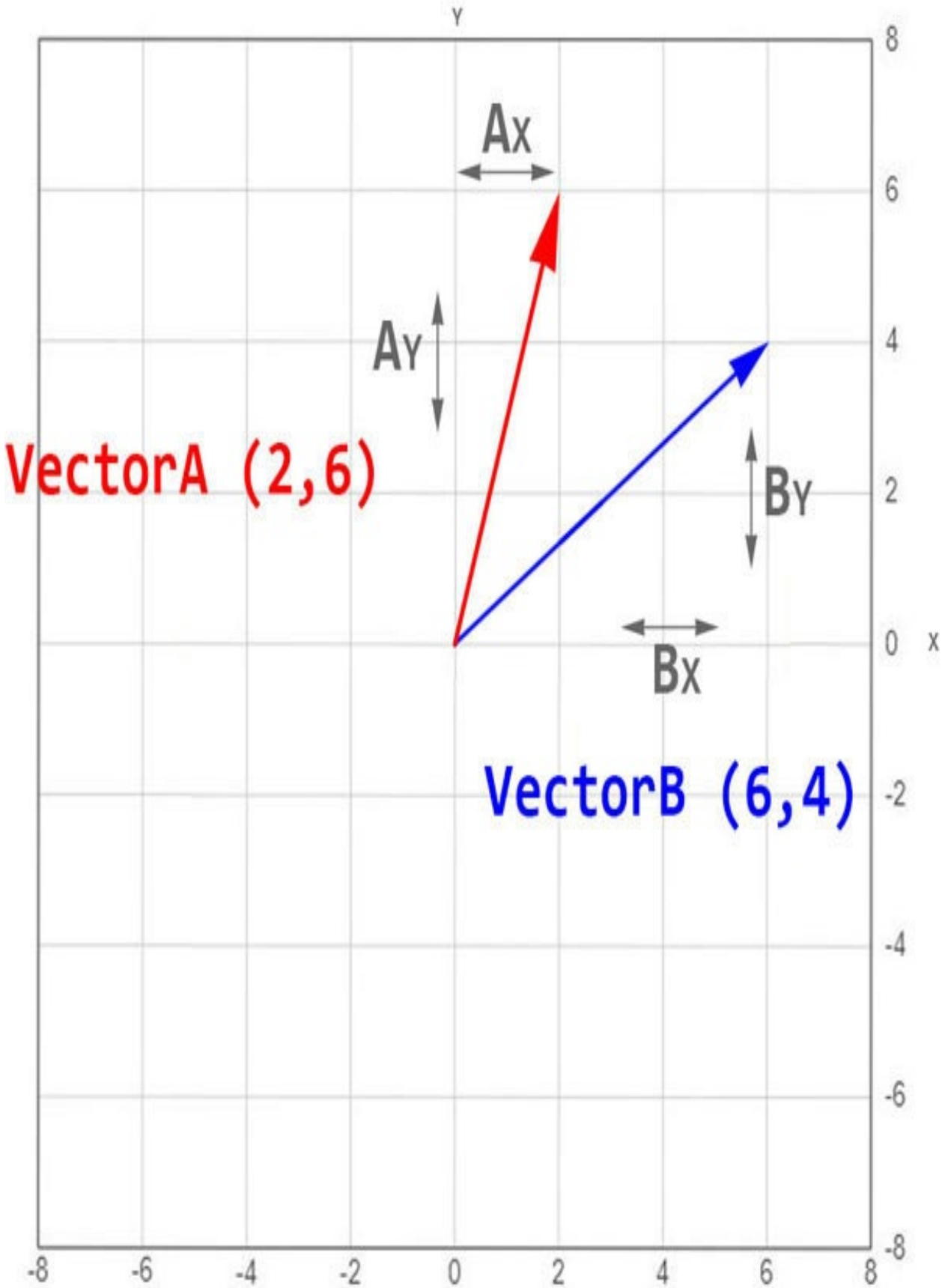

Y
X
Ax
Ay
By
Bx
VectorA (2,6)
VectorB (6,4)
8
6
4
2
0
-2
-4
-6
-8
-8
-6
-4
-2
0
2
4
6
8

Figure 2.8: Visual representation of elements of Vector A and B

You may be surprised at why such a number needs special operator to extract. This Dot Product shows features of vectors A and B and the angle between them:

When vectors A and B have a 90-degree angle between them, the Dot Product is always zero.

When vectors A and B have a 0-degree angle between them, the Dot Product is equal to multiply magnitude of each vector to other.

To calculate the Cosine of angle between vectors A and B, you need to calculate their Dot Product first, and then divide that by the value of multiplying the magnitude of each vector with the following formula:

$$A \,.\, B = \text{magnitude of } A \times \text{magnitude of } B \times \cos(\text{angle between } A \text{ and } B)$$

Figure 2.9 shows an example of finding angles between vectors by using Dot product:

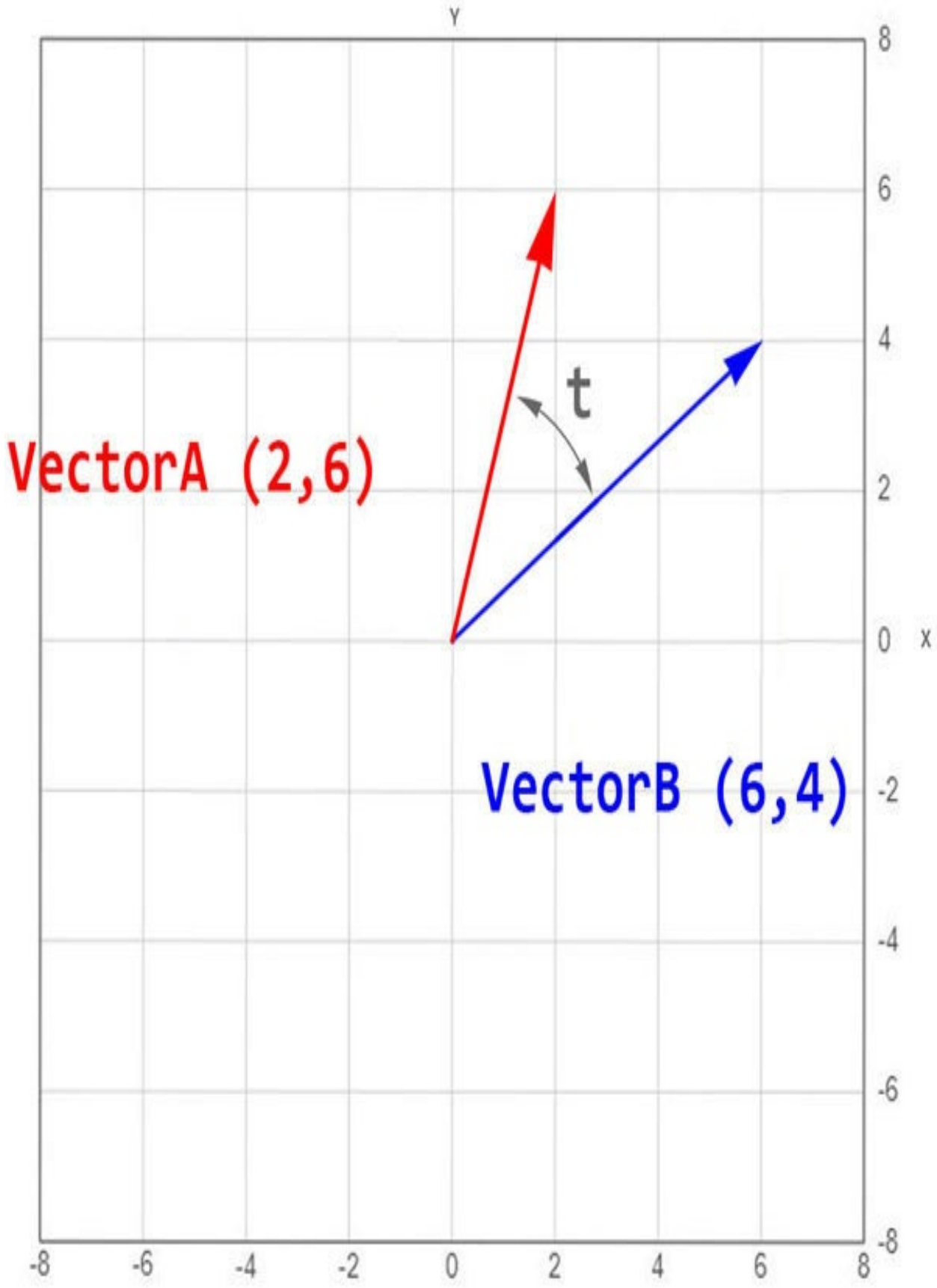

y
x
t
VectorA (2,6)
VectorB (6,4)
8
6
4
2
0
-2
-4
-6
-8
-8
-6
-4
-2
0
2
4
6
8

Figure 2.9: Vector A and B and the angle "t" between them

By using formula for vector, A (2, 6) and vector B (6, 4):

$$A \cdot B = \text{magnitude of } A \times \text{magnitude of } B \times \cos(\text{angle between } A \text{ and } B)$$

Then we have:

$$36 = 6.32456 \times 7.2111 \times \cos(t) \text{ which means } \cos(t) = 0.789$$

The angle t will be 37.8 degree.

Mathematical functions

Alongside mathematical objects like Vector, you need to use mathematical functions to simulate complex scenarios. For example, if you want to calculate power of a number or normalize a Vector, mathematical functions like Power and Normalize will be used. Unreal Engine 5 has in-depth collections of functions to express and use math for geometric, physical, and shader simulations. Here, we go through essential math functions that you must know in any game development scenario. In the following chapters, you will learn how to implement these functions into your code, but before that, you must know what they do and where to use them.

Math function: power

This function multiplies your base number by itself based on your multiplier value. For example, let's use 4 as base number and 2 as multiplier, so $4^2 = 4 \times 4 = 16$ and $3^4 = 3 \times 3 \times 3 \times 3 = 81$.

Math function: Pi

This function returns constant value for Pi number as 3.141592.

For example, the area of a circle can be found with the formula Area = $\pi \times$ radius^2, surface area of sphere can be calculated by Area = $4 \times \pi \times$ radius^2, and the formula for converting degree to radian uses Pi as well, which is degree°= $\pi \times 180 \times$ radians. There are several other formulas in geometry and physics that meet using Pi as a constant parameter.

Math function: ABS

This function returns the Absolute value of input by removing its negative sign. In case of having positive numbers as input, it returns them with no change. For example, imagine that you are a UI programmer of a city building strategy game and need to show the level of air pollution on players' monitors. You already have a variable, and if it goes below -40, an alarm message should come up and give the player information. So, by using ABS, you can simply change -40 to 40 and print a message like The pollution is 40% below Standard level!

Math function: floor

Using this function will remove the fraction from float numbers, so it returns 0 for 0.2 and 4 for 4.2. So, easy to remember, Floor only remove fraction from float numbers.

Math function: cell

Using this function, like floor, will remove fraction from float numbers, but it rounds up the number in output, so it returns 1 for 0.2 and 5 for 4.2. In short, cell remove and rounds up fraction from float numbers.

Math function: clamp

This function is used to clamp the input value to the specified minimum and maximum range as output. Suppose you need to develop code to show the positions of all players in a mini map of each player’s UI. Inside the game, distance between players can be hundreds of meters, but on the monitor, you only have an area of 240 x 240 pixels. So, a good solution will be using Clamp to Range function which converts values of player position, between minimum and maximum values of mini map`s size. That is how magic became easy: by using math functions!

Math functions: sine and cosine

Mathematics is not just Numeric and Booleans, as we discussed for game programming; it has a number of branches. One of the most important and ancient branches of mathematics that has been used for thousands of years is known as trigonometry. Trigonometry talks about triangles and their relations. This branch is extremely useful for game design and unfortunately, it isn't in the scope of this book to go through all the details of trigonometry, but as basics, let's learn the right triangle rules.

Any triangle with a 90-degree angle is called a right triangle. Each side of a right triangle has a title, as shown in Figure 2.10:

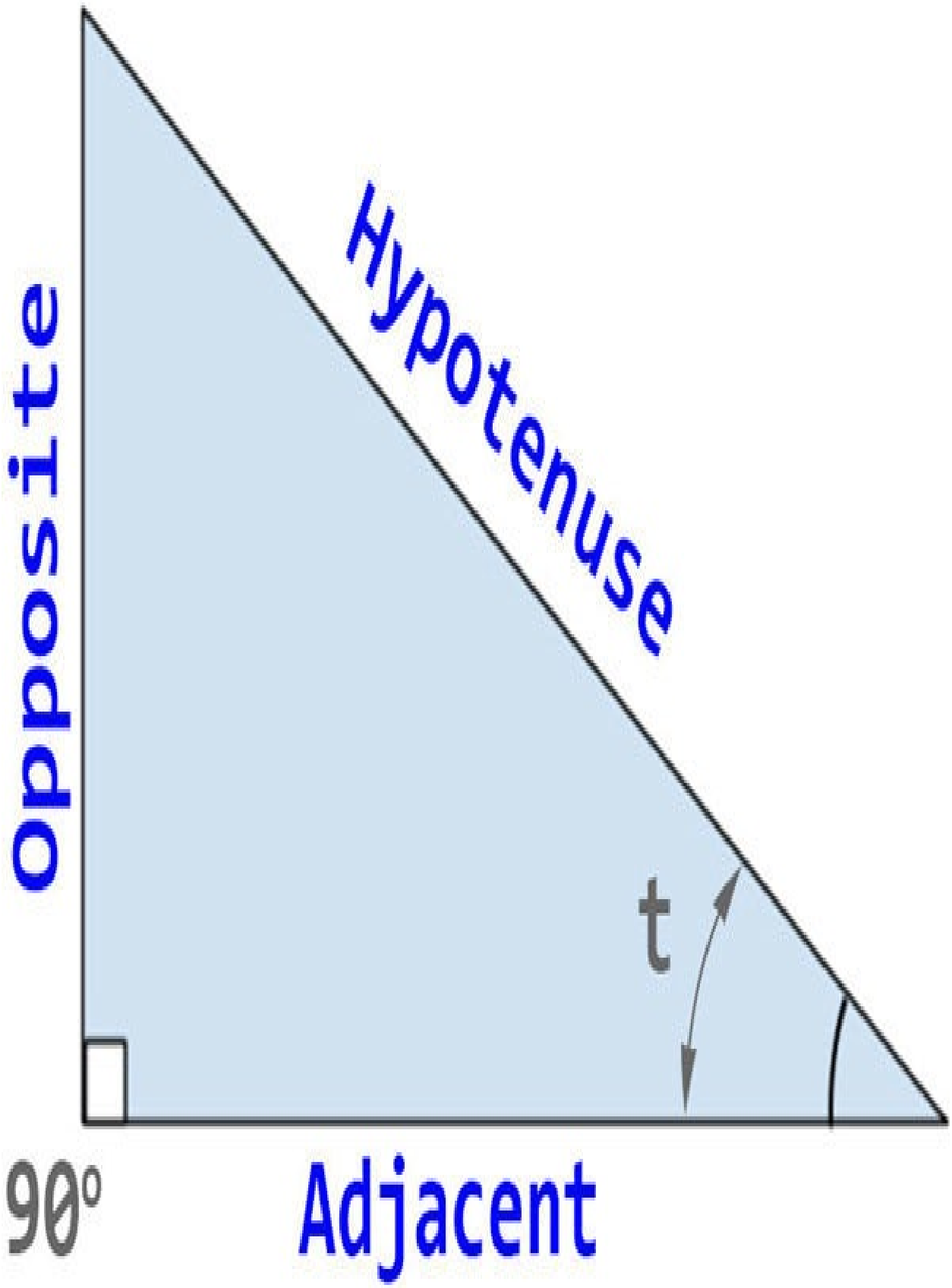

Opposite
Hypotenuse
t
90°
Adjacent

Figure 2.10: Right triangle and its side names related to angle "t"

Here:

Hypotenuse: The side opposite of the right angle, which is 90o

Adjacent: The side next to the angle t

Opposite: The side on opposite of the angle t

As the rules of trigonometry proved, we can calculate the size of each side of right-angled triangle, by using the ratios and the angle between pair of sides. Assume that we have a right triangle and the size of its hypotenuse is equal to one unit of measurement (for example 1 meter.). We can draw this triangle in a circle, as shown in Figure 2.11:

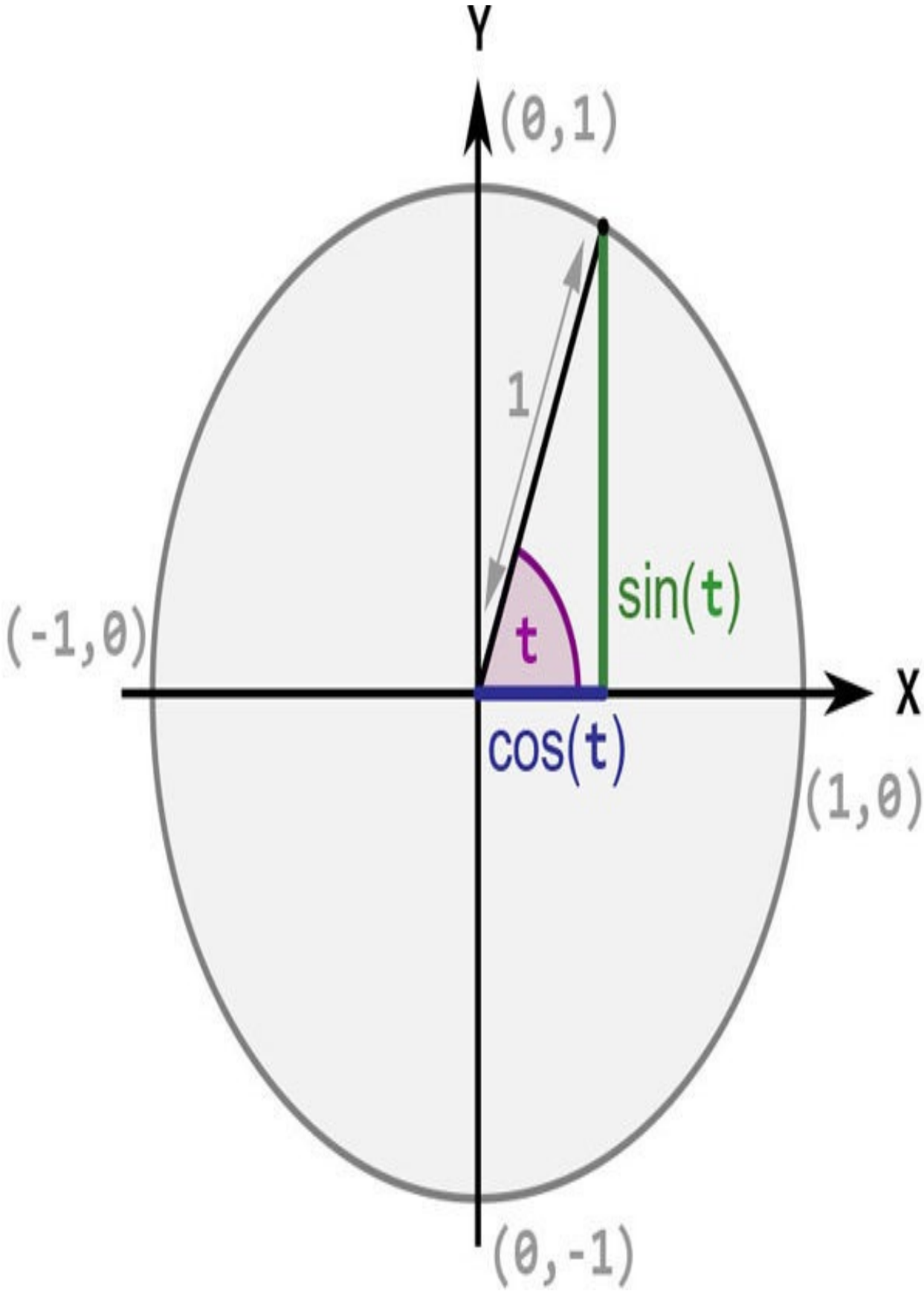

Y
(0,1)
1
sin(t)
(-1,0)
t
X
cos(t)
(1,0)
(0,-1)

Figure 2.11: Calculate Sin and Cos of angle "t" based on the right triangle with a hypotenuse of length is 1 unit of measurement.

The mathematical relation between angle t and other sides of a right triangle is presented by sine and cosine functions which also known as ratios:

$$sin\ (t) = Opposite\ /\ Hypotenuse$$

$$cos\ (t) = Adjacent\ /\ Hypotenuse$$

Sine and cosine are functions of angle and represent a ratio between the sides of a right triangle. Each angle returns a numeric float value for sine and cosine, and as the preceding image shows, the value is between the range of 1 and -1. Sine and cosine values are commonly used in engineering, physics and electronics, and you can find the sine and cosine buttons on each calculator. Now, use values between 0 – 360 for angle and draw the output graph of sine and cosine, probably by using a calculator or a drawing program (or even a table of sine and cosine from 100 years old book). You will end up with the same image as Figure 2.12:

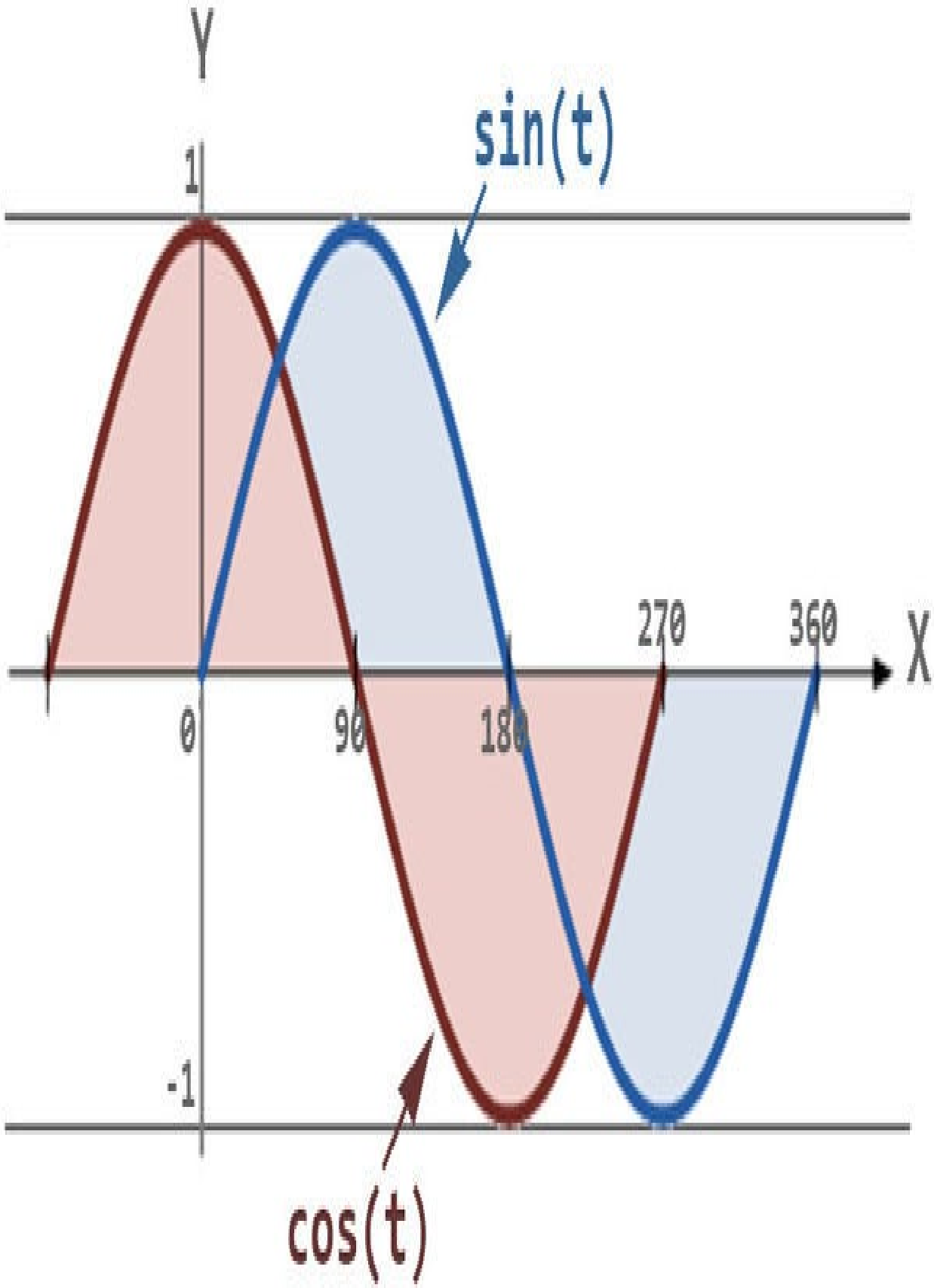

Y
sin(t)
1
270
360
X
0
90
180
-1
cos(t)

Figure 2.12: Visual representation of Sin(t) and Cos(t) where "t" is between 0 to 360

As the image shows, the values on the X axis represent the angle t, and they are between 0 and 360, and values on the Y axis represent the output of the sine and cosine functions, and the rate of change is between 1 and -1. This behavior in output makes sine and cosine ideal functions to simulate movement and vibration. When we go through shader code in the following chapters, we will use these values to make a blinking light visual effect in game by using "Material Editor" of the engine.

Math function: distance

Suppose you need to calculate the distance between Black cup and Green cup objects in the scene shown in Figure 2.13. For this, we need to use Vector as the position of each object and use the following formula:

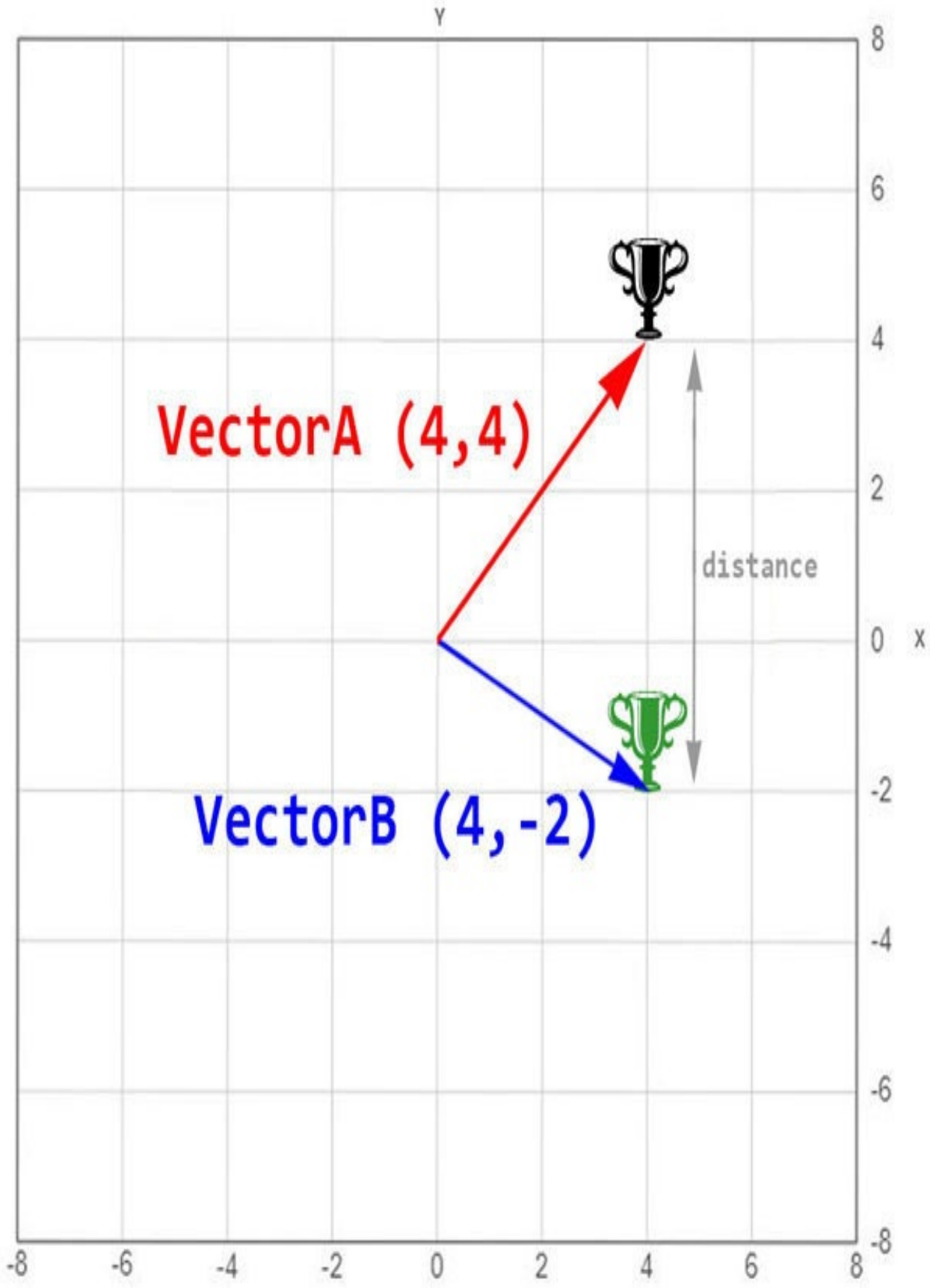
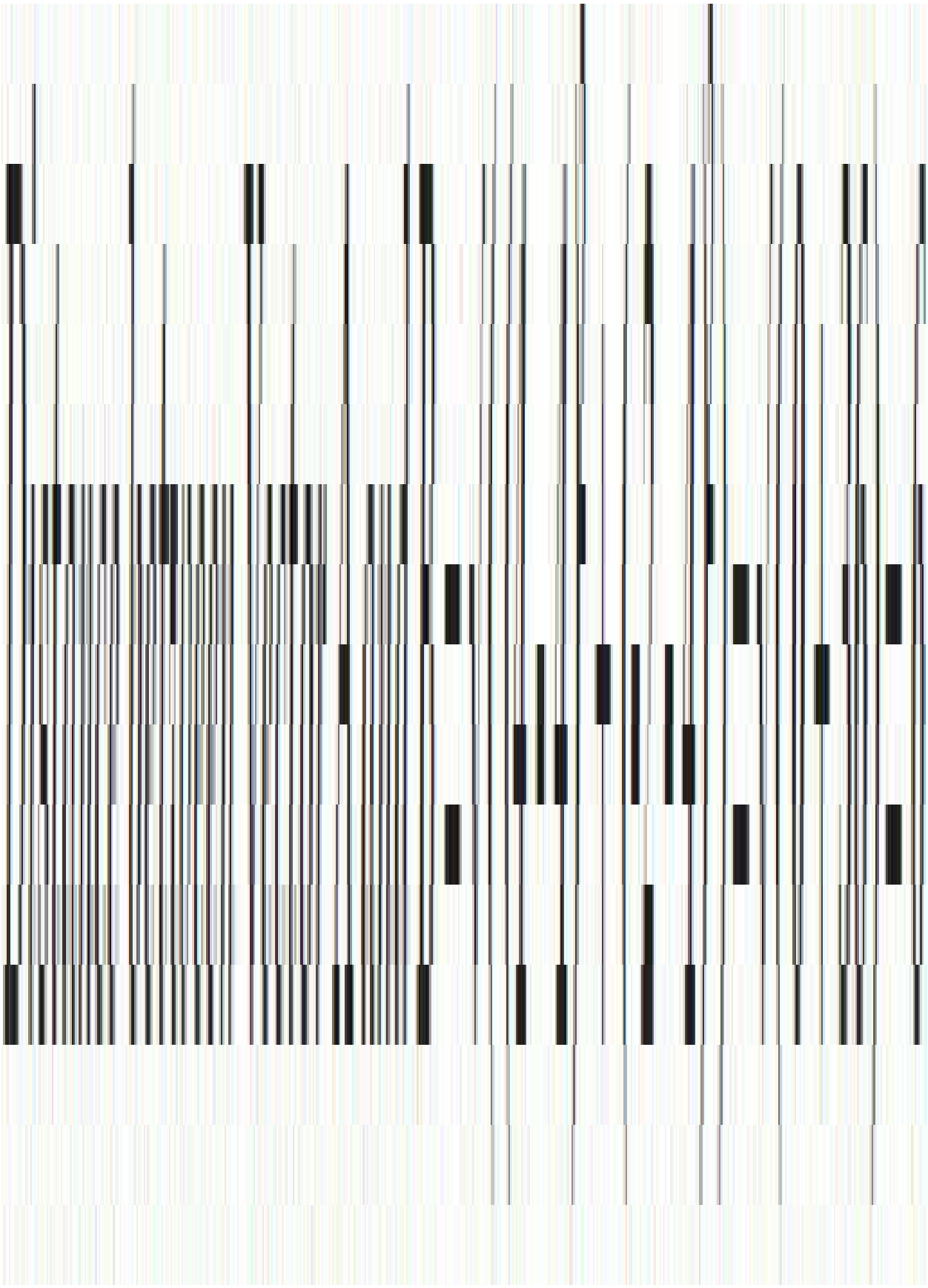
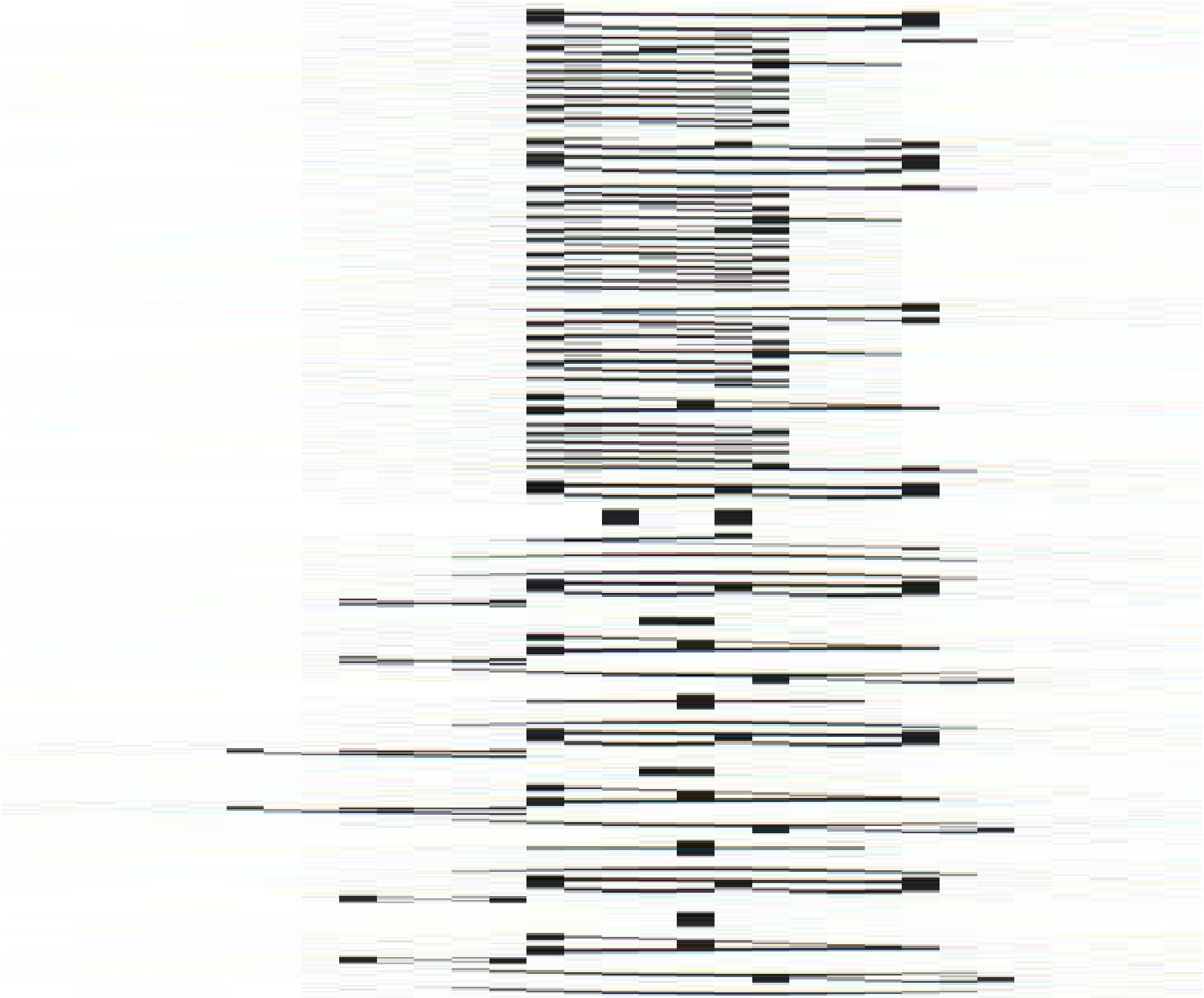

Y
X
VectorA (4,4)
VectorB (4,-2)
distance
8
6
4
2
0
-2
-4
-6
-8
-8
-6
-4
-2
0
2
4
6
8

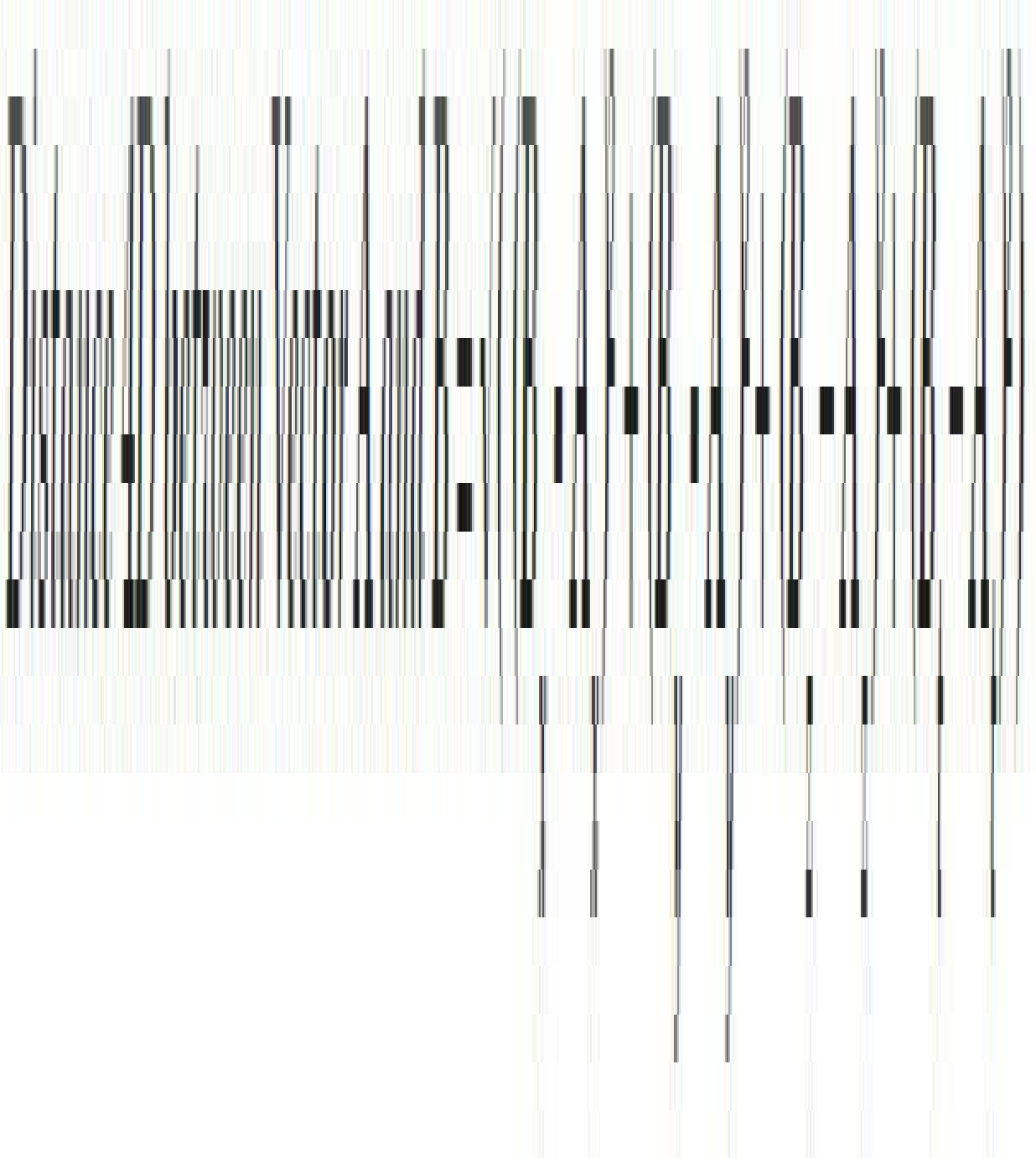
Figure 2.13: The graph shows that distance between objects is 6



As you see, the result from formula is an exact match to the preceding image.
We can use this formula to calculate distance in 3D scenes:



Also, by increasing the elements, you can use it for checking the distance between 4-dimensional vectors, but such a geometric coordination is unusual; perhaps you can assign the fourth element in these vectors to represent time:



Math function: normalized vectors

When a vector gets normalized, it’s magnitude will be changed to 1, and it saves its direction. You can calculate the normalization of a vector by dividing each element to the magnitude of vector. For example, for getting normalize of a 2D and 3D vector, we can use these formulas:

```
NormalizeSDVector[{A1, A2, A3}]
```

```
NormalizeSDVector[{B1, B2, B3, B4, B5, B6, B7, B8, B9, B10, B11, B12}]
```

Conclusion

Programming computer games is heavily dependent on mathematical operations and logics. Depending on the complexity of a game scenario, programmers use different types of mathematics. For example, for calculating the location and rotation of object in the scene, either 2D or 3D, you have to know and use vector operations and functions. Also, in the case of dynamics and physical behaviors, you may need to use functions and expressions related to trigonometry. Other examples are using logical variables to switch between game states like switching level or change animations type.

The Unreal Engine 5 provides a series of mathematical functions and procedures to use with game mechanics and also shaders. In the next chapter, we will use math to acauline built the game, and this chapter will be a reference for our scenarios and solutions while developing a game.

Points to remember

Numeric data types are numbers like Int, Float, and Byte.

Boolean data type is a bool type variable with only 2 values: True and False.

You can customize and remove each version of Unreal Engine by using launcher menus.

Multiple choice questions

What is Dot Product?

Dot Product is a Vector operation that results in a number.

Cosine of angle between Vector A and Vector B is equal to Dot Product of A and B, divided by the result of magnitude of A multiplied to the magnitude of B.

When Dot Product results in zero, it means that vectors have a 90-degree angle between them.

Answers a, b and c are correct.

Which sentence is correct about a right triangle?

Right triangle is a triangle that has a 90-degree angle.

Cosine of angle in right triangle is equal to the size of adjacent divided by hypotenuse, and sine of angle is equal to the size of opposite divided by

hypotenuse.

Sine and cosine return value between -1 and 1 for angles between 0 and 360 degrees.

Answers a, b and c are correct.

How do you calculate the distance between two objects in the scene?

By using the formula $\sqrt{((Bx - Ax)^2 + (By - Ay)^2)}$, where A and B represent locations of object as vector, we can calculate the distance between objects in 2D map.

By using the formula $\sqrt{((Bx - Ax)^2 + (By - Ay)^2)}$, where A and B represent locations of object as vector, we can calculate the distance between objects in 3D map.

By using the formula $\sqrt{((Bx - Ax)^2 + (By - Ay)^2 + (Bz – Az)^2)}$, where A and B represent locations of object as vector, we can calculate the distance between objects in 3D map.

Answers a and c are correct.

Answers

d

d

d

Questions

Refer to www.mathsisfun.com/algebra/vectors-cross-product.html; what is the main difference between “Dot Product” and “Cross Product” when we deal with vectors?

How can you calculate the tangent of an angle in a right triangle?

What is logarithm in mathematics?

What is a rotation matrix?

Key term

Epic Game Launcher is the application that installs and customizes the engine version and gives access to other Epic Game online services like Marketplace. You have to make an account and profile through the Epic Game home page, that is, https://www.epicgames.com/, before using this application.

CHAPTER 3

Editor Basics and Epic Launcher

This chapter will cover using the Epic Games launcher to open, update, or repair the engine, and it will walk you through how to use the asset Marketplace it provides. It will also cover the basic standard layout of the editor, how to modify the layout of the editor, where the important menus are located, their purpose, and how to use them. It will also explain useful hotkeys (and reroute nodes) and skim through the project settings and plugins menus.

Structure

In this chapter, we will discuss the following topics:

Epic Launcher layout

Editor layout

Common hotkeys

Important menu/window

Project settings

Plugins

Objectives

After studying this chapter, you should be able to check different sections of Epic Game Launcher related to create project or grab assets, learn the common menus and their functionalities in “Unreal Editor.” You will also be able to check and understand usage of default panels inside the editor. This chapter will equip you with Using “Project Setting” panel, and you will be able to check, add or remove plugins to the engine.

Epic Launcher layout

To start using UE5, you need to install it using the Epic Games Launcher (EGL), which was covered in Chapter 1: What Is Unreal Engine?

Inside the EGL there is a list of tabs in the top left of the Interface. These tabs are discussed in the following sections.

Home

The Home page contains news and deals from Epic Games that they want their users to see, as shown in Figure 3.1:

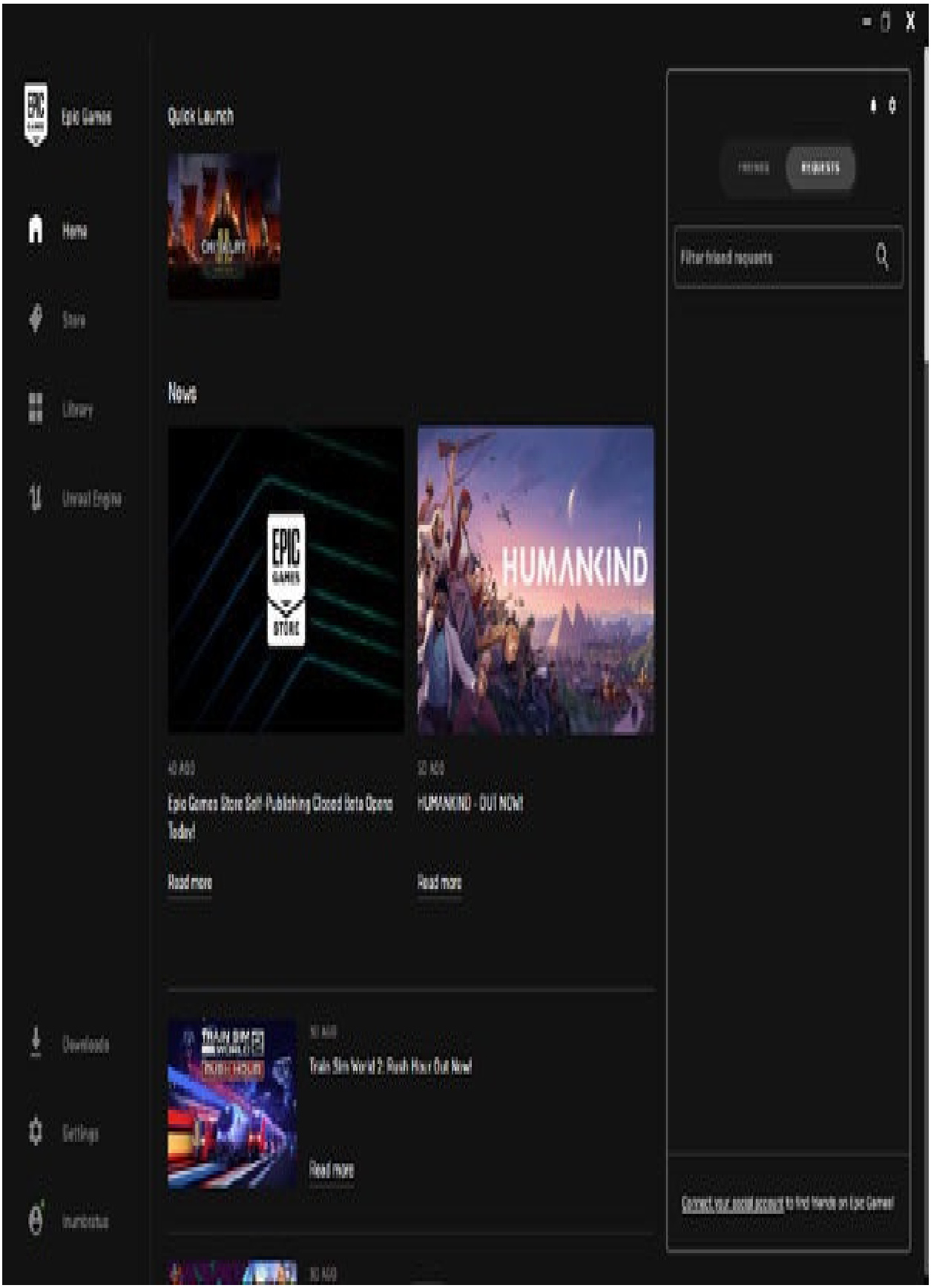

Epic Games
Home
Store
Library
Unreal Engine
Downloads
Settings
Quick Launch
News
EPIC GAMES STORE
HUMANKIND
40 AGO
Epic Games Store Self-Publishing Closed Beta Opens Today!
Read more
32 AGO
HUMANKIND - OUT NOW!
Read more
90 AGO
Train Sim World 2: Rush Hour Out Now!
Read more
Filter friend requests
Connect your social accounts to find friends on Epic Games!

Figure 3.1: Epic Games Launcher Home Page

This page doesn’t contain news regarding Unreal Engine; that is displayed elsewhere in the launcher.

Store

The Store page (shown in Figure 3.2) is where you can purchase games to play and manage through the Epic Games Launcher:

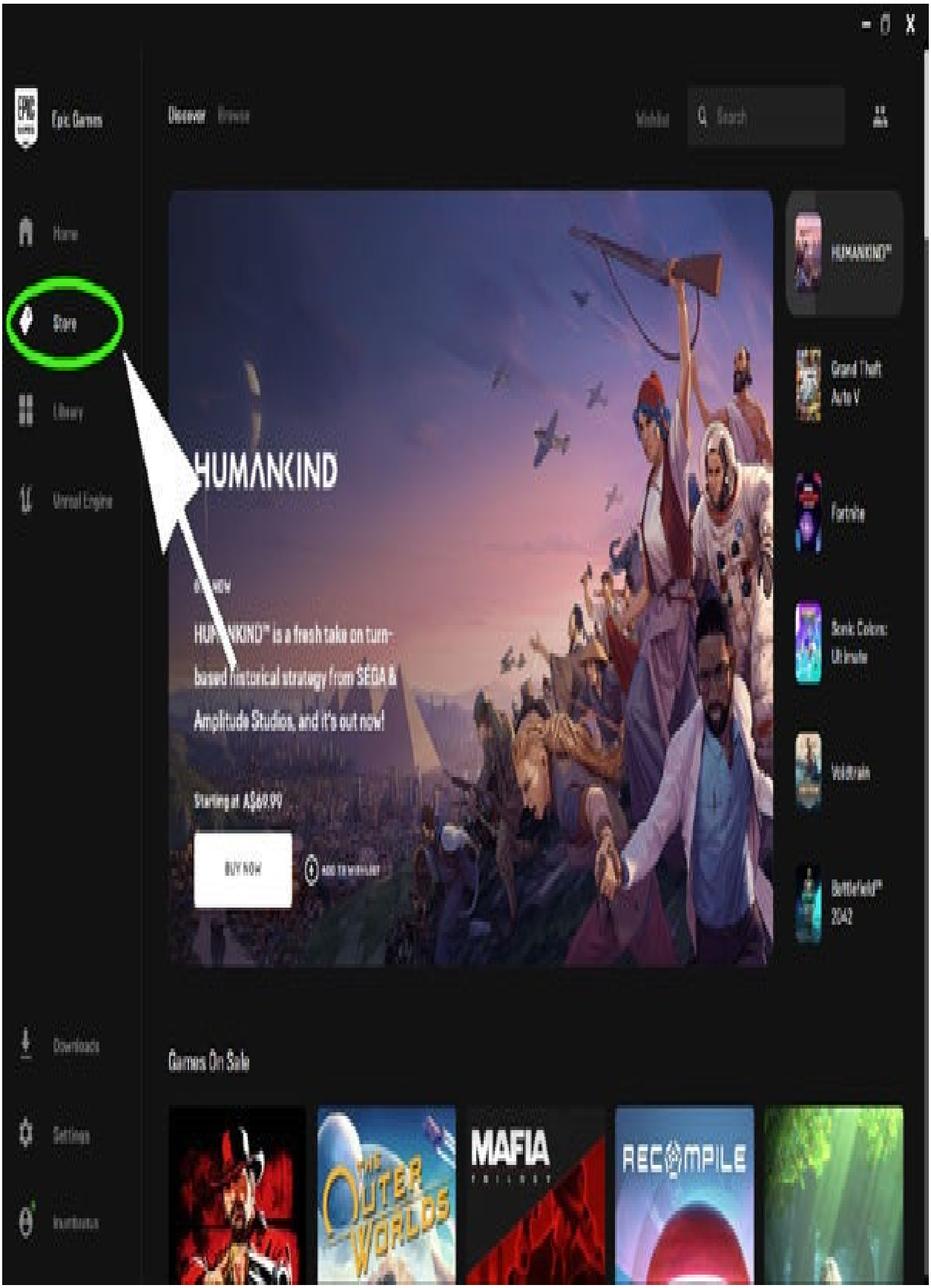

Epic Games
Discover
Browse
Wishlist
Search
Home
Store
Library
Unreal Engine
HUMANKIND
HUMANKIND™ is a fresh take on turn-based historical strategy from SEGA & Amplitude Studios, and it's out now!
Starting at A$69.99
BUY NOW
HUMANKIND™
Grand Theft Auto V
Fortnite
Sonic Colors: Ultimate
Voidtrain
Battlefield™ 2042
Downloads
Settings
Friends
Games On Sale
THE OUTER WORLDS
MAFIA
RECOMPILE

Figure 3.2: Epic Games Launcher Store Page

Epic Games frequently allows users to obtain games (to keep) for free and sell titles that are exclusive to the Epic Games Launcher and are unobtainable through other online game vendors (usually only temporarily before they're available elsewhere).

Library

The Library page (shown in Figure 3.3) is where you can manage games purchased through the Epic Games Launcher. On this page, you can install, uninstall, repair, and launch the games you have access to:

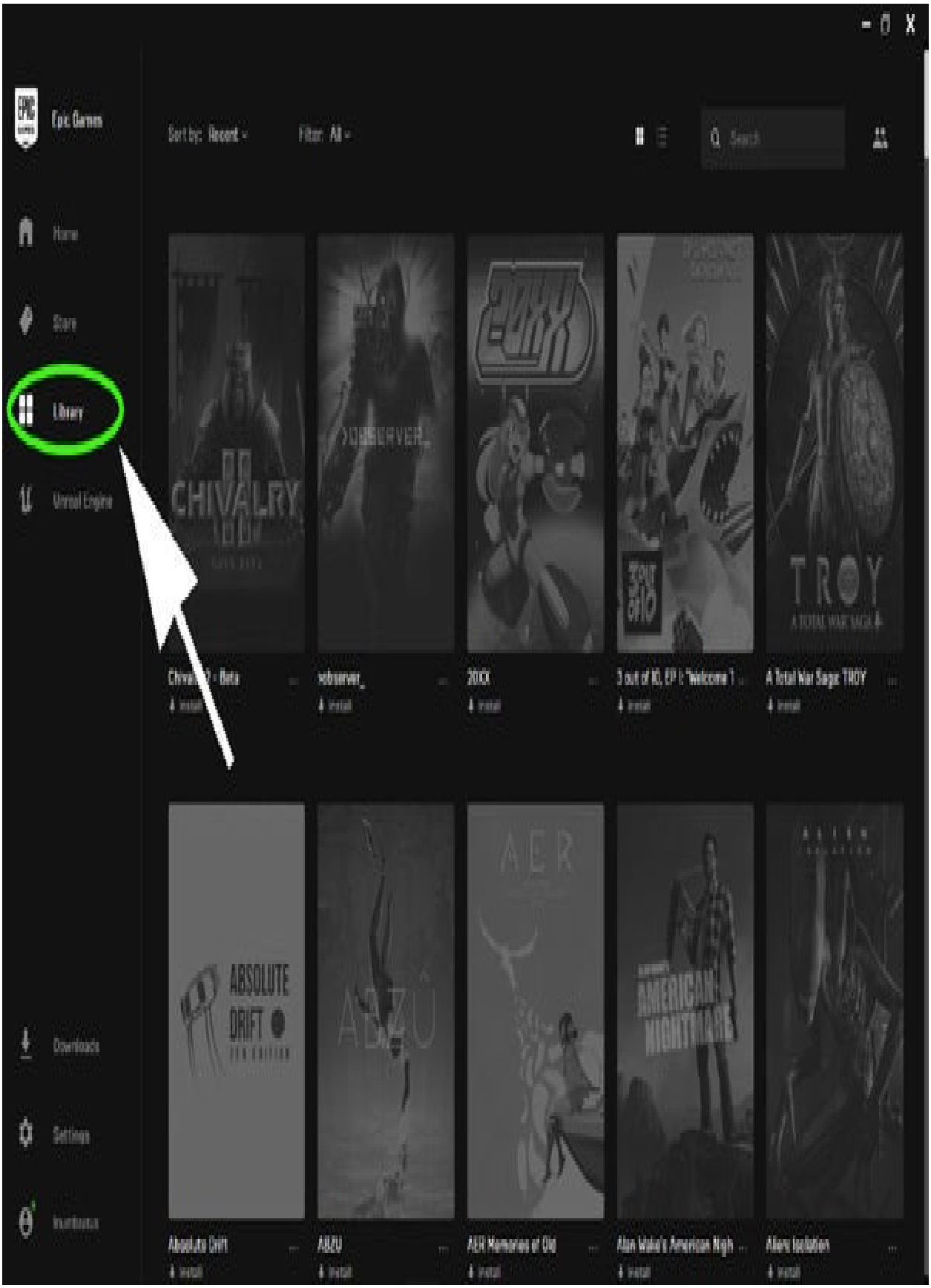

Epic Games
Sort by: Recent
Filter: All
Search
Home
Store
Library
Unreal Engine
Downloads
Settings
Chivalry - Beta
Install
Subserver_
Install
20XX
Install
3 out of 10, EP 1: "Welcome T...
Install
A Total War Saga: TROY
Install
Absolute Drift
Install
ABZÛ
Install
AER Memories of Old
Install
Alan Wake's American Nigh...
Install
Alien: Isolation
Install

Figure 3.3: Epic Games Launcher Library Page

Unreal Engine

This is a page that contains sub-pages related to the Unreal Engine; it is shown in Figure 3.4:

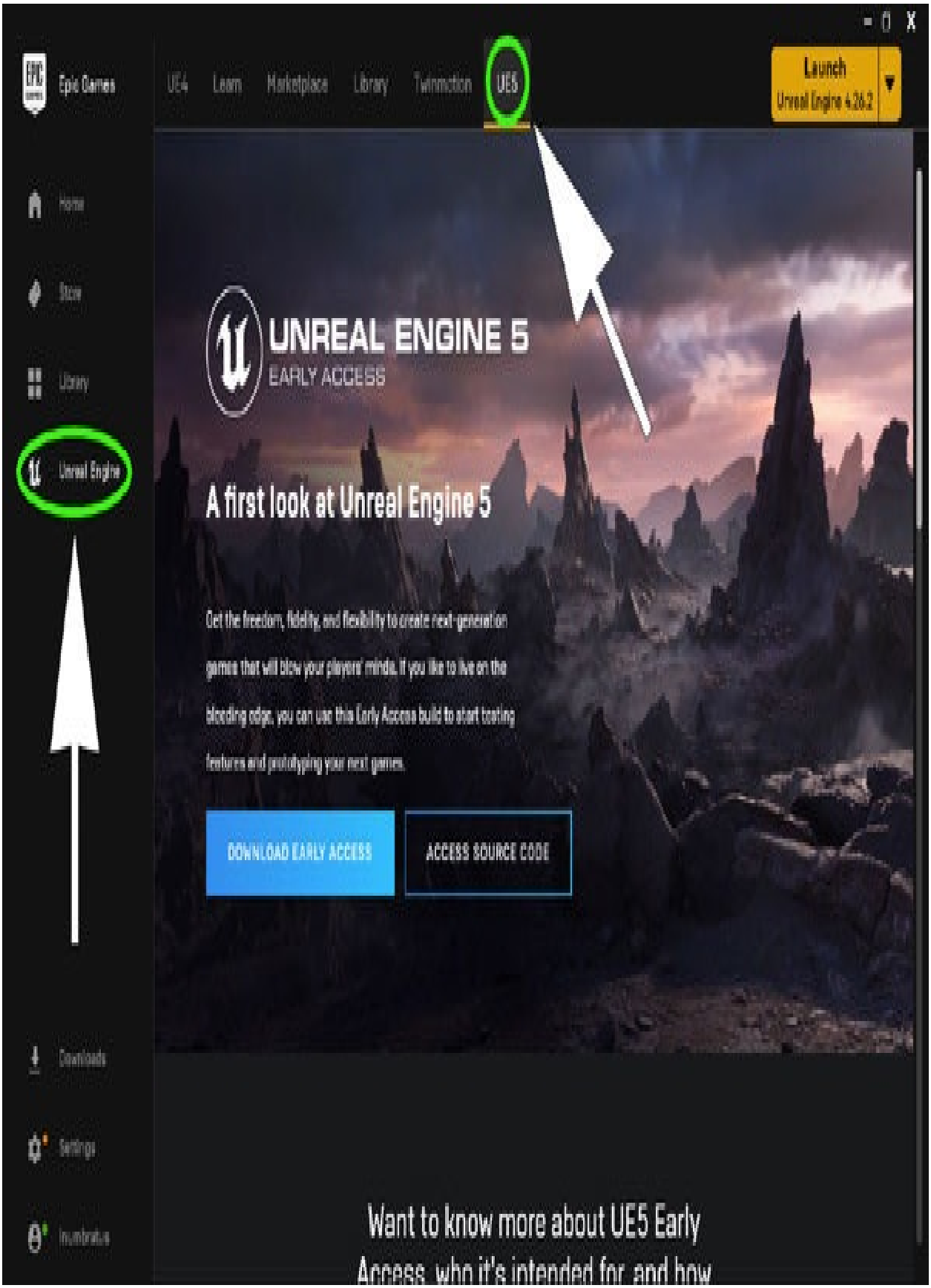

Epic Games
UE4
Learn
Marketplace
Library
Twinmotion
UE5
Launch
Unreal Engine 4.26.2
Home
Store
Library
Unreal Engine
Downloads
Settings
Invitations
UNREAL ENGINE 5
EARLY ACCESS
A first look at Unreal Engine 5
Get the freedom, fidelity, and flexibility to create next-generation games that will blow your players' minds. If you like to live on the bleeding edge, you can use this Early Access build to start testing features and prototyping your next games.
DOWNLOAD EARLY ACCESS
ACCESS SOURCE CODE
Want to know more about UE5 Early Access, who it's intended for, and how

Figure 3.4: Epic Games Launcher Unreal Engine Page, with the UE5 page selected

It has its own Home (One for UE4 and one for UE5), Learn, Marketplace, Library, and Twinmotion pages. The Home pages display featured content (related to unreal engine) that Epic Games want their users to see. The Learn page only contains content pertaining to Unreal Engine 4 currently, and the Twinmotion page is unimportant to the purpose of this book, so they will not be covered.

Marketplace

The Unreal Engine Marketplace (shown in Figure 3.5) contains a vast amount of content that is available to be purchased, downloaded, and used:

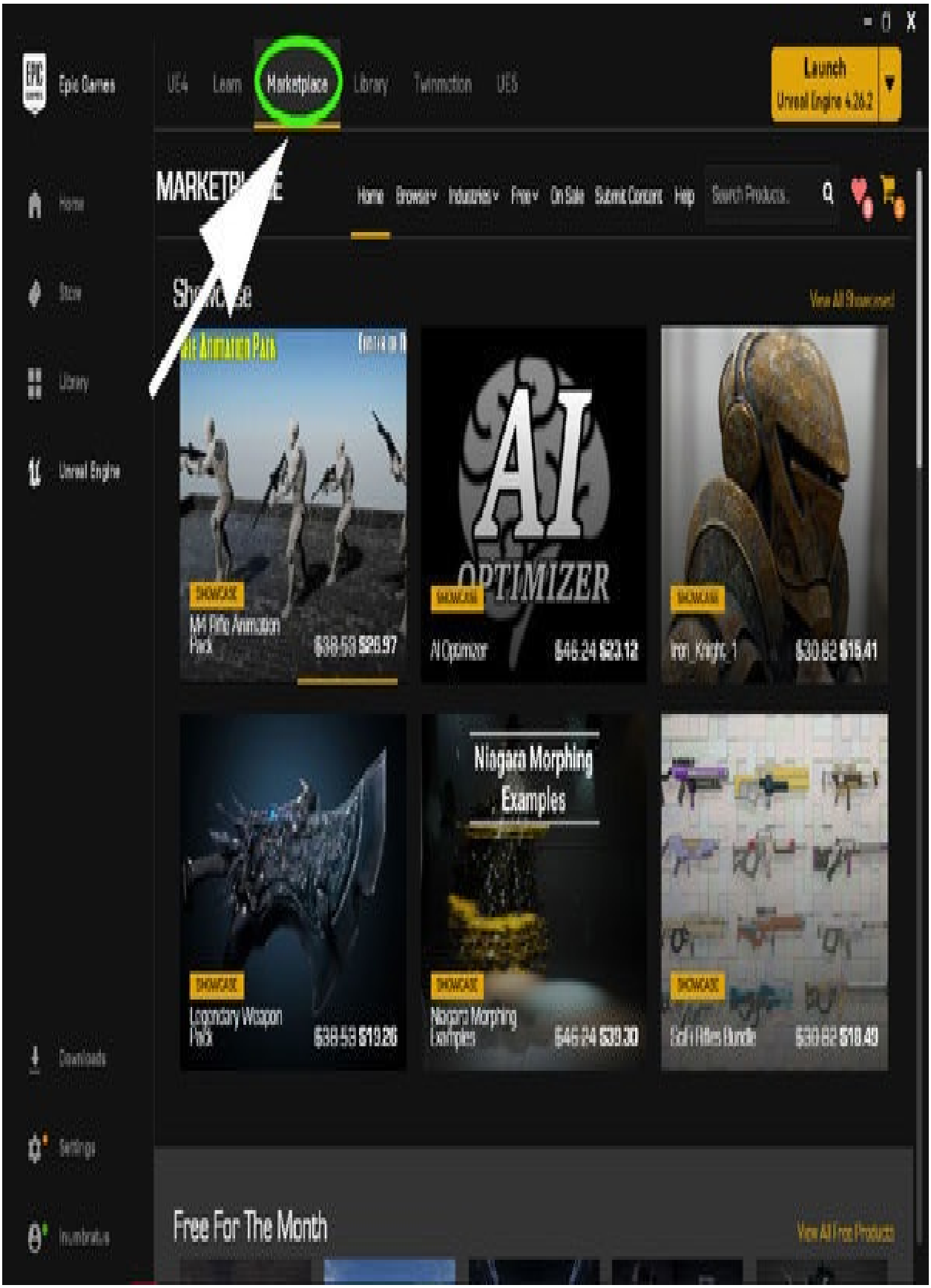

Epic Games
UE4
Learn
Marketplace
Library
Twinmotion
UE5
Launch
Unreal Engine 4.26.2
Home
Store
Library
Unreal Engine
Downloads
Settings
Home
Browse
Industries
Free
On Sale
Submit Content
Help
Search Products...
Showcase
View All Showcases
SHOWCASE
AI Optimizer
$46.24 $23.12
Iron Knight 1
$30.82 $15.41
Legendary Weapon Pack
$38.53 $19.26
Niagara Morphing Examples
SHOWCASE
Niagara Morphing Examples
$46.24 $39.30
SHOWCASE
$30.82 $18.49
Free For The Month
View All Free Products

Figure 3.5: Unreal Engine Marketplace

There is free content available as well; Epic Games very generously makes certain content free to keep each month. When using the marketplace, remember to make sure the content you are obtaining is compatible with the engine version(s) you are using.

Library

The Unreal Engine Library contains access to all projects associated with the launcher, all content purchased from the marketplace, and access to modify (update, install, verify, or uninstall) versions of the engine.

Epic Games
UE4
Learn
Marketplace
Library
Twinmotion
UE5
Launch
Unreal Engine 4.26.2
Home
Store
Library
Unreal Engine
ENGINE VERSIONS
GITHUB SOURCE
RELEASE NOTES
4.26.2
Launch
Installed Plugins
5.0.0
Early Access 2
Launch
Installed Plugins
MY PROJECTS
Search Projects
5.0
UE5_BasicProject
Downloads
Settings
Incubator
VAULT
Filter by: Category
Search Vault

Figure 3.6: Unreal Engine Library

Project Browser

Once you open Unreal Engine from the Epic Games Launcher, you will be prompted to create a new project or open an existing one through the project browser, which is shown in Figure 3.7:

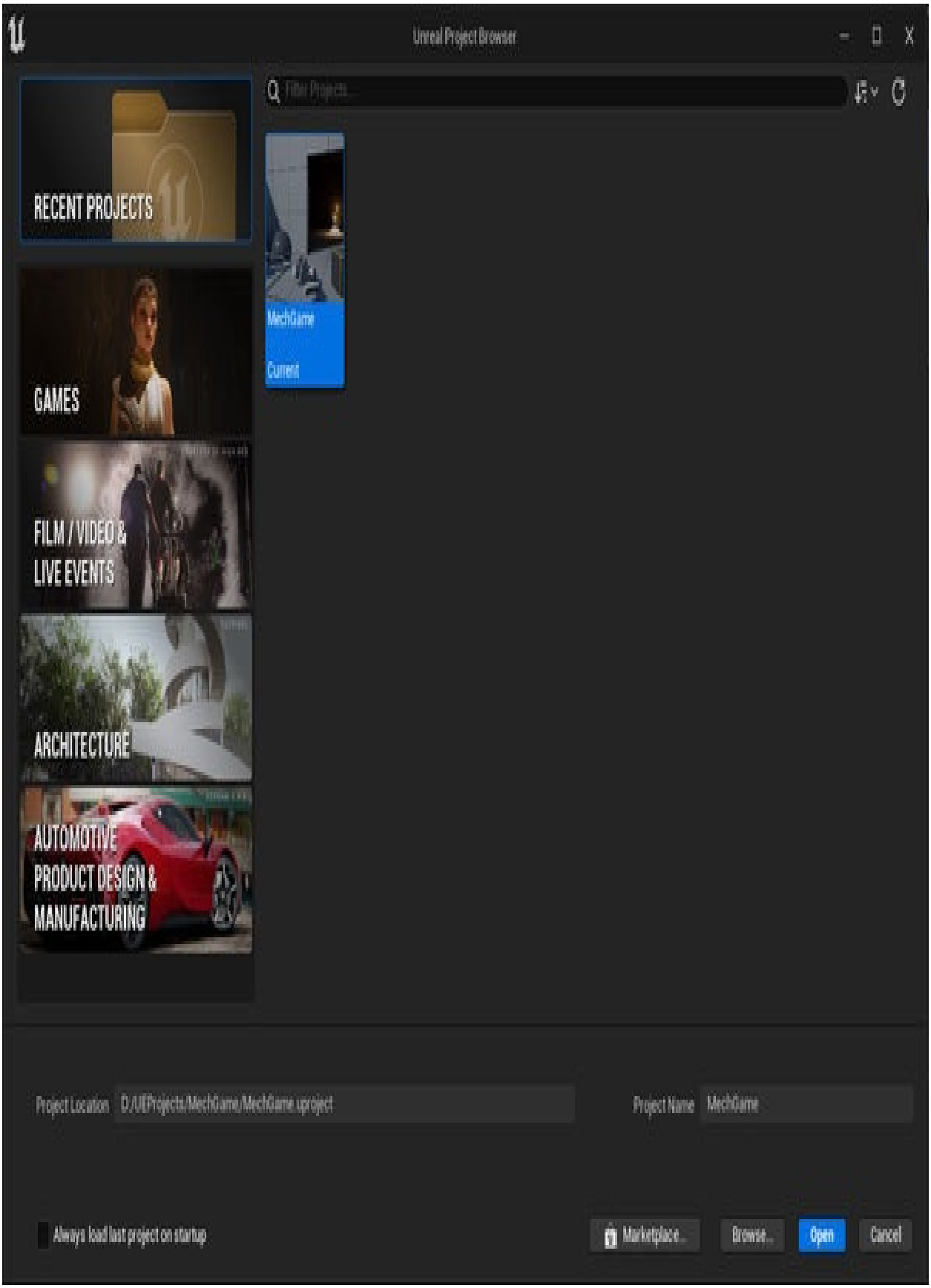

Unreal Project Browser
Filter Projects...
RECENT PROJECTS
GAMES
FILM / VIDEO & LIVE EVENTS
ARCHITECTURE
AUTOMOTIVE PRODUCT DESIGN & MANUFACTURING
MechGame
Current
Project Location
D:/UEProjects/MechGame/MechGame.uproject
Project Name
MechGame
Always load last project on startup
Marketplace...
Browse...
Open
Cancel

Figure 3.7: Unreal Engine 5 Project Browser

Once a project has been made or opened, the editor will load and then open. In the project browser, templates used to create new projects are situated on the left side of the interface, while existing projects are shown on the right.

Editor layout

The Editor’s interface is made up of a series of Panels, each of which provide specific functionalities. New windows can be opened to edit objects, most of which are also made up of panels.

Standard layout

This is what you will see after opening Unreal Engine 5 for the first time. This is the standard/default layout of the editor, as shown in Figure 3.8:

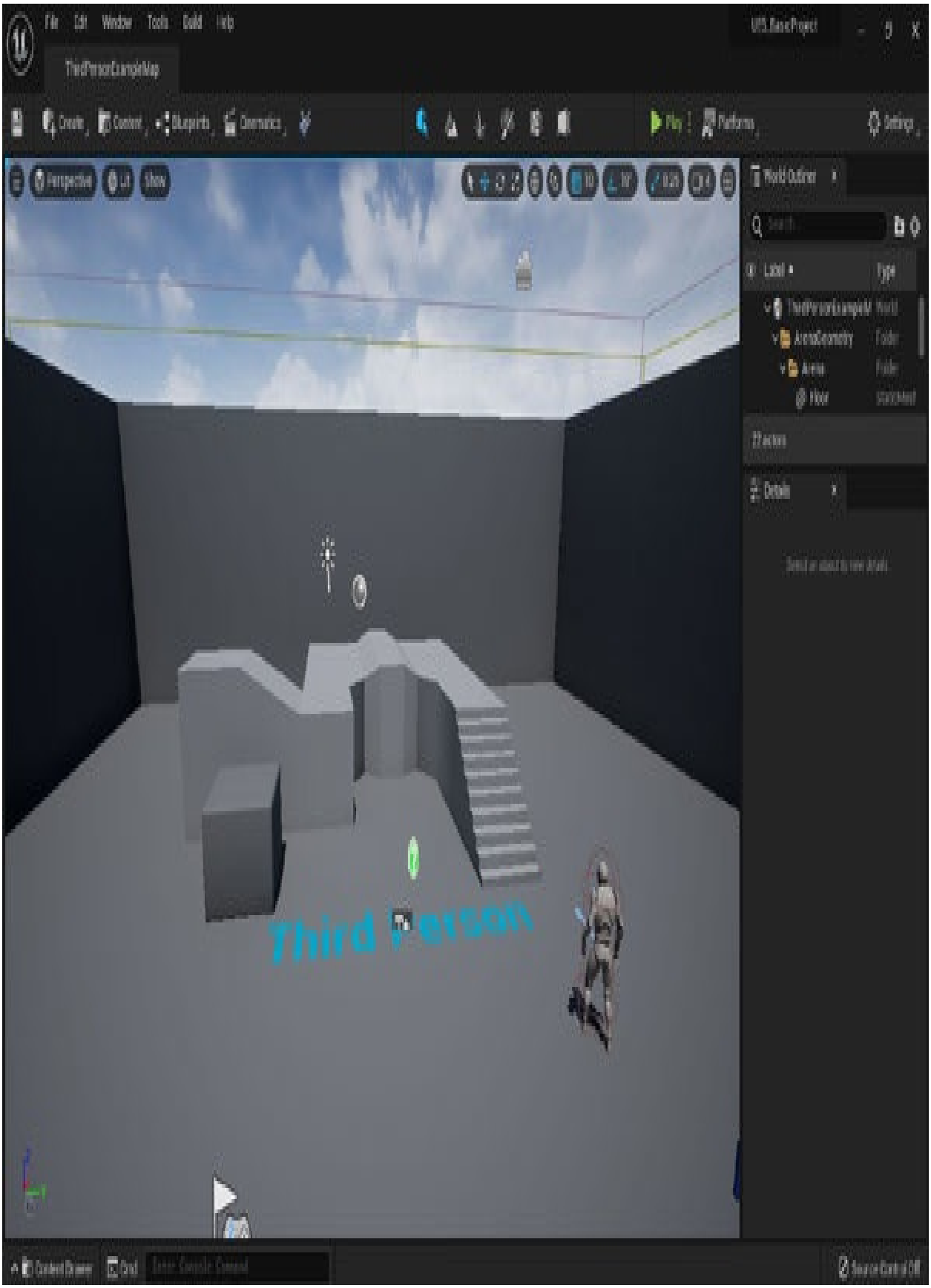

File
Edit
Window
Tools
Build
Help
UE5_BlankProject
ThirdPersonExampleMap
Create
Content
Blueprints
Cinematics
Play
Platforms
Settings
Perspective
Lit
Show
World Outliner
Label
Type
ThirdPersonExampleM
World
ArenaGeometry
Folder
Arena
Folder
Floor
22 actors
Details
Third Person
Content Browser
Cmd
Enter Console Command
Source Control Off

Figure 3.8: Unreal Engine 5 Editor (Default Layout)

It has the most commonly used editor panels, a single viewport allowing you to view the world that is currently loaded, and a toolbar providing the ability to simulate using/playing the project, and some means of modifying the current level and the objects within it.

Editing the layout

The layout of the editor can be changed at will by dragging and dropping panels as you please, for example (see Figure 3.9):

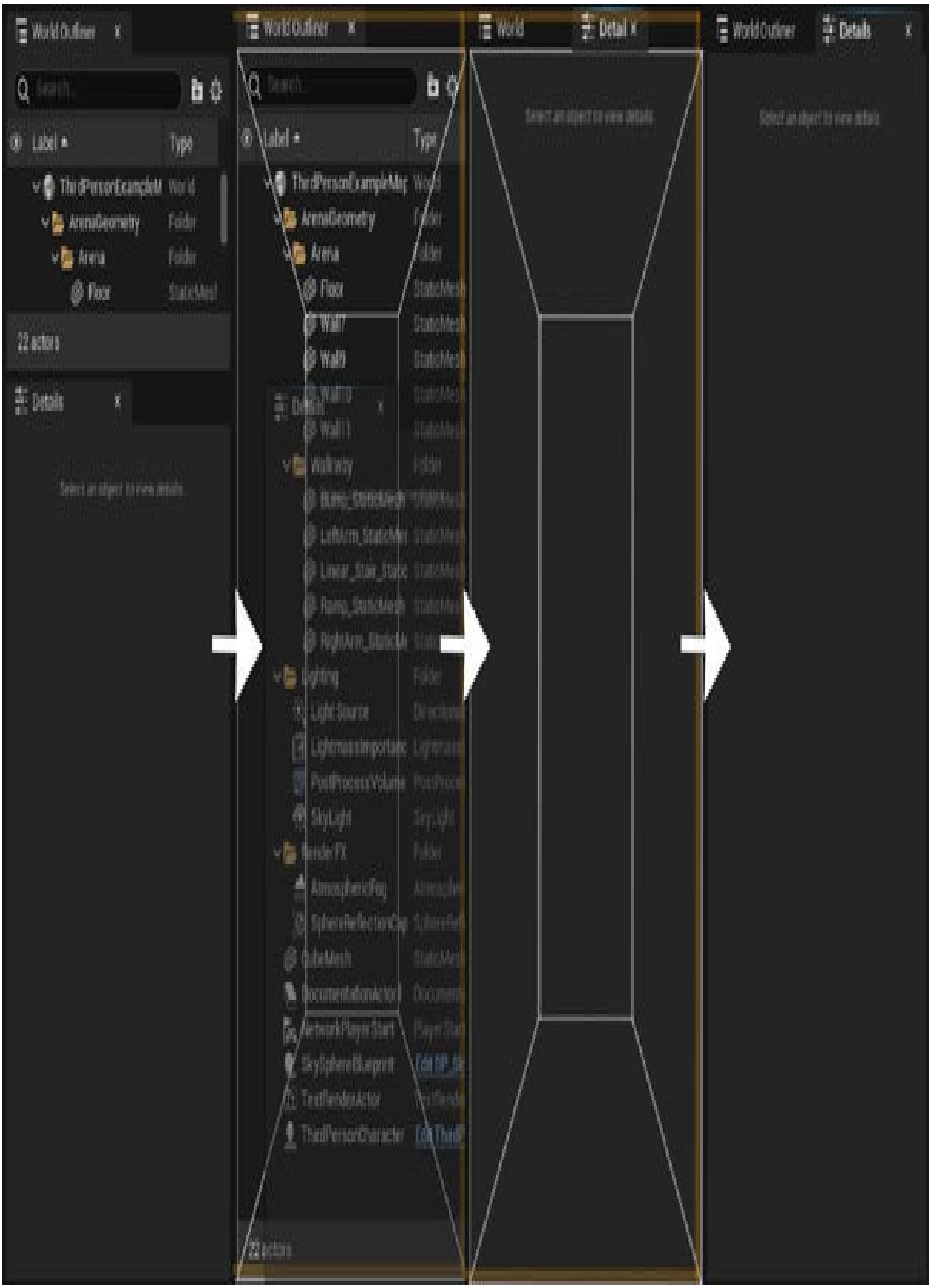

World Outliner
Search...
Label
Type
ThirdPersonExampleMap
World
ArenaGeometry
Folder
Arena
Folder
Floor
StaticMesh
22 actors
Details
Select an object to view details.
World Outliner
Search...
Label
Type
ThirdPersonExampleMap
World
ArenaGeometry
Arena
Floor
StaticMesh
Wall7
StaticMesh
Wall9
StaticMesh
Details
Walkway
Folder
Lighting
Folder
Light Source
LightmassImportanceVolume
PostProcessVolume
SkyLight
Sky Light
RenderFX
Folder
AtmosphericFog
SphereReflectionCapture
CubeMesh
StaticMesh
DocumentationActor
NetworkPlayerStart
SkySphereBlueprint
TestRendererActor
ThirdPersonCharacter
22 actors
World
Detail
Select an object to view details.
World Outliner
Details
Select an object to view details

Figure 3.9: Dragging and dropping panels

Layout menu

You have a great deal of control over the layout of the editor, so set it up as you see fit. If you would like to return to the standard layout, you can do so at any time by going to the layout menu, as shown in Figure 3.10. You can also save and apply custom layouts. So, if you like to change the layout depending on what exactly you're using the editor for, that can very easily be done/managed:

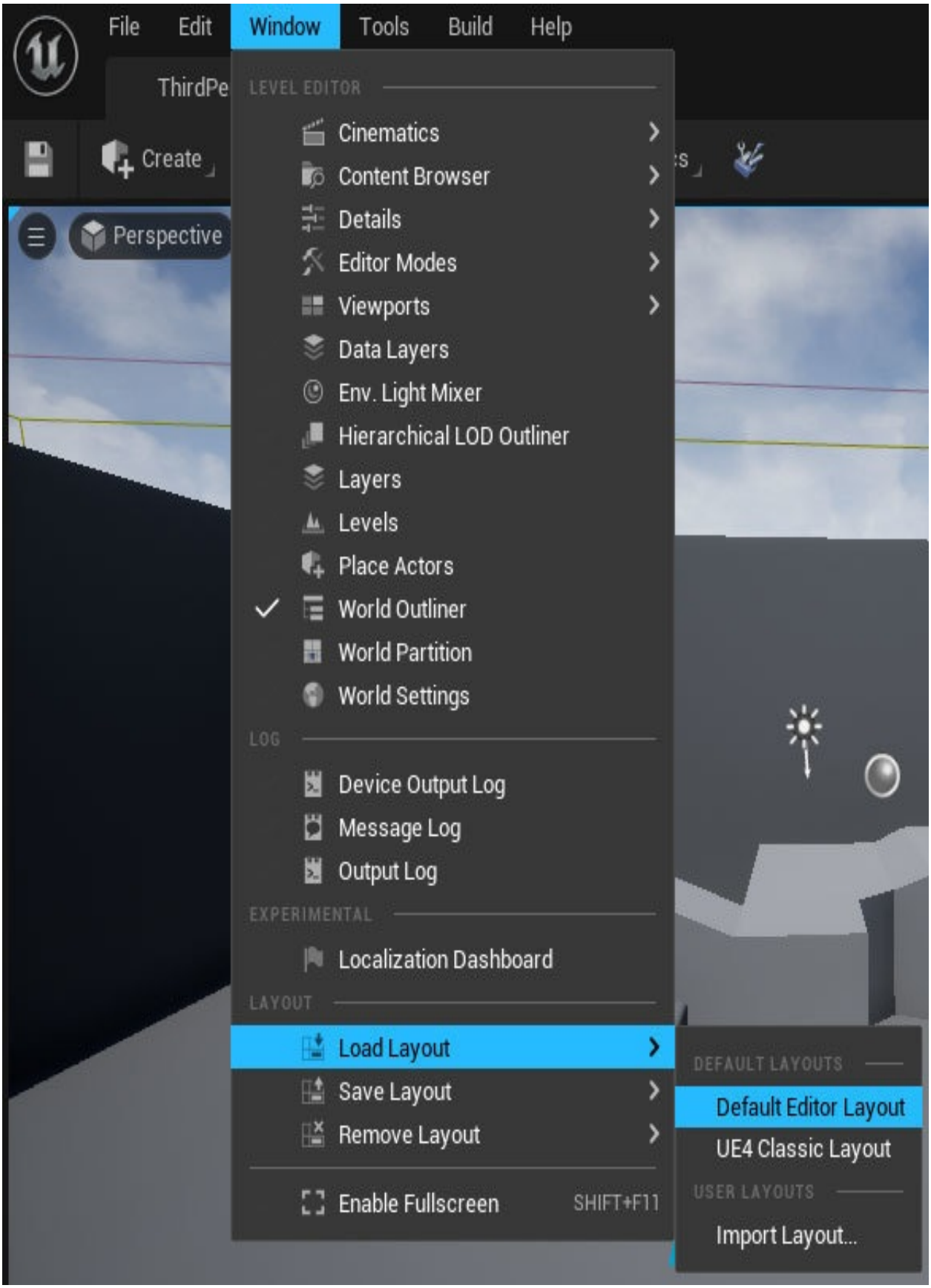

File
Edit
Window
Tools
Build
Help
ThirdPe
Create
Perspective
LEVEL EDITOR
Cinematics
Content Browser
Details
Editor Modes
Viewports
Data Layers
Env. Light Mixer
Hierarchical LOD Outliner
Layers
Levels
Place Actors
World Outliner
World Partition
World Settings
LOG
Device Output Log
Message Log
Output Log
EXPERIMENTAL
Localization Dashboard
LAYOUT
Load Layout
Save Layout
Remove Layout
Enable Fullscreen
SHIFT+F11
DEFAULT LAYOUTS
Default Editor Layout
UE4 Classic Layout
USER LAYOUTS
Import Layout...

Figure 3.10: Layout menu

Common hotkeys

Hotkeys are combinations of keys on the keyboard that when pressed together, will act as a shortcut to performing a specific function. Table 3.1 lists the most commonly used hotkeys in UE5:

Function	Hotkey
Undo	Ctrl + Z
Redo	Ctrl + Y
Cut	Ctrl + X
Copy	Ctrl + C
Paste	Ctrl + V
Duplicate	Ctrl + W
Rename Selected	F2
Toggle Full-screen mode	Shift + F11

Table 3.1: Common UE5 Hotkeys

Important menu/window locations

Inside the editor, there are a great deal of tabs, menus, and panels, all with their own unique purpose. Knowing which one is where and what each one's purpose will save a developer a great amount of time and effort. This chapter will cover the default/standard layout of the UE5 editor, though some elements may differ if you've modified the editor's layout. These tabs and menus can be found on the left side of the editor's title bar, as shown in Figure 3.11:

File Edit Window Tools Build Help

ThirdPersonExampleMap

Figure 3.11: Title Bar tabs

File tab

The File tab contains a series of options regarding file and editor management. From here, you can save your work, open, or start a new project, change or create levels, open an asset to modify, compress the current project for easy transferal, or close the editor.

Edit tab

The Edit tab (shown in Figure 3.12) in the top left of the editor's interface contains a number of options, most of which will be used via the hotkeys provided next to them (undo, cut, copy, paste, and so on):

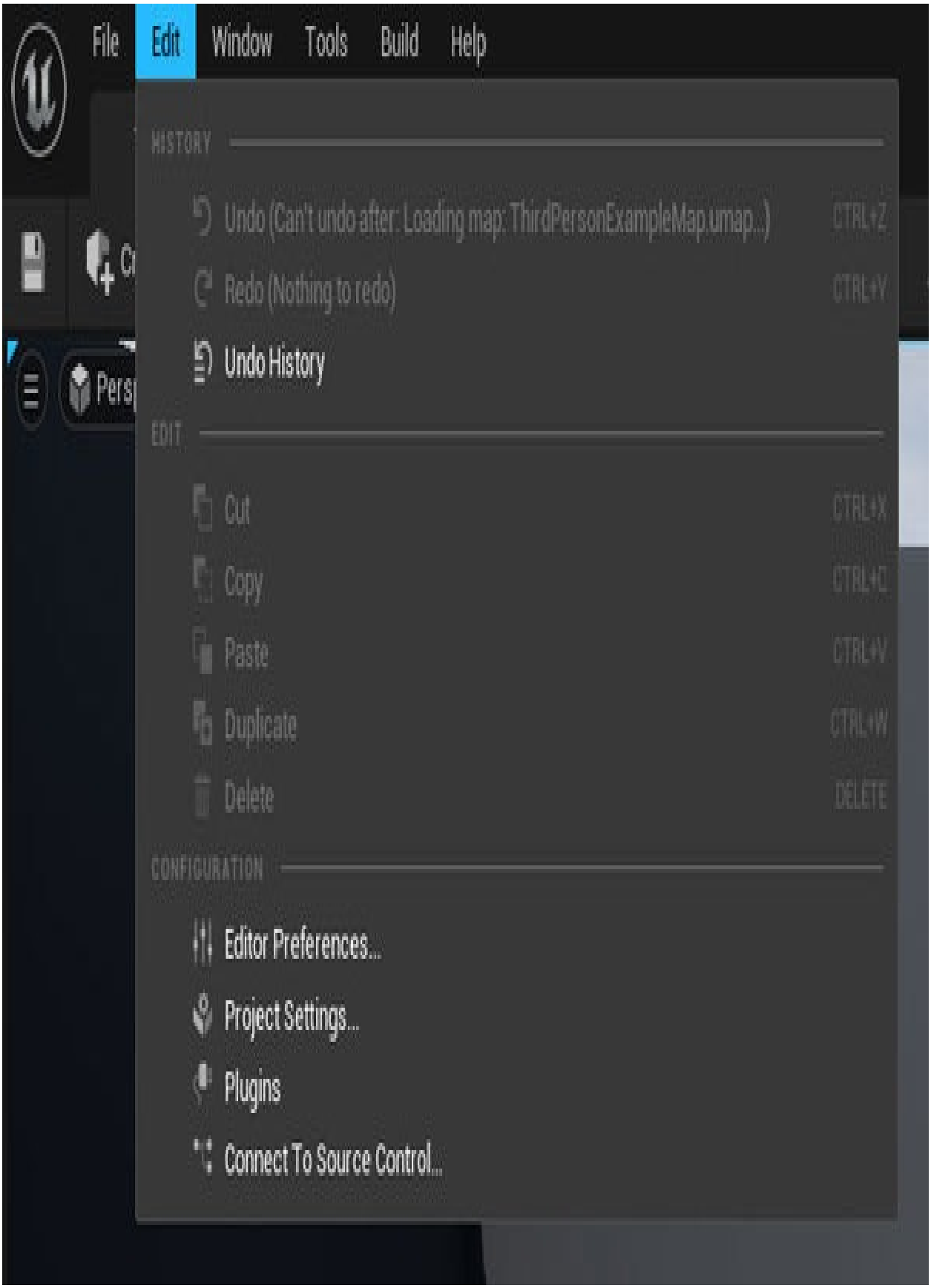

File
Edit
Window
Tools
Build
Help
HISTORY
Undo (Can't undo after: Loading map: ThirdPersonExampleMap.umap...)
CTRL+Z
Redo (Nothing to redo)
CTRL+Y
Undo History
EDIT
Cut
CTRL+X
Copy
CTRL+C
Paste
CTRL+V
Duplicate
CTRL+W
Delete
DELETE
CONFIGURATION
Editor Preferences...
Project Settings...
Plugins
Connect To Source Control...

Figure 3.12: Configuration menus

It also contains four very important configuration menus at the bottom of the list. In order, these are as follows:

Editor Preferences: This menu is used for making changes to the editor's appearance and modifying some of its functions; changes made in this menu apply to the editor, so their effects will be kept regardless of the project you are working on (while using the same system, of course).

Project Settings: This menu is for changing settings purely for the current project; it includes the ability to modify metadata for the project (version numbers, project name, etc.), AI/navigation settings, physics settings, platform settings (UE5 can be used to create apps for Windows, Android, Mac, iOS, and Linux, although some platforms require additional set up.). This menu also includes settings pages for active plugins.

Plugins: The plugins menu is a list that allows the user to activate and deactivate plugins, which provide added functionality to the engine/editor (depending on the plugin). The list contains many plugins that are provided with the engine, with many of them disabled by default.

Connect to source control: UE5 has integration with the common forms of source control (Subversion, Plastic SCM, Perforce, and Git). This is mostly useful when working on a project collaboratively, and it allows you to manage your source control from within the editor.

Window tab

The Window tab (shown in Figure 3.13) contains a long list of editor panels that aren’t opened by default and the option to open multiples of certain panels. Most of these panels are used for more advanced actions within the editor, so a brief explanation will be provided:

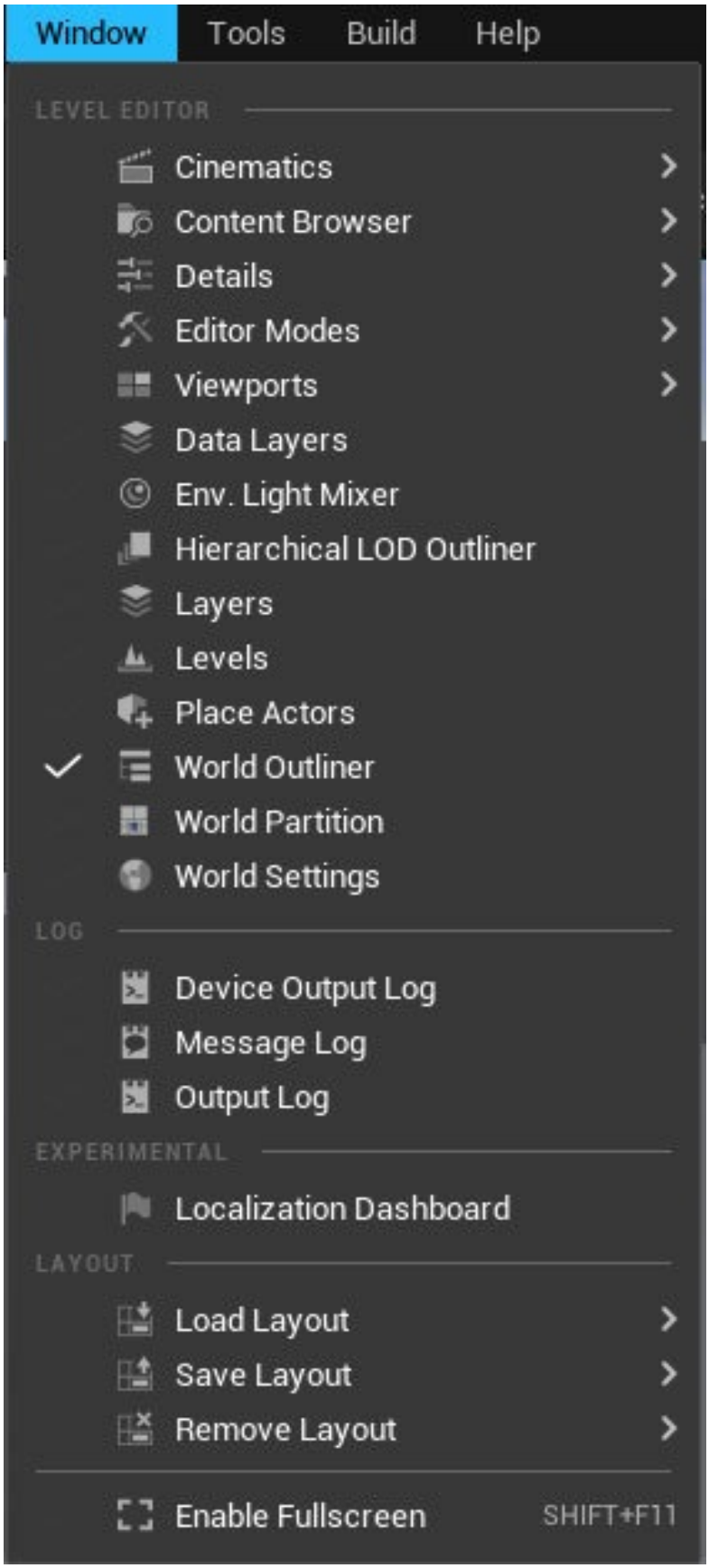

Window
Tools
Build
Help
LEVEL EDITOR
Cinematics
Content Browser
Details
Editor Modes
Viewports
Data Layers
Env. Light Mixer
Hierarchical LOD Outliner
Layers
Levels
Place Actors
World Outliner
World Partition
World Settings
LOG
Device Output Log
Message Log
Output Log
EXPERIMENTAL
Localization Dashboard
LAYOUT
Load Layout
Save Layout
Remove Layout
Enable Fullscreen
SHIFT+F11

Figure 3.13: Window tab

Level editor

Panels in this section of the list are used for editing the composition of the level and its settings:

Cinematics: Contains access to four panels used for making cinematics with the editor (cutscenes, movies, and so on)

Content browser: Allows creating multiples of the content browser panel (at the bottom of the interface by default)

Details: Allows creating multiples of the Details panel (at the right of the interface by default)

Editor modes: Opens toolbars for using the editor to edit level geometry and terrain (these toolbars are already open by default)

Viewports: Allows creating multiples of the Viewport (the Camera previewing the level, meaning you can get different angles or view different parts of the level at once)

Data layers: Opens a panel used to manage Layers within the level (a means of grouping map elements and a replacement for the Layers option further

down the list)

Env. light mixer: Opens a panel providing access to lighting details for light sources within the map, which greatly simplifies setting up a level's lighting

Hierarchical LOD outliner: Allows tweaking of hierarchical LODs if they are enabled (they aren't by default), which is a means of grouping together certain map element's LODs, primarily for optimization of a project

Layers: Opens a panel used to manage Layers within the level (a means of grouping map elements, and precursor to the Data Layers option covered previously)

Levels: Creates a panel for managing and modifying sub-levels used within the current one; it is very useful for setting up level streaming (enabling/disabling parts of the map depending on the player's location)

Place actors: Creates a panel used to spawn actors into the level, which can also be done using the content browser panel

World outliner: Opens the World Outliner panel, which provides a list of all actors placed within the currently opened level (the world), this panel is open by default (Right side of the editor)

World partition: Provides access to a panel used to manage sub-levels made using world partitioning (an automated process of dividing a large level into

smaller sub-levels)

World settings: Creates a panel providing access to settings for the current level (a Details panel for the level)

Logs

Logs are a text output of the results of the engine's various processes:

Device output log: Opens an output log for an attached device

Message log: Opens the message log, which reports compiler errors and warnings, among other things

Output log: Opens the output log, which reports almost everything the engine does

Experimental

The Experimental tab is for features of the engine that are still being tested, and as such may not be entirely stable or functional.

Localization dashboard is an interface to assist translating a project into multiple languages (referred to as Localization).

Layout

The Layout tab contains panels used to modify the appearance of the editor:

Load layout: Allows loading the default UE5 or UE4 layouts, as well as any custom layouts

Save layout: Used to save the current layout for future usage

Remove layout: Used to delete custom layouts that are no longer needed

Tools tab

The Tools tab allows access to a group of tools used for validating data within the project, finding references, viewing information about the project/editor and modifying/creating objects.

Build tab

The Build tab contains a list of functions used to compile/build aspects of the project (lighting, AI navigation), allowing the user to get a better idea of how the project will look/function once it is packaged out as its own application.

Help tab

The Help tab contains access to documentation regarding the engine and its uses, and a series of basic tutorials. It also contains information regarding the editor and its development, and a bug reporter.

Project settings

The Project Settings menu (shown in Figure 3.14) has a list of categories on the left side of its interface, which allows you to view all settings associated with them:

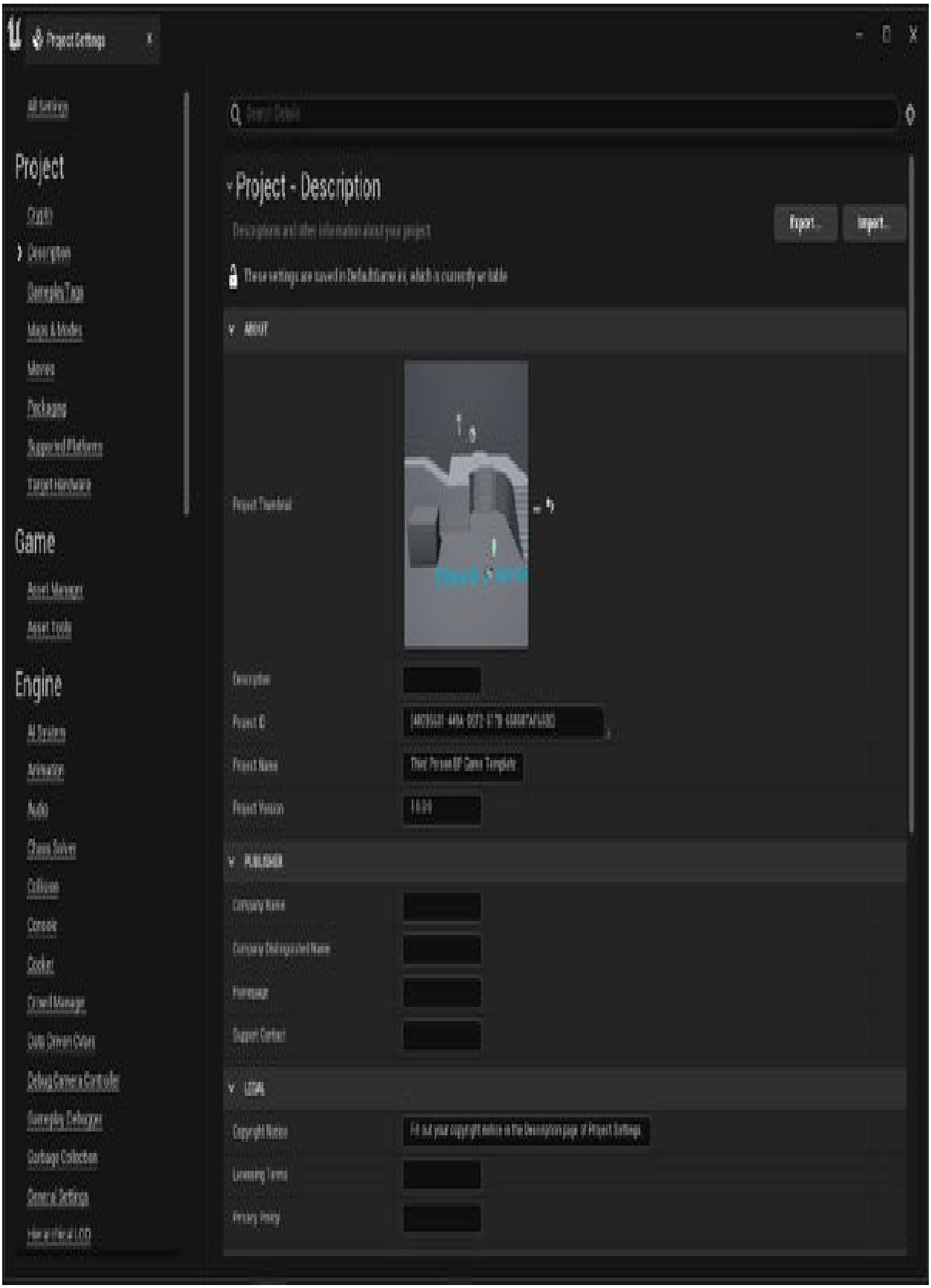

Project Settings
All Settings
Project
Description
Maps & Modes
Packaging
Supported Platforms
Target Hardware
Game
Asset Manager
Engine
Animation
Audio
Collision
Console
Cooker
Crowd Manager
Data Driven Values
Gameplay Debugger
Garbage Collection
General Settings
Project - Description
Export...
Import...
ABOUT
Project Thumbnail
Description
Project ID
Project Name
Third Person BP Game Template
Project Version
PUBLISHER
Company Name
Homepage
Support Contact
LEGAL
Copyright Notice
Fill out your copyright notice in the Description page of Project Settings.
Licensing Terms
Privacy Policy

Figure 3.14: Project Settings Menu

Modifying the settings in this menu will affect things in/about the project. This menu can be used to modify the project's meta-data (project version, name, and so on.), AI Navigation, physics settings, collision profiles, and much more.

Plugins

The Plugins menu (shown in Figure 3.15), just like the project settings menu has a list of categories on the left side of its' interface. Selecting one will filter the plugin list on the right side of the interface to only contain plugins associated with the selected category:

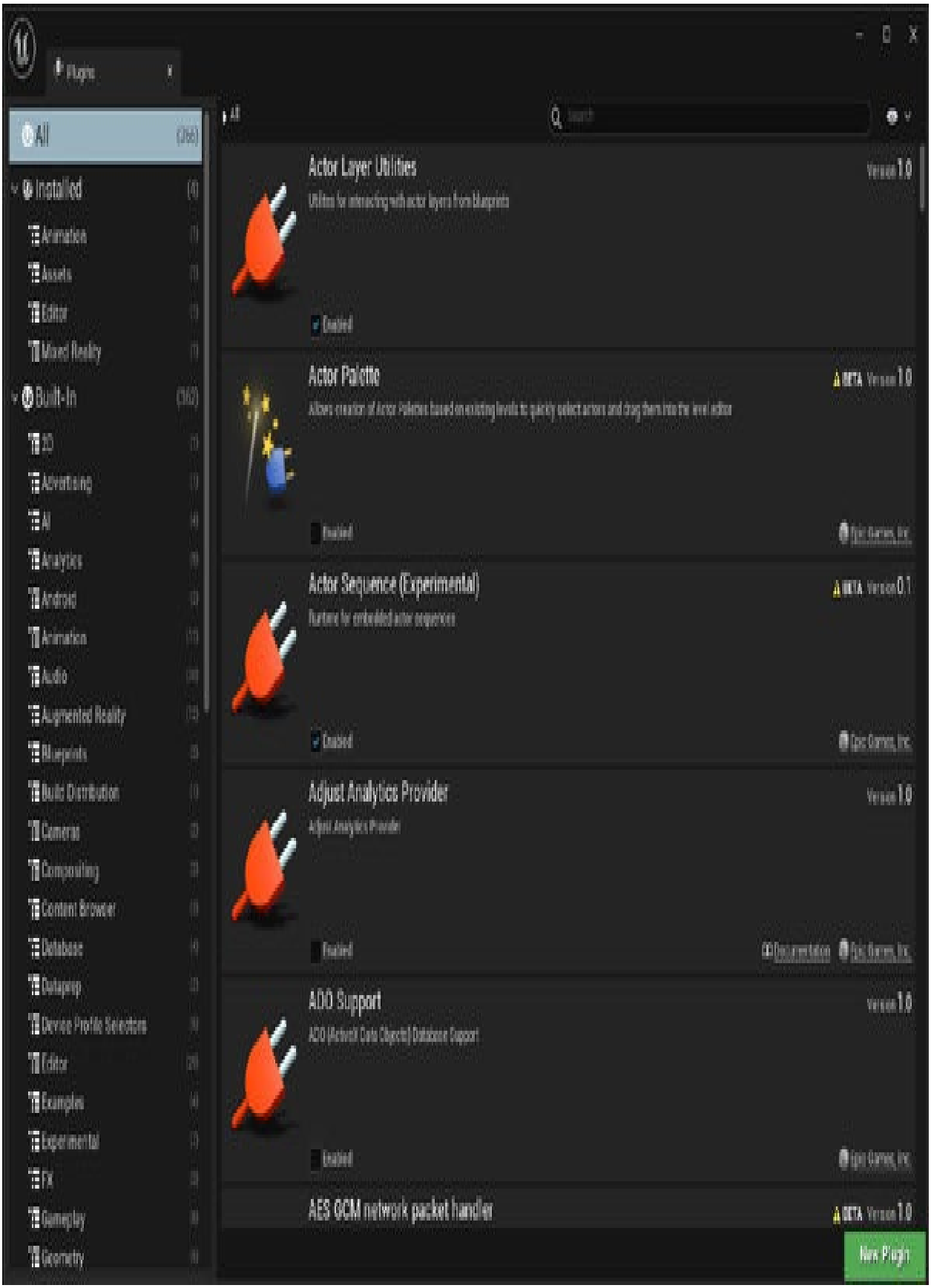

Plugins
All
Installed
Animation
Assets
Editor
Mixed Reality
Built-In
3D
Advertising
AI
Analytics
Android
Animation
Audio
Augmented Reality
Blueprints
Build Distribution
Cameras
Compositing
Content Browser
Database
Dataprep
Device Profile Selectors
Editor
Examples
Experimental
FX
Gameplay
Geometry
Actor Layer Utilities
Version 1.0
Utilities for interacting with actor layers from blueprints
Enabled
Actor Palette
BETA Version 1.0
Allows creation of Actor Palettes based on existing levels to quickly select actors and drag them into the level editor
Enabled
Epic Games, Inc.
Actor Sequence (Experimental)
BETA Version 0.1
Runtime for embedded actor sequences
Enabled
Epic Games, Inc.
Adjust Analytics Provider
Version 1.0
Adjust Analytics Provider
Enabled
Documentation
Epic Games, Inc.
ADO Support
Version 1.0
ADO (ActiveX Data Objects) Database Support
Enabled
Epic Games, Inc.
AES GCM network packet handler
BETA Version 1.0
New Plugin

Figure 3.15: Plugins menu

Unreal Engine 5 comes with many plugins, some of which are enabled by default, while some are not.

Plugins are packages that provide additional functionality and/or content to the project. If there is something you wish to do with the editor that you can't, there's a good chance there's a plugin in this menu that can assist you if not outright provide that functionality. Failing that, you may be able to find a custom plugin on the internet or potentially, make one yourself.

Conclusion

Unreal Engine 5 is extremely expansive. It has capabilities for just about anything you could imagine; knowing your way around the editor and what it is capable of is very important when trying to use it effectively and efficiently. You can change the way the editor is set up to match your preferences, and you can save and use different layouts depending on what exactly you are using the editor for. The locations of some elements of the editor cannot be changed (the title bar tabs). UE5 contains its own tutorial and links to documentation regarding itself and its usage. If you cannot figure something out or are curious as to what its exact purpose or usage is, chances are you can find out with a little research.

In the next chapter, we will go over the usage of Unreal Engine's visual scripting language blueprint and actor components.

Points to remember

Make sure whatever you get from the marketplace is compatible with the engine version you want to use it for.

Remember the hotkeys, as they will save you a great deal of time; learn the hotkeys for more advanced actions that were not included in this chapter.

Remember the purpose of the tabs in the title bar and the options within them, some of them will likely see common usage.

Research things you do not know about.

It is worth doing the tutorial included with UE5 (located in the Help tab).

The Epic Games Launcher is the home of Unreal Engine, but it is not its sole purpose.

There are many plugins provided with UE5; knowing what’s available may save you a great deal of time when developing a project.

The Log options within the Window tab is extremely useful for debugging

(finding the cause of errors).

Multiple choice questions

Which tab contains the layout menu?

File

Edit

Window

Help

What is the purpose of the world outliner?

A list of all the objects in the world

Closing the editor

Modifying sub levels and level streaming

Building geometry

Answers

c

a

Questions

Where do you get assistance with using the editor?

Explain what a plugin is.

What can the project settings menu be used to change?

Key terms

Editor: The Unreal Engine 5 program with a project loaded

Panel: An element within the editor with a specific purpose that can be moved around the editor

Log: A text output containing information regarding the current/previous running instance(s) of the project

Level: An environment to be used within the project

World: The space that contains all the currently open levels

CHAPTER 4

Using Blueprints

Each game engine has its own method and patterns to facilitate design and develop game assets. For example, having a 3D editor like Unity to edit and design level by user, or having in-depth physic simulation functions and procedure to simulate physics like Source engine are basically some tools provided by game engine to help users make game materials. The Unreal Engine has its own method known as blueprint to create game assets, organize them on the scene, control them with game mechanics rules, and optimize them during runtime for player depending on machine features.

In this chapter, we will learn how to create and design blueprint game objects, which is a fundamental learning step for both designer and programmers to use Unreal Engine. And then by going through step-by-step practical examples, we will learn how to use blueprint components. Then we learn how to add static mesh and physical behaviour to blueprint game object.

Structure

In this chapter, we will discuss the following topics:

What is a blueprint?

Design with blueprint

Blueprint components

Adding Mesh to blueprint

Adding physics (basic)

Objectives

After studying this unit, you should be able to create blueprint objects inside Unreal Engine. The blueprint object supports different functionalities and purpose within your game application, so we will go through making an actor blueprint and components attached to it, and we will learn hierarchical relation between these components in order to support game scenario and procedures of game.

What is a blueprint?

To answer this question, let us assume you are the following:

A designer with an experience of using 3D design applications for business, game design or art, and also having 2D design experience with applications like Photoshop and Illustrator.

A programmer with experience of coding simple functions and class.

New to game design and programming and would like to discover your talent in Unreal Engine 5.

Now, let us explain blueprint for each of these groups.

As a 3D designer, you know that users can Create objects and also Edit these objects in each 3D application. Also, the user has details of size, rotations, and coordination of the objects somewhere on their user interface. A good example of these tools is Blender. As Figure 4.1 shows, by opening Blender, the user has a basic 3D object with its coordination on right and some tools to edit on the left:

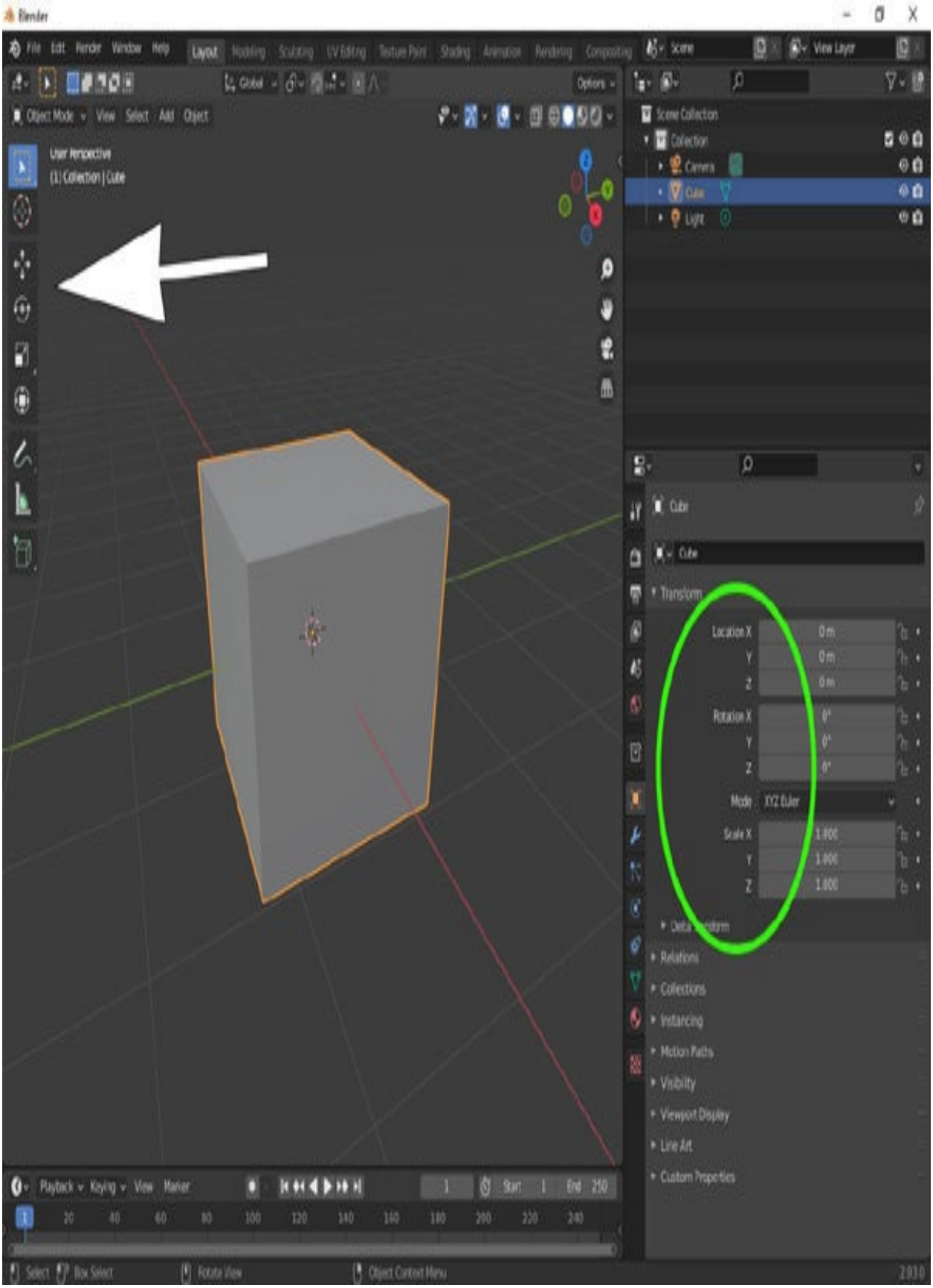

Blender
File Edit Render Window Help
Layout Modeling Sculpting UV Editing Texture Paint Shading Animation Rendering Compositing
Scene
View Layer
Global
Options
Object Mode View Select Add Object
User Perspective
(1) Collection | Cube
Scene Collection
Collection
Camera
Cube
Light
Cube
Transform
Location X 0 m
Y 0 m
Z 0 m
Rotation X 0°
Y 0°
Z 0°
Mode XYZ Euler
Scale X 1.000
Y 1.000
Z 1.000
Relations
Collections
Instancing
Motion Paths
Visibility
Viewport Display
Line Art
Custom Properties
Playback Keying View Marker
1
Start 1 End 250
Select Box Select Rotate View Object Context Menu
2.93.0

Figure 4.1: Visual

As a 2D designer, you already know about color pallet, image size in pixel, and transparency between image layers when they overlap. This is basic knowledge of 2D design that, for example Photoshop, provides a massive toolset as Figure 4.2 shows, which are designed for working with a 2 dimensional images. :

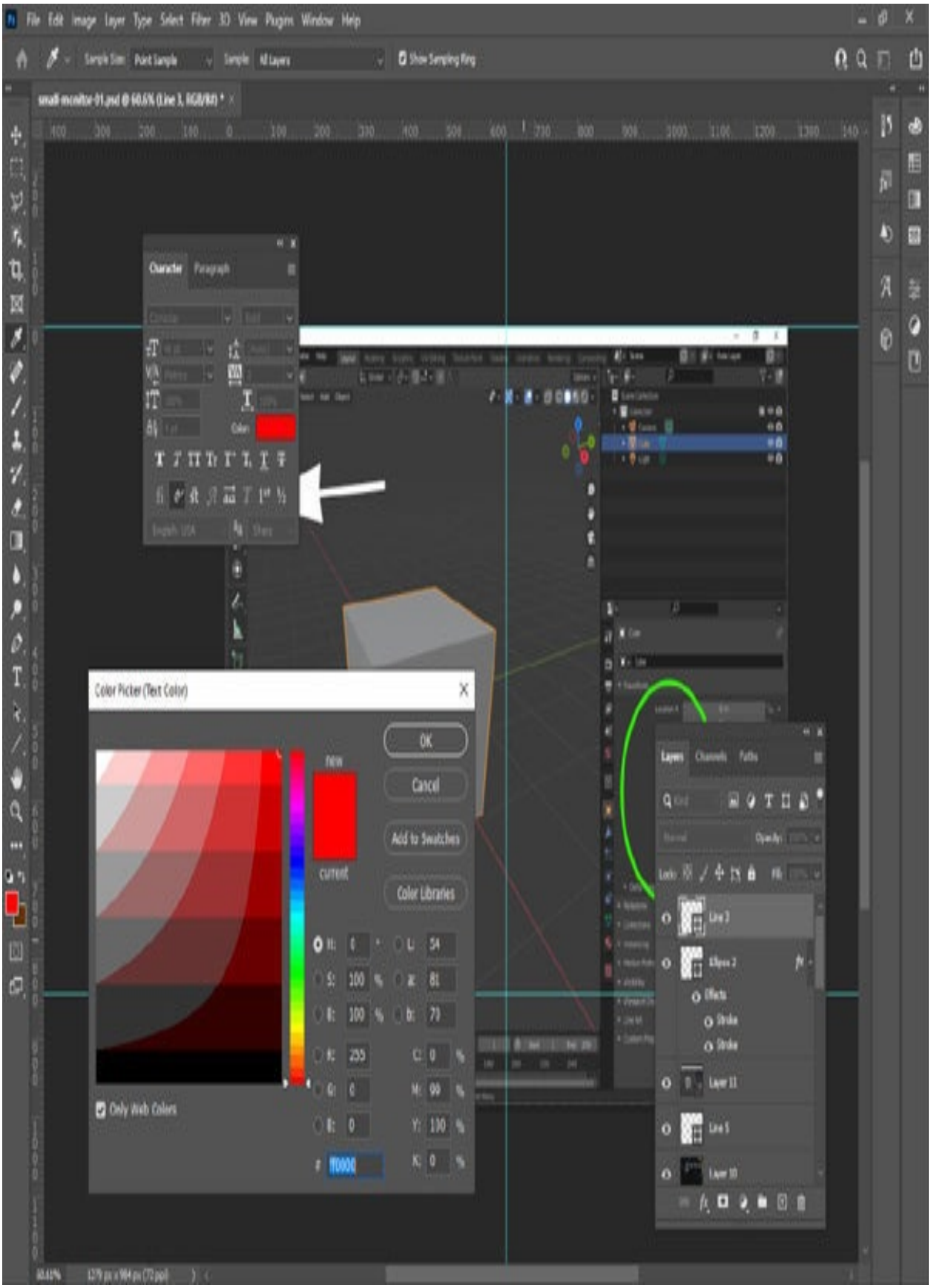

File Edit Image Layer Type Select Filter 3D View Plugins Window Help
Sample Size: Point Sample
Sample: All Layers
Show Sampling Ring
small-monitor-01.psd @ 60.6% (Line 3, RGB/8#) *
Character
Paragraph
Color
Color Picker (Text Color)
OK
Cancel
Add to Swatches
Color Libraries
new
current
Only Web Colors
Layers
Channels
Paths
Line 2
Effects
Stroke
Stroke
Layer 11
Line 5
Layer 10

Figure 4.2: Visual

Figure 4.3 is a screenshot of Unreal Tournament. This game is first-person shooter (FPS), which is completely designed with Unreal Engine:

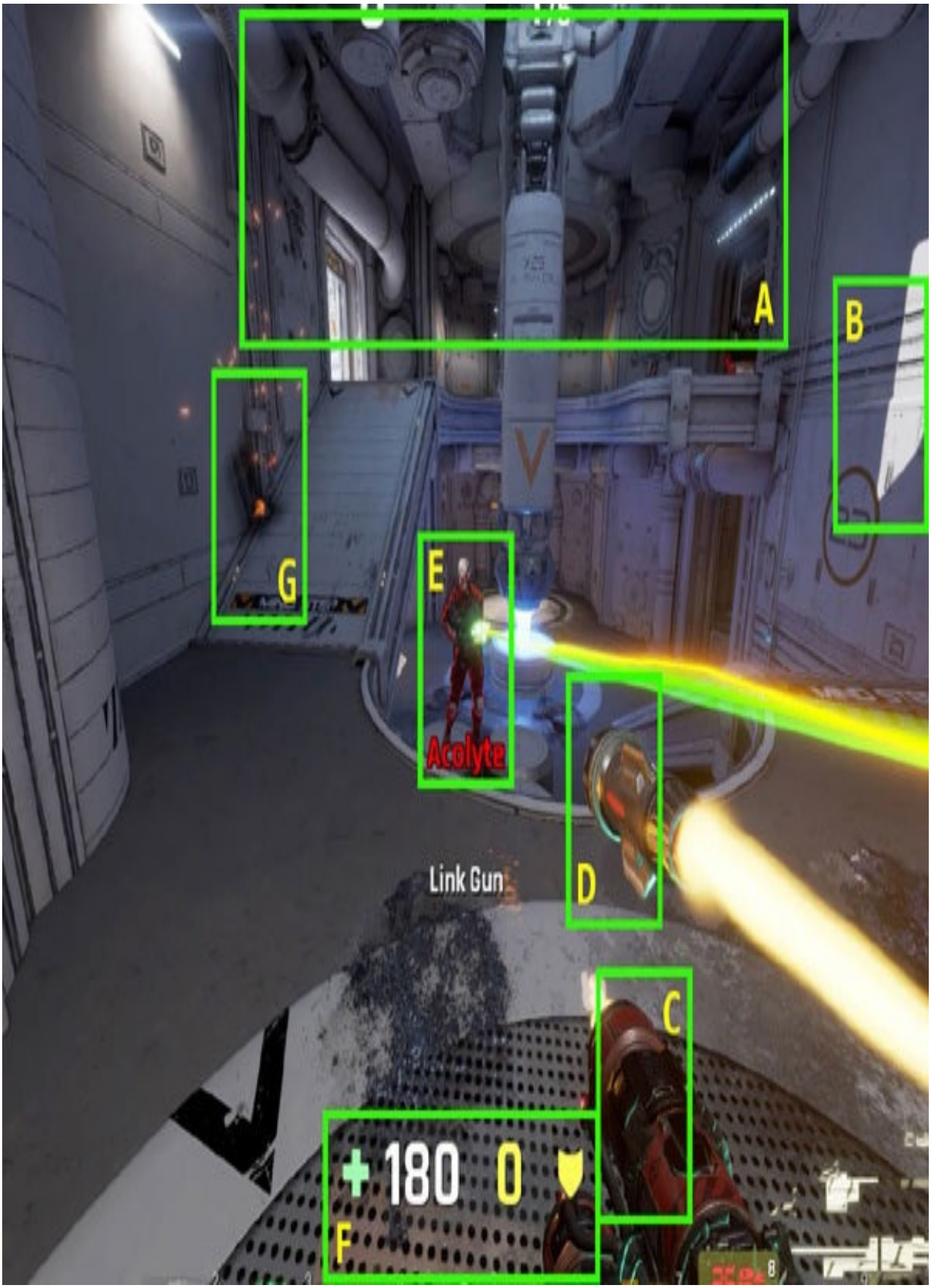

A
B
G
E
Acolyte
Link Gun
D
C
+180
0
F

Figure 4.3: Screenshot of Unreal Tournament with marked game elements

As you can see in Figure 4.3, there are a number of game elements; some have 3D locations in the scene, and some are render data for the user, like material and UI. As examples of blueprint, we marked some game elements like 3D details and materials of level (green box A), lighting effects in environment (green box B), the weapon object (green box C), the actual rocket round that the player shoots (green box D), the player`s user interface UI (green box F), and finally, the enemy unit (green box E). Each of these elements uses a blueprint object to present its own contents, render materials, and change their own state based on player interaction in game. For example, on impact of rocket to the walls, the material blueprint on that location automatically renders a decal effect, which is marked by green box G, or the fire behind the rocket in green box D is switched on by rocket blueprint, and it is a particle system, which again, is a blueprint by itself.

Similar to what you experienced in 2D, and 3D design, a blueprint in Unreal Engine is like an Object. This Object, or let’s say Blueprint, has many types, and each one is designed to perform specific Action in the game, like providing a visual effect, presenting user interface, grabbing player inputs, generating time-based cinematics, playing audio, and so on.

Designers can use blueprints to implement physics, create special effects like particles (like fog and fire), simulate day and night lighting in map, provide game assets (like weapons), and for animation and cinematography. Blueprints have different types, and each type has its own properties and features. For now, we will focus on the basics of design and automation in blueprint. Good design of blueprint always saves time and increased performance in massive scale projects.

As a programmer, assume that you are already aware of logic and methods in a programming language to develop the main code, make function and declare class, and also know about the order of execution in code, which means the sequence of running each line of your code after each other. In Unreal Engine, blueprint works like code, but instead of executing lines of code, the engine will execute blocks of procedures and functions in a sequence similar to the order of execution.

Refer to Figure 4.3; there are a number of blueprint objects, like the weapon marked in green box C. Each time a player presses fire, a code inside the weapon`s Blueprint is executed and visual effect of shooting is activated; then, it plays animation on weapon and spawns a projectile in the scene, which is basically a Blueprint of a rocket round (marked by green box D). The user interface marked in green box F is also a series of Blueprint objects which grab data from player`s states and show them to the user on screen.

Another way to imagine Blueprint as a developer is to assume that each Blueprint is like a Class with properties, methods, and functions. As you know, there can be different types of class in any application to perform different tasks. In Unreal Engine as well, there are different types of Blueprints to perform specific functionalities in game. For example, Character Blueprint can accept AI navigations, HUD Blueprint is designed for user interface interactions, Animation Blueprint supports a number of methods and functions for running animations, and so on. We will cover blueprint programming in the following chapters, and we will cover these Blueprint objects in depth.

Now, assume that you are not a programmer, and designing is not your concern. This means you never seriously touched any 3D application, you don’t have Photoshop experience, and your knowledge about coding is zero. Well, the good news is, there is no problem in this situation; using blueprint in Unreal Engine is a mix of design and code, which is an opportunity for beginners to discover their own talent, either in coding or design (or maybe both!), for making game assets. So, let’s take a deep breath and start.

The word Blueprint by its own meaning: it is a photographic presentation and guide of an early plan for a visual structure or interactive system.

Imagine that you have an empty magic Paper Box, as shown in Figure 4.4. Now, because it’s a magical item, we can attach anything to it easily, like flashlight, wheels, maybe weapon, smoke, or camera. Now, assume that we like to make a simple vehicle, so add four wheels to it and an electrical engine to move the wheels. Also, add a camera to see where it goes:

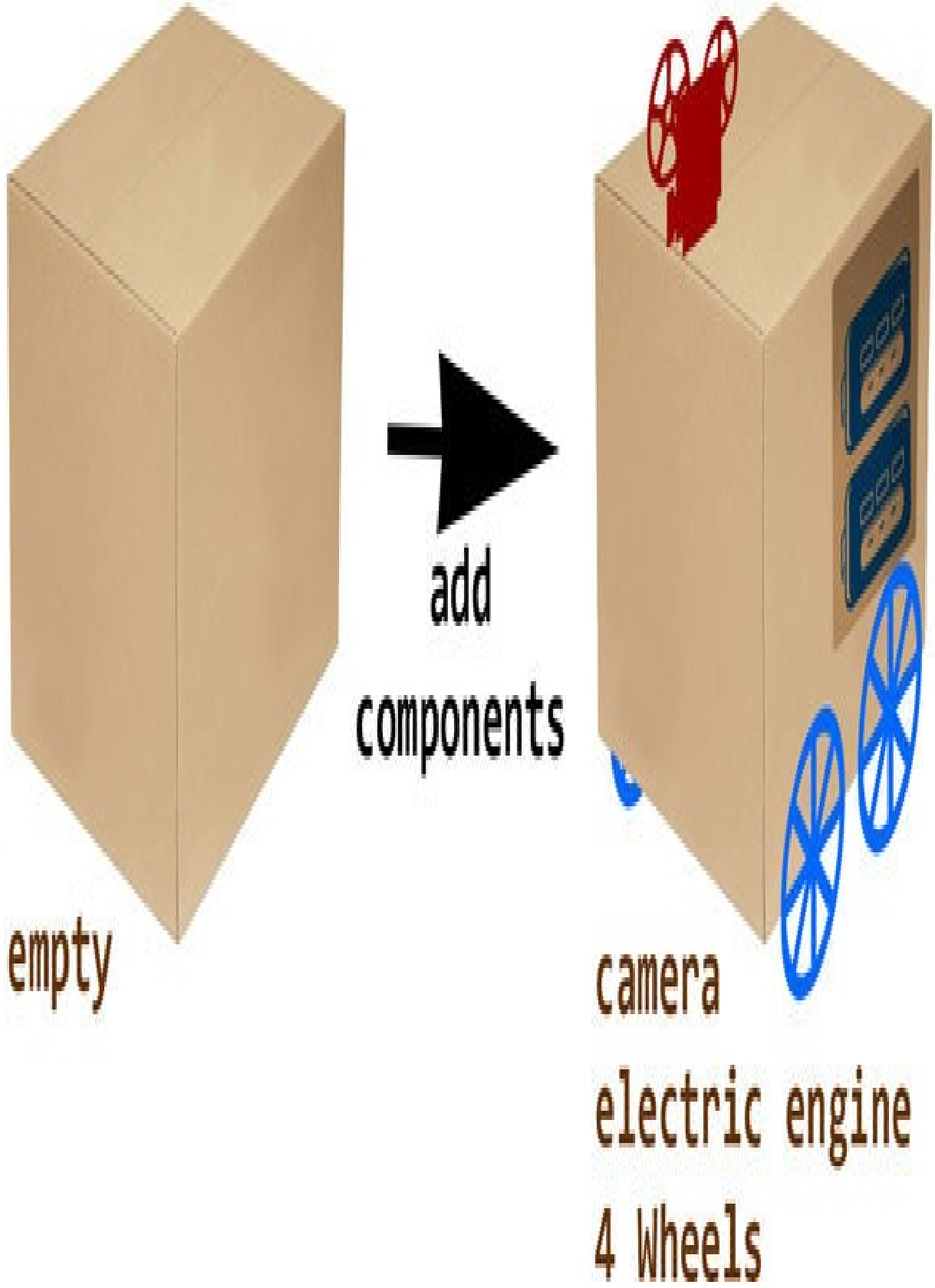

empty
add
components
camera
electric engine
4 Wheels

Figure 4.4: Example of making a very basic Blueprint of a vehicle with 4 wheels and an electric engine and camera

At this stage, having an engine, wheels and a camera is NOT enough, we need something to Control it and get it to move and stop. So, by using magic, we simply add a remote receiver and some mechanics that can get events from receiver and apply them to the engine. Sounds simple, doesn't it? So, what we made by magic is a Blueprint of a remote car. This approach is extremely useful at the beginning of any Blueprint development.

The blueprint explains features of design and address events and explains the result of each event as visual presentation or informative data. For example, refer to Figure 4.3: the weapon's blueprint already has weapon mesh with a number of materials, and it also has code to grab the click event from mouse and then execute an event for play weapon-shoot animation (same as the remote vehicle explained in Figure 4.4: when you press run in remote control, the engine moves the wheels and the box starts moving). When the player shoots the rocket in game, the weapon's blueprint will spawn smoke and flash on screen by an event, and a projectile will spawn in the scene and move to the target. Each of these events, (mouse input, animation, and visual effect) occurs in a sequence and uses a component to show the result. For example, weapon-shoot animation is played on weapon 3D mesh object component, and smoke and fire are made by particle system component, and mouse detection is using Player Controller component to work with. This is the same as the example in Figure 4.4: each component is responsible for a unique task (wheels for movement, engine for power, and so on).

Each Blueprint in Unreal Engine has an editor known as Blueprint Editor. Blueprint Editor prepares tools to create and customize visual elements of a game object that we will go through in this chapter. At the same time, it has an object-oriented node-base visual scripting language for programming game

object functionalities. This language is designed to be easy to learn and has massive support by C++ libraries developed for the engine. We will cover blueprint programming in detail in a later chapter.

It sounds complicated, but be patient, Blueprint is magically designed to be simple; by the end of this book, you will be able to make your own weapon blueprint and use it in your own game.

Design with blueprint

The Unreal Engine has a series of tools developed for use with blueprints known as engine's Blueprint Components. These components provide support to design game elements (like the weapon in the earlier example), develop functionality like AI, spawn particle effect, play audio, and animation. They cover 90% of making a basic-advanced asset for putting in a game scene. In this chapter, we will learn the basics of design game assets with Blueprint components.

Revisit the previous chapter, open Unreal Engine 5, and quickly make a new project by using the Third Person template from the Game template category, as shown in Figure 4.5:

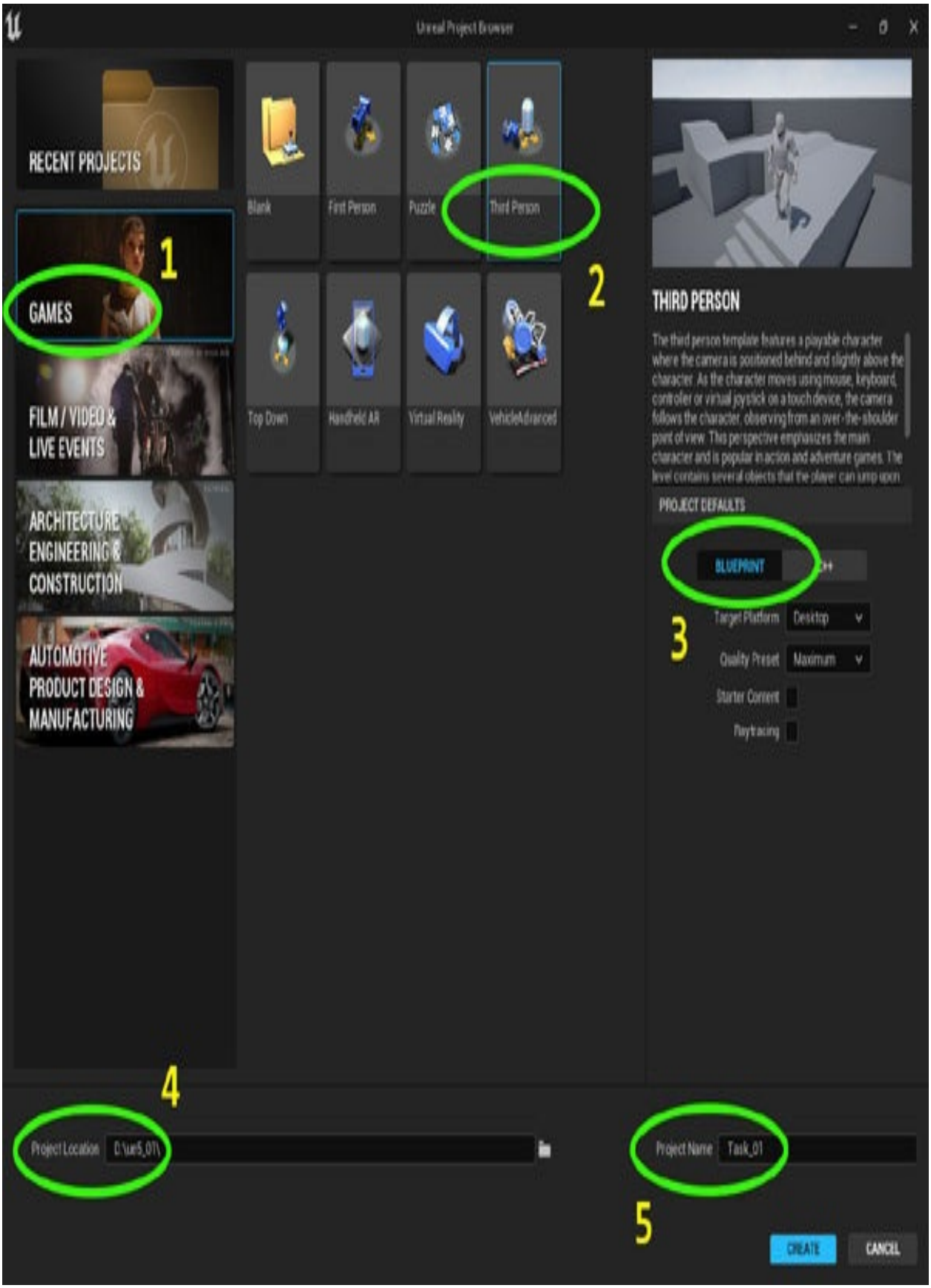

Unreal Project Browser
RECENT PROJECTS
GAMES
1
FILM / VIDEO & LIVE EVENTS
ARCHITECTURE ENGINEERING & CONSTRUCTION
AUTOMOTIVE PRODUCT DESIGN & MANUFACTURING
Blank
First Person
Puzzle
Third Person
2
Top Down
Handheld AR
Virtual Reality
VehicleAdvanced
THIRD PERSON
The third person template features a playable character where the camera is positioned behind and slightly above the character. As the character moves using mouse, keyboard, controller or virtual joystick on a touch device, the camera follows the character, observing from an over-the-shoulder point of view. This perspective emphasizes the main character and is popular in action and adventure games. The level contains several objects that the player can jump upon
PROJECT DEFAULTS
BLUEPRINT
3
Target Platform
Desktop
Quality Preset
Maximum
Starter Content
Raytracing
4
Project Location
D:\ue5_01\
Project Name
Task_01
5
CREATE
CANCEL

Figure 4.5: Select the GAMES category (1), then choose Third Persson template (2), then select BLUEPRINT in the project defaults (3), and then set project location (4) and project name (5) and click on the "CREATE" button.

Open the project, select the ThirdPersonBP folder in content browser and then select the Blueprints folder. At the same time, on top of content browser, you can find the folder path that you just navigate (this area is useful when you navigate between folders). Now, right-click in the content browser and click on Blueprint Class from the list, as shown in Figure 4.6:

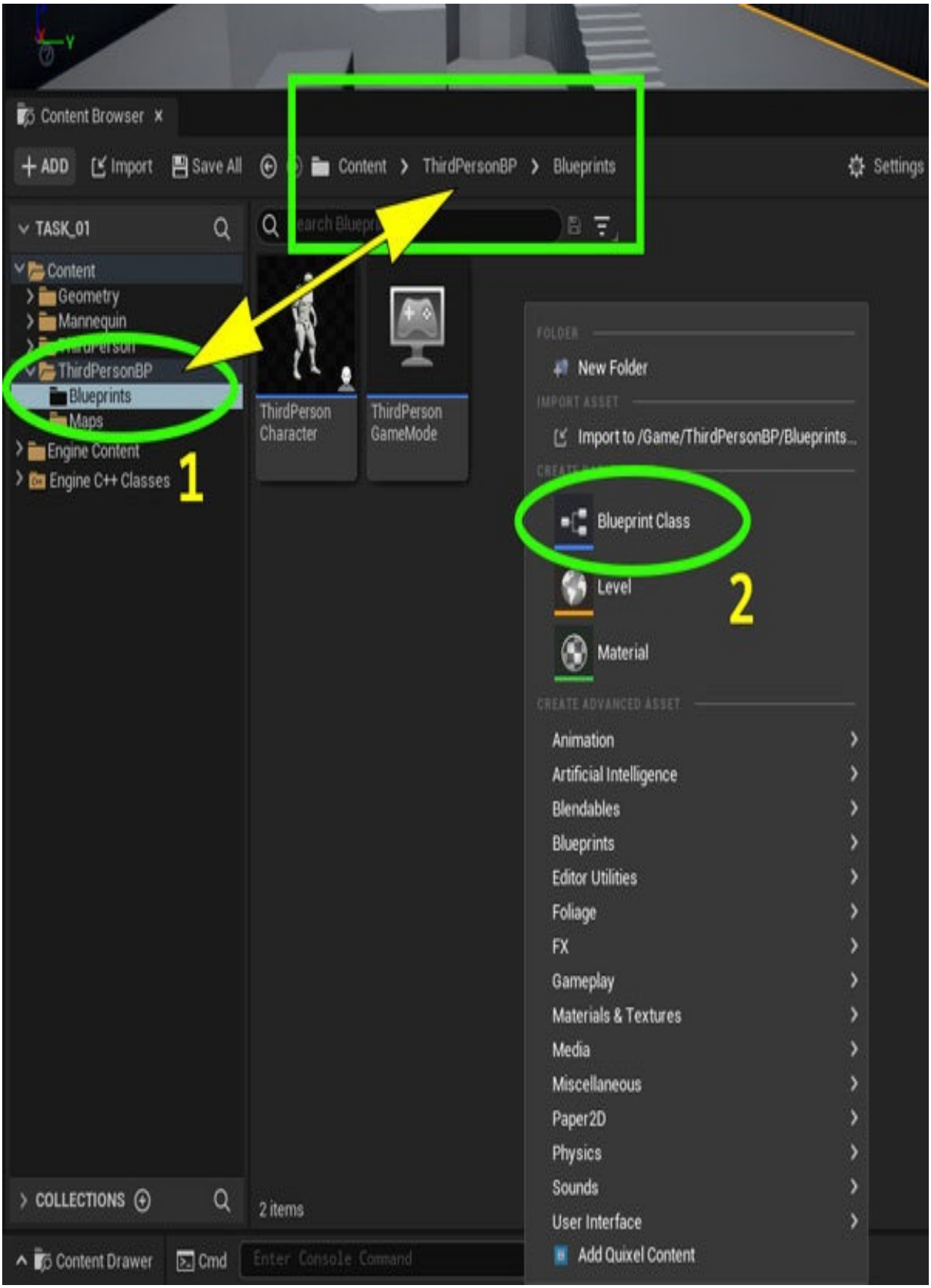

Content Browser
ADD
Import
Save All
Content > ThirdPersonBP > Blueprints
Settings
TASK_01
Content
Geometry
Mannequin
ThirdPersonBP
Blueprints
Maps
Engine Content
Engine C++ Classes
1
ThirdPerson Character
ThirdPerson GameMode
FOLDER
New Folder
IMPORT ASSET
Import to /Game/ThirdPersonBP/Blueprints...
Blueprint Class
Level
Material
2
CREATE ADVANCED ASSET
Animation
Artificial Intelligence
Blendables
Blueprints
Editor Utilities
Foliage
FX
Gameplay
Materials & Textures
Media
Miscellaneous
Paper2D
Physics
Sounds
User Interface
Add Quixel Content
COLLECTIONS
2 items
Content Drawer
Cmd
Enter Console Command

Figure 4.6: Make new blueprint by choose a folder in content browser (1) and then right click in there and select "Blueprint Class"(2)

The engine will automatically open the Pick Parent Class window with a list of Blueprint objects to select, as shown in Figure 4.7. As this image shows, this window contains a number of blueprint classes, and by clicking on the ALL CLASSES drop-down list, you will find a complete list of available blueprint classes. We will cover the essential blueprint classes shown here by the end of this book:

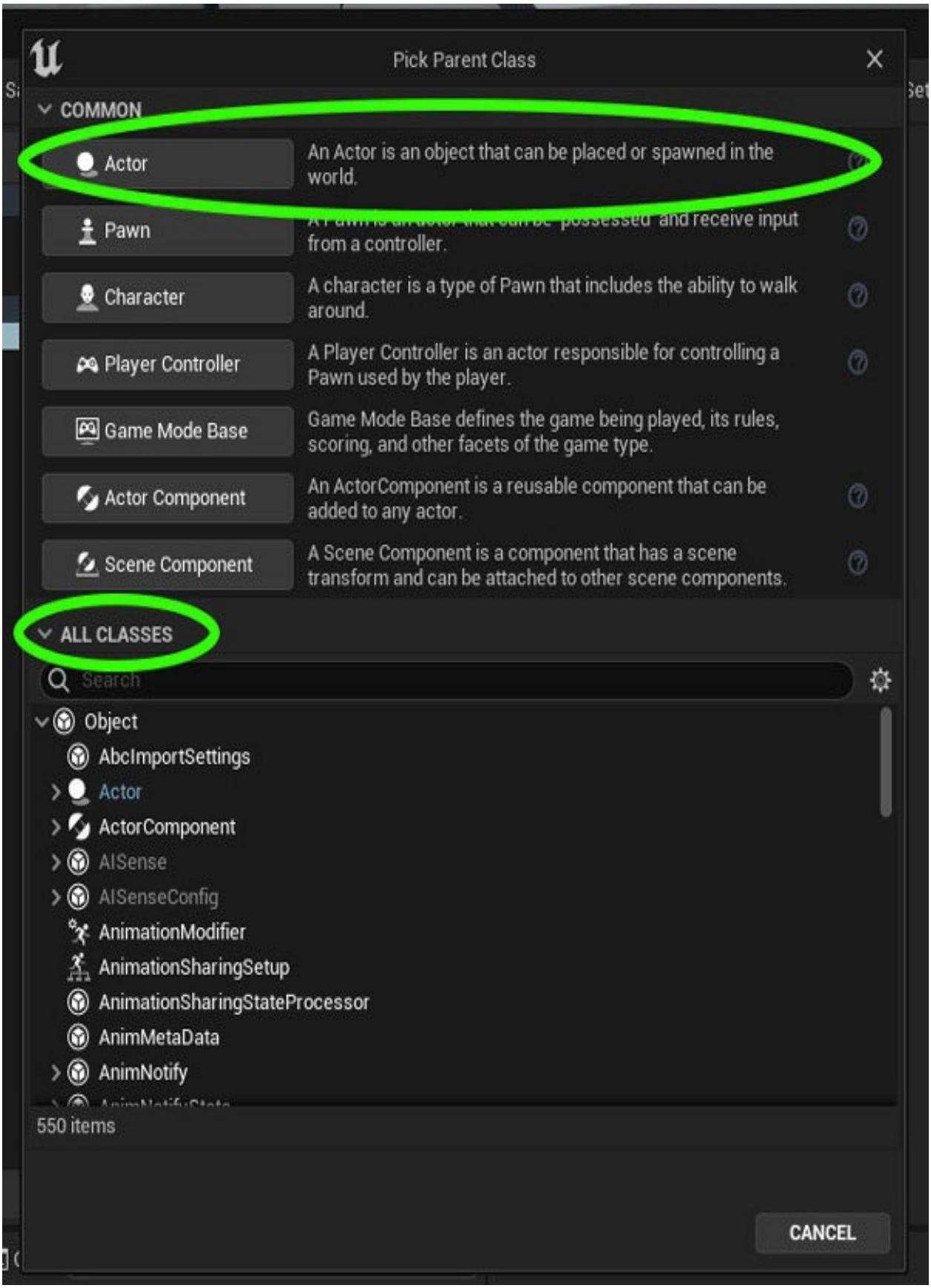

Pick Parent Class
COMMON
Actor
An Actor is an object that can be placed or spawned in the world.
Pawn
and receive input from a controller.
Character
A character is a type of Pawn that includes the ability to walk around.
Player Controller
A Player Controller is an actor responsible for controlling a Pawn used by the player.
Game Mode Base
Game Mode Base defines the game being played, its rules, scoring, and other facets of the game type.
Actor Component
An ActorComponent is a reusable component that can be added to any actor.
Scene Component
A Scene Component is a component that has a scene transform and can be attached to other scene components.
ALL CLASSES
Search
Object
AbcImportSettings
Actor
ActorComponent
AISense
AISenseConfig
AnimationModifier
AnimationSharingSetup
AnimationSharingStateProcessor
AnimMetaData
AnimNotify
550 items
CANCEL

Figure 4.7: Select blueprint class type from the ”Pick Parent Class” window. Click on “ALL CLASSES” to expand the list

For now, click on Actor, and the engine will automatically make a new object in your content browser, which is your new Blueprint. Now, rename this blueprint in content browser to BP_Item_01 by right-clicking on the object and selecting rename or by pressing F2, as shown in Figure 4.8. Using BP_ as the prefix for naming a blueprint is an industry standard that we will follow in this book:

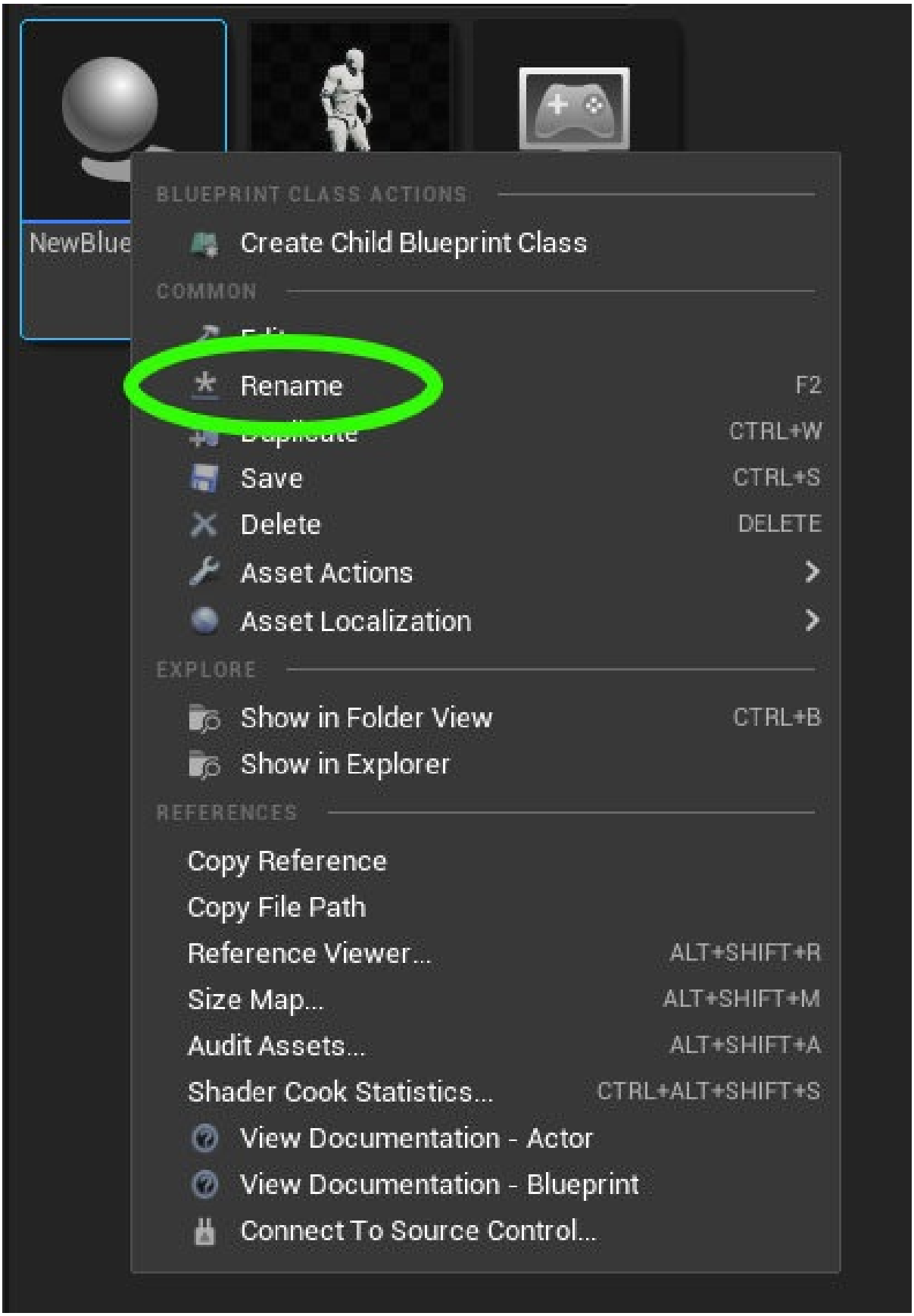

NewBlue
BLUEPRINT CLASS ACTIONS
Create Child Blueprint Class
COMMON
Rename F2
CTRL+W
Save CTRL+S
Delete DELETE
Asset Actions
Asset Localization
EXPLORE
Show in Folder View CTRL+B
Show in Explorer
REFERENCES
Copy Reference
Copy File Path
Reference Viewer... ALT+SHIFT+R
Size Map... ALT+SHIFT+M
Audit Assets... ALT+SHIFT+A
Shader Cook Statistics... CTRL+ALT+SHIFT+S
View Documentation - Actor
View Documentation - Blueprint
Connect To Source Control...

Figure 4.8: Right-click on blueprint and select Rename from the list

The new object is an Actor Blueprint object. It is a basic game asset that can be placed on stage, spawned in game, and can receive user interactions. Double-clicks on BP_Item_01 blueprint in your content browser, and you will open a blueprint editor, as shown in Figure 4.9. First, click on the Viewport panel to activate it. Then, on the left, locate the Component panel, click on +ADD button, and select Cube from drop-down list:

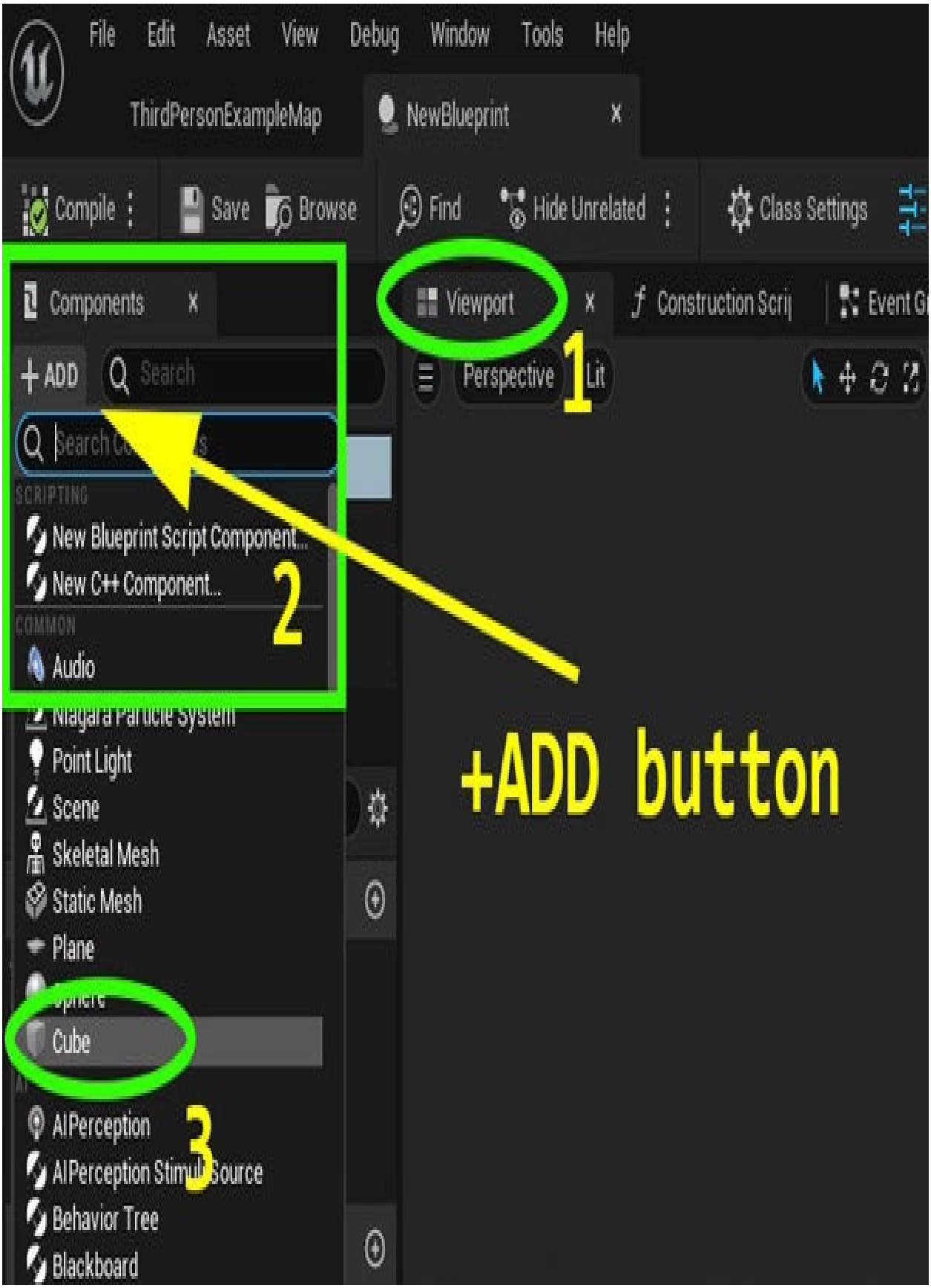

File
Edit
Asset
View
Debug
Window
Tools
Help
ThirdPersonExampleMap
NewBlueprint
Compile
Save
Browse
Find
Hide Unrelated
Class Settings
Components
Viewport
Construction Scrij
Event G
ADD
Search
Perspective
Lit
1
SCRIPTING
New Blueprint Script Component...
New C++ Component...
2
COMMON
Audio
Point Light
Scene
Skeletal Mesh
Static Mesh
Plane
Cube
AIPerception
AIPerception Stimuli Source
Behavior Tree
Blackboard
3
+ADD button

Figure 4.9: Click on Viewport panel (1) and then click on the +ADD button in the Components panel (2) and select Cube from the drop-down list (3)

Now, navigate to the main editor; as you can see, the BP_Item_01 blueprint has changed and now it shows a cube. Now, drag and drop three instances of BP_Item_01 to stage by using mouse, as shown in Figure 4.10:

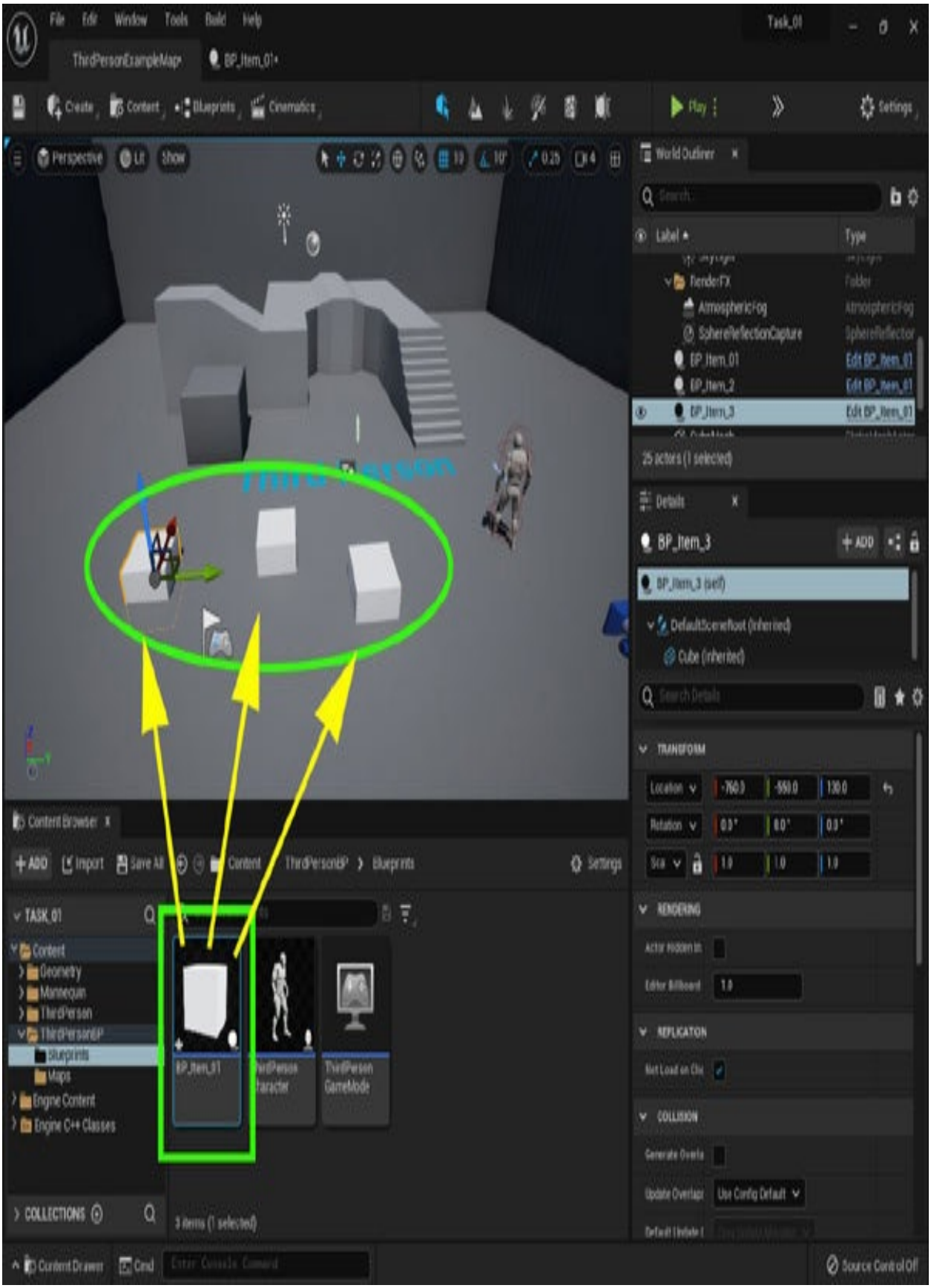

File Edit Window Tools Build Help
Task_01
ThirdPersonExampleMap
BP_Item_01*
Create
Content
Blueprints
Cinematics
Play
Settings
Perspective
Lit
Show
World Outliner
Label
Type
RenderFX
AtmosphericFog
SphereReflectionCapture
BP_Item_01
BP_Item_2
BP_Item_3
Edit BP_Item_01
25 actors (1 selected)
Details
BP_Item_3
ADD
BP_Item_3 (self)
DefaultSceneRoot (inherited)
Cube (inherited)
TRANSFORM
Location
Rotation
Scale
RENDERING
Actor Hidden In
Editor Billboard
REPLICATION
Net Load on Clie
COLLISION
Generate Overla
Update Overlaps
Use Config Default
Content Browser
ADD
Import
Save All
Content
ThirdPersonBP
Blueprints
Settings
TASK_01
Content
Geometry
Mannequin
ThirdPerson
ThirdPersonBP
Blueprints
Maps
Engine Content
Engine C++ Classes
BP_Item_01
ThirdPerson Character
ThirdPerson GameMode
COLLECTIONS
3 items (1 selected)
Content Drawer
Cmd
Enter Console Command
Source Control Off

Figure 4.10: Drag and drop three instances of BP_Item_01 to the scene

Now, click on each BP_Item_01 blueprint instance and use transform tools (located on top of viewport) to change location, rotate, and rescale each object on the stage, as shown in Figure 4.11. When you use transition tools, the values of each property (location, rotation, and scale) are shown in the Details panel in the Transform section. At the same time, you have a list of your objects and blueprints in the scene in the World Outliner panel:

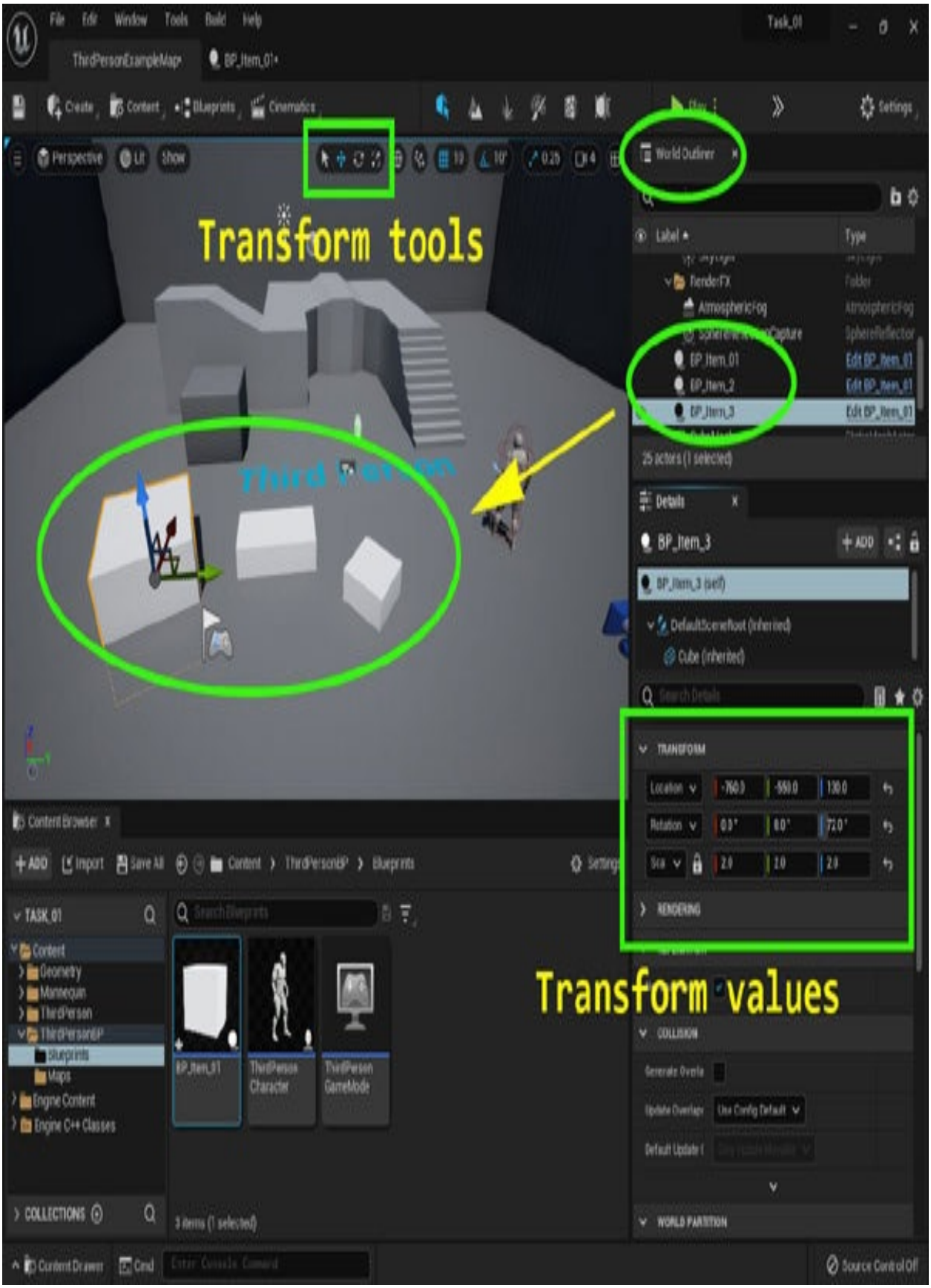

Transform tools
Transform values

Figure 4.11: You can customize transform values (Location, rotation, scale) in the Details panel

You can directly click on each item in the World Outliner panel and check properties that belong to them in the Details panel. To delete items from the scene, press Delete on keyboard or right-click on the object/blueprint anywhere and then select Delete from the Edit section. Here, you have options for Cut, Copy, Paste, Duplicate, Delete, and Rename, as shown in Figure 4.12:

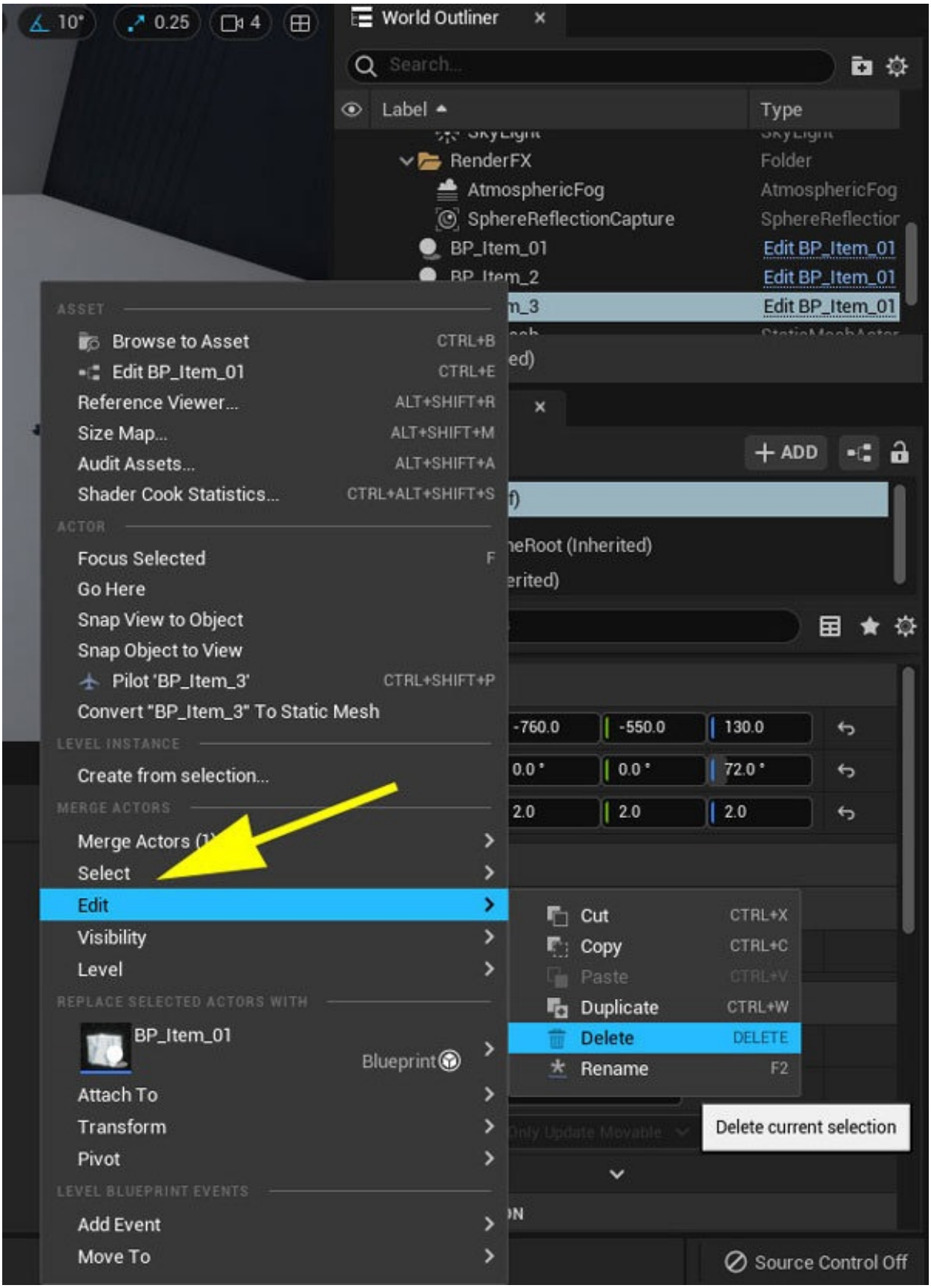

World Outliner
Search...
Label
Type
RenderFX
Folder
AtmosphericFog
SphereReflectionCapture
BP_Item_01
Edit BP_Item_01
BP_Item_2
Edit BP_Item_01
Edit BP_Item_01
ASSET
Browse to Asset CTRL+B
Edit BP_Item_01 CTRL+E
Reference Viewer... ALT+SHIFT+R
Size Map... ALT+SHIFT+M
Audit Assets... ALT+SHIFT+A
Shader Cook Statistics... CTRL+ALT+SHIFT+S
ACTOR
Focus Selected F
Go Here
Snap View to Object
Snap Object to View
Pilot 'BP_Item_3' CTRL+SHIFT+P
Convert "BP_Item_3" To Static Mesh
LEVEL INSTANCE
Create from selection...
MERGE ACTORS
Merge Actors (1)
Select
Edit
Visibility
Level
REPLACE SELECTED ACTORS WITH
BP_Item_01
Blueprint
Attach To
Transform
Pivot
LEVEL BLUEPRINT EVENTS
Add Event
Move To
ADD
-760.0
-550.0
130.0
0.0 °
0.0 °
72.0 °
2.0
2.0
2.0
Cut CTRL+X
Copy CTRL+C
Paste CTRL+V
Duplicate CTRL+W
Delete DELETE
Rename F2
Delete current selection
Source Control Off

Figure 4.12: Edit options for blueprint instances on the scene

Now, follow the same procedure and create BP_Item_02. Then, from the Component panel, use the +ADD button to add sphere static mesh component. Then, drag and drop two instances of them into the stage and change their transform values, as shown in Figure 4.13:

File
Edit
Asset
View
Debug
ThirdPersonExampleMap
Compile
Save
Browse
Components
ADD
Search Components
New Blueprint Script Component...
New C++ Component...
Audio
Niagara Particle System
Point Light
Scene
Skeletal Mesh
Plane
sphere
Cube
AIPercepton
AIPercepton Stmuli Source
Behavior Tree
Blackboard
Pawn Noise Emitter
Pawn Sensing
ARLife Cycle
Content Drawer
Cmd

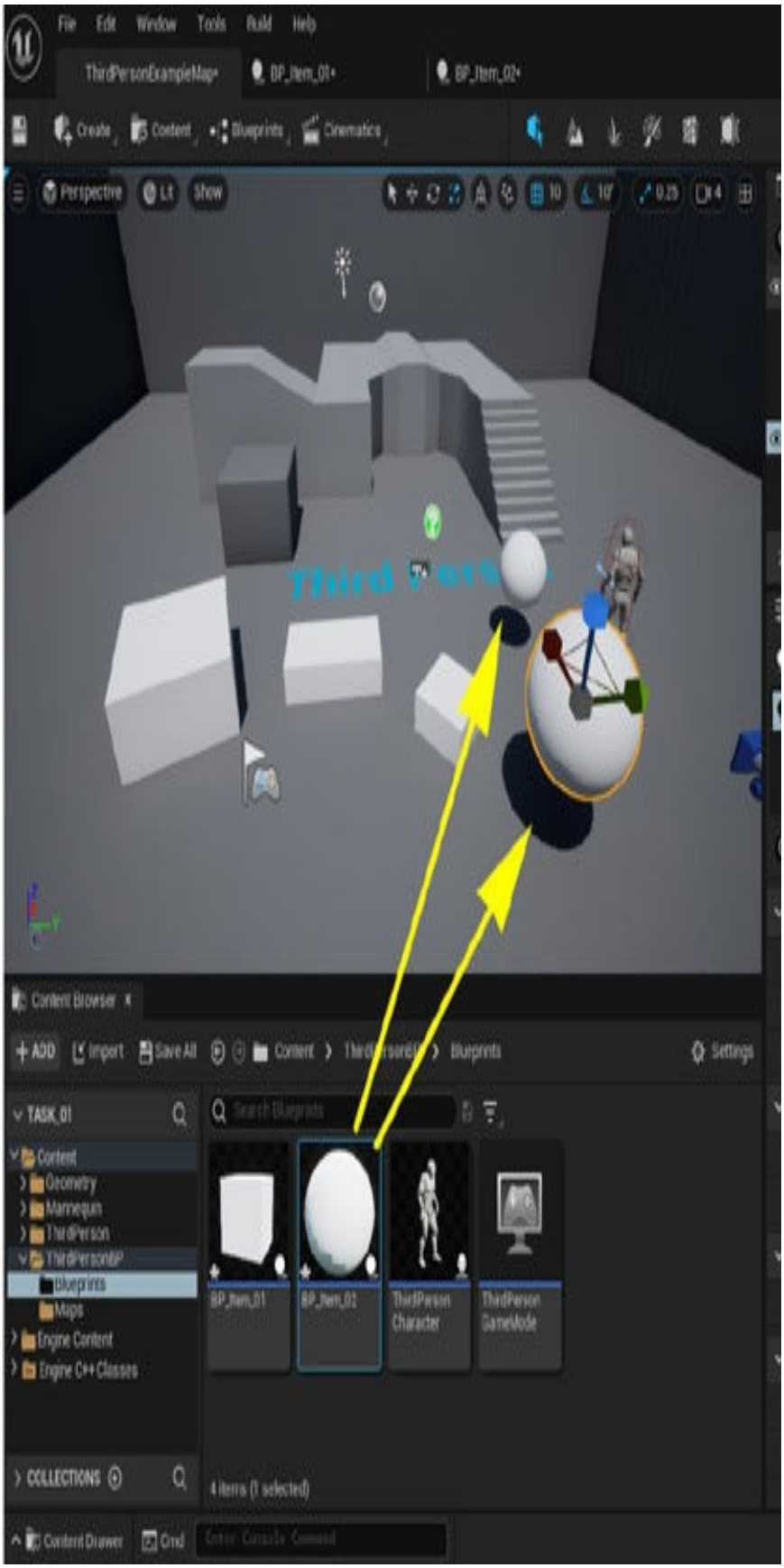

File
Edit
Window
Tools
Build
Help
ThirdPersonExampleMap
BP_Item_01
BP_Item_02
Create
Content
Blueprints
Cinematics
Perspective
Lit
Show
Content Browser
ADD
Import
Save All
Content
Blueprints
Settings
TASK_01
Content
Geometry
Mannequin
ThirdPerson
ThirdPersonBP
Blueprints
Maps
Engine Content
Engine C++ Classes
COLLECTIONS
BP_Item_01
BP_Item_02
ThirdPerson Character
ThirdPerson GameMode
4 items (1 selected)
Content Drawer
Cmd
Enter Console Command

Figure 4.13: Left: Add Sphere static mesh component in Blueprint editor to BP_Item_02 and drop two instances of it into the scene

Now, press the Play button and test the blueprints you made in the scene, which will be similar to the ones in Figure 4.14. This is the magic behind blueprint in Unreal Engine, which enhanced making game assets and simplified populating them on the scene:

Content Browser
+ ADD
Import
Save All
Content
ThirdPersonBP
Blueprints
Settings
TASK_01
Search Blueprints
Content
Geometry
Mannequin
ThirdPerson
ThirdPersonBP
Blueprints
Maps
Engine Content
Engine C++ Classes
BP_Item_01
BP_Item_02
ThirdPerson Character
ThirdPerson GameMode

Figure 4.14: Testing new actor blueprints in the scene

With this done, it’s time to take a closer look at the blueprint editor and components.

Blueprint components

In Unreal Engine, blueprints are designed to accelerate design and coding process to make game assets. At any level of skill in game design, when you use Unreal Engine, you must make a number of blueprint components to make a game asset. These components are either used in designs like cubes and spheres, which we used before or are used for expressing a functionality like character movement or play audio file. To work with components, you must know the basics of blueprint Editor, which is similar to main editor in case of viewport tools and navigations, except that the blueprint editor is customized to develop and design blueprint objects.

Double-click on the BP_Item_01 blueprint to open blueprint editor. As Figure 4.15 shows, there are various panels and buttons in blueprint editor that look complicated, but the majority of your work (at the beginning) are with these panels:

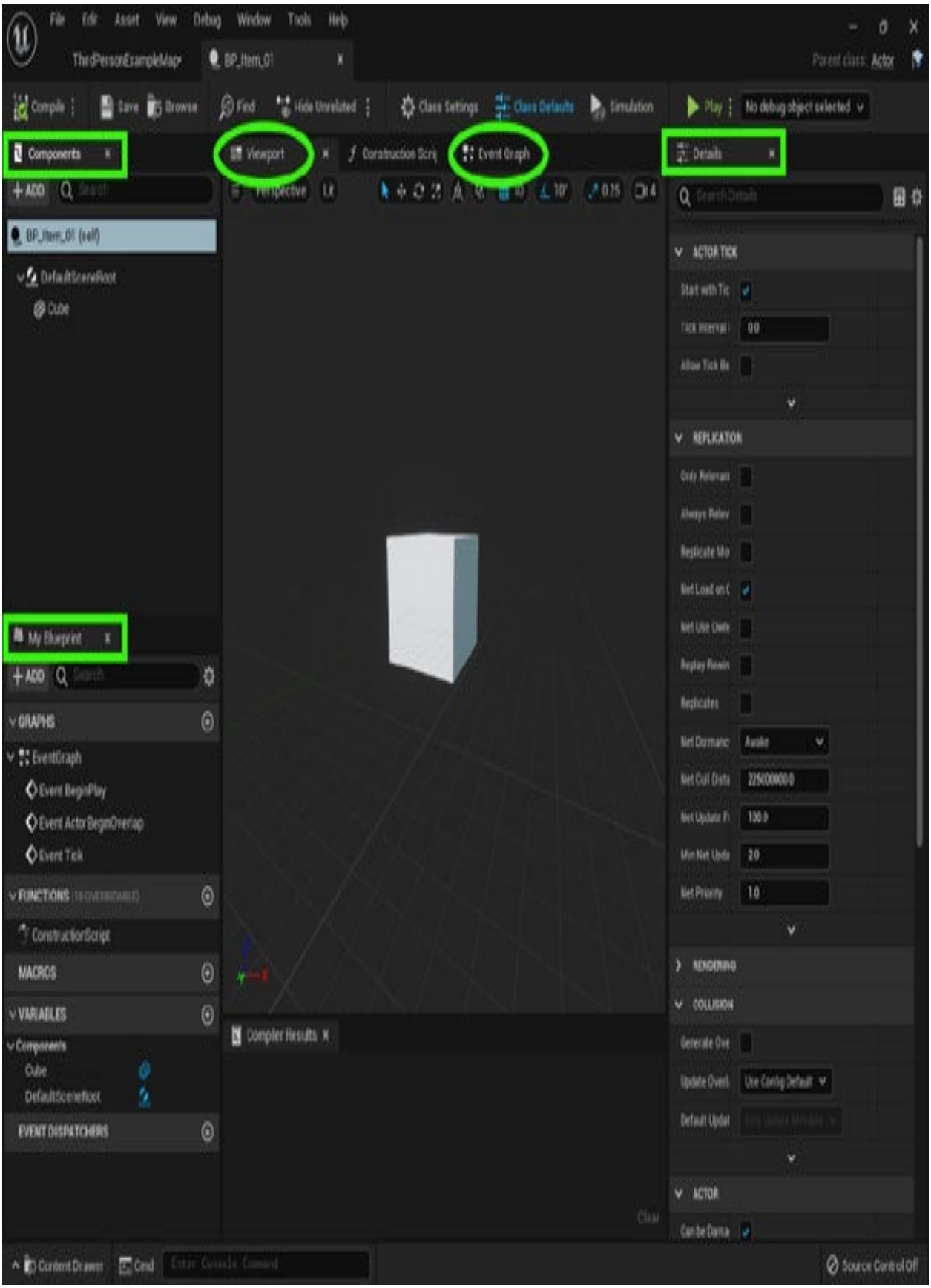

File
Edit
Asset
View
Debug
Window
Tools
Help
ThirdPersonExampleMap
BP_Item_01
Parent class: Actor
Compile
Save
Browse
Find
Hide Unrelated
Class Settings
Class Defaults
Simulation
Play
No debug object selected
Components
Viewport
Construction Script
Event Graph
Details
ADD
Perspective
BP_Item_01 (self)
DefaultSceneRoot
Cube
ACTOR TICK
REPLICATION
My Blueprint
GRAPHS
EventGraph
Event BeginPlay
Event ActorBeginOverlap
Event Tick
FUNCTIONS
ConstructionScript
MACROS
VARIABLES
Components
Cube
DefaultSceneRoot
EVENT DISPATCHERS
RENDERING
COLLISION
ACTOR
Compiler Results
Clear
Content Drawer
Cmd
Enter Console Command
Source Control Off

Figure 4.15: Most in use Blueprint Editor panels: Components (1), My Blueprint (2), Details (3), Viewport (4) and EventGraph (5)

Components: This panel is for adding, selecting, and editing blueprint components; also, the hierarchy of components are editable from this panel. You can attach components to each other by simply dragging and dropping them over each other with the mouse.

My Blueprint: This panel is designed to show properties, procedures, and inherited variables of the actual blueprint you work with. We will go through more details on this panel when we begin coding in a later chapter.

Details: When you select an item from previous panels, it will automatically refresh the Details panel and give the properties of that specific item. For example, as shown in Figure 4.16, if you choose Cube static mesh in the Components panel, the Detail panel will show the series of properties related to Cube, like transforms and material, which can directly change and customize the Cube component.

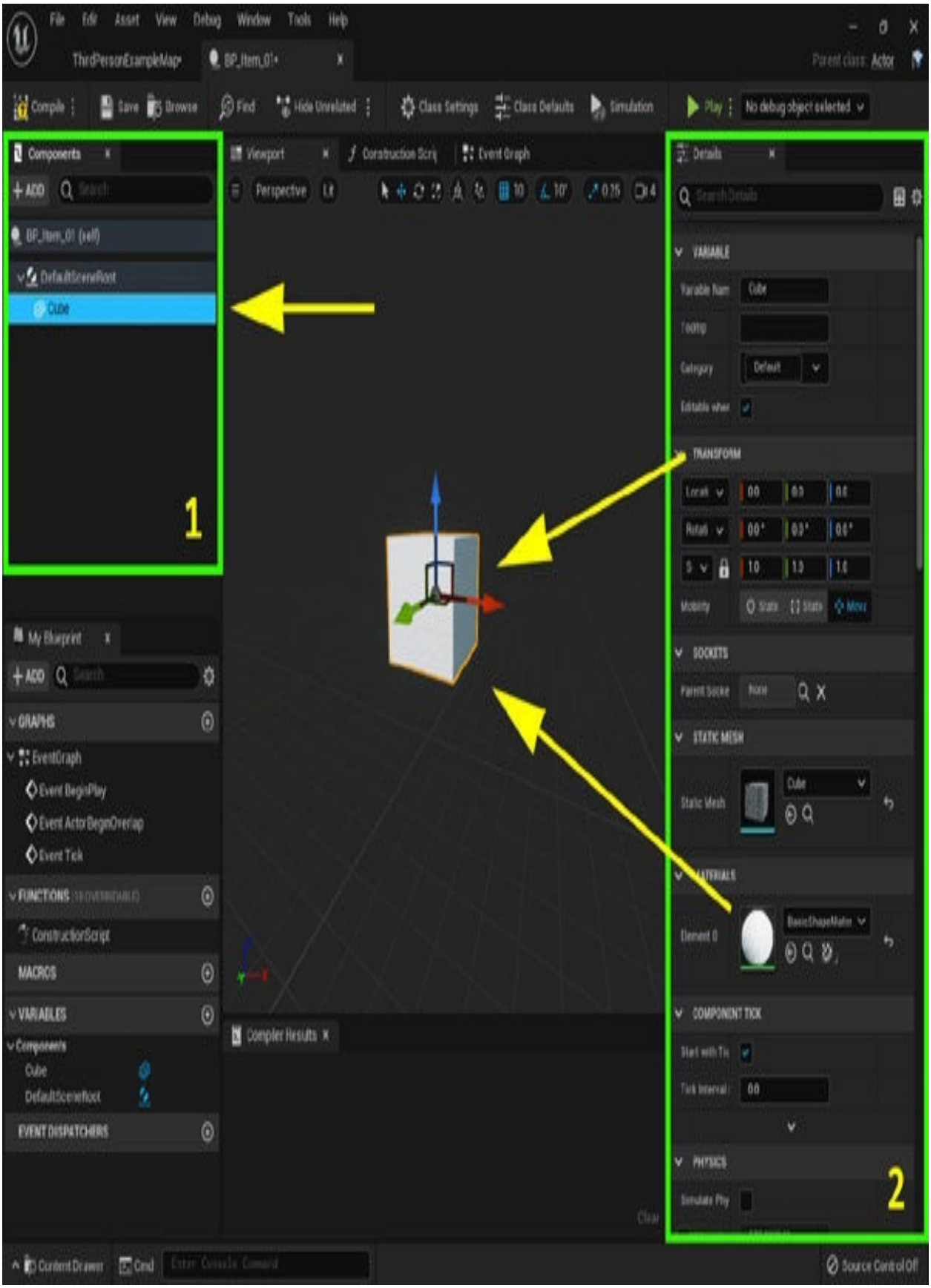

File
Edit
Asset
View
Debug
Window
Tools
Help
ThirdPersonExampleMap
BP_Item_01
Parent class: Actor
Compile
Save
Browse
Find
Hide Unrelated
Class Settings
Class Defaults
Simulation
Play
No debug object selected
Components
ADD
BP_Item_01 (self)
DefaultSceneRoot
Cube
1
Viewport
Construction Script
Event Graph
Perspective
Lit
Details
VARIABLE
Variable Name
Cube
Tooltip
Category
Default
Editable when
TRANSFORM
Local
Rotation
Scale
Mobility
Static
Stationary
Movable
SOCKETS
Parent Socket
None
STATIC MESH
Static Mesh
Cube
MATERIALS
Element 0
BaseShapeMaterial
COMPONENT TICK
Start with Tick
Tick Interval
0.0
PHYSICS
Simulate Physics
2
My Blueprint
ADD
GRAPHS
EventGraph
Event BeginPlay
Event ActorBeginOverlap
Event Tick
FUNCTIONS
ConstructionScript
MACROS
VARIABLES
Components
Cube
DefaultSceneRoot
EVENT DISPATCHERS
Compiler Results
Clear
Content Drawer
Cmd
Enter Console Command
Source Control Off

Figure 4.16: After clicking on Cube in Components panel (1), Detail panel will show properties related to Cube (2) or any component chosen from Components panel

Viewport: The Viewport panel is the main area of designing a blueprint, and it works like main editor viewport but with less options. As Figure 4.17 shows, on top of this panel, user has options to change perspective and rendering mode, select/rotate/scale tool and handy snapping option for each and camera speed:

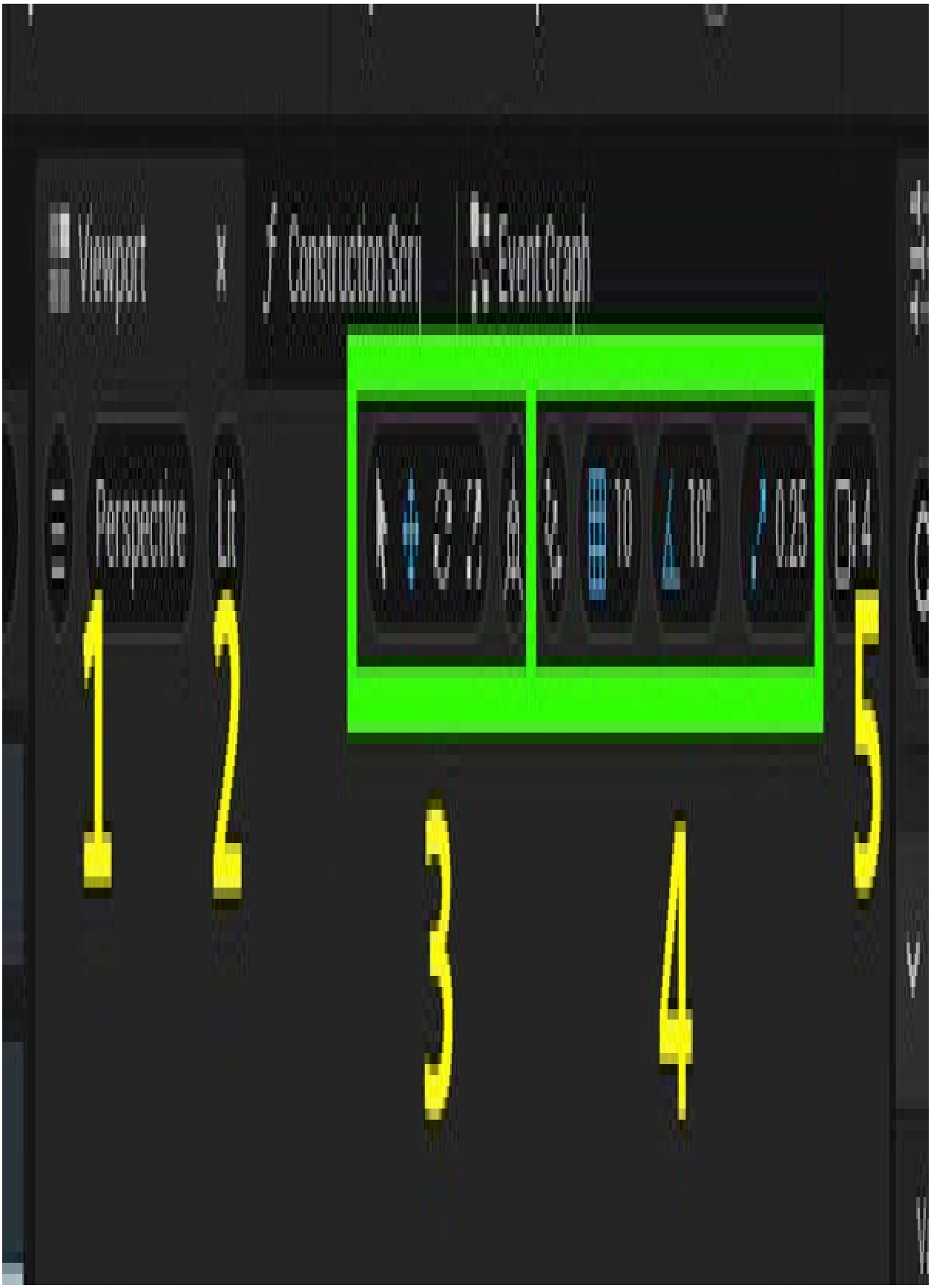

Viewport
Construction Scan
Event Graph
Perspective
1
2
3
4
5

Figure 4.17: Tool set on top of Viewport panel: Viewport mode (1), rendering options (2), editing tools (3), grid and snap setup (4) and camera speed setting (5)

Event Graph: This is the editor for coding game functions and procedures by using the Blueprint Visual Scripting system in Unreal Engine. This is a gameplay scripting system supported by C++ and is based on the concept of using a node-based interface. Users can drag and drop items to this panel from the Components panel and the My Blueprint panel and use them as reference in code. Also, by right-clicking inside this panel, as Figure 4.18 shows, user has access to a series of blueprint node, which we will cover in the later chapters when we dig into coding with blueprint:

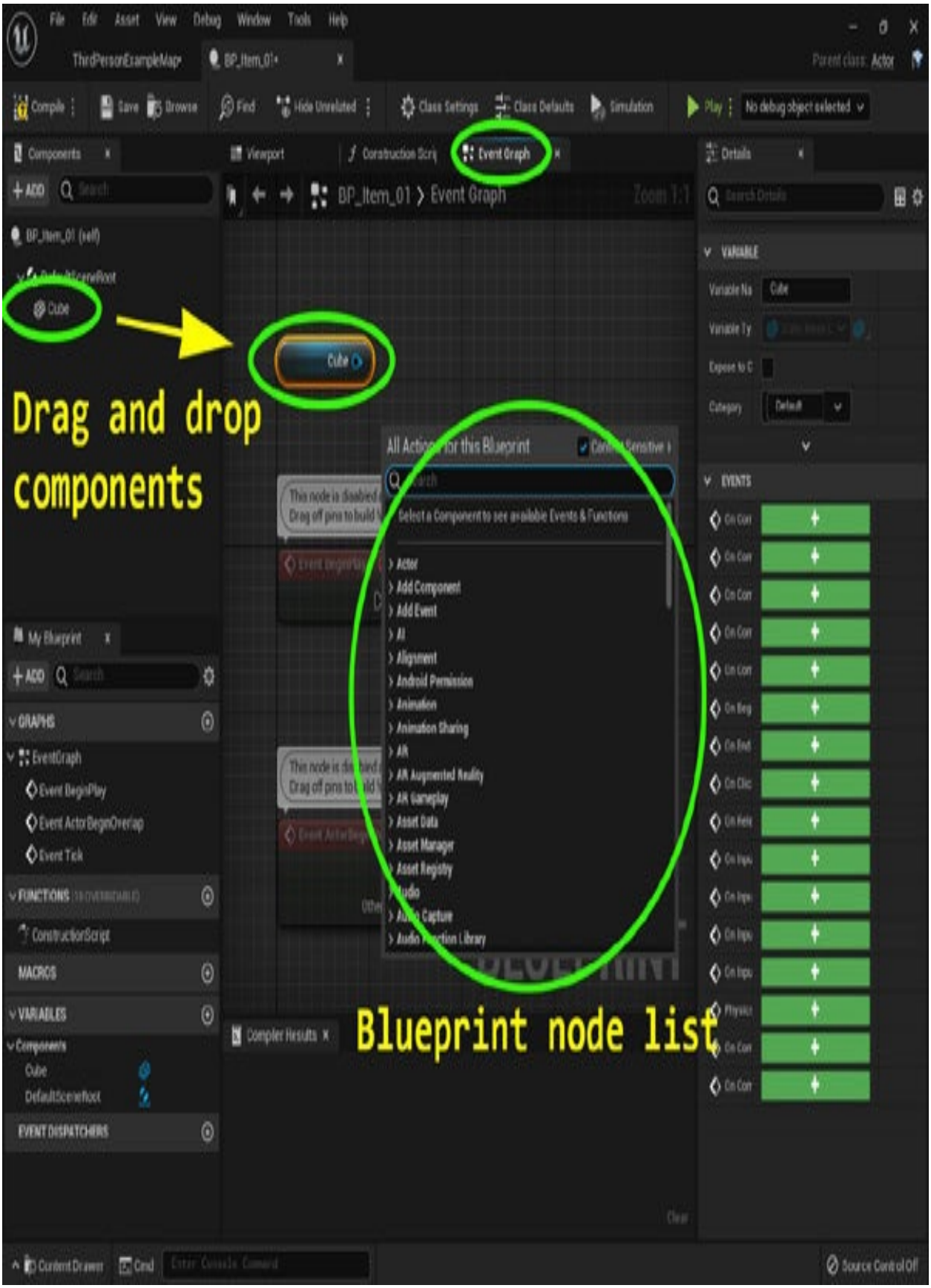

Drag and drop components
Blueprint node list
BP_Item_01 > Event Graph
Cube
Select a Component to see available Events & Functions
Actor
Add Component
Add Event
AI
Alignment
Android Permission
Animation
Animation Sharing
AR
AR Augmented Reality
AR Gameplay
Asset Data
Asset Manager
Asset Registry
Audio
Audio Capture
Audio Function Library
Event BeginPlay
Event ActorBeginOverlap
Event Tick
ConstructionScript
DefaultSceneRoot

Figure 4.18: EventGraph with a reference to Cube static mesh and right-click to get blueprint node list

In case a user accidently closes any of these panels, the Components, My Blueprint, Details and Viewport panels have shortcuts in the Windows menu, as shown in Figure 4.19; however, to open EventGraph, the user will have to double-click on the EventGraph title in the My Blueprint panel in the Graphs section:

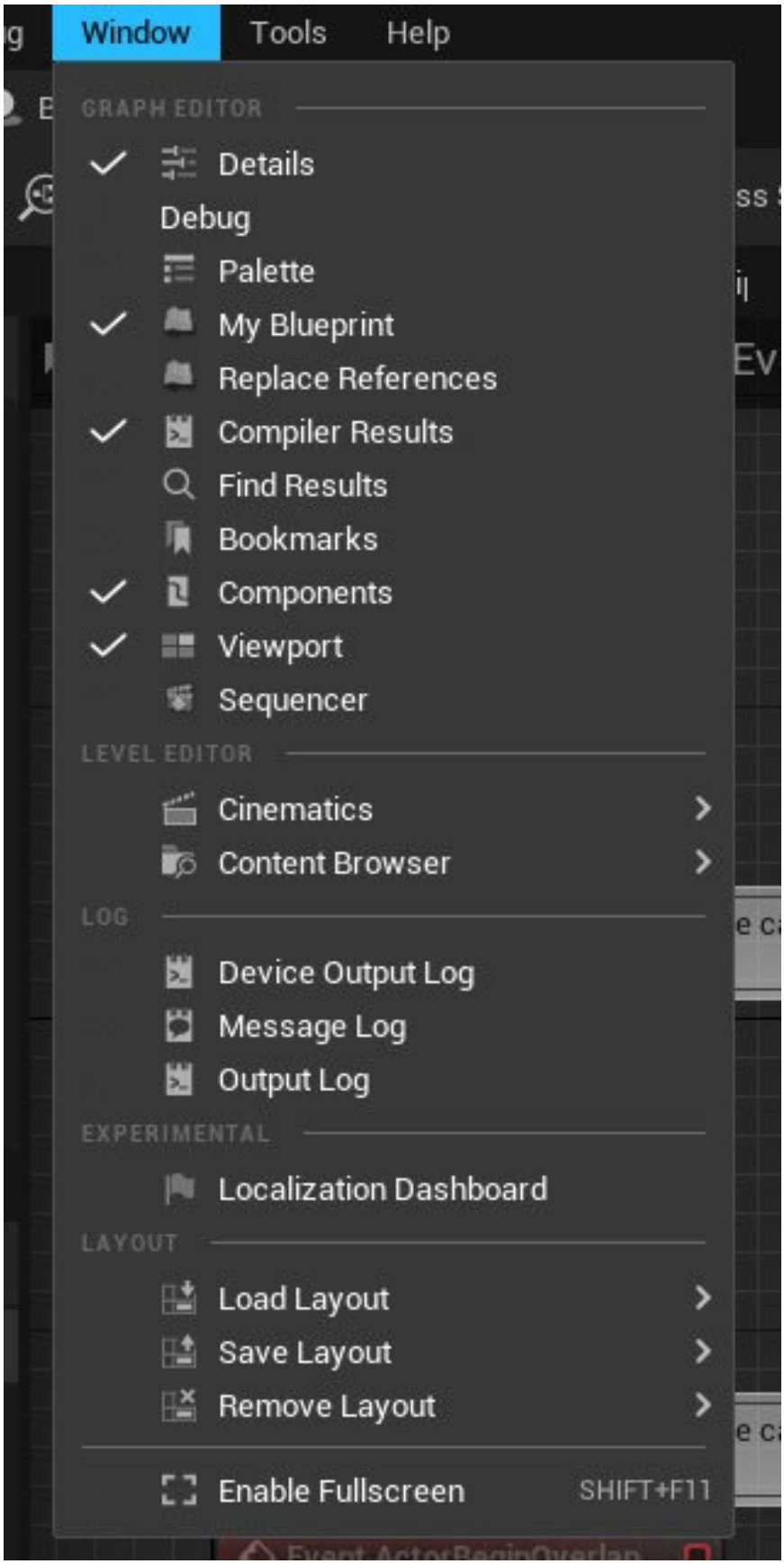

Window
Tools
Help
GRAPH EDITOR
Details
Debug
Palette
My Blueprint
Replace References
Compiler Results
Find Results
Bookmarks
Components
Viewport
Sequencer
LEVEL EDITOR
Cinematics
Content Browser
LOG
Device Output Log
Message Log
Output Log
EXPERIMENTAL
Localization Dashboard
LAYOUT
Load Layout
Save Layout
Remove Layout
Enable Fullscreen
SHIFT+F11

Figure 4.19: Windows menu in Blueprint editor

Now, let's focus on the Component and Viewport panels. There is a hierarchical relation between components in the Component panel. Each object inherits the properties of its parents. You can simply grab a component in the Component panel with a left-click and then drag it onto other components there and create a parent and child hierarchy. For example, as Figure 4.20 shows, the Hierarchical relationship between components in the component's panel in which the Sphere static mesh component is the child of Cube3 static mesh component, which means any change on Cube3 will be applied on Sphere as well at the same time, so if we move Cube3, then Sphere will move as well. Also, any change in its rotation and size will affect the child's objects:

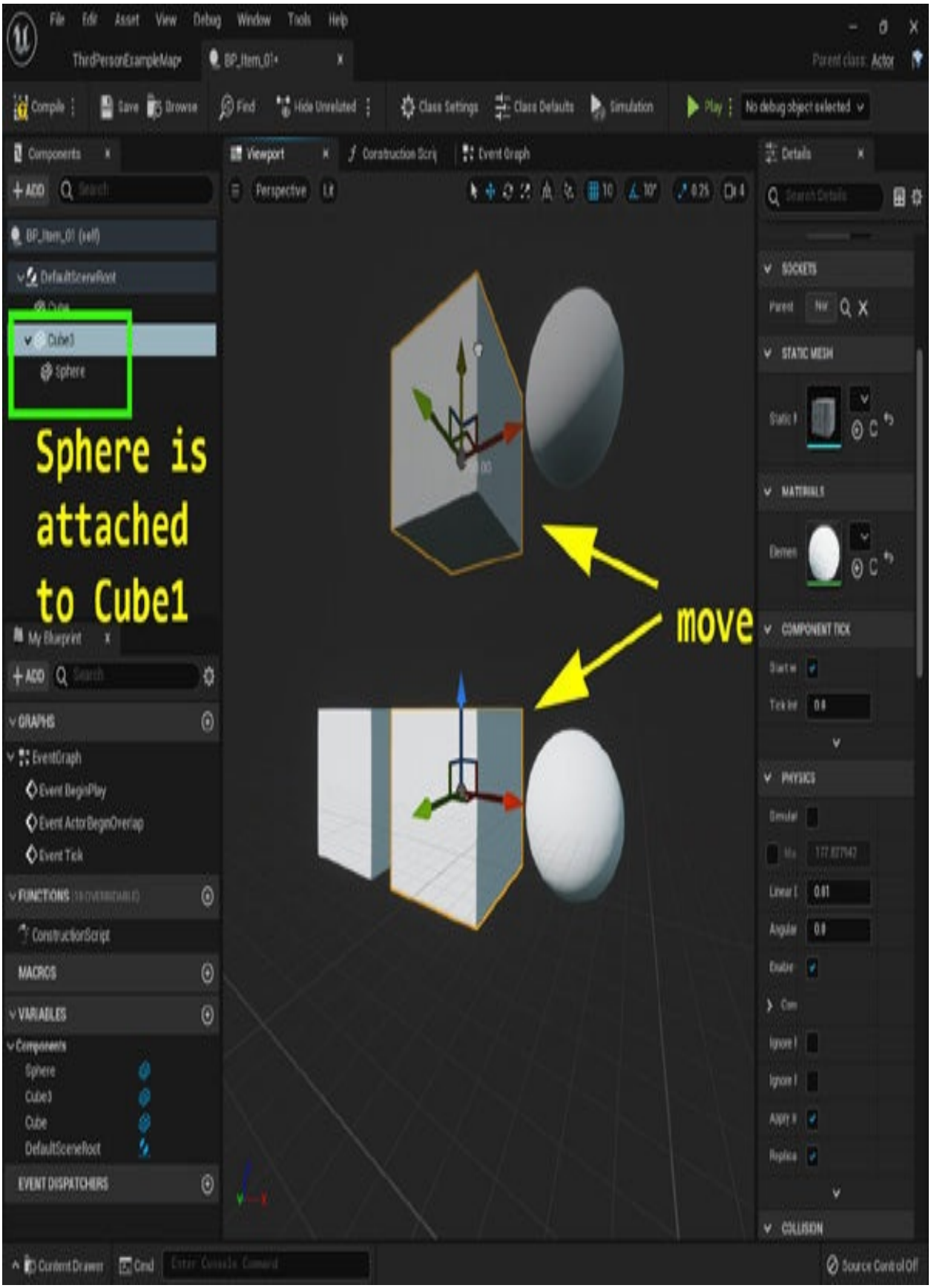

Sphere is attached to Cube1
move

Figure 4.20: Sphere static mesh component is a "child" of Cube3 static mesh component and at the same time, Cube3 static mesh component, is the parent of Sphere static mesh component

Hierarchical relationship between components is critical in the process of designing a game asset when using many components, like static meshes, light sources, and audio components. A wise design of parent and children's components can beautifully perform game scenarios when the blueprint object is in the scene. Suppose you need to make a character like assassin creed's enemy units that shoot arrows of fire on the player. The blueprint object has a static mesh component for the character, another static mesh component for arrow, a Point Light component for light of fire, a Niagara Particle System component for the fire itself, and finally, the arrow static mesh component. So, in case of shooting the arrow, the arrow static mesh component must be parent of light and particle system component because when the arrow moves, all children will move at the same time.

Also, the hierarchy rule is valid for the blueprints that are in the scene; you can simply click on each blueprint in the World Outliner panel and drag them onto other ones to make parent and child hierarchy. This is very useful when relocating or rotating groups of objects together and making complex assets. Figure 4.21 shows an example of making an asset by using only one blueprint:

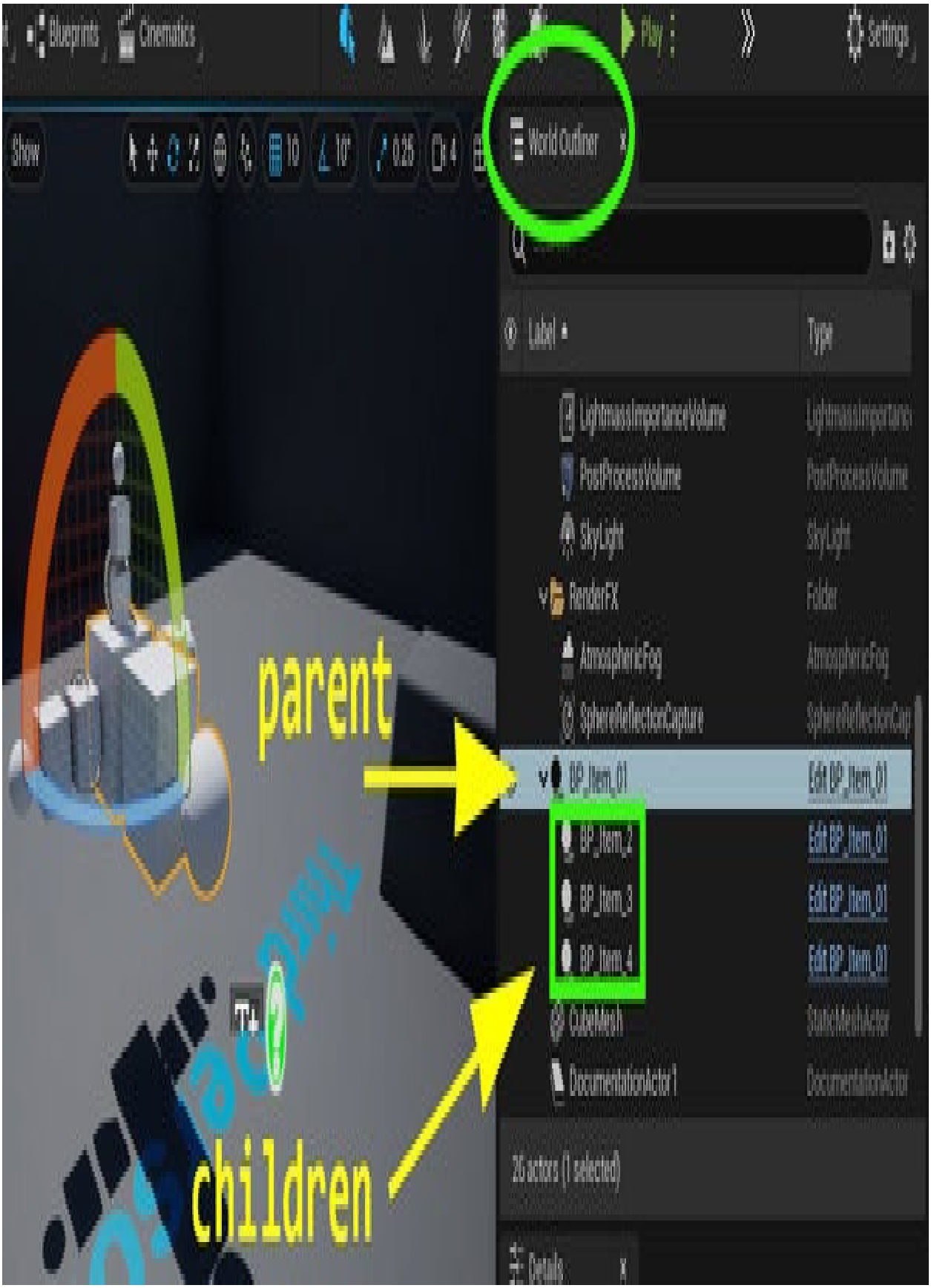

Blueprints
Cinematics
Play
Settings
Show
World Outliner
Label
Type
LightmassImportanceVolume
PostProcessVolume
SkyLight
RenderFX
Folder
AtmosphericFog
SphereReflectionCapture
BP_Item_01
Edit BP_Item_01
BP_Item_2
BP_Item_3
BP_Item_4
CubeMesh
StaticMeshActor
DocumentationActor1
26 actors (1 selected)
Details
parent
children

Figure 4.21: The BP_Item_01 is used as parent for 3 other BP_Item_01 blueprints with different sizes

Similar to the blueprint editor, a user can add blueprint components to blueprint on the stage in the main editor and customize them. Let's try one of them; as shown in Figure 4.22, choose the blueprint object, click on the +ADD button in the Details panel, and then select the Rotating Movement component. This component is designed to rotate the assigned blueprint object in runtime:

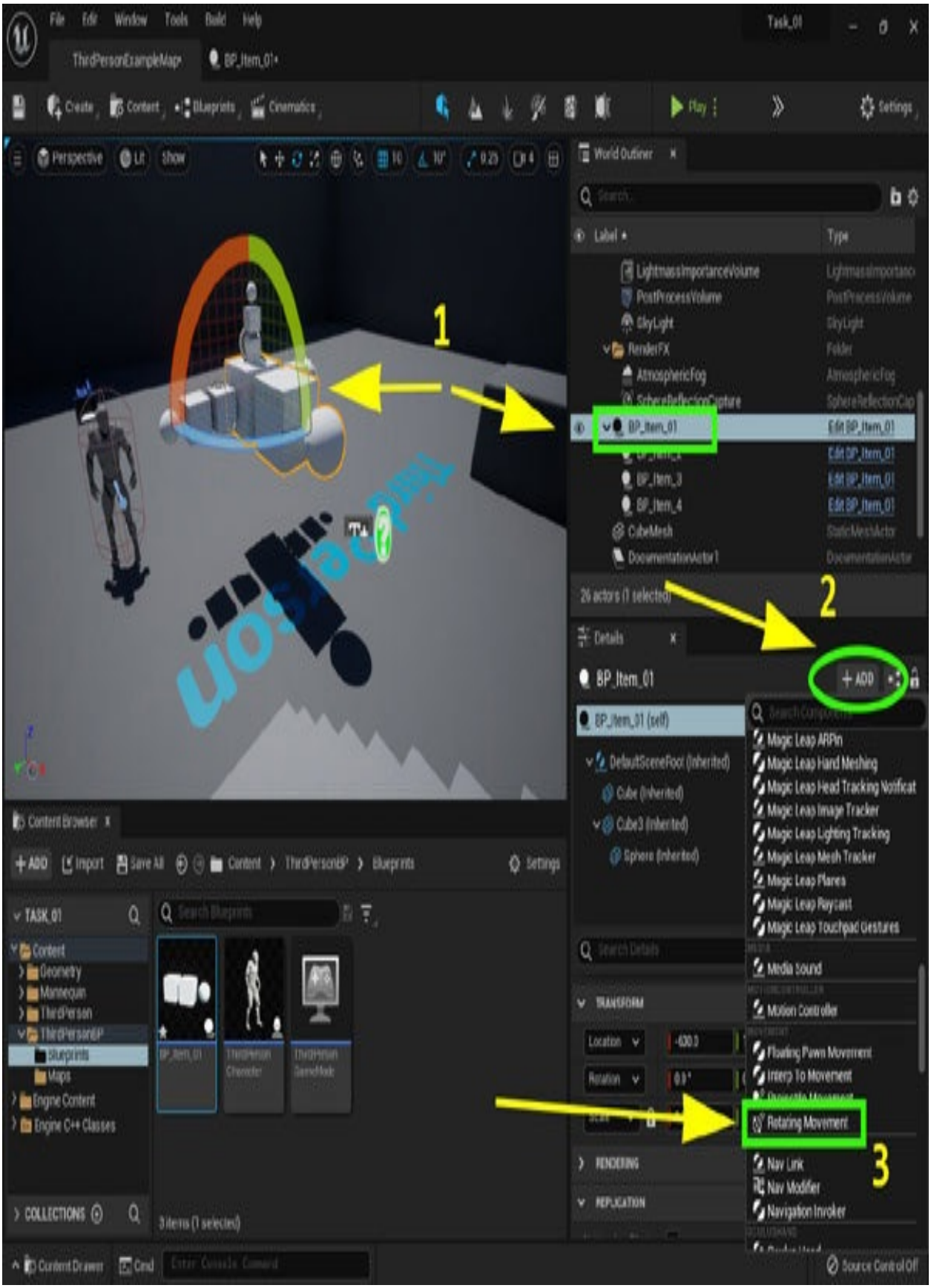

File Edit Window Tools Build Help
Task_01
ThirdPersonExampleMap
BP_Item_01*
Create
Content
Blueprints
Cinematics
Play
Settings
Perspective
Lit
Show
World Outliner
Label
Type
LightmassImportanceVolume
PostProcessVolume
SkyLight
RenderFX
Folder
AtmosphericFog
BP_Item_01
BP_Item_3
BP_Item_4
CubeMesh
DocumentationActor1
26 actors (1 selected)
1
2
Details
BP_Item_01
+ ADD
BP_Item_01 (self)
DefaultSceneRoot (inherited)
Cube (inherited)
Cube3 (inherited)
Sphere (inherited)
Magic Leap ARPin
Magic Leap Hand Meshing
Magic Leap Head Tracking Notificat
Magic Leap Image Tracker
Magic Leap Lighting Tracking
Magic Leap Mesh Tracker
Magic Leap Planes
Magic Leap Raycast
Magic Leap Touchpad Gestures
Media Sound
Motion Controller
Floating Pawn Movement
Interp To Movement
Rotating Movement
Nav Link
Nav Modifier
Navigation Invoker
3
TRANSFORM
Location
Rotation
RENDERING
REPLICATION
Content Browser
ADD
Import
Save All
Content
ThirdPersonBP
Blueprints
Settings
TASK_01
Content
Geometry
Mannequin
ThirdPerson
ThirdPersonBP
Blueprints
Maps
Engine Content
Engine C++ Classes
BP_Item_01
ThirdPerson Character
ThirdPerson GameMode
COLLECTIONS
3 items (1 selected)
Content Drawer
Cmd
Enter Console Command
Source Control Off

Figure 4.22: Add Rotating Movement component to blueprint object in scene

When you press Play at the top, you will find that the object rotates around Z axis in the scene. Now, press Esc to return to the editor and click on the Rotating Movement component in your blueprint details panel, as shown in Figure 4.23:

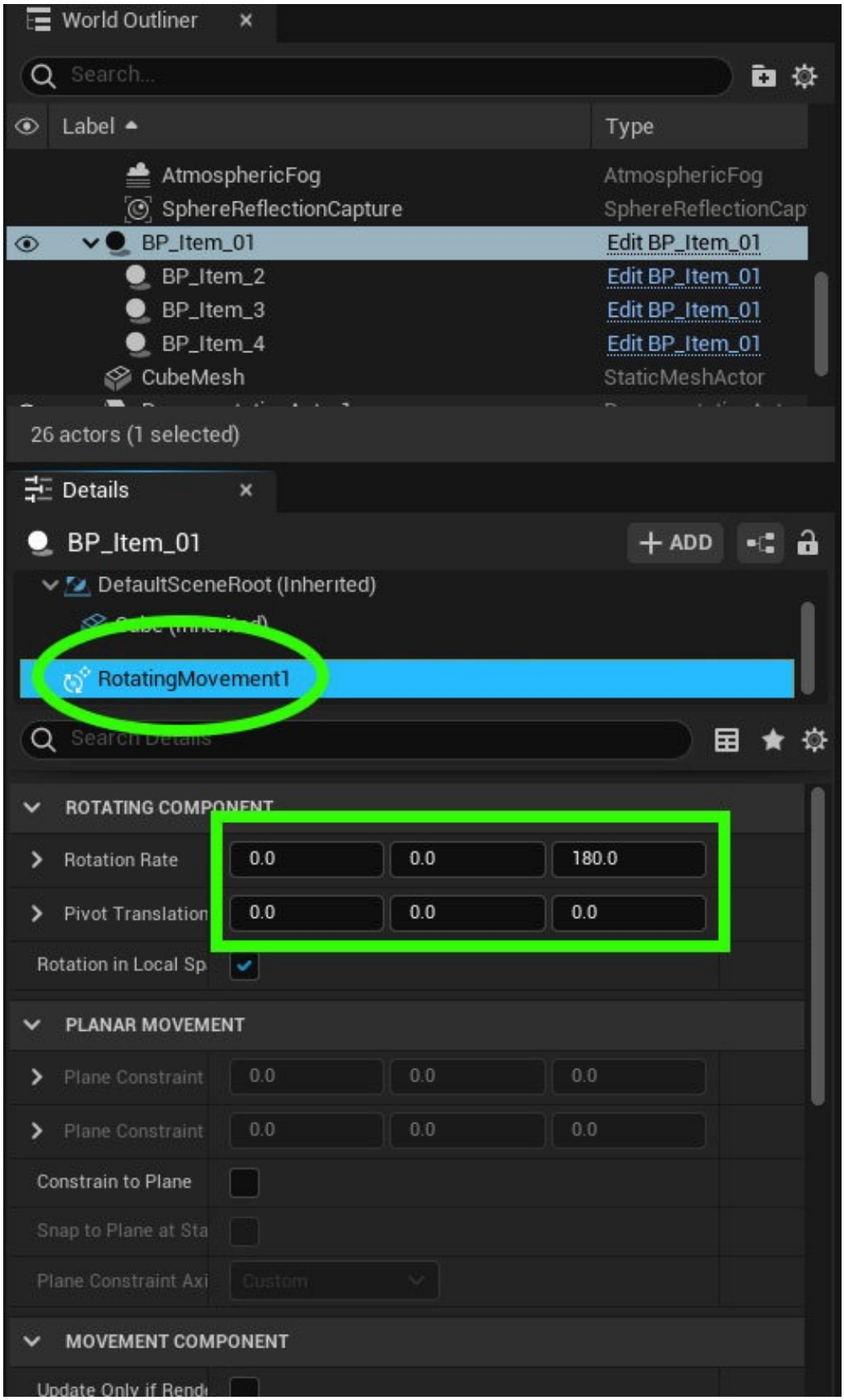

World Outliner
Search...
Label
Type
AtmosphericFog
AtmosphericFog
SphereReflectionCapture
SphereReflectionCap
BP_Item_01
Edit BP_Item_01
BP_Item_2
Edit BP_Item_01
BP_Item_3
Edit BP_Item_01
BP_Item_4
Edit BP_Item_01
CubeMesh
StaticMeshActor
26 actors (1 selected)
Details
BP_Item_01
+ ADD
DefaultSceneRoot (Inherited)
RotatingMovement1
ROTATING COMPONENT
Rotation Rate
0.0
0.0
180.0
Pivot Translation
0.0
0.0
0.0
Rotation in Local Sp
PLANAR MOVEMENT
Plane Constraint
0.0
0.0
0.0
Plane Constraint
0.0
0.0
0.0
Constrain to Plane
Snap to Plane at Sta
Plane Constraint Axi
Custom
MOVEMENT COMPONENT
Update Only if Rend

Figure 4.23: Rotating Movement component properties in Detail panel

As you see, there are a number of properties there to change rotation rat, pivot, and so on. There is a similar component called InterpToMovement, which results in the movement of blueprint with the same properties. As a practice, remove the Rotating Movement component and add InterpToMovement; then, add two points in the Control Points property and test the result.

Adding mesh to blueprint

Making assets with Cube, Sphere, and Cone static mesh component is interesting, but how about importing your own mesh into the engine with materials and animations? Suppose we want to import and replace Cube static mesh component in BP_Item_01 with a FBX mesh that we already designed in a 3D application. We use the Abandoned Cottage House 3D model from https://free3d.com/, which is free to download and use.

Now, switch to main editor and navigate to the ThirdPersonBP folder in content browser. When you select a folder in content browser, it automatically shows the path of that folder on top of the panel. Now, right-click in the content browser panel and select New Folder, as shown in Figure 4.24, to create a new folder and then rename it to Mesh:

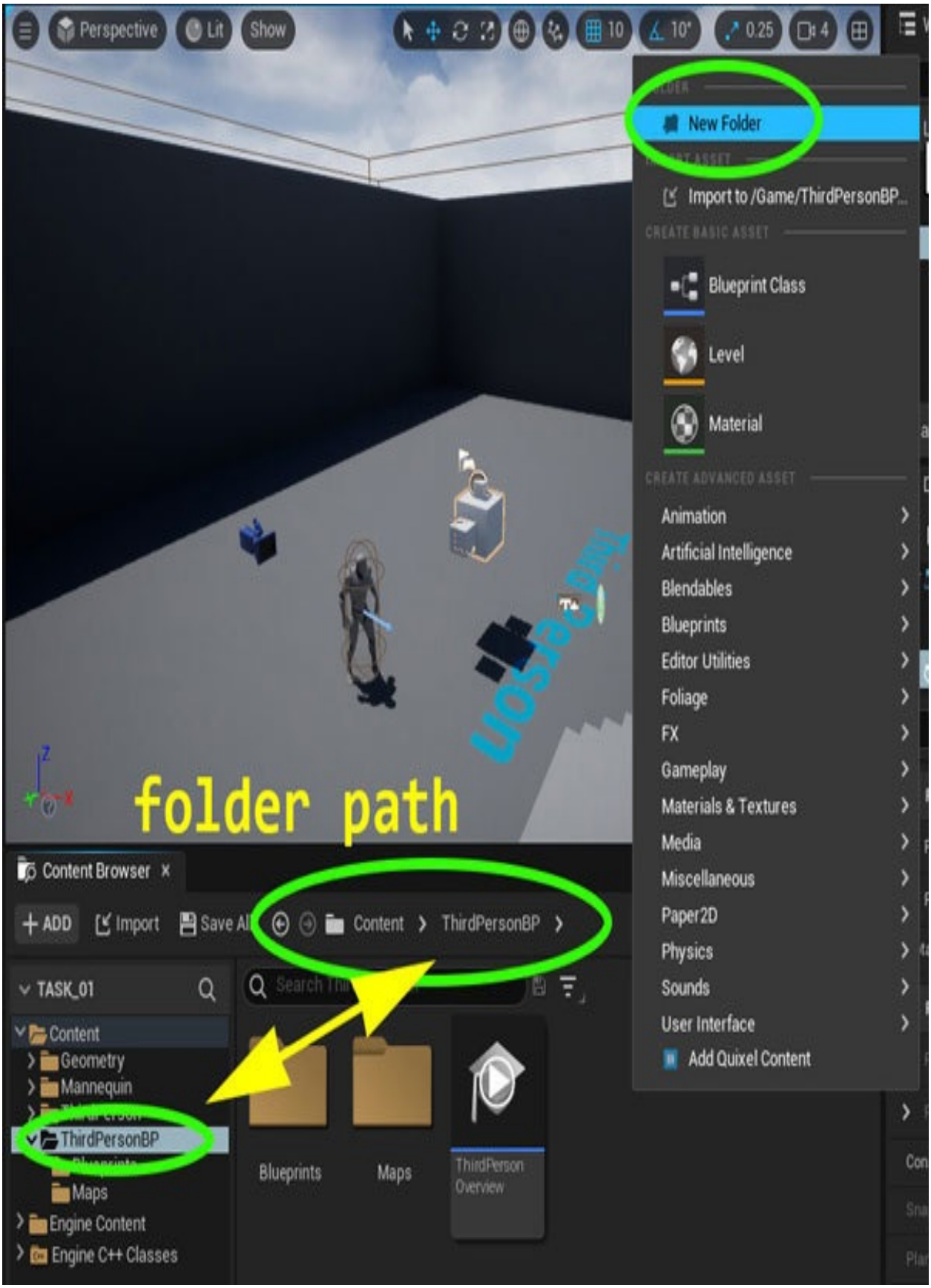

Perspective
Lit
Show
New Folder
Import to /Game/ThirdPersonBP...
CREATE BASIC ASSET
Blueprint Class
Level
Material
CREATE ADVANCED ASSET
Animation
Artificial Intelligence
Blendables
Blueprints
Editor Utilities
Foliage
FX
Gameplay
Materials & Textures
Media
Miscellaneous
Paper2D
Physics
Sounds
User Interface
Add Quixel Content
folder path
Content Browser
ADD
Import
Save All
Content
ThirdPersonBP
TASK_01
Content
Geometry
Mannequin
ThirdPersonBP
Maps
Engine Content
Engine C++ Classes
Blueprints
Maps
ThirdPerson Overview

Figure 4.24: Folder path is always shown on top of content browser panel when you select each folder in there

Then, select the Mesh folder, and then select import, as shown in Figure 4.25. Next, navigate to the location of the FBX model, select it, and click on Import. You can drag and drop the FBX model from windows into the Unreal Engine as well:

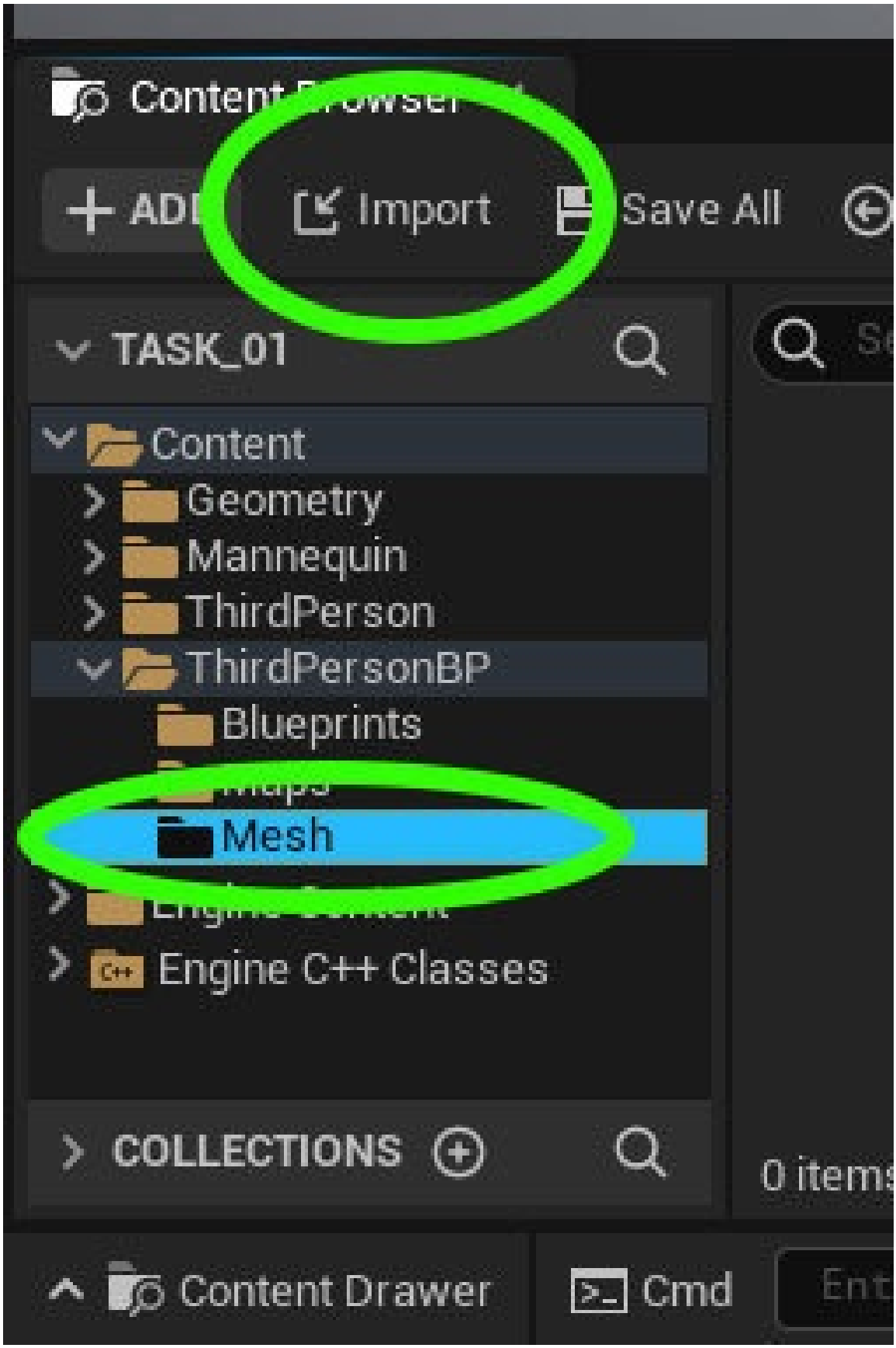

Content Browser
ADD
Import
Save All
TASK_01
Content
Geometry
Mannequin
ThirdPerson
ThirdPersonBP
Blueprints
Mesh
Engine C++ Classes
COLLECTIONS
0 items
Content Drawer
Cmd

Figure 4.25: To add extra assets to your project, choose the desired folder in content browser as the destination of files and then click on import

The engine will open the FBX Importer Options windows, as shown in Figure 4.26, with options to import 3D models known as Static Mesh and Skeletan mesh objects and animation objects:

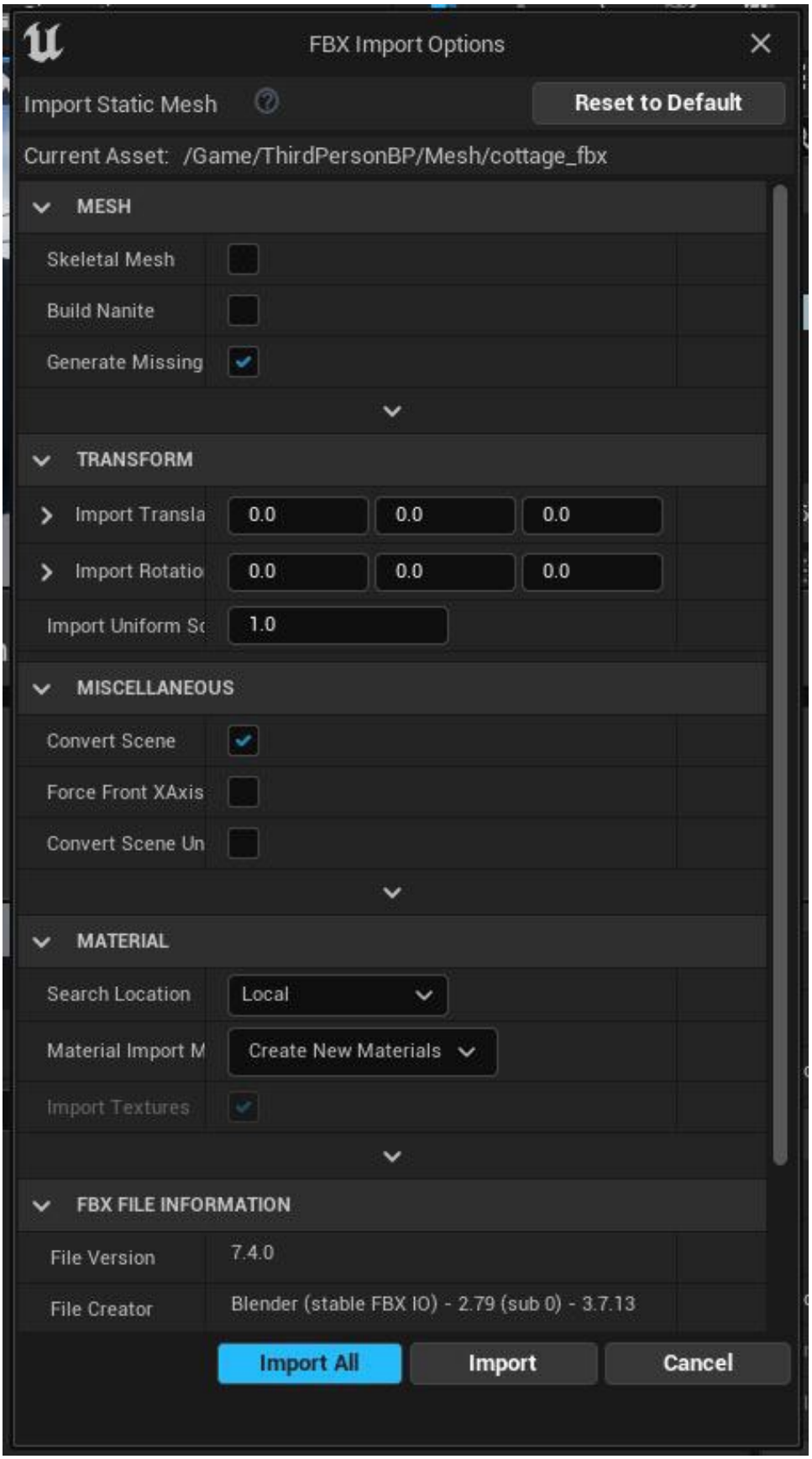

FBX Import Options
Import Static Mesh
Reset to Default
Current Asset: /Game/ThirdPersonBP/Mesh/cottage_fbx
MESH
Skeletal Mesh
Build Nanite
Generate Missing
TRANSFORM
Import Transla
0.0
0.0
0.0
Import Rotatio
0.0
0.0
0.0
Import Uniform Sc
1.0
MISCELLANEOUS
Convert Scene
Force Front XAxis
Convert Scene Un
MATERIAL
Search Location
Local
Material Import M
Create New Materials
Import Textures
FBX FILE INFORMATION
File Version
7.4.0
File Creator
Blender (stable FBX IO) - 2.79 (sub 0) - 3.7.13
Import All
Import
Cancel

Figure 4.26: FBX Import Option windows

Here are the options for importing Static Mesh object into Unreal Engine 5:

MESH>Skeletal Mesh: The engine will attempt to import the FBX file as a Skeletal Mesh, and the import options will switch to handle importing the FBX file as a Skeletal Mesh.

MESH>Build Nanite: Nanite is a virtualized geometry system that uses an engine's internal mesh format and rendering technology to render pixel scale detail and high object counts. Nanite's data format is highly compressed and supports fine-grained streaming with automatic level of detail. Engine. By clicking on this option, you can activate Nanite procedures to render you mesh in the scene.

MESH>Generate Missing: The engine will automatically generate collision on your mesh.

TRANSFORM: By default, your static mesh will inherit transform data from the original 3D design application. Sometimes, you may need to alter the setting and for example, rotate your import object 180 on Y axis to match the game scene. These options can change values of original location, rotation, and uniform scale of the imported static mesh.

MATERIAL>Search Location: It defines the location to search material.

MATERIAL>Import method: It defines the actual material file that will be applied to static mesh after importing it. This option will affect Import texture, which allows you to import texture files into engine.

MATERIAL>Invert Normal Maps: This option with invert the Normal map applied to the object in 3D modeler application.

MATERIAL>Reorder Material to FBX Order: The 3D model sometimes has more than one material involve. This option reorder materials to support flexibility.

FBX FILE INFORMATION: It shows built data of 3D model before import.

Keep in mind that after you import any FBX object into the engine, like cottage_fbx.fbx in our example, it will be translated to a different file format known as .uasset, so if you check content folder form a windows browser, you will find cottage_fbx.uasset, and this file can’t be import to any other 3D application. The .uasset is just valid with the engine.

Now, double-click on BP_Item_01, and in blueprint editor in component panel, right-click on Cube and select delete. This way, the component will be deleted from the Blueprint and will disappear from Viewport panel. Now, add the Static Mesh component and then select cottage_fbx in the StaticMesh section from the Detail panel, as shown in Figure 4.27:

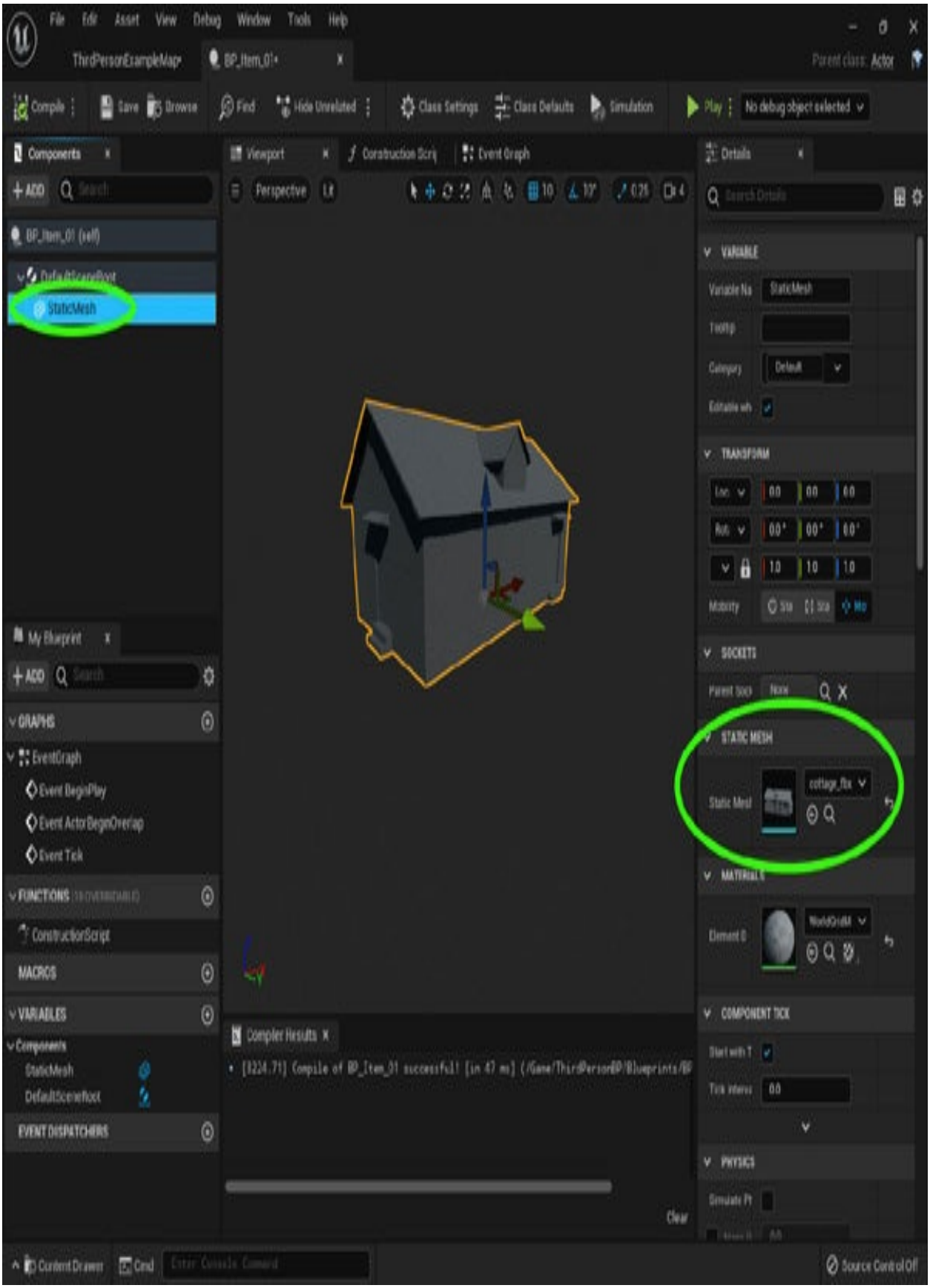

File Edit Asset View Debug Window Tools Help
ThirdPersonExampleMap
BP_Item_01
Parent class: Actor
Compile
Save
Browse
Find
Hide Unrelated
Class Settings
Class Defaults
Simulation
Play
No debug object selected
Components
ADD
BP_Item_01 (self)
DefaultSceneRoot
StaticMesh
Viewport
Construction Script
Event Graph
Perspective
Details
VARIABLE
TRANSFORM
SOCKETS
STATIC MESH
MATERIALS
COMPONENT TICK
PHYSICS
My Blueprint
GRAPHS
EventGraph
Event BeginPlay
Event ActorBeginOverlap
Event Tick
FUNCTIONS
ConstructionScript
MACROS
VARIABLES
Components
StaticMesh
DefaultSceneRoot
EVENT DISPATCHERS
Compiler Results
Clear
Content Drawer
Cmd
Source Control Off

Figure 4.27: Add Rotating Movement component to blueprint object in scene

When you switch back to editor, you will find that all instances of BP_Item_01 are replaced with imported static mesh.

Adding physics

When players play games like Counter Strike, the realism features of actions and reactions from or with environment is a critical feature of game. These features are calculated and provided by a Physic simulator program, which has processing support from graphic card and CPU by using special libraries in the operating system, which mostly are part of graphic card drivers and update. Some physical simulations meet heavy processing with both CPU and GPU, which serve scientific, artistic, and business scenarios. The good news is Unreal Engine has one of the most complete set of tools for simulating physics on collisions, materials, character's mesh, physical force, wind, clothing, ray casting, damping and frictions, destruction geometries and physical constraint. We don't have enough space in this book to cover all of these, but as an introduction, let's check physics constraints and use them in an example.

Referring to what we covered earlier in the chapter, make a new actor blueprint called BP_Item_02 and add a Sphere static mesh component to it; finally, place two instances of this blueprint in the scene with different scales, as shown in Figure 4.28:

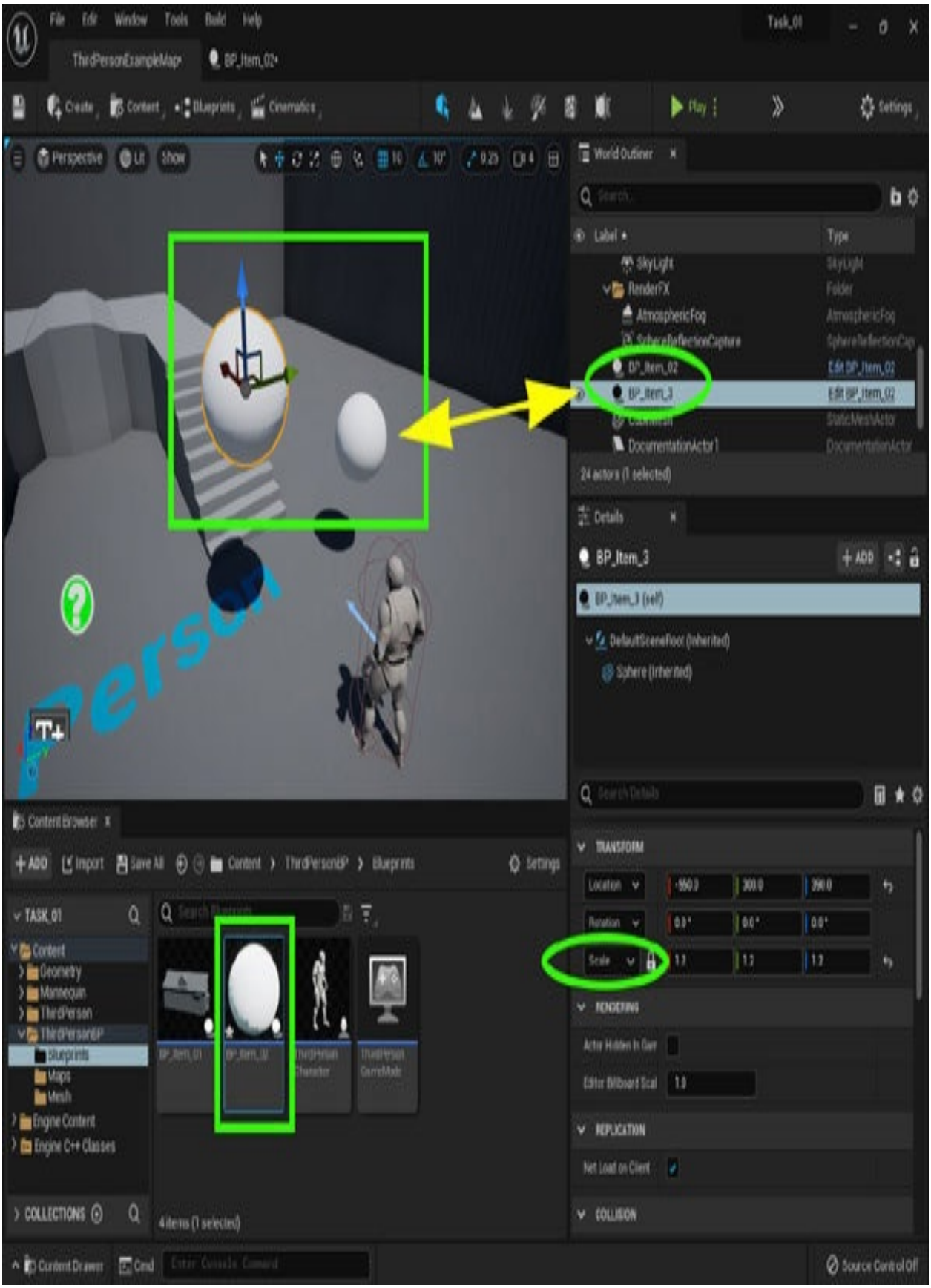

File Edit Window Tools Build Help
Task_01
ThirdPersonExampleMap
BP_Item_02*
Create
Content
Blueprints
Cinematics
Play
Settings
Perspective
Lit
Show
World Outliner
Label
Type
SkyLight
RenderFX
AtmosphericFog
BP_Item_02
BP_Item_3
DocumentationActor1
24 actors (1 selected)
Details
BP_Item_3
+ ADD
BP_Item_3 (self)
DefaultSceneRoot (inherited)
Sphere (inherited)
Search Details
TRANSFORM
Location
Rotation
Scale
RENDERING
Actor Hidden In Game
Editor Billboard Scale
REPLICATION
Net Load on Client
COLLISION
Content Browser
+ ADD
Import
Save All
Content
ThirdPersonBP
Blueprints
Settings
TASK_01
Content
Geometry
Mannequin
ThirdPerson
ThirdPersonBP
Blueprints
Maps
Mesh
Engine Content
Engine C++ Classes
COLLECTIONS
4 items (1 selected)
Content Drawer
Cmd
Enter Console Command
Source Control Off

Figure 4.28: Making new actor blueprint "BP_Item_02"and placing two instances on the stage

Now, if you press the Play button, the BP_Item_02 blueprints will stay at their locations without any change, as shown in Figure 4.29:

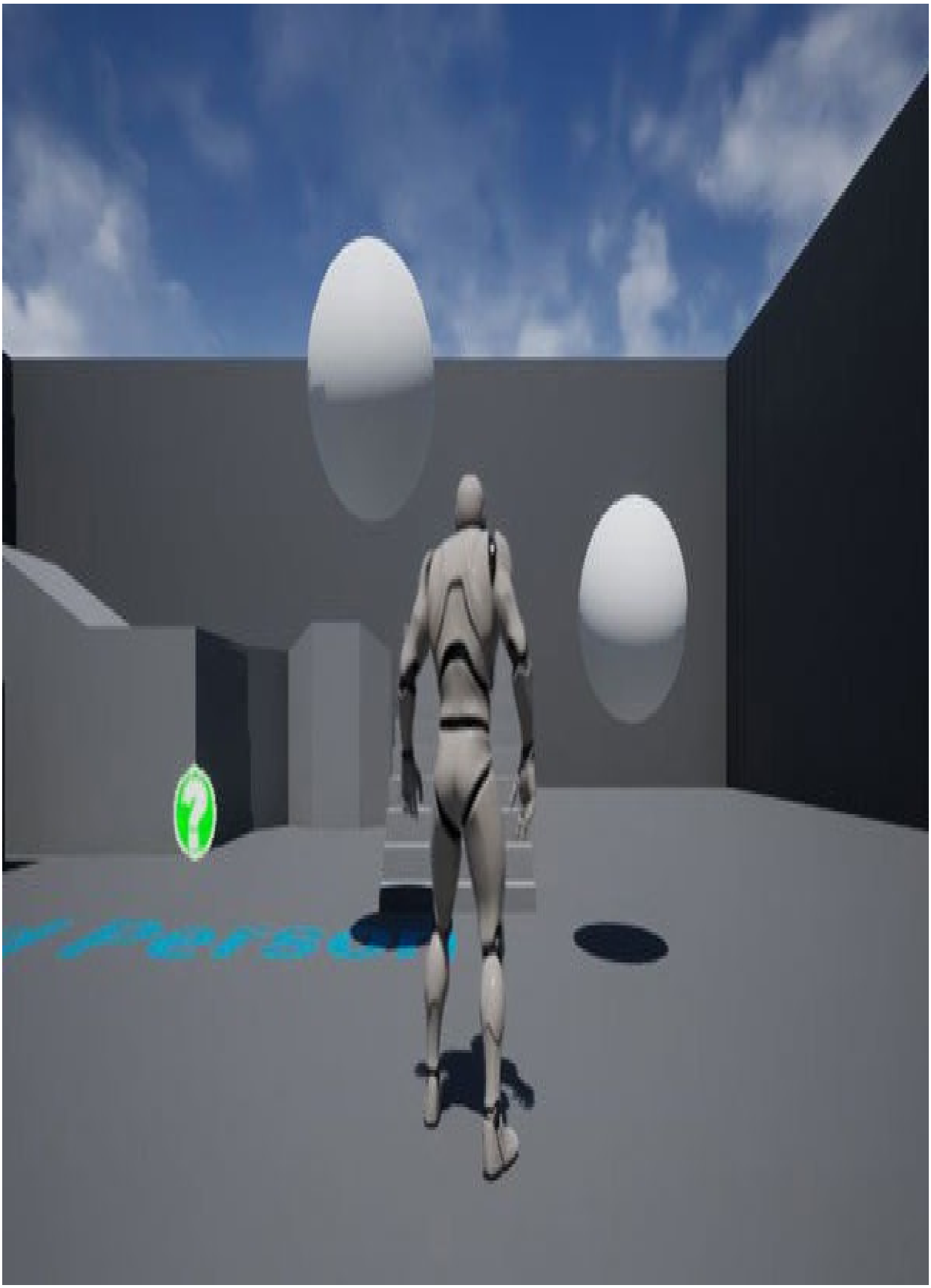


Figure 4.29: Scene with two instances of VP_Item_02

Return to the main editor by pressing escape and open the BP_Item_02 blueprint editor. Select the Sphere static mesh component in the Components panel and check Simulate Physics in the PHYSICS properties of the Details panel, as shown in Figure 4.30. This will activate an accurate physical-based simulation of gravity by using the engine`s tools designed for this feature. User can tick Mass and change the object weight by kilograms:

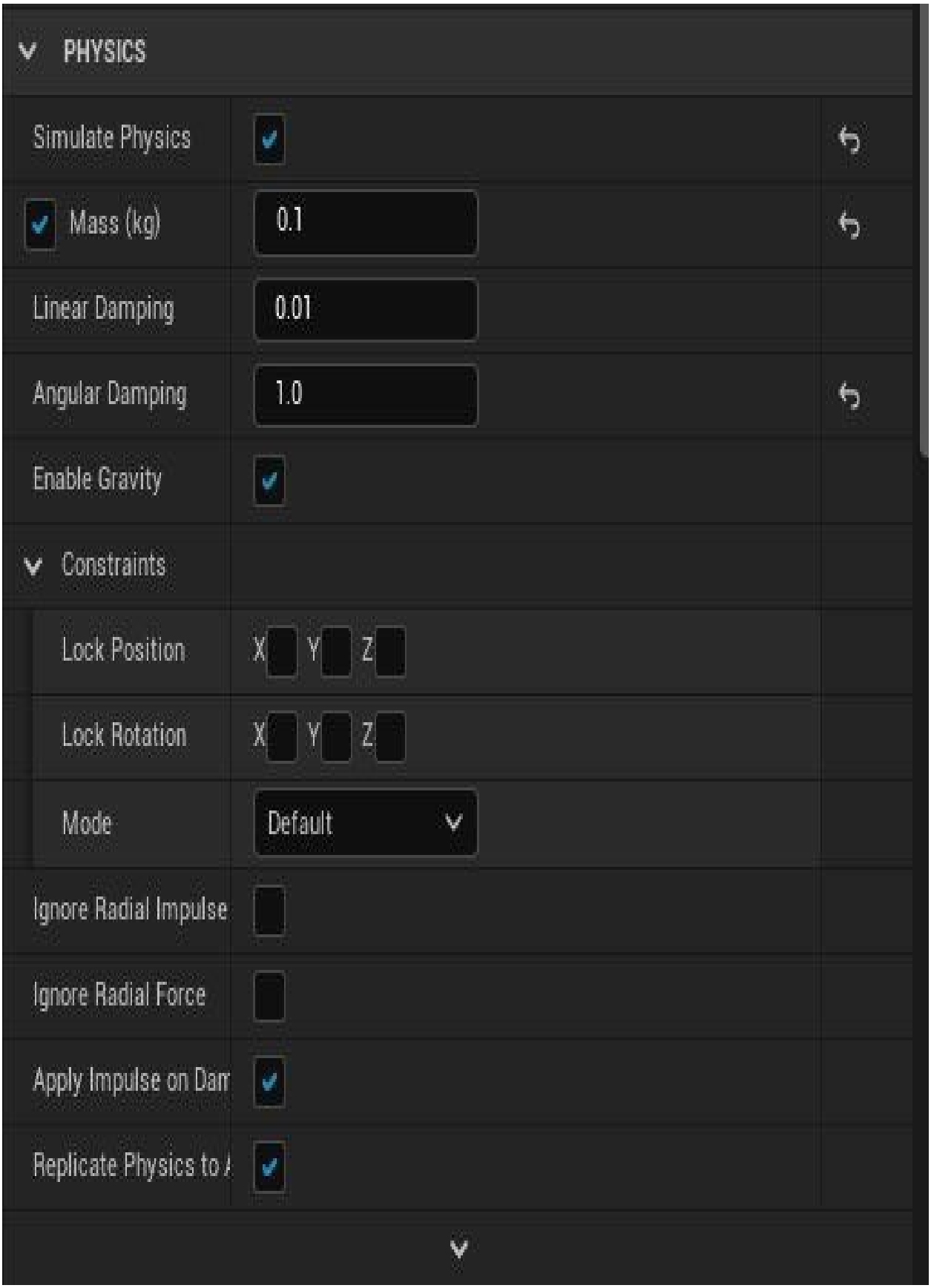

PHYSICS
Simulate Physics
Mass (kg)
0.1
Linear Damping
0.01
Angular Damping
1.0
Enable Gravity
Constraints
Lock Position
X
Y
Z
Lock Rotation
X
Y
Z
Mode
Default
Ignore Radial Impulse
Ignore Radial Force
Apply Impulse on Dam
Replicate Physics to A

Figure 4.30: PHYSICS properties in Details panel with customized Mass as 0.1 Kg

When you press Play, the Spheres fall dawn to the scene, which means they accept engine's simulated gravity force and respond by falling towards the surface of the scene, as shown in Figure 4.31:

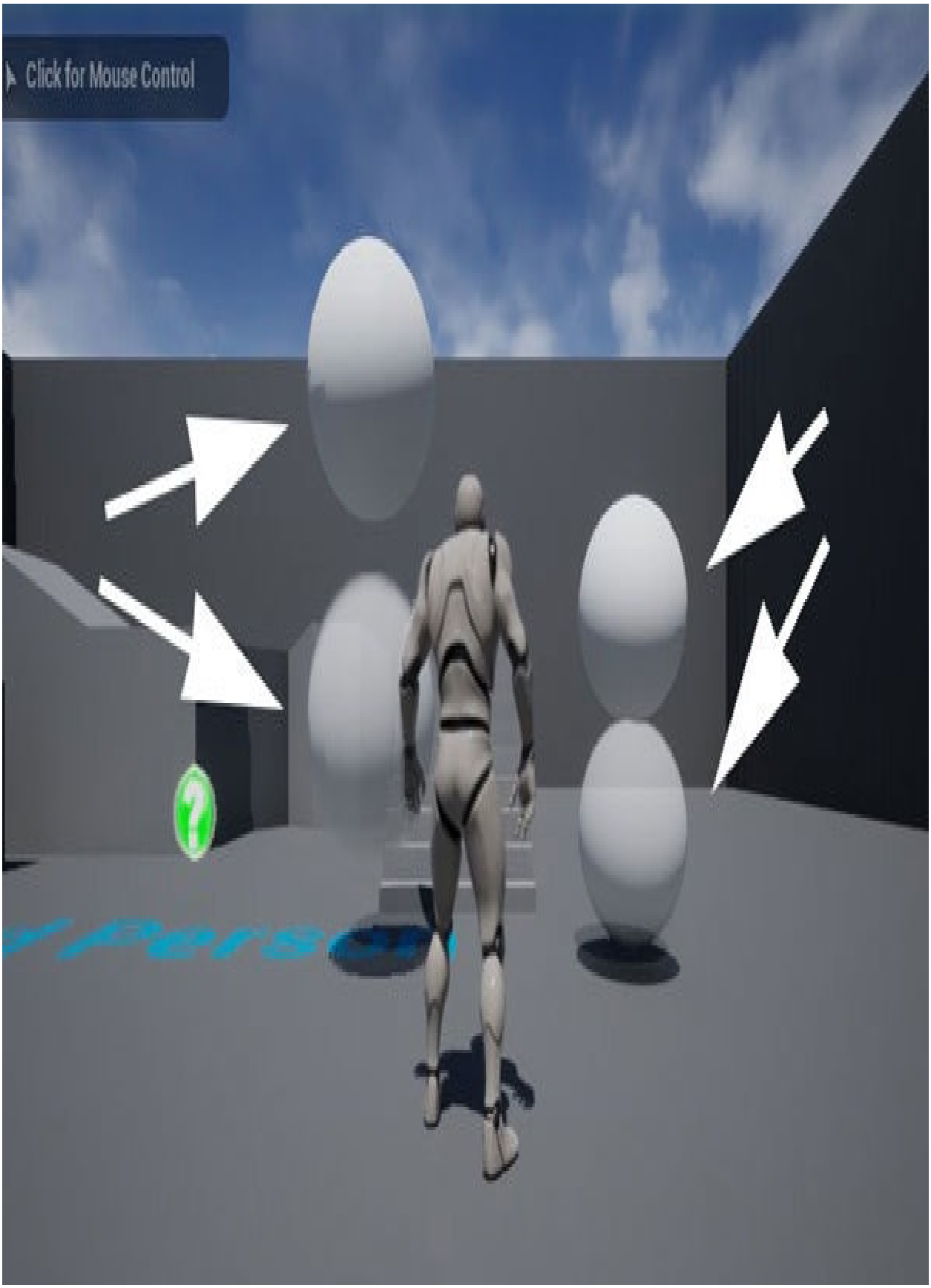

Click for Mouse Control

Figure 4.31: Simulate gravity, by activate Simulate Physics check box in Details panel for each Sphere

Now, switch back to BP_item_02 blueprint editor, add a Cube static mesh component to this blueprint, and move it above the Sphere. Then, add one PhysicsConstraint component to your blueprint, select it, and place it between Cube and Sphere static mesh components. Then, in the Details panel, put Sphere in one of the Component Name text boxes, as shown in Figure 4.32:

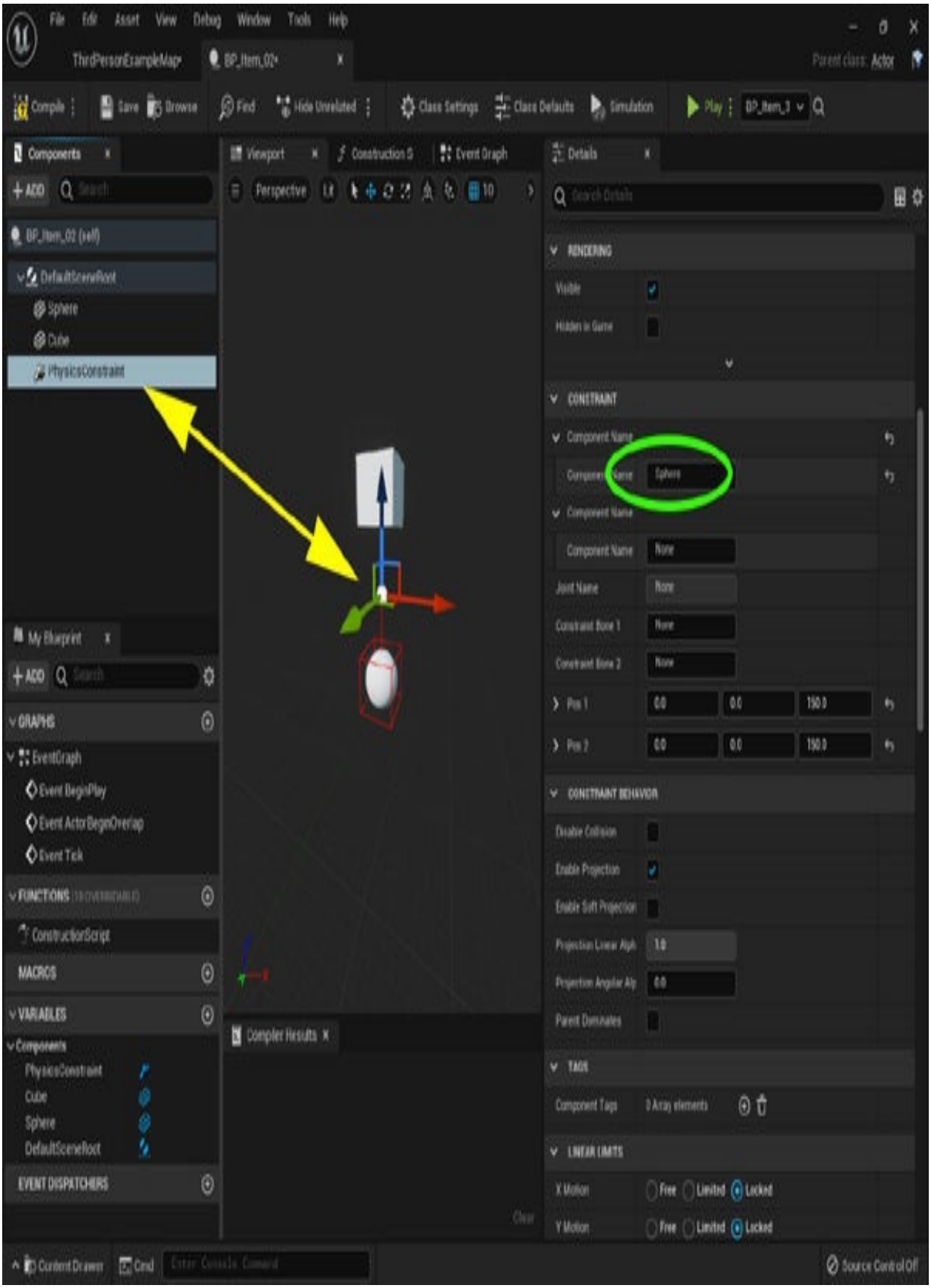

File Edit Asset View Debug Window Tools Help
ThirdPersonExampleMap
BP_Item_02*
Parent class: Actor
Compile
Save
Browse
Find
Hide Unrelated
Class Settings
Class Defaults
Simulation
Play
BP_Item_3
Components
Viewport
Construction S
Event Graph
Details
ADD
Search
Perspective
BP_Item_02 (self)
DefaultSceneRoot
Sphere
Cube
PhysicsConstraint
RENDERING
Visible
Hidden in Game
CONSTRAINT
Component Name
Sphere
None
Joint Name
Constraint Bone 1
Constraint Bone 2
Pos 1
Pos 2
0.0
150.0
CONSTRAINT BEHAVIOR
Disable Collision
Enable Projection
Enable Soft Projection
Projection Linear Alpha
1.0
Projection Angular Alpha
Parent Dominates
TAGS
Component Tags
0 Array elements
LINEAR LIMITS
X Motion
Free
Limited
Locked
Y Motion
My Blueprint
GRAPHS
EventGraph
Event BeginPlay
Event ActorBeginOverlap
Event Tick
FUNCTIONS
ConstructionScript
MACROS
VARIABLES
Components
PhysicsConstraint
Cube
Sphere
DefaultSceneRoot
EVENT DISPATCHERS
Compiler Results
Clear
Content Drawer
Cmd
Enter Console Command
Source Control Off

Figure 4.32: Add PhysicsConstraint component and place it between Sphere and Cube in BP_Item_02 blueprint actor

Play the game and push Sphere static mesh in the scene with third person character of the game. As you see, it looks like PhysicsConstraint is grabbing the Sphere and forcing it to remain there and rotate around the PhysicsConstraint, as shown in Figure 4.32. This component works like a joint for any physics enabled (Figure 4.30) component in a blueprint object:

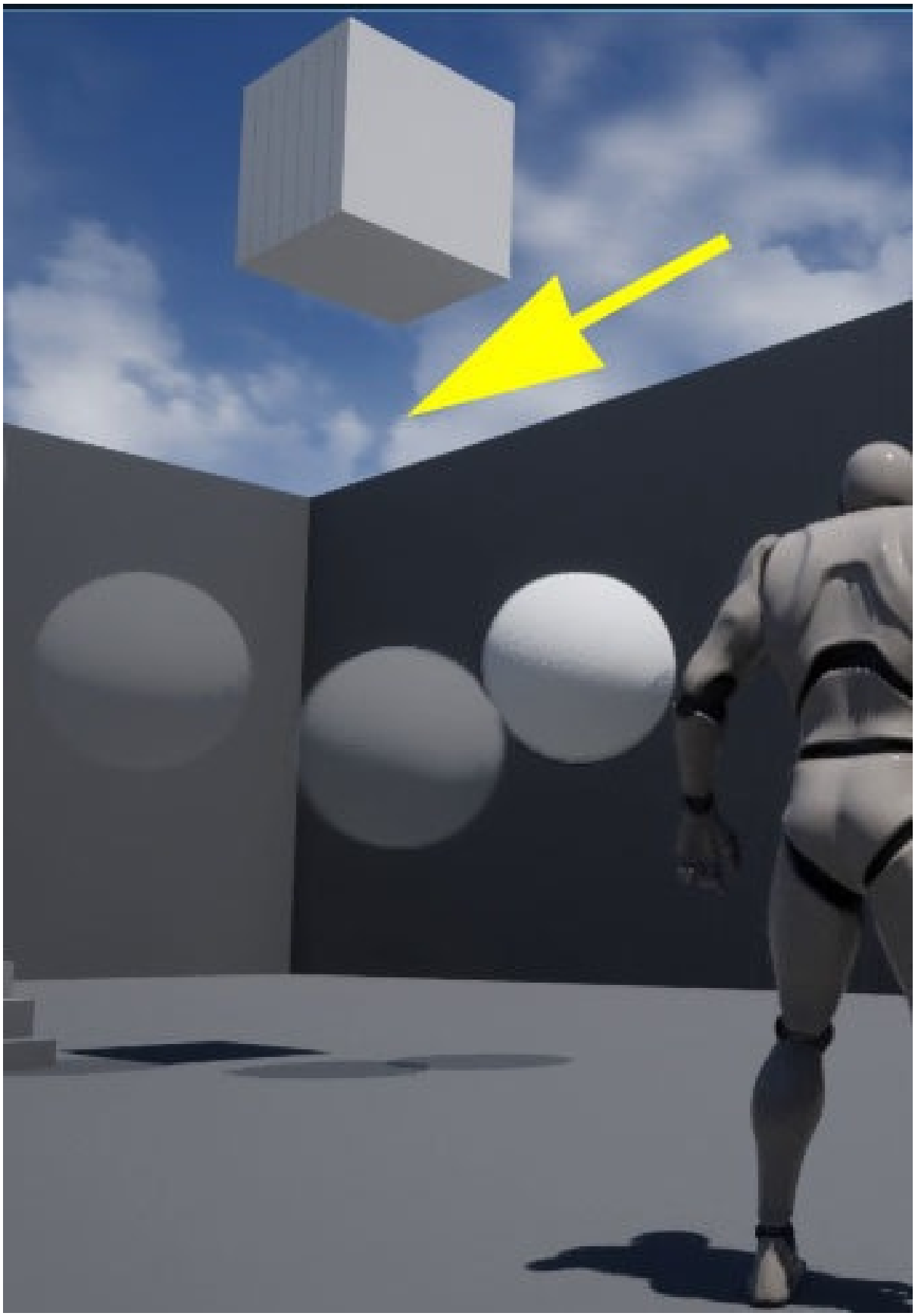


Figure 4.33: Location of PhysicsConstraint component and the effect on Sphere in the scene

There are a lot of other details about physical simulations in Unreal Engine. A good source for beginning is Epic Games online documentations on Physics and its example projects.

Conclusion

The Blueprints are basic elements of each Unreal Engine application. Any designer or developer must learn how to create blueprint object, add component to it, and populate it on the scene. Blueprint components support a wide range of game elements and procedures like static mesh and physics. There is a hierarchical relationship between components of blueprint and blueprint itself in the actual scene. Some of these components can be customized with external materials, like static mesh components that a user can import and assign custom made mesh by using them. Also, blueprints can handle scripting language and perform functionalities in runtime, and we will go through the basics of blueprint scripting language in the later chapters.

Points to remember

A good design of blueprint will always save time and increased performance in massive projects.

Using BP_ as the prefix for naming blueprint is an industry standard.

The Actor Blueprint object is a game asset that can be placed on stage, spawned in game and can receive user interactions.

Each change to parents in a hierarchical relationship will immediately affect all children.

Multiple choice questions

What is the hierarchical relationship of components in Unreal Engine?

Each child is immediately affected if the parent is affected.

Parent is immediately affected if any child is affected.

Parents are immediately affected if all children are affected.

Changes in any will immediately change others.

ThePhysicsConstraintis which of the following?

An independent object that works unlike blueprints.

Designed to disable physics in game.

Working like a joint for any physics enabled component in a blueprint object.

Change the physical behavior of containing object.

How many blueprint objects can we create in Unreal Engine?

There are limitations on making blueprints by default.

Some blueprints are just working with special components, so we can’t make them until we make those components.

It depends on your system features, but there are no limitations on making them.

Only a minimum number of blueprints are allowed in Unreal Engine.

Answers

a

c

c

Questions

Refer to https://docs.unrealengine.com/4.27/en-US/InteractiveExperiences/Physics; what is PhAT?

How can you calculate the tangent of an angle in a right triangle?

How can you use linear limits in the PhysicsConstraint component to filter motion based on axis?

What are angular limits in PhysicsConstraint component?

Key terms

Blueprint editor – Each blueprint type has a compatible editor inside the engine to develop, design and customize blueprint game objects of that type. Example are animation blueprint editor used for animation game objects, Niagara blueprint editor used for particle system game objects, Material blueprint editor used for shader programming, and so on.

Blueprint component – Standalone game objects that are attached to a blueprint object as child and perform extra functionalities for the application.

Component hierarchy – The parent and child relationship within blueprint components which can be customized by user or dynamically changed in runtime.

Blueprint node list – The list of blueprint functions which user can access by a right click inside the Event Graph panel.

CHAPTER 5

Project Templates and User Interaction

Making basic functionalities in a game application is directly related to the scenario and type of that game. For example, basic functionalities in shooter games are like moving around, shooting, and changing camera view. On the other hand, in a VR game, basic functionalities are directly dependent on VR controllers and the way the VR headset is working. Unreal Engine provides a number of templates with premade functionalities that match the template scenario. This can save a lot of time on prototyping and making sample projects from scratch.

In this chapter, we will go through default templates of the engine and review their details. Then we develop user input functionalities by learning basics of blueprint programming which is based on blueprint implementations which we learned from previous chapter. Then we will create a simple game asset with collision detection by learning more about blueprint code.

Structure

In this chapter, we will discuss the following topics:

Using templates in Unreal Engine 5

Adding user interaction to blueprint

Developing code in blueprint

Simple collision detection

Making simple game assets

Objectives

In this chapter, we will learn about the templates that exist in Unreal Engine 5 and explain their usage on making game and applications. Then, we will learn how to develop our first code in blueprint and handle user interactions with application. A user can press keys on the keyboard, controller, or mouse to make changes inside their application, based on how they program those key events.

By the end of this chapter, you will be able to create and program a blueprint asset inside the engine and use it based on your preferences and code.

Using Templates in Unreal Engine 5

As we mentioned in Chapter 4, Using Blueprints, by making a new project in Unreal Engine, the user must choose one Project Template at the beginning. The engine provides four categories of project templates for users, and each one contains several project templates. Each Project template is a game/application prototype with basic functionalities and default setting for making a standalone game or application. They have predefined assets, customized rendering options, default map, and tools based on the category which been selected from. Press the Launch button in the Library tab of Unreal Engine 5, and you will navigate to Unreal Project Browser windows, as shown in Figure 5.1:

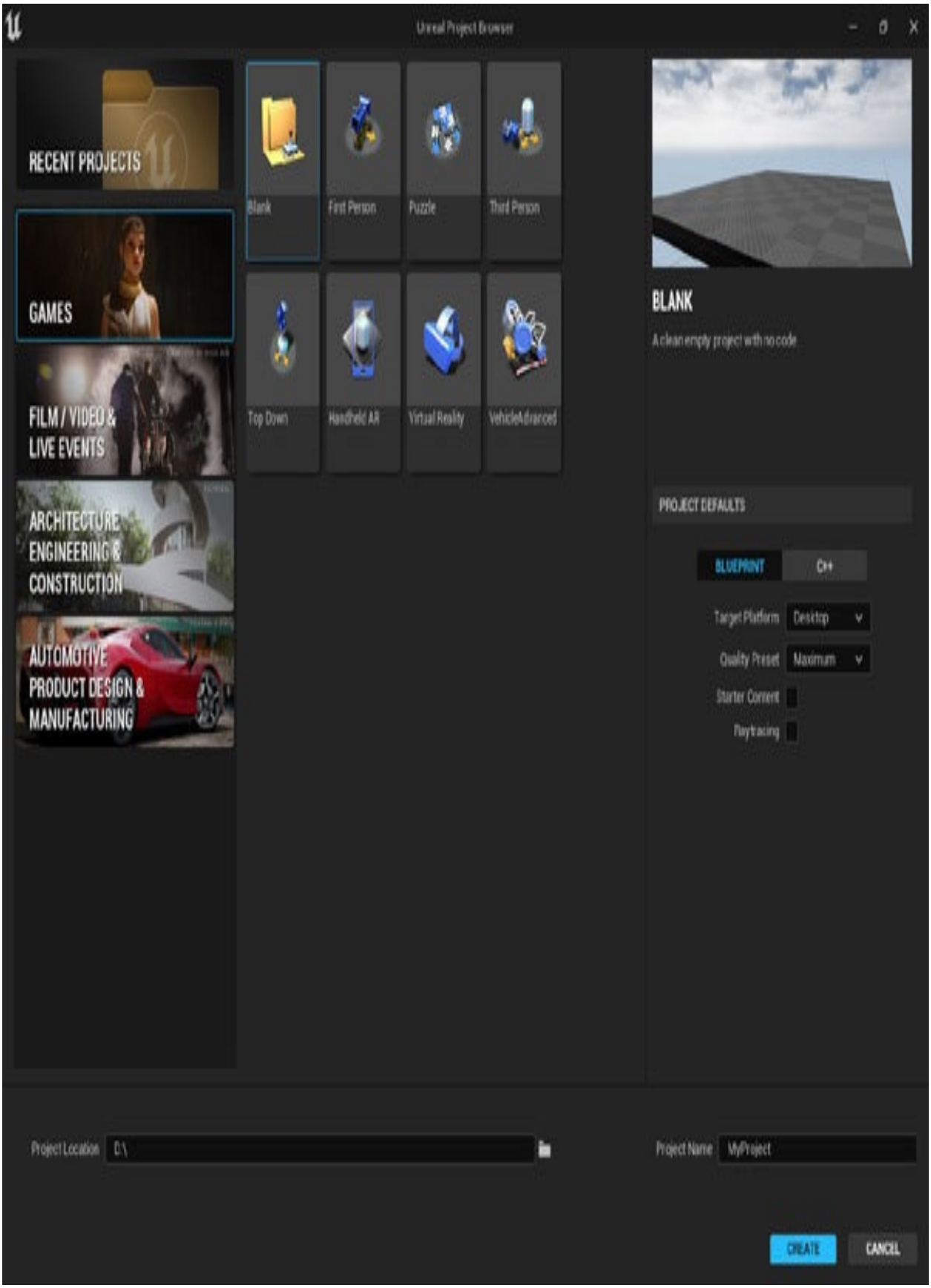

Unreal Project Browser
RECENT PROJECTS
GAMES
FILM / VIDEO & LIVE EVENTS
ARCHITECTURE ENGINEERING & CONSTRUCTION
AUTOMOTIVE PRODUCT DESIGN & MANUFACTURING
Blank
First Person
Puzzle
Third Person
Top Down
Handheld AR
Virtual Reality
VehicleAdvanced
BLANK
A clean empty project with no code
PROJECT DEFAULTS
BLUEPRINT
C++
Target Platform
Desktop
Quality Preset
Maximum
Starter Content
Raytracing
Project Location
D:\
Project Name
MyProject
CREATE
CANCEL

Figure 5.1: Unreal Project Browser windows in Unreal Engine 5

After the user clicks on each category, the engine shows a number of project templates available for that category. Here is a list of categories:

GAMES: These project templates shown in Figure 5.2 are designed to support specific game types, including some customizable options and basic games assets. A very common template in this section is the Third Person template, which we will use in this chapter:

Blank
First Person
Puzzle
Third Person
Top Down
Handheld AR
Virtual Reality
VehicleAdvanced

Figure 5.2: List of "Games" templates in Unreal Engine 5

FILM, TELEVISION/VIDEO, AND LIVE EVENTS: Project templates arranged and designed for Virtual Production and cinematography template are located in this category; it is shown in Figure 5.3:

Blank
Virtual Production
DMX
InCameraVFX

Figure 5.3: List of "Film, Television/Video, and Live Events" templates in Unreal Engine 5

ARCHITECTURE, ENGINEERING AND CONSTRUCTION: Project templates related to architecture, engineering, and Microsoft HoloLens are available in this category; it is shown in Figure 5.4. These templates have some special plugins like Datasmith, which are designed to work with AutoDesk applications for collaborative industrial or architectural projects:

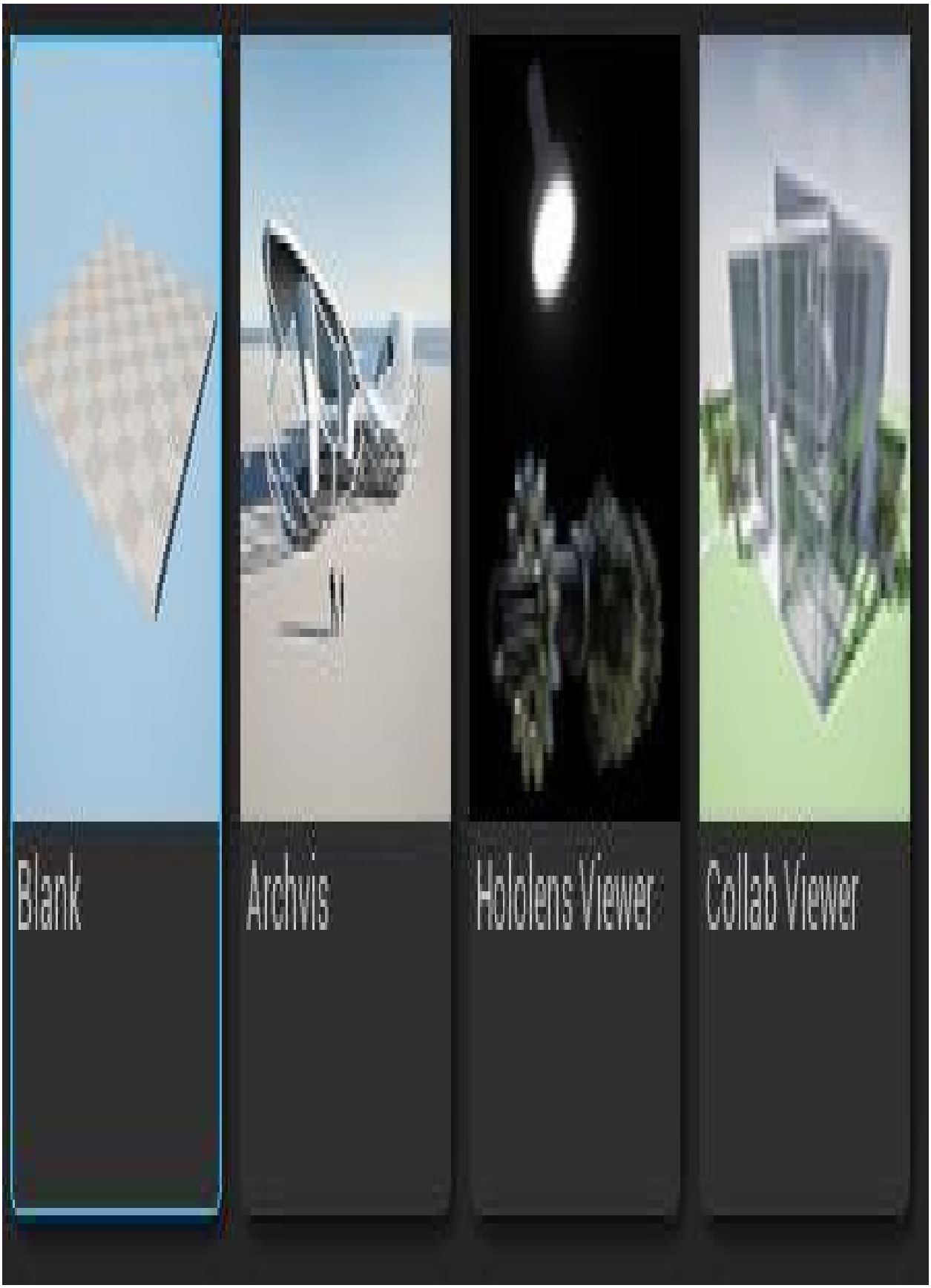

Blank
Archvis
Hololens Viewer
Collab Viewer

Figure 5.4: List of "Architecture, Engineering and Construction" templates in Unreal Engine 5

AUTOMOTIVE, PRODUCT DESIGN, AND MANUFACTURING: These project templates support high-quality, realistic, real-time rendering, which is a brilliant feature in Unreal Engine 5. These project templates are designed for advertisement and product presentations scenarios, as shown in Figure 5.5:

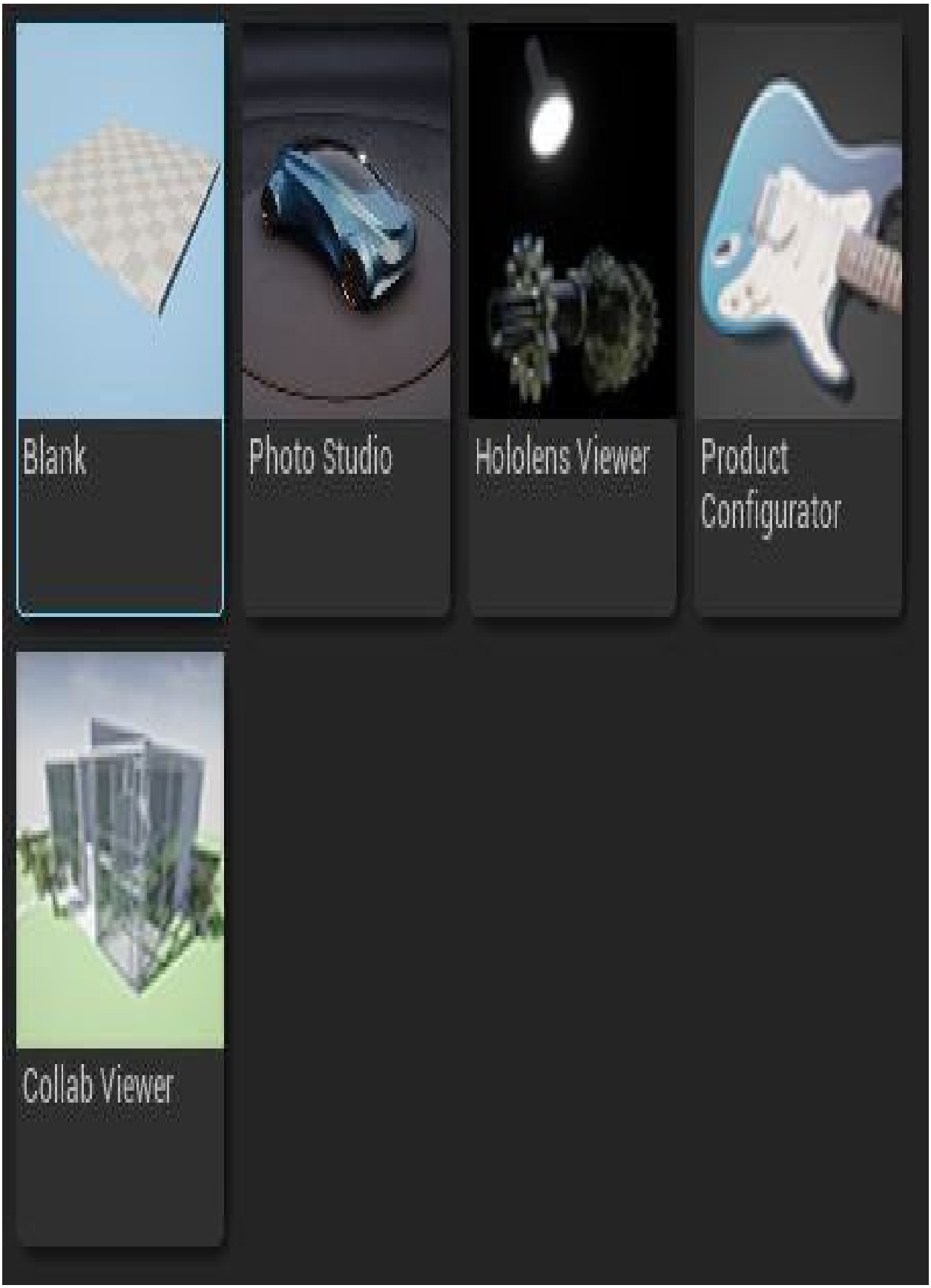

Blank
Photo Studio
Hololens Viewer
Product Configurator
Collab Viewer

Figure 5.5: List of "Automotive, Product Design, and Manufacturing" templates in Unreal Engine 5

Each category has a Blank project template, which is an empty project using default rendering configurations related to chosen category and an empty map/level. The remaining project templates of each category have special features to support different scenarios, which is out of the scope of this chapter.

For this book, we will use the Third Person template from the GAMES category. This template is designed for developing a third person game like Tomb Raider and Assassin Creed; it has predefined features that we will use to learn basics of user interactions in Unreal Engine 5.

Click on the GAMES category and then select the Third Person template from the options; then, change the name and project path, uncheck Starter Contents, and then click on the CREATE button. The engine will build a standalone project with selected template totally in C++ programming language. Then, the engine will run Unreal Editor to open the project. The Unreal Editor is an application that provides basic and advanced tools to edit and create an application with Unreal Engine.

When your project comes up with unreal editor, press the Play button on top of the editor. The Unreal Engine will run a third person game prototype, in which user can run and jump by using keyboard and change camera view by moving the mouse. You can press the Esc key on your keyboard or click on the Stop button to stop the game. As a practice on what you learned from the previous chapter, make some actor blueprints, add them to the scene, and make a simple third person game.

Adding user interaction to blueprint

In the previous chapter, we learned how to design a blueprint by adding blueprint components like static mesh. Now, we would like to do some basic coding in blueprint, which is essential for everyone who likes to use unreal engines. A very good point to start with is to define and change the user interface. Click on Project Setting… from the Edit menu, as shown in Figure 5.6:

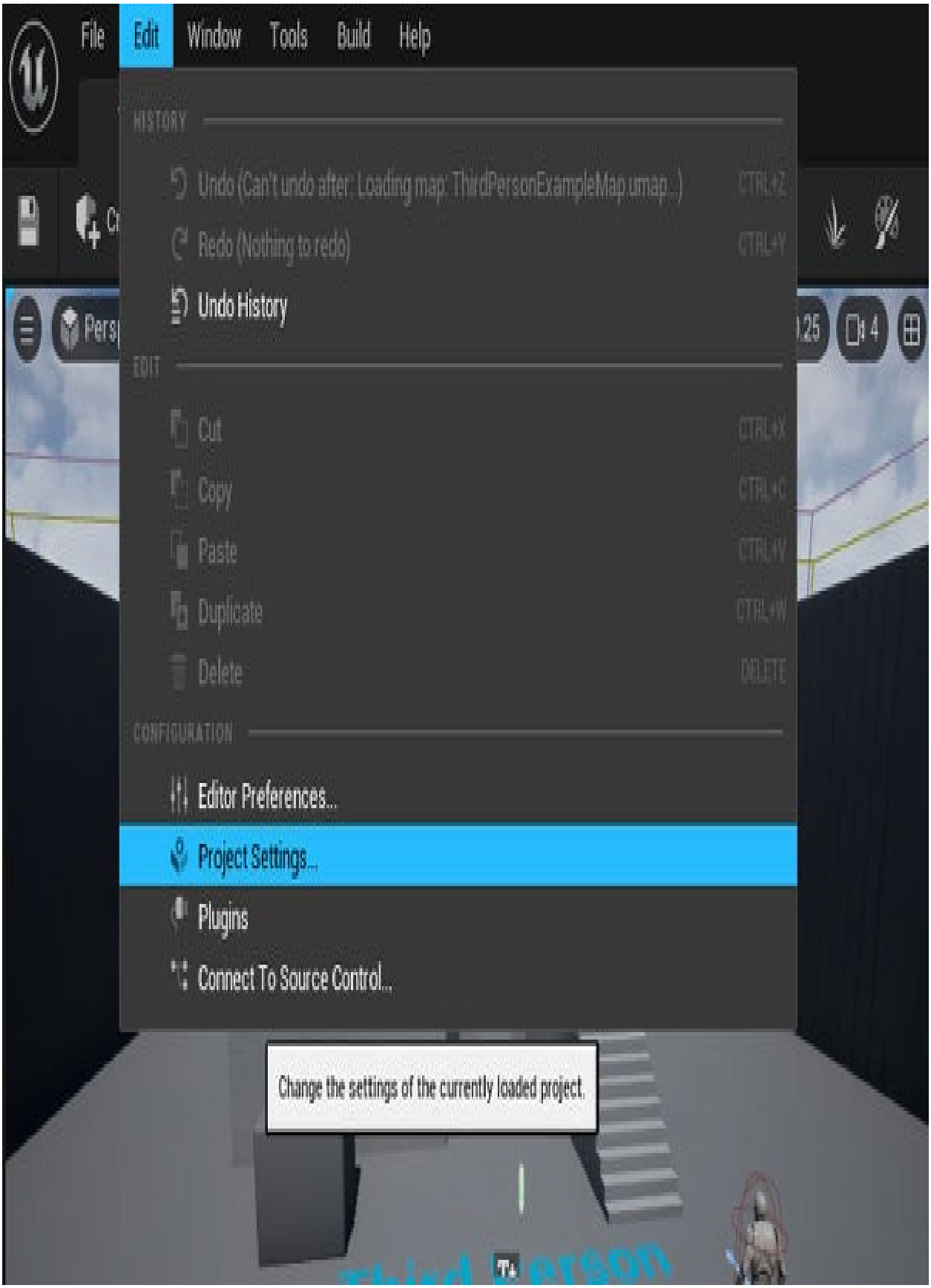

File
Edit
Window
Tools
Build
Help
HISTORY
Undo (Can't undo after: Loading map: ThirdPersonExampleMap.umap...)
CTRL+Z
Redo (Nothing to redo)
CTRL+Y
Undo History
EDIT
Cut
CTRL+X
Copy
CTRL+C
Paste
CTRL+V
Duplicate
CTRL+W
Delete
DELETE
CONFIGURATION
Editor Preferences...
Project Settings...
Plugins
Connect To Source Control...
Change the settings of the currently loaded project.

Figure 5.6: Project Setting in Edit menu

The engine will open the Project Settings window, which is designed to customize features and functionalities of a project. For this chapter, we would like to add new input keys to project, so click on Input, which is located at All Settings list on the left, and then click on and expand Action Mappings and Axis Mappings drop-down list, as shown in Figure 5.7:

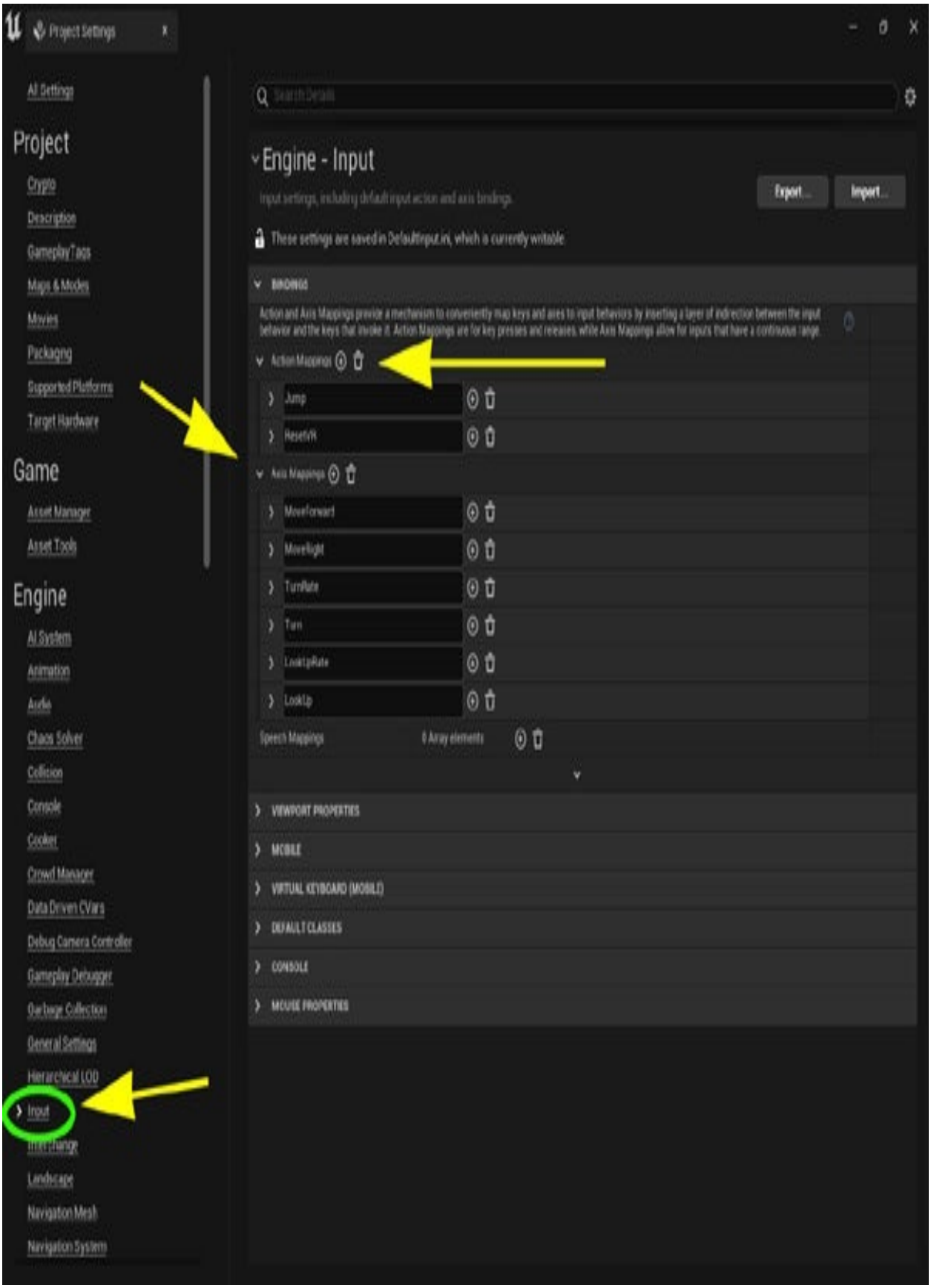

Project Settings
All Settings
Project
Crypto
Description
Gameplay Tags
Maps & Modes
Movies
Packaging
Supported Platforms
Target Hardware
Game
Asset Manager
Asset Tools
Engine
AI System
Animation
Audio
Chaos Solver
Collision
Console
Cooker
Crowd Manager
Data Driven CVars
Debug Camera Controller
Gameplay Debugger
Garbage Collection
General Settings
Hierarchical LOD
Input
Landscape
Navigation Mesh
Navigation System
Engine - Input
Export...
Import...
These settings are saved in DefaultInput.ini, which is currently writable
BINDINGS
Action Mappings
Jump
ResetVR
Axis Mappings
MoveForward
MoveRight
TurnRate
Turn
LookUpRate
LookUp
Speech Mappings
0 Array elements
VIEWPORT PROPERTIES
MOBILE
VIRTUAL KEYBOARD (MOBILE)
DEFAULT CLASSES
CONSOLE
MOUSE PROPERTIES

Figure 5.7: Access to Input setting in Unreal Engine 5

The Action Mappings dropdown is responsible for your direct actions in game, and in this template (Third Person), actions Jump and Reset VR are already assigned by default. Click on Jump and expand its dropdown; as you see in Figure 5.8, the space bar of keyboard, gamepad face button, and a number of other machines are listed here. You can add new ones by clicking on plus with a circle button and delete them by clicking on the bin icon:

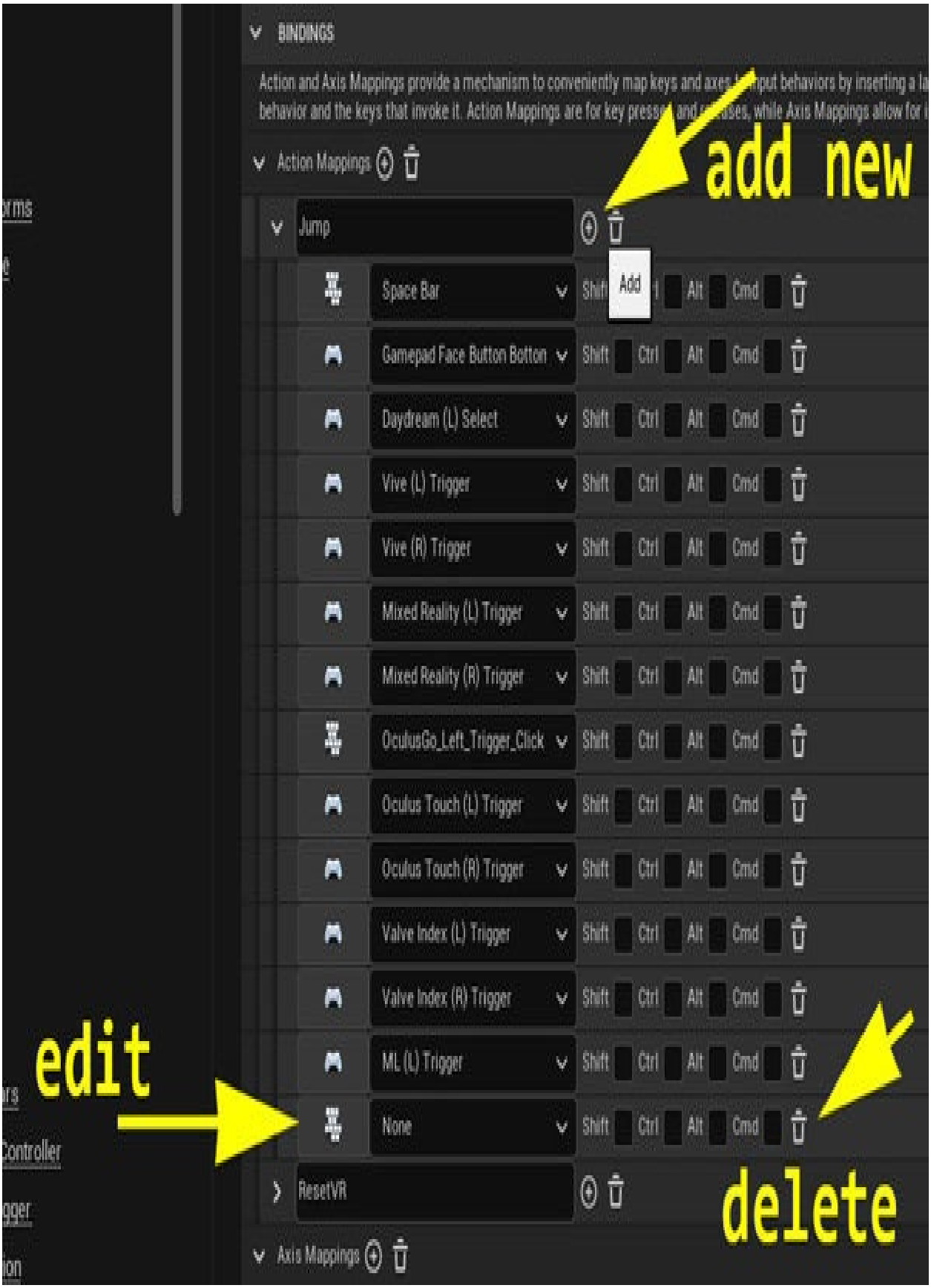

BINDINGS
Action and Axis Mappings provide a mechanism to conveniently map keys and axes to input behaviors by inserting a la
behavior and the keys that invoke it. Action Mappings are for key presses and releases, while Axis Mappings allow for i
Action Mappings
add new
Jump
Add
Space Bar
Gamepad Face Button Botton
Daydream (L) Select
Vive (L) Trigger
Vive (R) Trigger
Mixed Reality (L) Trigger
Mixed Reality (R) Trigger
OculusGo_Left_Trigger_Click
Oculus Touch (L) Trigger
Oculus Touch (R) Trigger
Valve Index (L) Trigger
Valve Index (R) Trigger
ML (L) Trigger
None
Shift Ctrl Alt Cmd
edit
delete
ResetVR
Axis Mappings

Figure 5.8: Add new input for “Jump” action

To edit a key, click on None, and as you see in Figure 5.9, the engine automatically shows a list of available target machines. Select Keyboard and then from the list of keys, select Backspace just for testing. You can always return here and change the key or remove it:

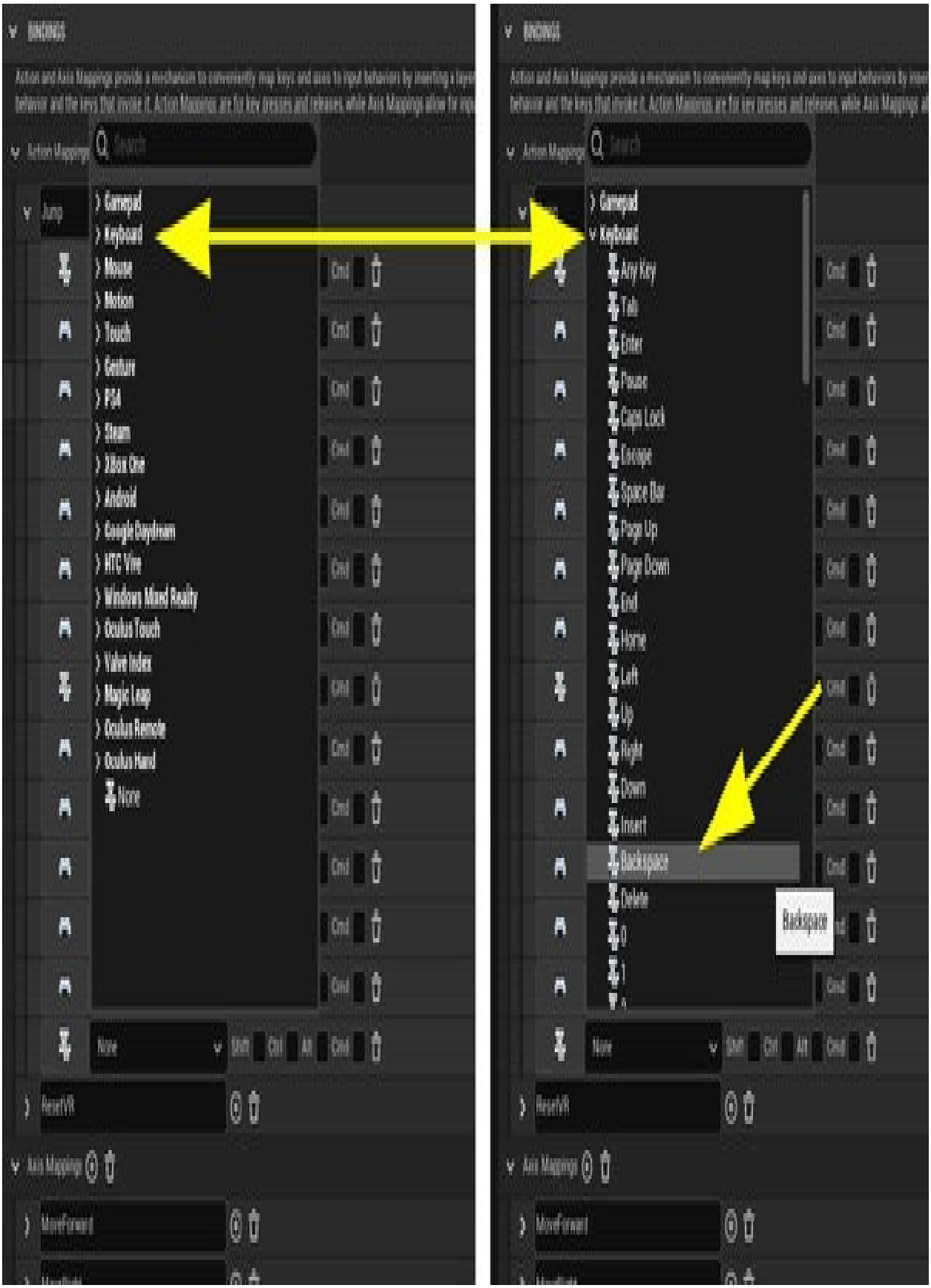

Action Mappings
Jump
Gamepad
Keyboard
Mouse
Motion
Touch
Gesture
PS4
Steam
Xbox One
Android
Google Daydream
HTC Vive
Windows Mixed Reality
Oculus Touch
Valve Index
Magic Leap
Oculus Remote
Oculus Hand
None
Any Key
Tab
Enter
Pause
Caps Lock
Escape
Space Bar
Page Up
Page Down
End
Home
Left
Up
Right
Down
Insert
Backspace
Delete
0
1
Backspace
Cmd
Shift
Ctrl
Alt
ResetVR
Axis Mappings
MoveForward

Figure 5.9: Add new input for "Jump" action

Close these windows, and the engine will automatically save your changes. Go back to the editor and press play and then press Backspace. As you see, the third person player character will Jump with this key as well as with the Spacebar. Users can assign other target machines like gamepad and test them with same result.

Now, let's go back to Edit | Project Settings… | Input and check Axis Mappings. As you can see in Figure 5.10, we have W and A to move forward and S and D keys to move right. The difference between Axis Mappings and Action Mappings is important to know. Action Mappings are basically support on and off interactions like Jump. When you press space bar, the character moves up, and after a delay, it moves down; you can press Jump again. The Axis Mappings, however, are best to support on and off interaction, but it is designed to send values. For example, if you press W to walk forward, as Figure 5.10 shows, the engine will use a scale value, which is 1, for walking forward. Now if you like to move backward, you have to press S, and as you see in Figure 5.10, the engine uses a scale value of -1 to move the character in opposite direction of moving forward, i.e., backward. The same logic is working for the A and D buttons, which move characters left and right:

BINDINGS

Action and Axis Mappings provide a mechanism to conveniently map keys and axes to input behav
behavior and the keys that invoke it. Action Mappings are for key presses and releases, while Axis

Action Mappings

Axis Mappings

MoveForward		
	W	Scale 1.0
	S	Scale -1.0
	Up	Scale 1.0
	Down	Scale -1.0
	Gamepad Left Thumbstick Y-	Scale 1.0
	Daydream (L) Trackpad Y	Scale 1.0
	Vive (L) Trackpad Y	Scale 1.0
	Mixed Reality (L) Thumbstick	Scale 1.0
	OculusGo_Left_Trackpad_Y	Scale 1.0
	Oculus Touch (L) Thumbstick	Scale 1.0
	Valve Index (L) Thumbstick Y	Scale 1.0
	ML (L) Trackpad Y	Scale 1.0
MoveRight		
	A	Scale -1.0
	D	Scale 1.0
	Gamepad Left Thumbstick X-	Scale 1.0

Figure 5.10: Axis Mappings" need Scale value to send user interaction to engine

Developing code in Blueprint

Now, let us assign a keyboard key and learn how to print a message on screen. First, add a new input to Action Mapping, and then assign My Action as its name; then, select Keyboard from the drop-down list of target machines and then select 0, as shown in Figure 5.11 and then close the project setting windows. The engine will automatically save your changes:

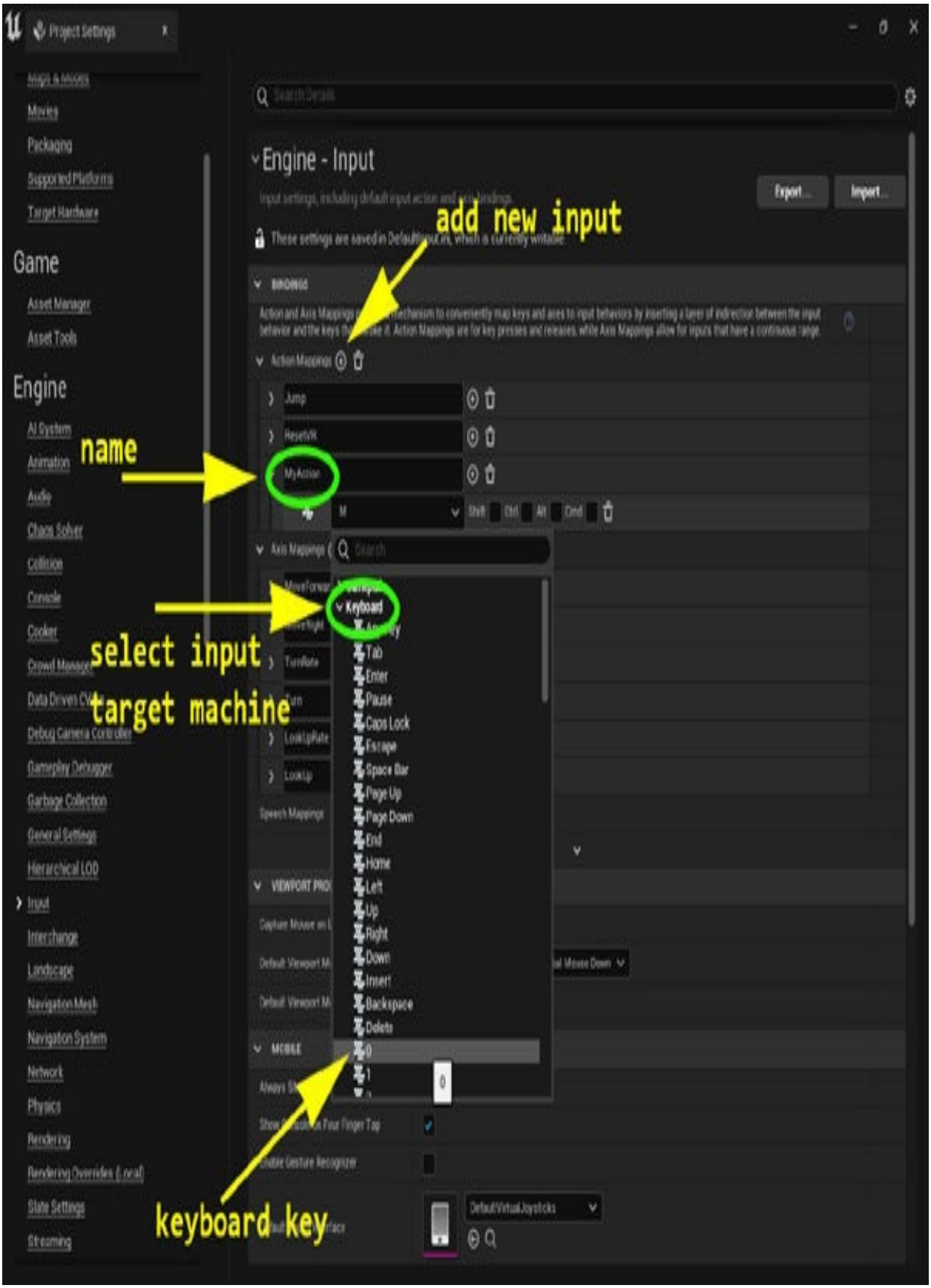

Project Settings
Engine - Input
Export...
Import...
add new input
name
select input
target machine
keyboard key
Game
Engine
Movies
Packaging
Supported Platforms
Target Hardware
Asset Manager
Asset Tools
AI System
Animation
Audio
Chaos Solver
Collision
Console
Cooker
Crowd Manager
Debug Camera Controller
Gameplay Debugger
Garbage Collection
General Settings
Hierarchical LOD
Input
Interchange
Landscape
Navigation Mesh
Navigation System
Network
Physics
Rendering
Rendering Overrides (Local)
Slate Settings
Streaming
BINDINGS
Action Mappings
Jump
ResetVR
MyAction
Axis Mappings
Keyboard
Tab
Enter
Pause
Caps Lock
Escape
Space Bar
Page Up
Page Down
End
Home
Left
Up
Right
Down
Insert
Backspace
Delete
MOBILE
DefaultVirtualJoysticks

Figure 5.11: Make new input key for keyboard

At this stage, the engine knows that we like to use key 0 as an input. Now, we need to add code to our game to implement this action. Locate th ethird person blueprint in Content/ThirdPersonBP/Blueprints/and double-click on it to open. After the blueprint editor opens, click on the Event Graph tab, and in an empty area there, right-click and type My Action, as shown in Figure 5.12:

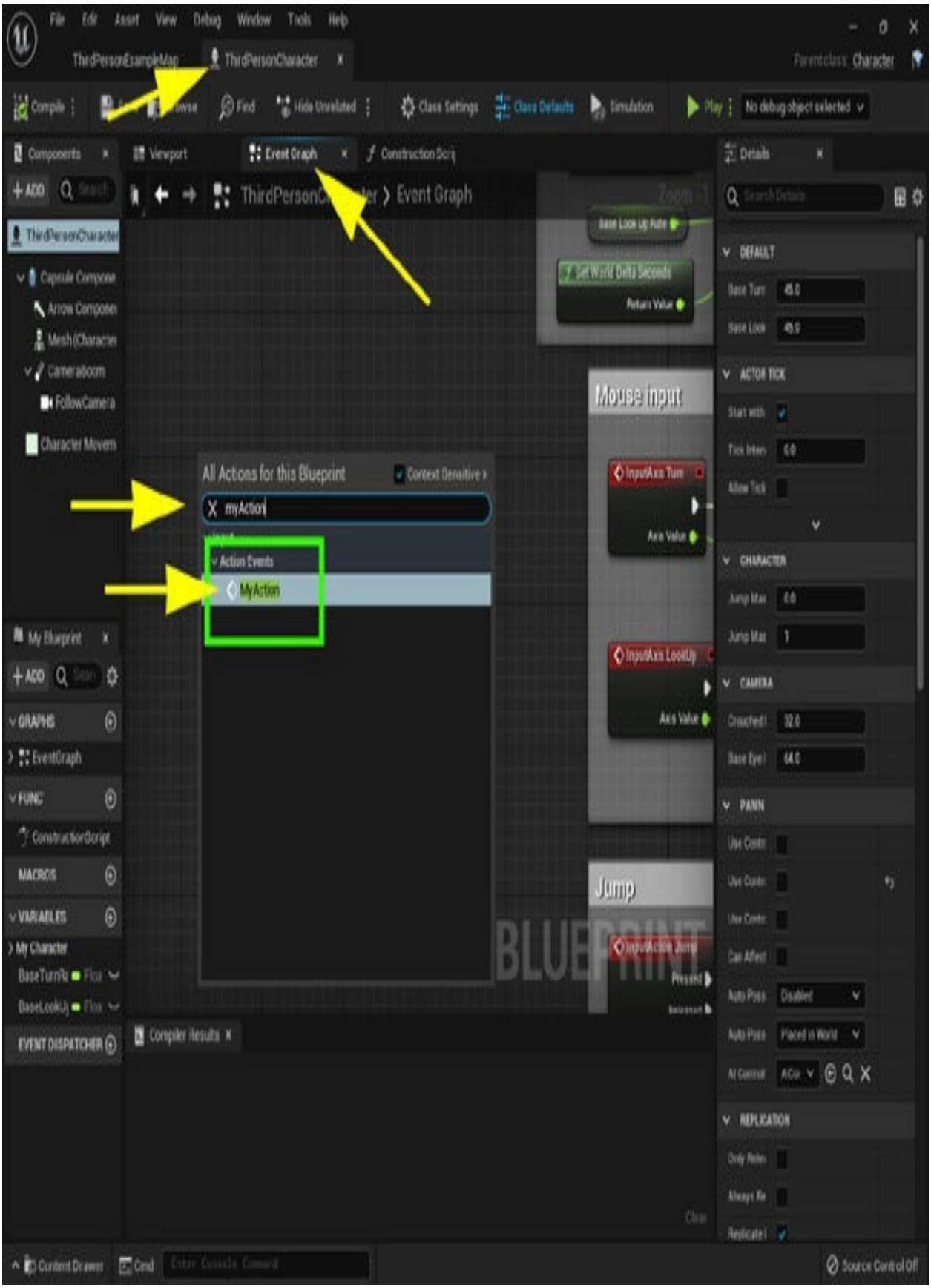

File Edit Asset View Debug Window Tools Help
ThirdPersonExampleMap
ThirdPersonCharacter
Parent class: Character
Compile
Find
Hide Unrelated
Class Settings
Class Defaults
Simulation
Play
No debug object selected
Components
Viewport
Event Graph
Construction Script
Details
ThirdPersonCharacter > Event Graph
Mouse input
Jump
All Actions for this Blueprint
Context Sensitive
myAction
Action Events
MyAction
My Blueprint
GRAPHS
EventGraph
FUNC
ConstructionScript
MACROS
VARIABLES
My Character
EVENT DISPATCHER
Compiler Results
DEFAULT
ACTOR TICK
CHARACTER
CAMERA
PAWN
REPLICATION
BLUEPRINT
Content Drawer
Cmd
Source Control Off

Figure 5.12: Navigate to Event Graph in Third Person blueprint, and then right-click and type "My Action" and click on "MyAction" in the list

The engine will show a drop-down list with the name of input event that you already made. Now, click on it in drop-down list, and the engine automatically will add a red titled block to the Event Graph with the title Input Action My Action, as shown in Figure 5.13. This is a Blueprint block of code that is responsible for detecting press and release of key 0 from keyboard by user:

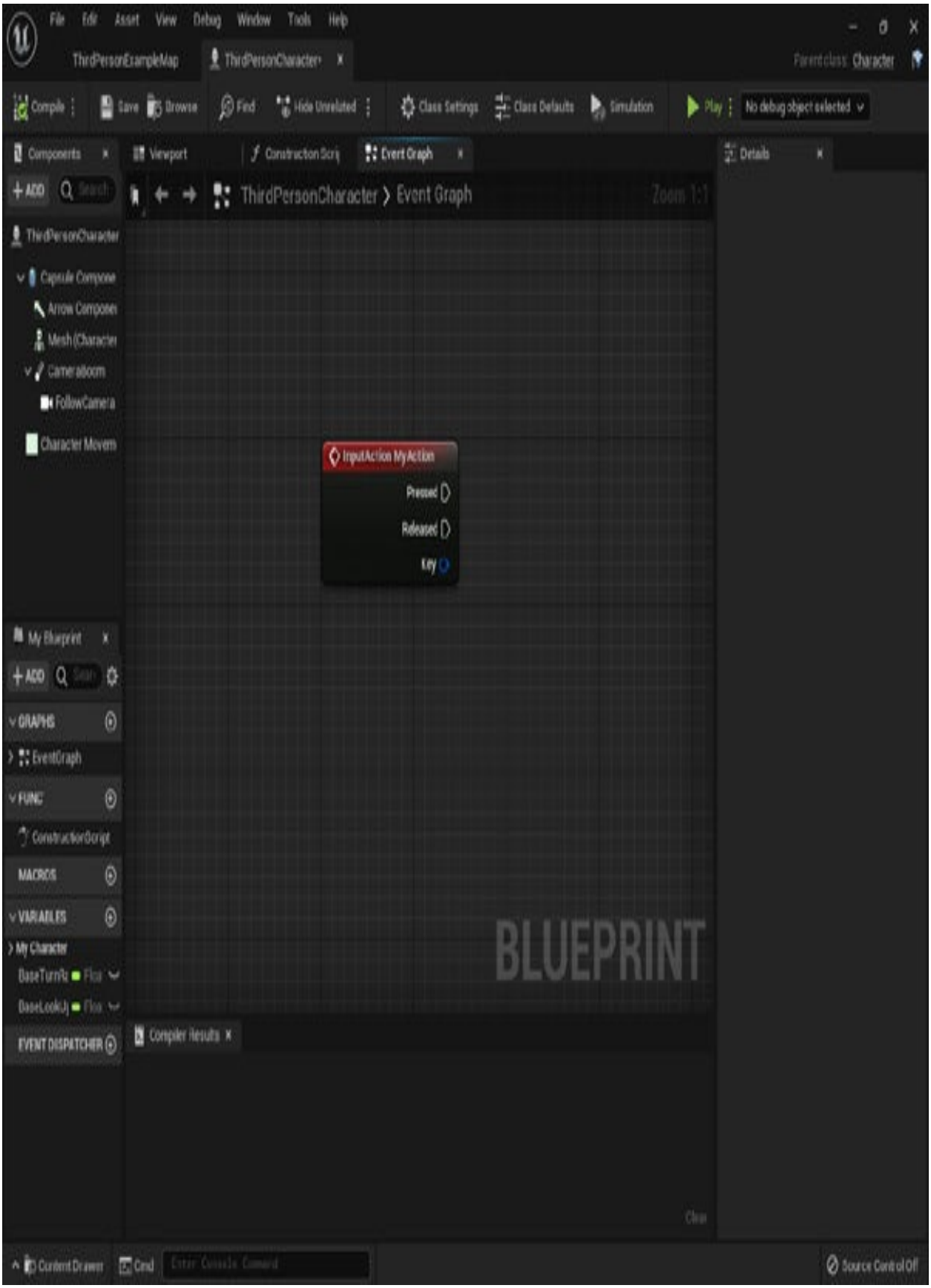

File Edit Asset View Debug Window Tools Help
ThirdPersonExampleMap
ThirdPersonCharacter
Parent class: Character
Compile
Save
Browse
Find
Hide Unrelated
Class Settings
Class Defaults
Simulation
Play
No debug object selected
Components
Viewport
Construction Scrip
Event Graph
Details
ADD
ThirdPersonCharacter > Event Graph
Zoom 1:1
ThirdPersonCharacter
Capsule Compone
Arrow Componen
Mesh (Character
CameraBoom
FollowCamera
Character Movem
InputAction MyAction
Pressed
Released
Key
My Blueprint
ADD
GRAPHS
EventGraph
FUNC
ConstructionScript
MACROS
VARIABLES
My Character
BaseTurnRa
BaseLookUp
EVENT DISPATCHER
BLUEPRINT
Compiler Results
Clear
Content Drawer
Cmd
Enter Console Command
Source Control Off

Figure 5.13: "My Action" key event after implementation in blueprint

Right-click again in front of your event block and type Print and again, the engine will automatically show a proper match for what you typed in; then, click on Print String. Now you have a new block with the title Print String, as shown in Figure 5.14. This is a blueprint block of code and is responsible for printing the message on the screen:

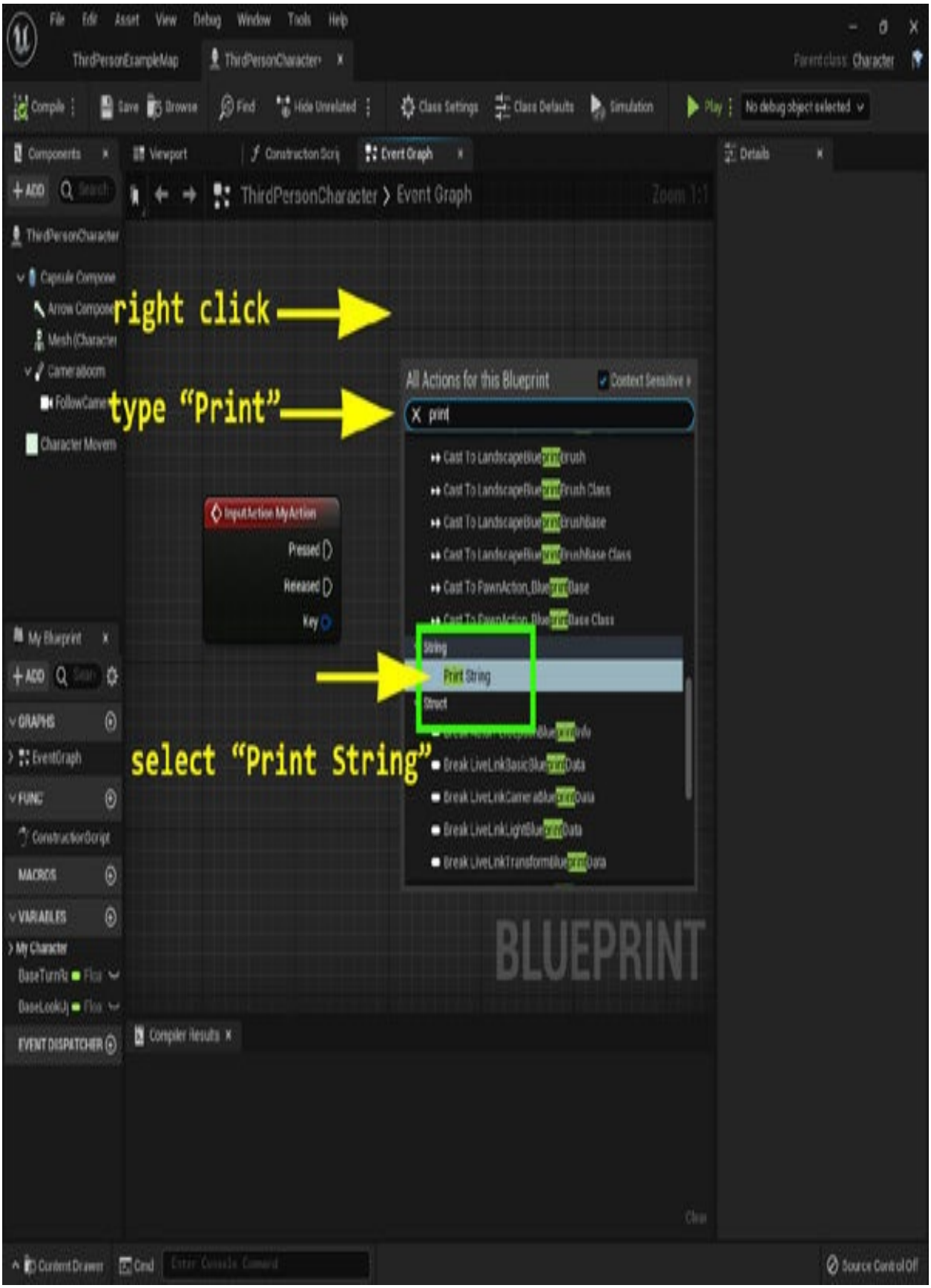
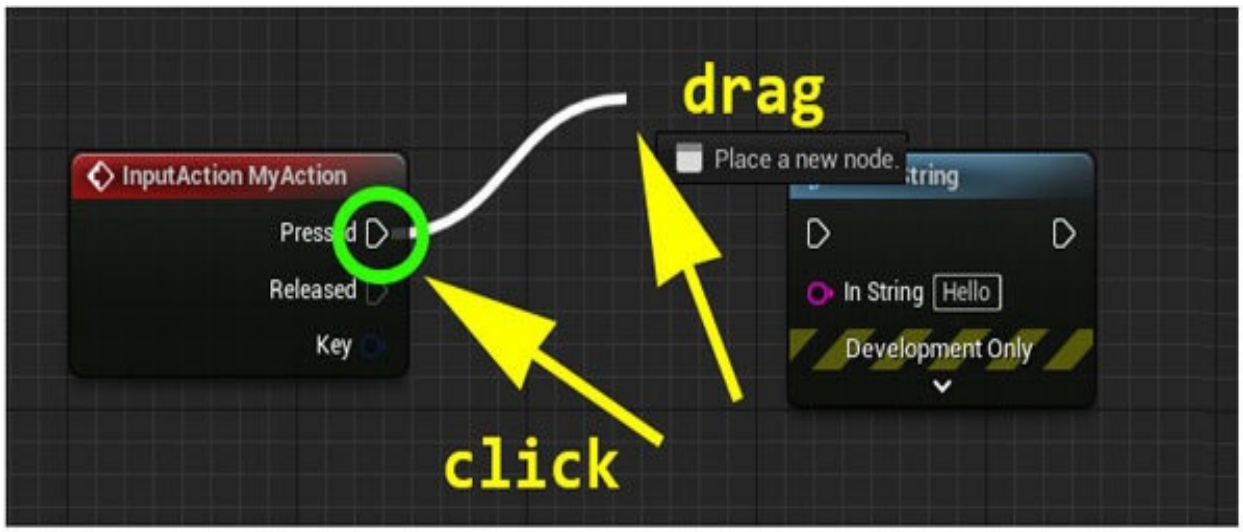
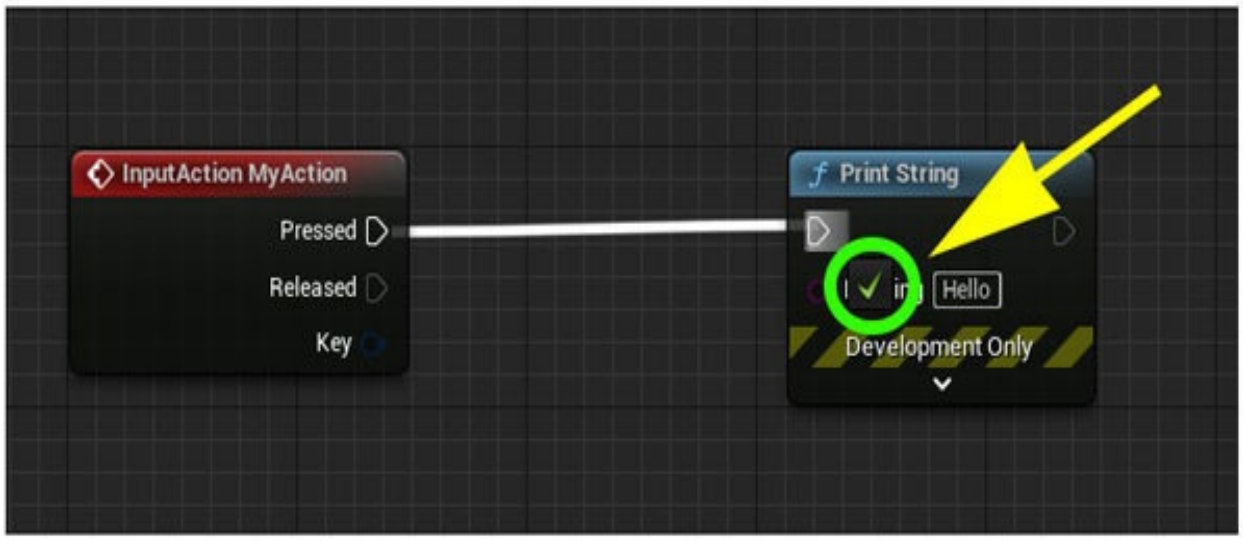

ThirdPersonExampleMap
ThirdPersonCharacter
Compile
Save
Browse
Find
Hide Unrelated
Class Settings
Class Defaults
Simulation
Play
No debug object selected
Components
Viewport
Construction Script
Event Graph
Details
ADD
ThirdPersonCharacter > Event Graph
right click
type "Print"
All Actions for this Blueprint
Context Sensitive
print
InputAction MyAction
Pressed
Released
Key
String
Print String
Struct
select "Print String"
My Blueprint
GRAPHS
EventGraph
FUNC
ConstructionScript
MACROS
VARIABLES
My Character
EVENT DISPATCHER
BLUEPRINT
Compiler Results
Content Drawer
Cmd
Source Control Off

Figure 5.14: Right-click in an empty space and then type "print" and select "Print String"

Now we need to make an execution line between these two blocks. Select Input Action My Action and then click on and drag (don't release mouse button) the small triangle in front of Pressed; immediately, the engine will draw a white curvy line from that triangle to the location of the mouse pointer. Now, move the mouse over the right triangle in Print String (without releasing the mouse button). When a small green tick shape appears, release the mouse button, and the white line will automatically connect these two blocks. After this, click on and change Hello in the In String text area to The key is Pressed, as shown Figure 5.15. You already made your first blueprint code! Run the game and press key 0. You will see The key is Pressed message on the screen:


drag
Place a new node.
InputAction MyAction
Pressed
Released
Key
In String
Hello
Development Only
click


InputAction MyAction
Pressed
Released
Key
Print String
Hello
Development Only

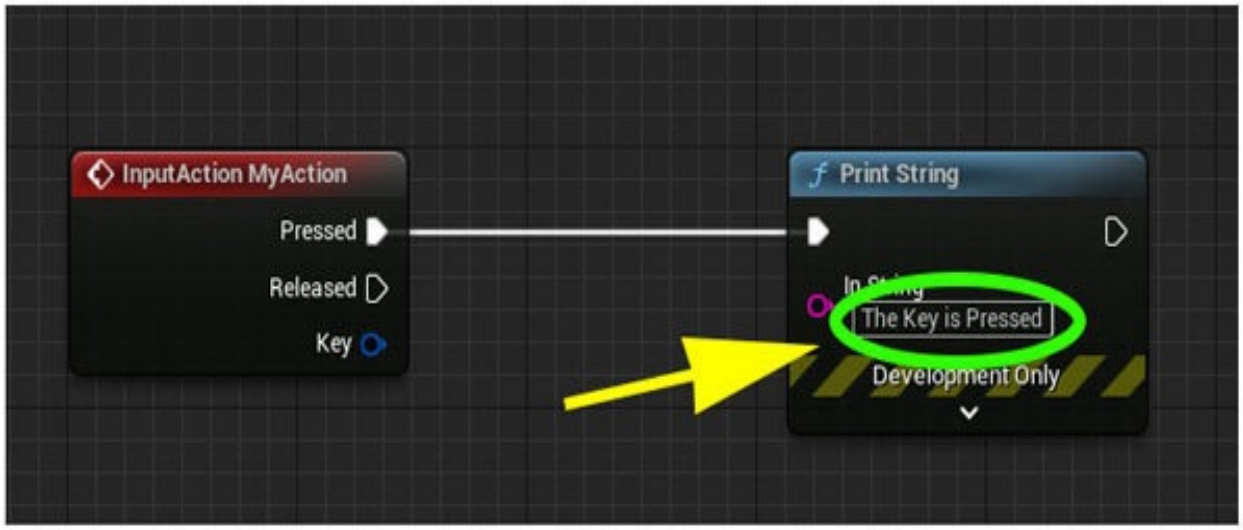

InputAction MyAction
Pressed
Released
Key
Print String
The Key is Pressed
Development Only

Figure 5.15: Click on the small triangle that has the "Pressed" title and drag a white curvy line from it; then, without releasing mouse, move it over the "left" triangle of Print String block. Then release the mouse, and block will get automatically connected by one white line. Then in the text box of Print String, type a message. When you run the game and press key 0, the message will be printed on the screen by engine.

The white curvy line is known as execution line; it executes each blueprint block from left to right when you run the game. To understand this order, add two more print string blocks and connect them to the previous block, as shown in Figure 5.16, and run the game. User can select any one or a group of blueprint blocks and copy/paste them by using the keyboard, or they can right-click and type Print and select Print String, as we did earlier:

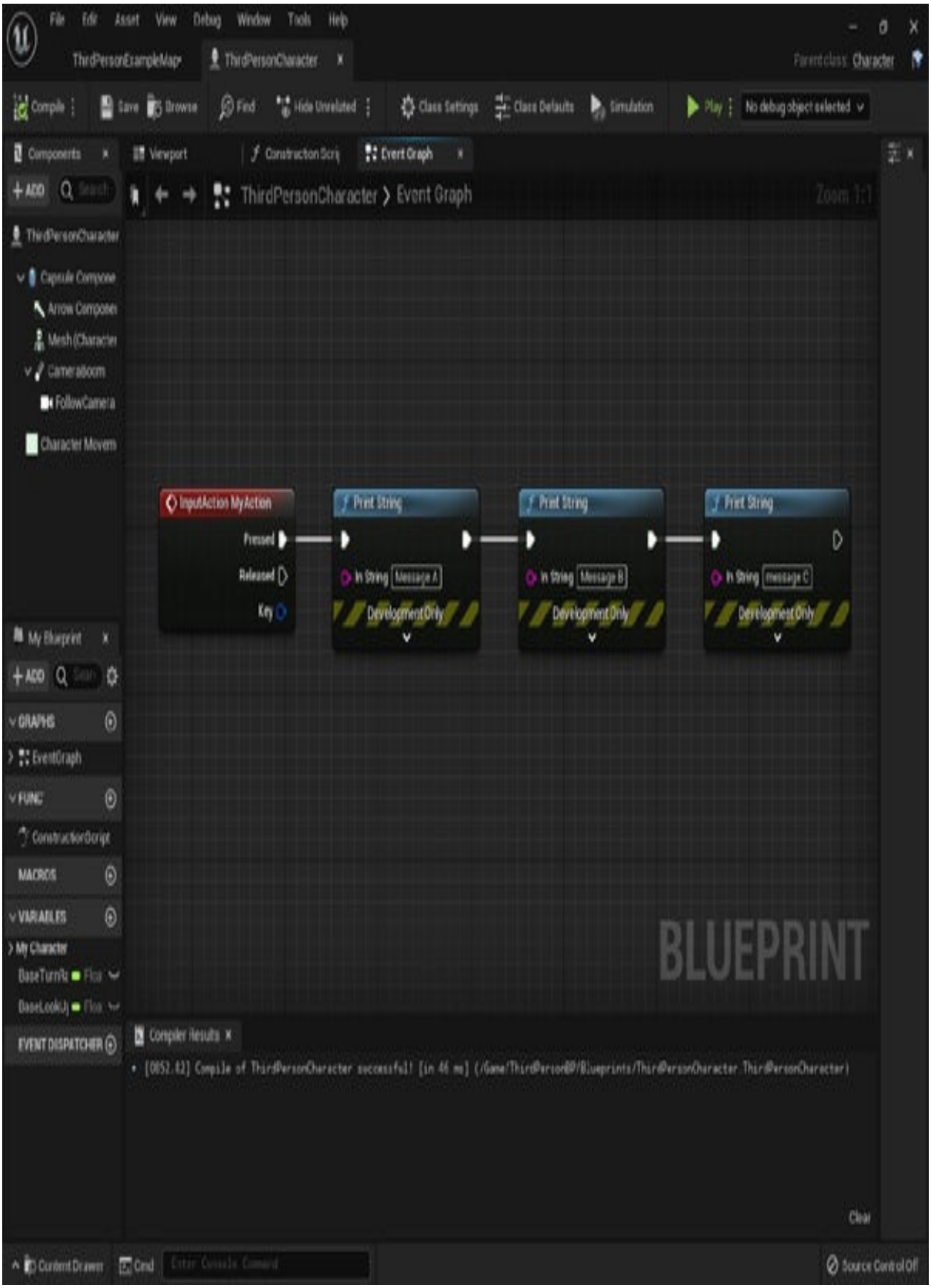

File Edit Asset View Debug Window Tools Help
ThirdPersonExampleMap
ThirdPersonCharacter
Parent class: Character
Compile
Save
Browse
Find
Hide Unrelated
Class Settings
Class Defaults
Simulation
Play
No debug object selected
Components
Viewport
Construction Scrip
Event Graph
ThirdPersonCharacter > Event Graph
Zoom 1:1
ThirdPersonCharacter
Capsule Compone
Arrow Componen
Mesh (Character
Cameraboom
FollowCamera
Character Movem
InputAction MyAction
Pressed
Released
Key
Print String
In String
Message A
Message B
message C
Development Only
My Blueprint
GRAPHS
EventGraph
FUNC
ConstructionScript
MACROS
VARIABLES
My Character
BaseTurnRa
BaseLookUp
EVENT DISPATCHER
BLUEPRINT
Compiler Results
[0852.02] Compile of ThirdPersonCharacter successful! [in 46 ms] (/Game/ThirdPersonBP/Blueprints/ThirdPersonCharacter.ThirdPersonCharacter)
Clear
Content Drawer
Cmd
Enter Console Command
Source Control Off

Figure 5.16: Add two more Print String blueprint blocks with different message

As per the order of the three messages shown in Figure 5.17, the execution line run prints blocks from Left to Right, so Message A, then Message B, and finally, message C get printed on the screen:

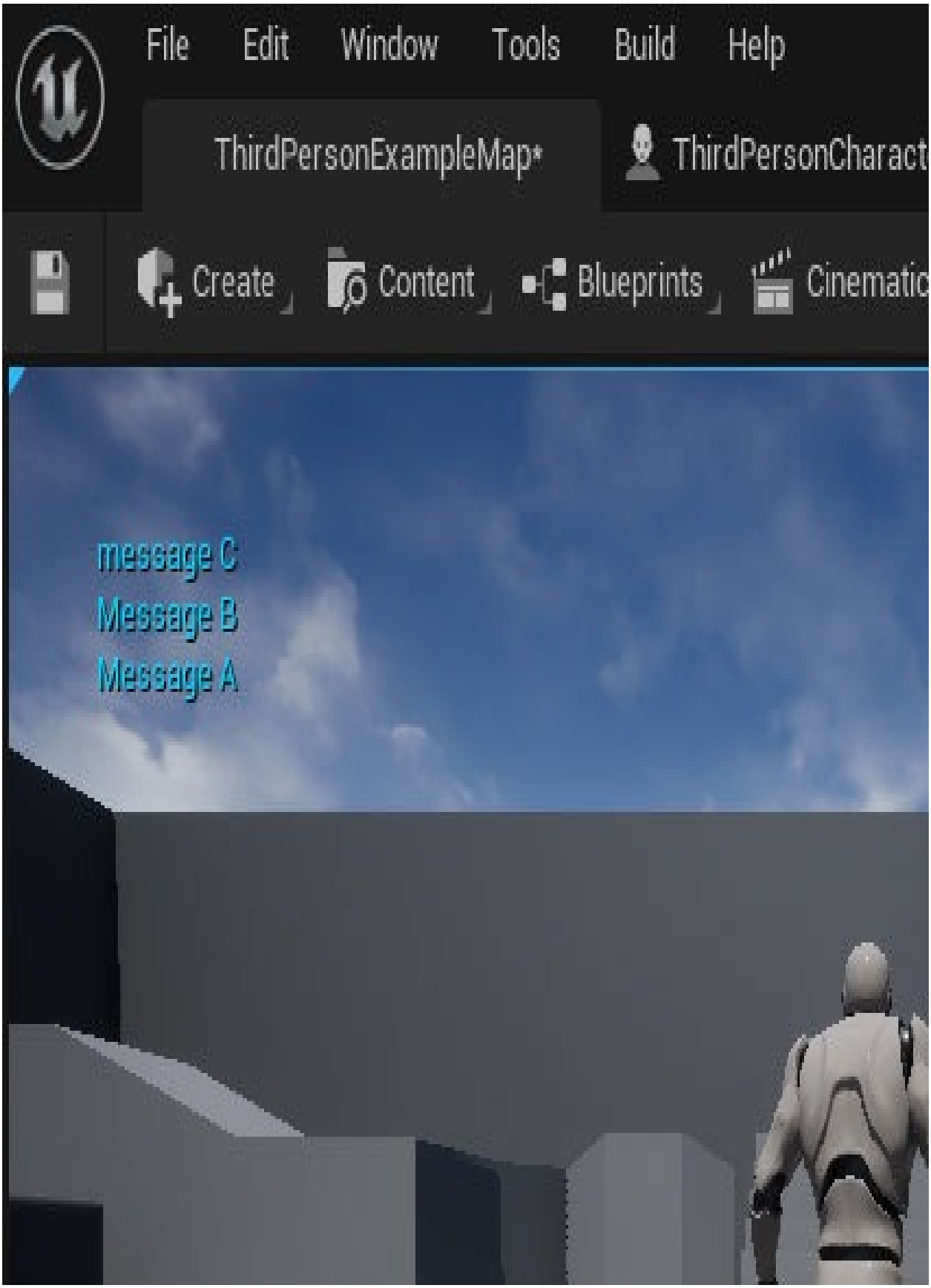

File
Edit
Window
Tools
Build
Help
ThirdPersonExampleMap*
ThirdPersonCharact
Create
Content
Blueprints
Cinematic
message C
Message B
Message A

Figure 5.17: Messages print in order after running the game

Now, let’s use another blueprint block known as Delay and check the execution order again. Right-click on Event Graph, type Delay, and then select the Delay command from blueprint list, as shown in Figure 5.18:

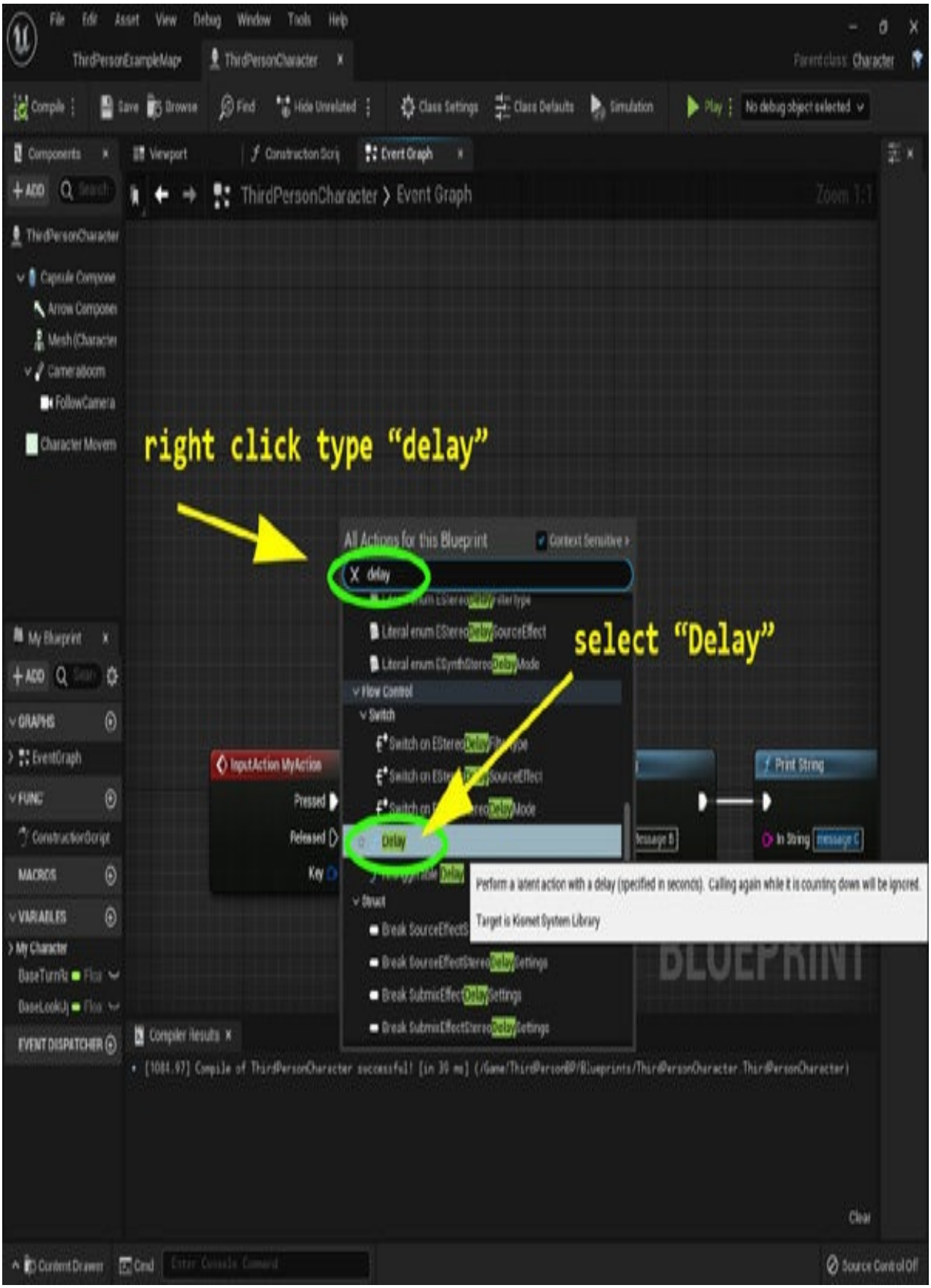

ThirdPersonExampleMap
ThirdPersonCharacter
Parent class: Character
Compile
Save
Browse
Find
Hide Unrelated
Class Settings
Class Defaults
Simulation
Play
No debug object selected
Components
Viewport
Construction Script
Event Graph
ThirdPersonCharacter > Event Graph
Zoom 1:1
ThirdPersonCharacter
Capsule Component
Arrow Component
Mesh (Character)
CameraBoom
FollowCamera
Character Movem
right click type "delay"
All Actions for this Blueprint
Context Sensitive
delay
Literal enum EStereoDelayFilterType
Literal enum EStereoDelaySourceEffect
Literal enum ESynthStereoDelayMode
select "Delay"
Flow Control
Switch
Switch on EStereoDelayFilterType
Switch on EStereoDelaySourceEffect
Switch on EStereoDelayMode
Delay
Struct
Break SourceEffectS
Break SourceEffectStereoDelaySettings
Break SubmixEffectDelaySettings
Break SubmixEffectStereoDelaySettings
InputAction MyAction
Pressed
Released
Key
Print String
In String
message C
Perform a latent action with a delay (specified in seconds). Calling again while it is counting down will be ignored.
Target is Kismet System Library
My Blueprint
GRAPHS
EventGraph
FUNC
ConstructionScript
MACROS
VARIABLES
My Character
EVENT DISPATCHER
Compiler Results
Clear
Content Drawer
Cmd
Source Control Off

Figure 5.18: Right-click in an empty space, type "delay", then select Delay command from the list

On the Delay block, locate Duration and change it to 2; add it between Message A and Message B by attaching execution line from the Print String blocks to the Delay block (simply click and drag execution line from each of print string blocks and attach them to delay). Now add another delay between Message B and message C with Duration equal to 3, as shown in Figure 5.19:

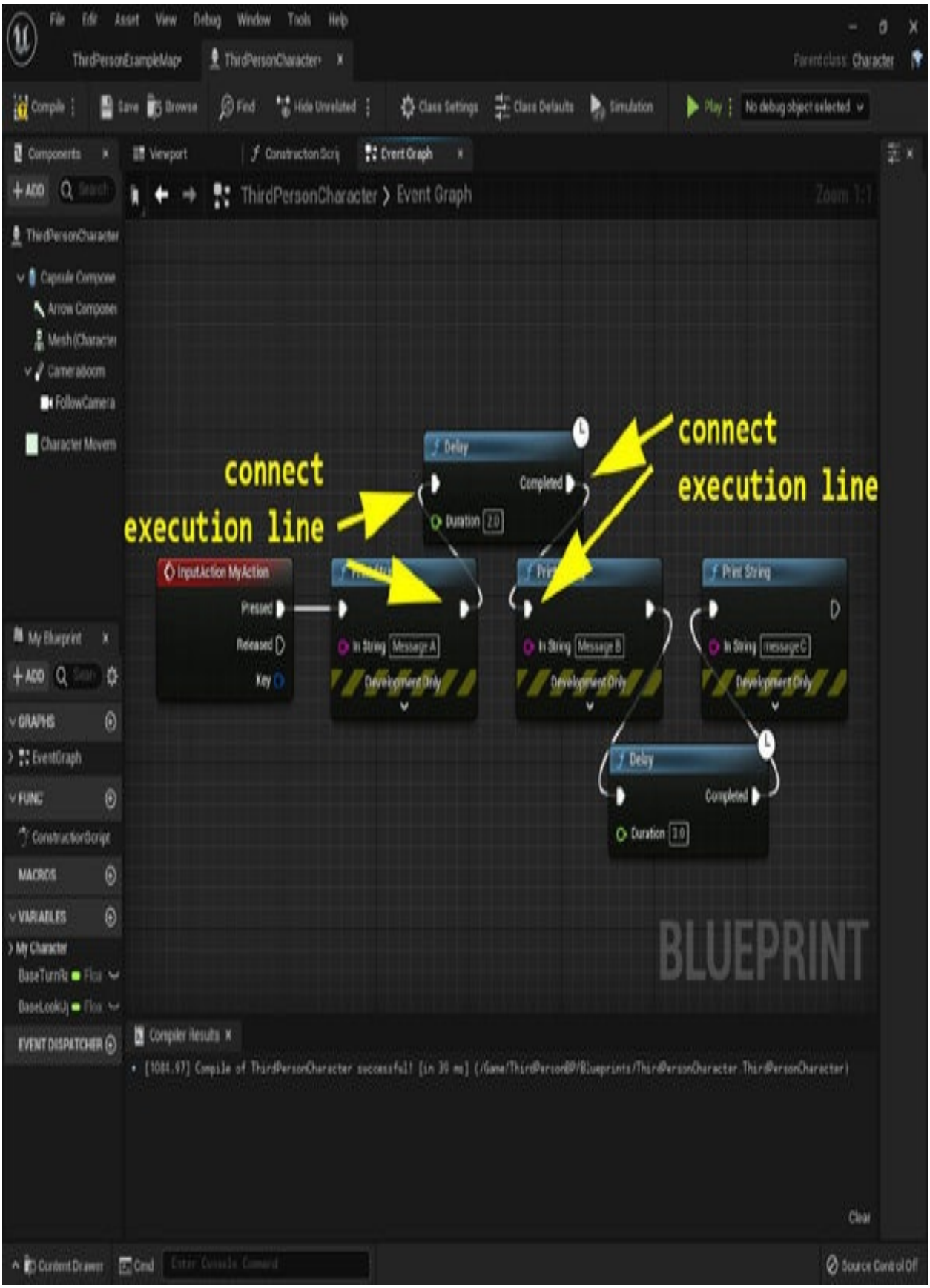

connect
execution line
connect
execution line
Delay
Completed
Duration 2.0
InputAction MyAction
Pressed
Released
Key
In String Message A
In String Message B
In String message C
Print String
Delay
Completed
Duration 3.0
BLUEPRINT

Figure 5.19: After selecting Delay from list, engine will add A Delay block to event graph. Drag and Drop execution lines between previous and next blocks of print string

When you run this code, the engine follows execution line from left to right; first, it runs the first print message, then the delay after it, which leads to a 2-second pause, and then it runs the next print message, followed by the Delay after it, which is 3 seconds. Finally, it runs the last print string block.

This is how you develop code in blueprint. Developers can add different blueprint blocks from the blueprint list and receive different results after running the code; we will cover this in further detail in the later chapters. If you are familiar with coding in a programming language like C++, Python, or JavaScript, you just need to understand two simple rules in blueprint programming: each blueprint block (like Delay and Print String, which we used) is like A Function, and as you already experienced, the compiler Run each line of code in traditional programming, After each other. In blueprint programming, the execution line (white curvy line) is Running each block of blueprint After each other from Left to Right. So, by using these two simple rules on your logic, you can easily adapt and use blueprint programming in Unreal Engine 5 for developing game and applications.

Simple collision detection

Collision detection is one the most important topics in game development. When (at least) two game objects collide with each other, then there is a game event, called Collision. There are methods and functions inside the engine to help developers to detect it. We touch and learn the simplest way to detect collision in this part to expand basic knowledge on blueprint programming.

Follow the given steps to do so:

Refer to Chapter 4: Using Blueprints, make an Actor blueprint, and call it BP_Item_01.

From the blueprint component list, add Box Collision to actor and untick the Hidden in Game properties from the Details panel located in the REBDERING section for it.

Add a Cone static mesh and change its scale to (.5,.5,.5). The result should look like Figure 5.20:

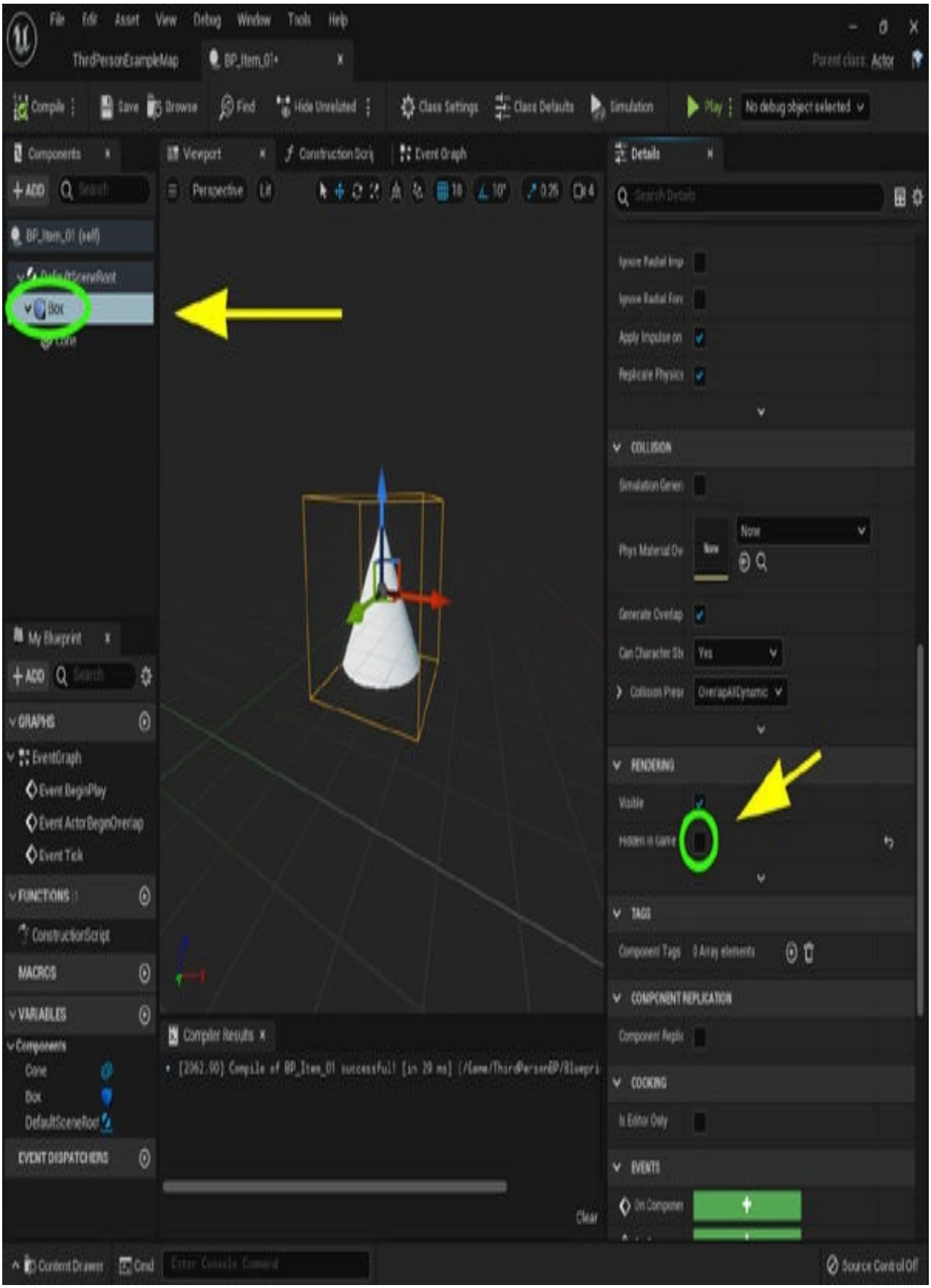

File Edit Asset View Debug Window Tools Help
ThirdPersonExampleMap
BP_Item_01
Parent class: Actor
Compile
Save
Browse
Find
Hide Unrelated
Class Settings
Class Defaults
Simulation
Play
No debug object selected
Components
Viewport
Construction Script
Event Graph
Details
Perspective
Lit
BP_Item_01 (self)
DefaultSceneRoot
Box
Cone
Ignore Radial Imp
Ignore Radial Forc
Apply Impulse on
Replicate Physics
COLLISION
Simulation Gener
Phys Material Ov
None
Generate Overlap
Can Character Ste
Yes
Collision Presi
OverlapAllDynamic
RENDERING
Visible
Hidden in Game
TAGS
Component Tags
0 Array elements
COMPONENT REPLICATION
Component Replic
COOKING
Is Editor Only
EVENTS
On Componen
My Blueprint
GRAPHS
EventGraph
Event BeginPlay
Event ActorBeginOverlap
Event Tick
FUNCTIONS
ConstructionScript
MACROS
VARIABLES
Components
Cone
Box
DefaultSceneRoot
EVENT DISPATCHERS
Compiler Results
[2062.90] Compile of BP_Item_01 successful! [in 20 ms]
Clear
Content Drawer
Cmd
Enter Console Command
Source Control Off

Figure 5.20: Actor with Box Collision and Cone static mesh. The Box Collision is visible when player play the game

Switch to Event Graph, click on the Box Collision component, and then locate EVENTS drop-down list. In this list, the engine already provides some blueprint events for developers to use, so click on the plus (+) button for event known as On Component Begin Overlap, as shown in Figure 5.21:

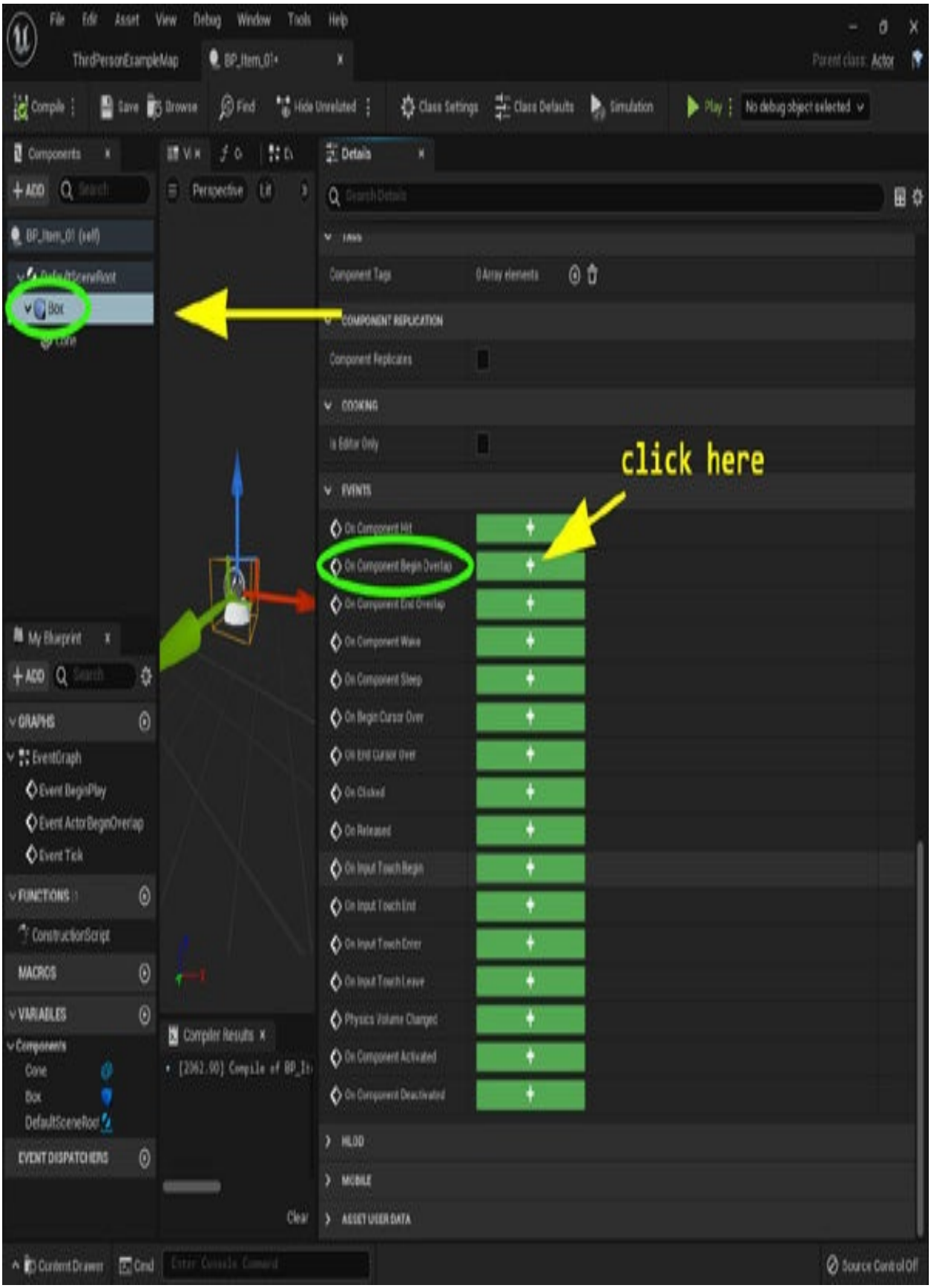

click here
Components
Details
Box
Component Tags
COMPONENT REPLICATION
Component Replicates
COOKING
Is Editor Only
EVENTS
On Component Hit
On Component Begin Overlap
On Component End Overlap
On Component Wake
On Component Sleep
On Begin Cursor Over
On End Cursor Over
On Clicked
On Released
On Input Touch Begin
On Input Touch End
On Input Touch Enter
On Input Touch Leave
On Component Activated
On Component Deactivated
HLOD
MOBILE
ASSET USER DATA
My Blueprint
GRAPHS
EventGraph
Event BeginPlay
Event ActorBeginOverlap
Event Tick
FUNCTIONS
ConstructionScript
MACROS
VARIABLES
Components
Cone
Box
DefaultSceneRoot
EVENT DISPATCHERS
Compiler Results

Figure 5.21: Select Box Collision and locate "On Component Being Overlap" event from event list

After you click on the plus button, the engine automatically navigates to Event Graph and adds a new event for you, as shown in Figure 5.22; this is just like what we made before for detect key 0 in keyboard. This event will get fired when the Box Collision component collides with another game object. Let's practice this by printing some messages, as we did for keyboard before:

On Component Begin Overlap (Box)
Overlapped Component
Other Actor
Other Comp
Other Body Index
From Sweep
Sweep Result

Figure 5.22: Default collision detection blueprint event for Box Collision component

Add the Sphere Collision component and the Capsule Collision component to your actor and untick the Hidden in Game option for all in RENDERING, as shown in Figure 5.23:

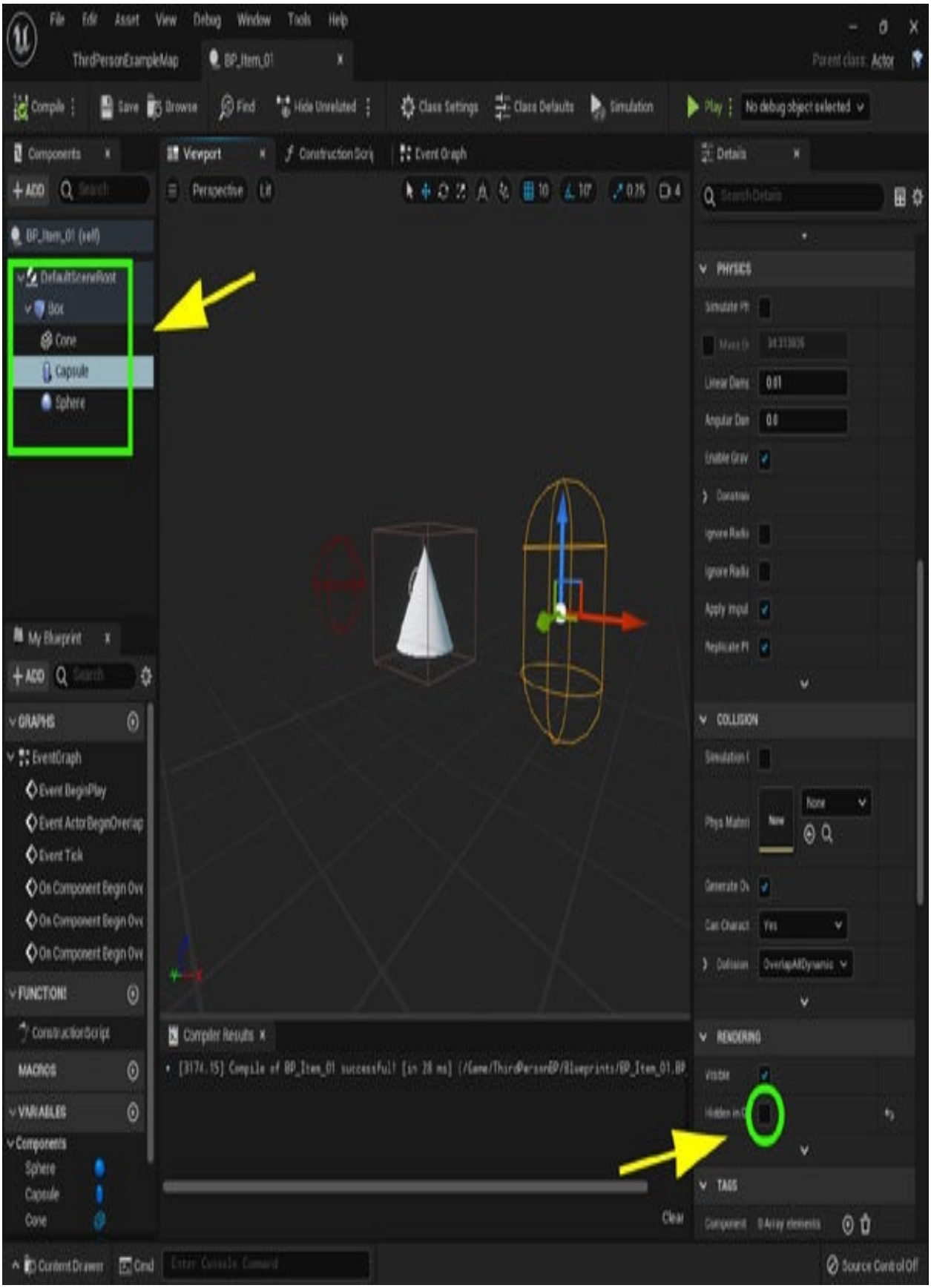

File Edit Asset View Debug Window Tools Help
ThirdPersonExampleMap
BP_Item_01
Parent class: Actor
Compile
Save
Browse
Find
Hide Unrelated
Class Settings
Class Defaults
Simulation
Play
No debug object selected
Components
Viewport
Construction Script
Event Graph
Details
Perspective
Lit
BP_Item_01 (self)
DefaultSceneRoot
Box
Cone
Capsule
Sphere
PHYSICS
COLLISION
RENDERING
TAGS
My Blueprint
GRAPHS
EventGraph
Event BeginPlay
Event ActorBeginOverlap
Event Tick
FUNCTIONS
ConstructionScript
MACROS
VARIABLES
Components
Sphere
Capsule
Cone
Compiler Results
Clear
Content Drawer
Cmd
Source Control Off

Figure 5.23: Box, Capsule and Sphere collision components which are visible in game

Now make collision events for new components, as we did for Box Collision component, and add the Print String command to each of them for showing a message when they collide, as shown in Figure 5.24:

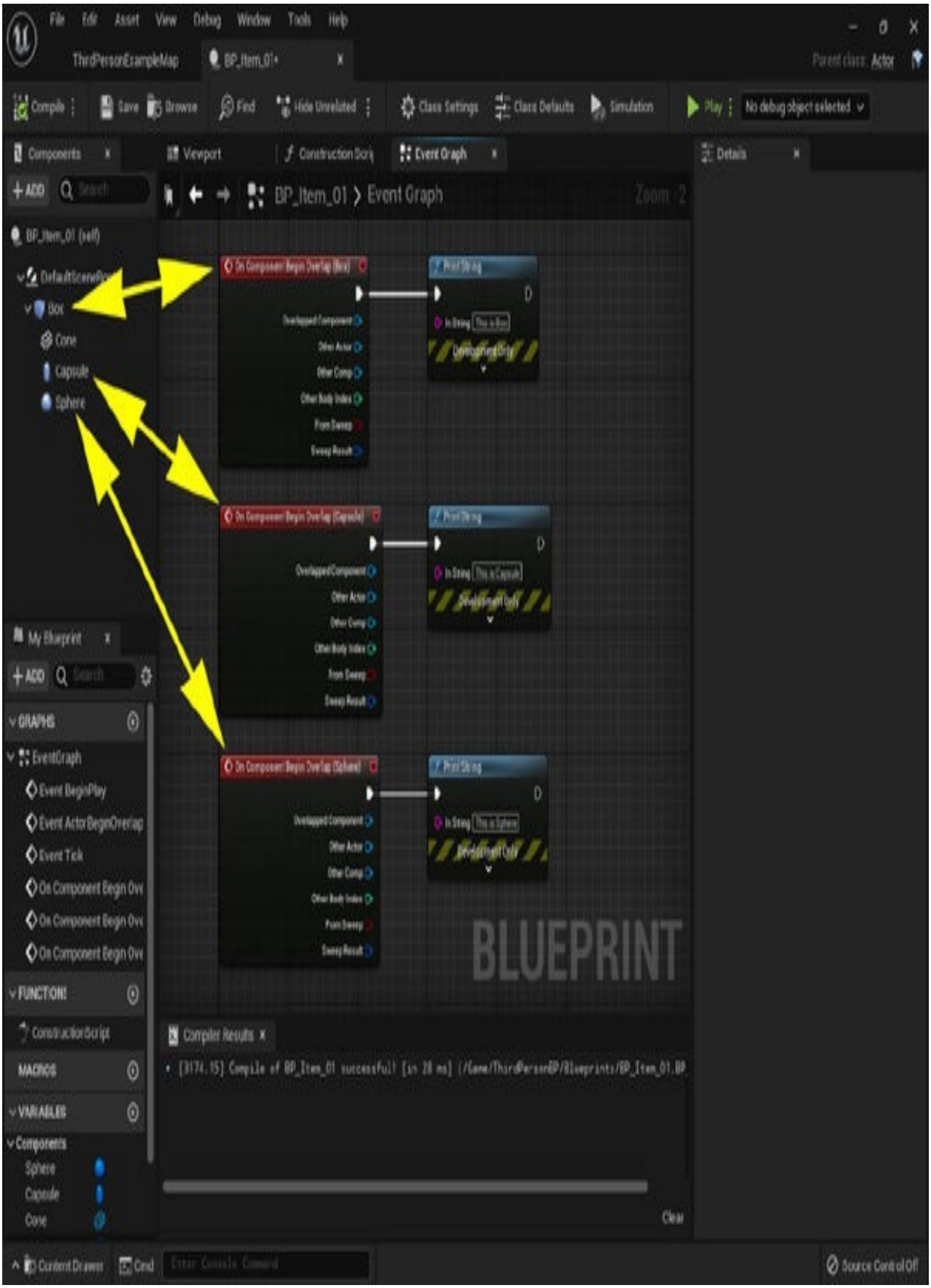

File Edit Asset View Debug Window Tools Help
ThirdPersonExampleMap
BP_Item_01*
Parent class: Actor
Compile
Save
Browse
Find
Hide Unrelated
Class Settings
Class Defaults
Simulation
Play
No debug object selected
Components
Viewport
Construction Script
Event Graph
Details
BP_Item_01 > Event Graph
Zoom -2
BP_Item_01 (self)
DefaultSceneRoot
Box
Cone
Capsule
Sphere
On Component Begin Overlap (Box)
On Component Begin Overlap (Capsule)
On Component Begin Overlap (Sphere)
Overlapped Component
Other Actor
Other Comp
Other Body Index
From Sweep
Sweep Result
Print String
In String
This is Box
This is Capsule
This is Sphere
BLUEPRINT
My Blueprint
GRAPHS
EventGraph
Event BeginPlay
Event ActorBeginOverlap
Event Tick
FUNCTIONS
ConstructionScript
MACROS
VARIABLES
Components
Sphere
Capsule
Cone
Compiler Results
[3174.15] Compile of BP_Item_01 successful! [in 28 ms]
Clear
Content Drawer
Cmd
Enter Console Command
Source Control Off

Figure 5.24: Add Print String to each collision event

As you can see in Figure 5.25, after the game is running, each time the Third Person character gets into box, sphere, and capsule collision component, the engine will print out the message you developed:

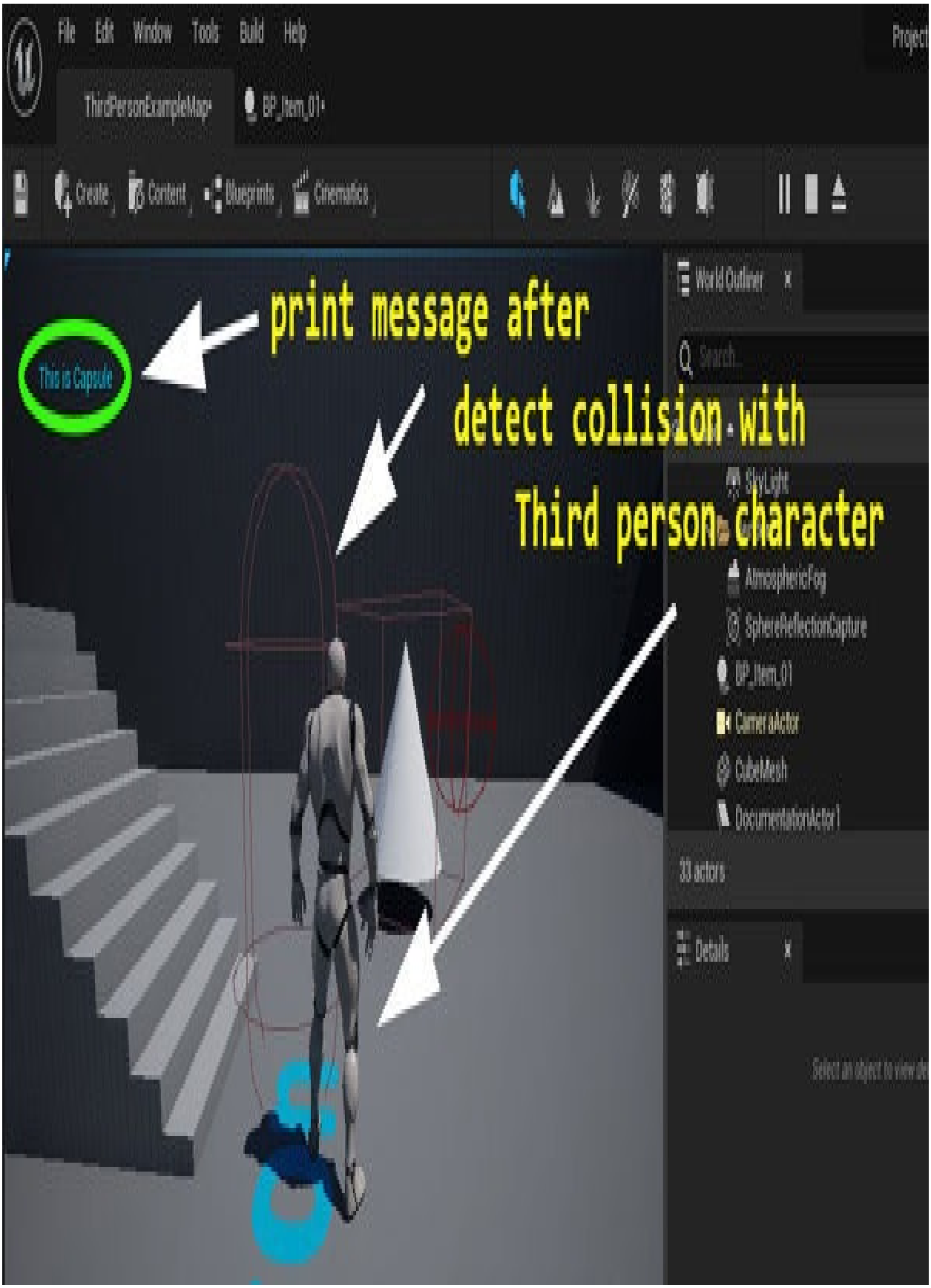

File Edit Window Tools Build Help
ThirdPersonExampleMap*
BP_Item_01*
Create
Content
Blueprints
Cinematics
World Outliner
Search...
SkyLight
AtmosphericFog
SphereReflectionCapture
BP_Item_01
CameraActor
CubeMesh
DocumentationActor1
33 actors
Details
This is Capsule
print message after
detect collision with
Third person character

Figure 5.25: Each collision component gets active after colliding with third person character

Making simple game assets

Now, let’s make a simple game asset from the blueprint actor we already have, which works with collision events. Refer to the previous chapter, replace Cone with a Cube static mesh component, and resize it to (2.75, 0.25, 0.25); then, add the Rotating Movement component to your actor, as shown in Figure 5.26:

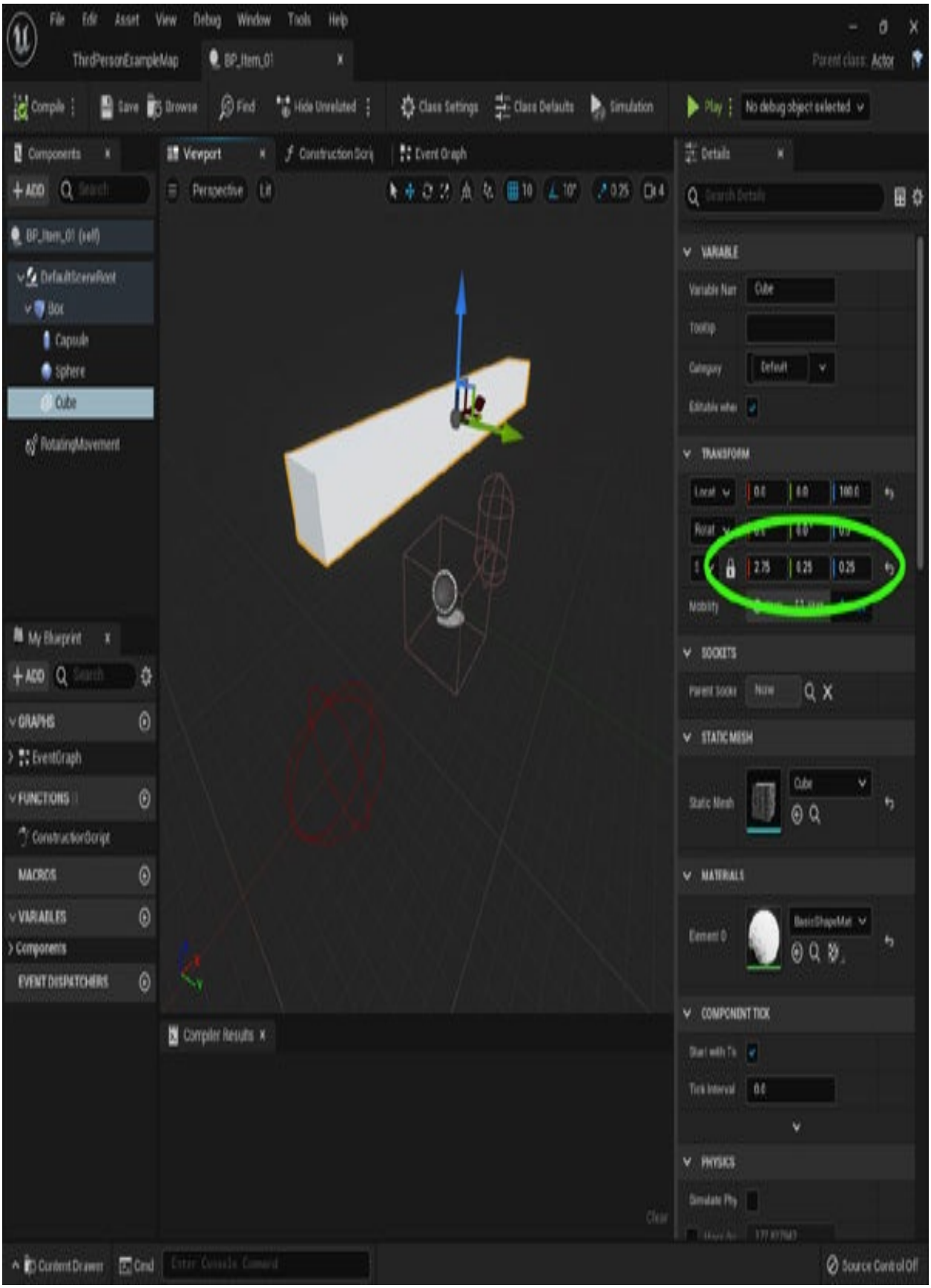

File
Edit
Asset
View
Debug
Window
Tools
Help
ThirdPersonExampleMap
BP_Item_01
Parent class: Actor
Compile
Save
Browse
Find
Hide Unrelated
Class Settings
Class Defaults
Simulation
Play
No debug object selected
Components
Viewport
Construction Script
Event Graph
Details
Perspective
Lit
BP_Item_01 (self)
DefaultSceneRoot
Box
Capsule
Sphere
Cube
RotatingMovement
VARIABLE
Variable Name
Cube
Tooltip
Category
Default
Editable when
TRANSFORM
Local
Mobility
SOCKETS
Parent Socket
None
STATIC MESH
Static Mesh
Cube
MATERIALS
Element 0
BasicShapeMat
COMPONENT TICK
Start with Tick
Tick Interval
0.0
PHYSICS
Simulate Physics
My Blueprint
GRAPHS
EventGraph
FUNCTIONS
ConstructionScript
MACROS
VARIABLES
Components
EVENT DISPATCHERS
Compiler Results
Clear
Content Drawer
Cmd
Enter Console Command
Source Control Off

Figure 5.26: Add Cube static mesh and Rotating Movement component

If you run the game now, all components begin to rotate together, which is not what we would like to happen. Navigate to event graph and locate Event Begin Play; then, drag and drop one instance form Cube and Rotation Movement components close to it. Then, click on the Rotation Movement blue pin on the right side of its block and drag the mouse and release. Engine straightaway shows a list of compatible blueprint blocks for this component. Type Set Updated Component and select the Blueprint block that matches the title, as shown in Figure 5.27:

Debug Window Tools Help
BP_Item_01*
Find
Hide Unrelated
Class Settings
Class Defaults
Simulation
Construction Scrip
Event Graph
BP_Item_01 > Event Graph
Zoom 1:1
click, drag and
then release the mouse
Event BeginPlay
Rotating Movement
Cube
Actions taking a(n) Rotating Movement Component Object Reference
setupdate
Components
Set Updated Component
Variables
Event ActorBeginOverlap
Other Actor
Then type the blueprint function
name and choose

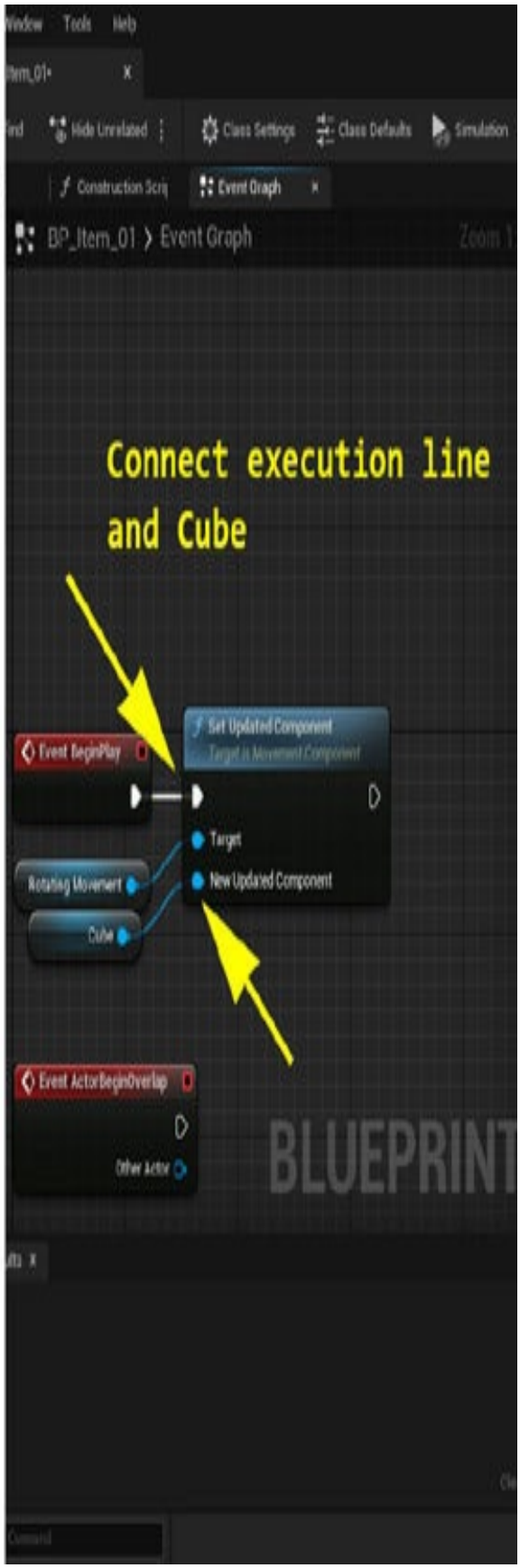

Tools Help
Hide Unrelated
Class Settings
Class Defaults
Simulation
Construction Scrip
Event Graph
BP_Item_01 > Event Graph
Connect execution line
and Cube
Event BeginPlay
Set Updated Component
Target is Movement Component
Target
New Updated Component
Rotating Movement
Cube
Event ActorBeginOverlap
Other Actor
BLUEPRINT

Figure 5.27: Add Set Update Component blueprint block to the code to assign Cube as target of rotation

The engine will show a new blueprint block that accepts execution lines (like print string and delay), and the Rotating Movement Component is connected to its Target pin. The Target pin represents the reference of the blueprint block that the code needs to be activated for; here, it is Rotating Movement Component. Now, connect the cube to the New Updated Component pin; this way, you assign the static mesh component that you like to rotate only. Now, connect this block with the execution line to Begin Play event, as shown in Figure 5.27. We will talk more about the Begin Play event in the next chapter, but in short, this event gets run (called) exactly after the beginning of the game. So, when you run the game, you ask Rotating Movement Component to assign only the Cube static mesh component for rotation at the beginning of game and then game is running, which happens after you run the code.

Now, locate collision events that you already made for the Capsule and Sphere collision components, and drag another instance of Rotation Movement in front of Capsule collision, where the Print String ends. Then, click and drag a blue curvy line form Rotation Movement and release the mouse button; the engine will automatically open a drop-down list with the blueprint command, and then type Deactivate and locate the Deactivate blueprint command in the list shown in Figure 5.28:

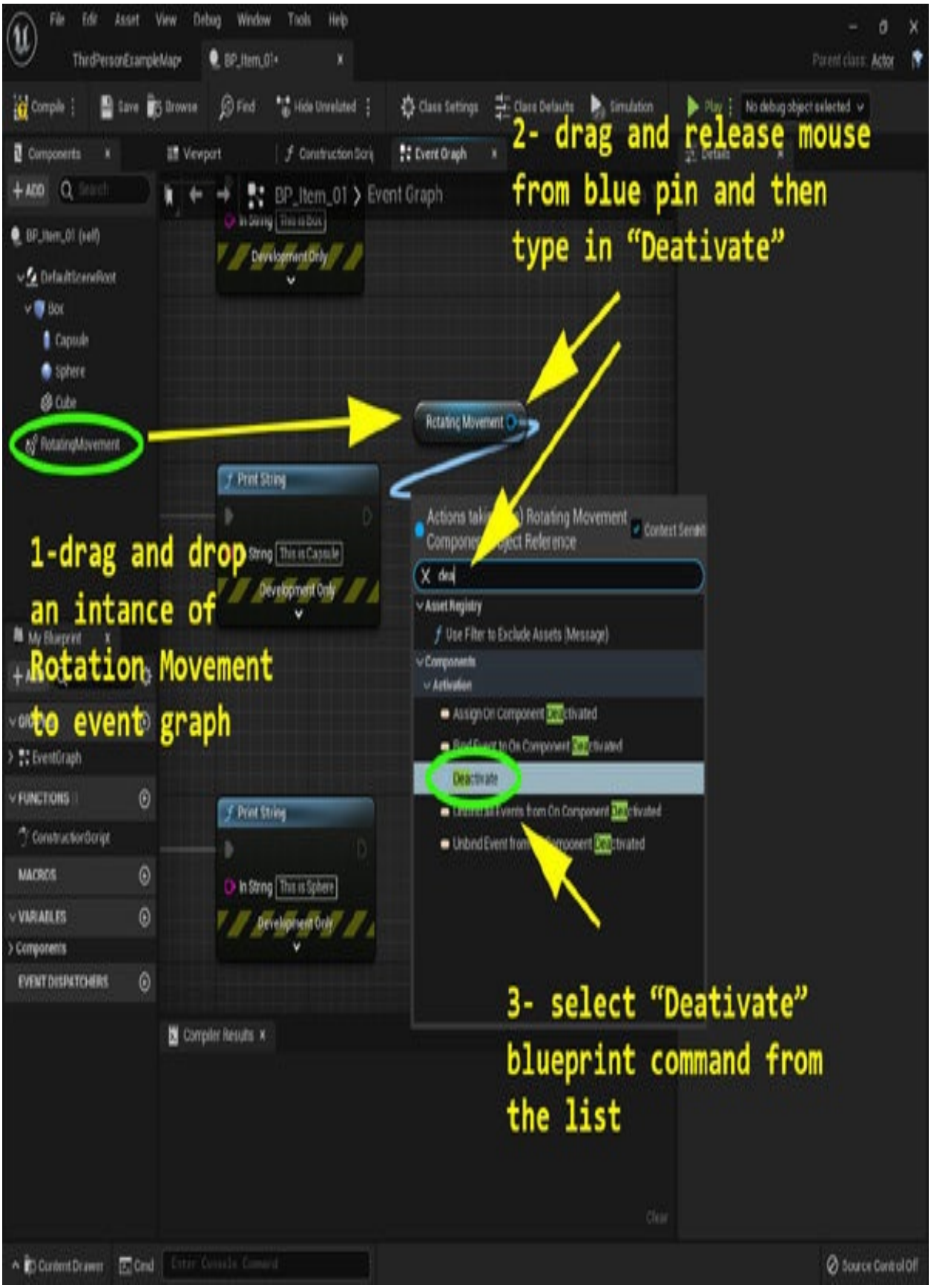

2- drag and release mouse from blue pin and then type in "Deativate"
1-drag and drop an intance of Rotation Movement to event graph
3- select "Deativate" blueprint command from the list
BP_Item_01 > Event Graph
Rotating Movement
Print String
Deactivate

Figure 5.28: Locate "Deactivate" blueprint command for Rotation Movement component

After you click on Deactivate, engine automatically adds Deactivate blueprint block to event graph. Now, connect the execution line from print string to this block, as shown in Figure 5.29:

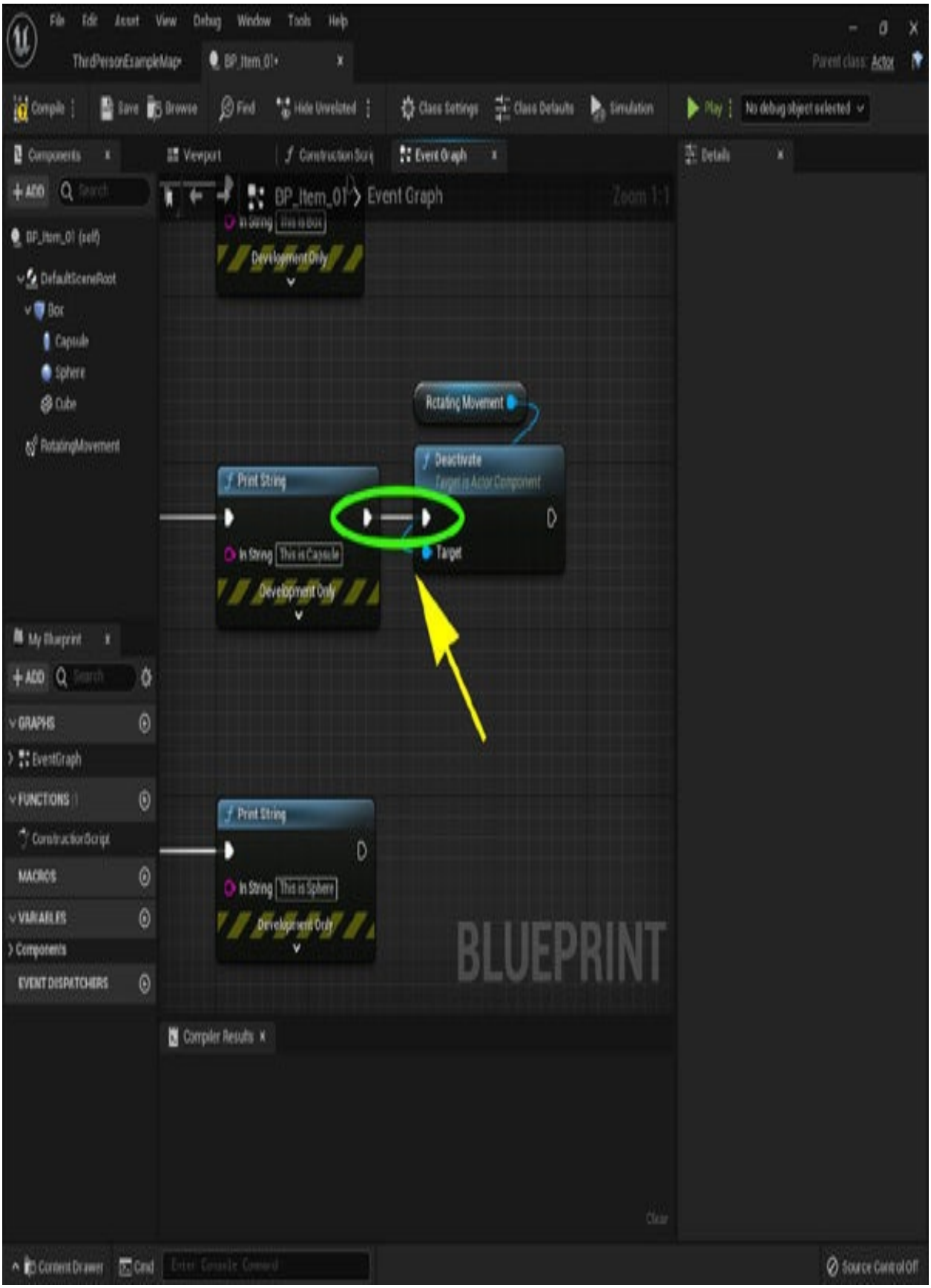

File Edit Asset View Debug Window Tools Help
ThirdPersonExampleMap
BP_Item_01
Parent class: Actor
Compile
Save
Browse
Find
Hide Unrelated
Class Settings
Class Defaults
Simulation
Play
No debug object selected
Components
Viewport
Construction Script
Event Graph
Details
BP_Item_01 > Event Graph
Zoom 1:1
BP_Item_01 (self)
DefaultSceneRoot
Box
Capsule
Sphere
Cube
RotatingMovement
Rotating Movement
Deactivate
Target is Actor Component
Target
Print String
In String
This is Capsule
Development Only
This is Box
This is Sphere
My Blueprint
ADD
GRAPHS
EventGraph
FUNCTIONS
ConstructionScript
MACROS
VARIABLES
Components
EVENT DISPATCHERS
BLUEPRINT
Compiler Results
Clear
Content Drawer
Cmd
Enter Console Command
Source Control Off

Figure 5.29: Connect "Deactivate" blueprint command for Rotation Movement component to the end of Capsule collision blueprint code

When you run the game, on each collision with the Capsule collision component, the rotation movement gets deactivated by this code. Press Esc and add Activate blueprint code to the Rotation Movement component by following the same method (drag line from blueprint pin, release, type the blueprint command in the list, and select it). Then, connect it to the Sphere collision code, as shown in Figure 5.30:

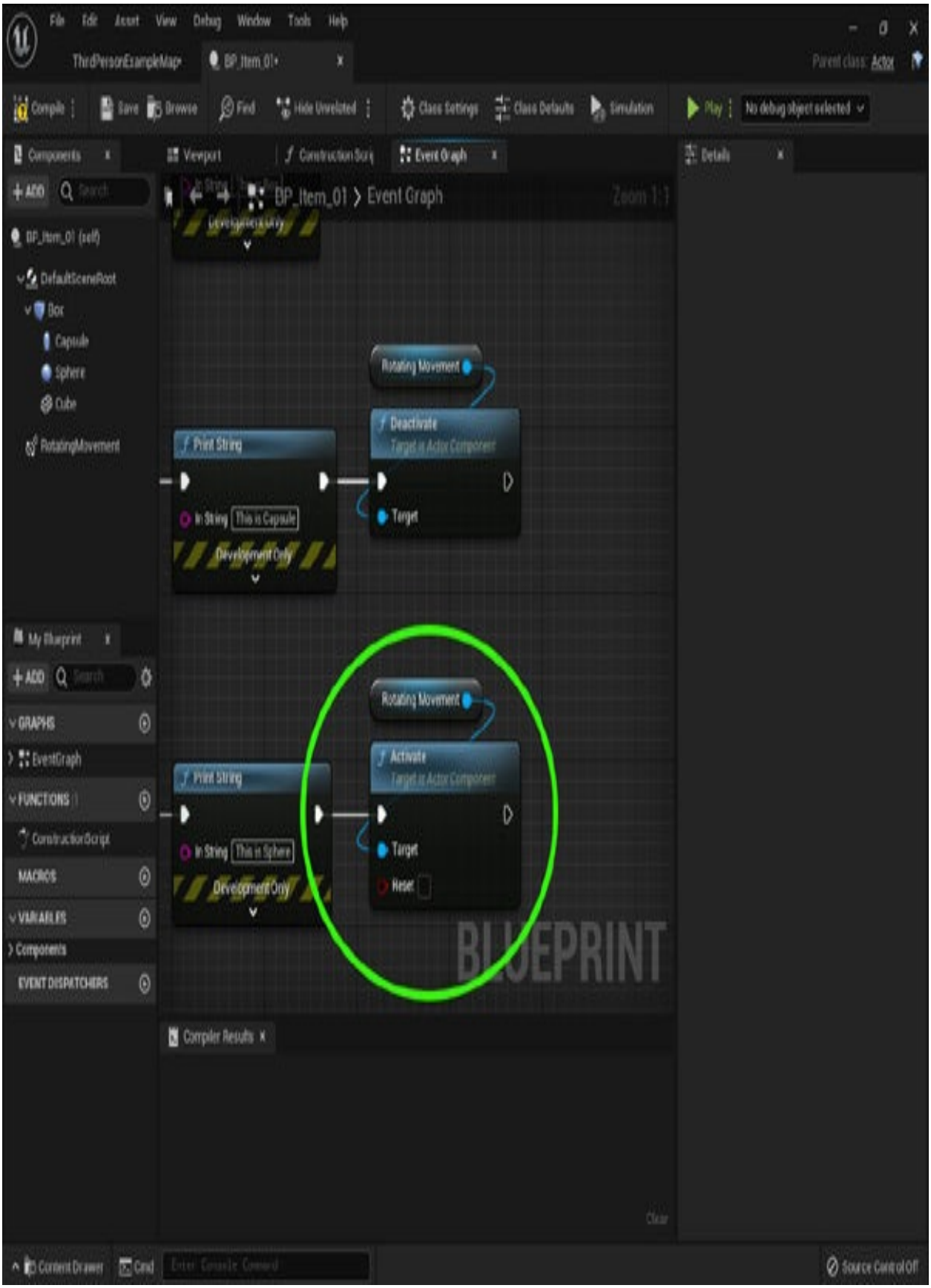

File Edit Asset View Debug Window Tools Help
ThirdPersonExampleMap
BP_Item_01
Parent class: Actor
Compile
Save
Browse
Find
Hide Unrelated
Class Settings
Class Defaults
Simulation
Play
No debug object selected
Components
Viewport
Construction Script
Event Graph
Details
BP_Item_01 > Event Graph
Zoom 1:1
BP_Item_01 (self)
DefaultSceneRoot
Box
Capsule
Sphere
Cube
RotatingMovement
Rotating Movement
Deactivate
Target is Actor Component
Print String
In String
This is Capsule
Development Only
Target
My Blueprint
GRAPHS
EventGraph
FUNCTIONS
ConstructionScript
MACROS
VARIABLES
Components
EVENT DISPATCHERS
Rotating Movement
Activate
Target is Actor Component
Print String
In String
This is Sphere
Development Only
Target
Reset
BLUEPRINT
Compiler Results
Clear
Content Drawer
Cmd
Enter Console Command
Source Control Off

Figure 5.30: Connect "Activate" blueprint command for Rotation Movement component to the end of Sphere collision blueprint code

When the game is running, each time a player collides with Capsule, the rotation will stop, and each time a player collides with Sphere, the rotation begins.

Congratulations! You've designed and developed your first Unreal Engine 5`s blueprint game assets by using two collision components: one static mesh component and one Rotation Movement component in an actor blueprint.

Conclusion

You have made your first Unreal Engine interactive game assets that works based on collision detection. We started from project templates, where a user can choose different types of environments to begin with, and we chose the Third Person template to use over this chapter. Then, we learned where to find target machines and user inputs in engine setting.

We developed our first blueprint code by printing messages on the screen by pressing keyboard buttons during game play, and then we made a blueprint actor with collision events and used these events to print messages. At the end, by using another blueprint component, we developed code for an interactive simple game asset.

This is how you design and develop blueprint actors for game. Each blueprint component has a number of blueprint commands that can mix with others and run by execution line to present game activities. We will dig into more details on how to make more complex objects and learn blueprint programming method, but for now, try to use the First Person project template, and make same game assets that are sensitive to weapon projectile, which already exists in there. All assets are ready to use in this project template, and this practice increased your skills on design and develop blueprint in Unreal Engine 5.

It’s time to practice!

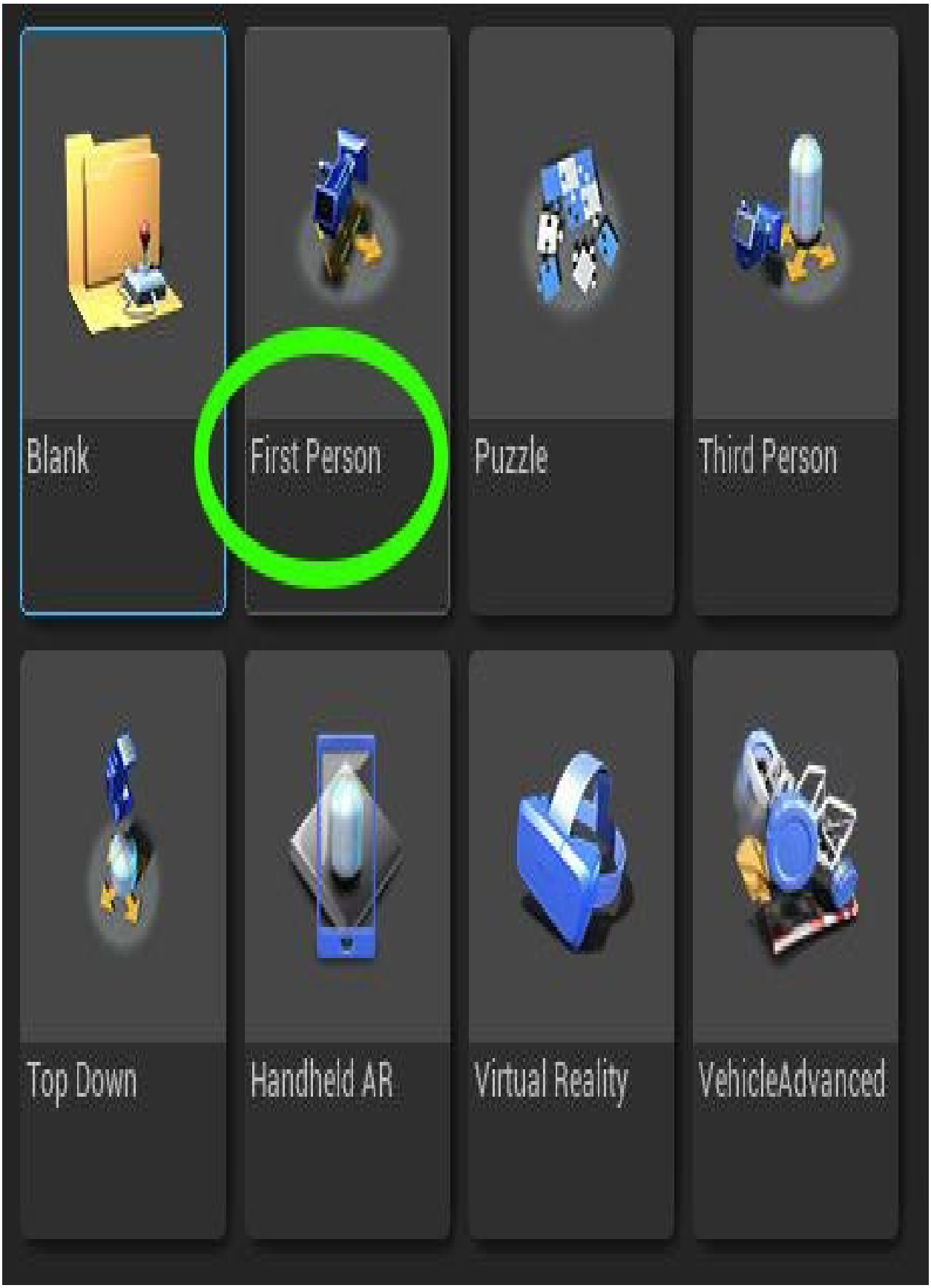

Blank
First Person
Puzzle
Third Person
Top Down
Handheld AR
Virtual Reality
VehicleAdvanced

Figure 5.31: List of "Games" templates in Unreal Engine 5

In the next chapter, we will learn more about game objects and how to add materials to our assets and make more proper assets for our applications.

Points to remember

To change input keys, open Edit | Project Settings and select Input.

The Action Mappings is like Boolean; engine will generate true or false on user interactions. On the other hand, Axis Mappings are making float values, depending on user interactions.

The white blueprint execution line executes blueprints blocks from left to right.

Multiple choice questions

When user moves to a different location by one click, this kind of movement is known as Teleport. What is the best mapping method to simulate teleport action by user?

Action mappings

Both action mappings and axis mappings are required

Axis mappings

Teleport is not available in Unreal Engine

When a collision collider gets triggered, which events are called inside blueprint?

Nothing is set automatically, and users need to create new custom events to support this functionality

Event begin play

Event on component begin & end overlap

Event tick

What is execution line?

The graphical white line that connects execution pin between blueprint node in event graph

A special type of template

An engine internal procedure to detect collision

Located in project setting, it defines the input values by user interface

Answers

a

c

a

Questions

How can you swap mouse axis from project setting?

How can you swap mouse axis by blueprint code?

Which blueprint component can play sound, and can you switch it on and off with blueprint code?

Third person character blueprint has an inherited blueprint component known as Character Movement, which has a number of functions and properties involved with the player character on the scene. How can the user change player speed from walk to run by pressing and holding the Shift button on the keyboard?

Key terms

Blueprint Block – Visual presentation of each blueprint function inside blueprint editor at Event Graph panel.

Input Setting – The engine input setting located in Project Setting.

Project Setting – An editor windows which shows most of the settings related to application and game engine.

Blueprint Command – A blueprint block which performs a procedure in the application.

Action Mapping – Design and address keys, on an input device like keyboard or controller, and so on, in order to interact with application with "press" and "release" methods.

Axis Mapping - Design and address keys, on an input device like keyboard or controller, and so on, in order to interact with application based on a continuous range of input.

Event Graph (editor) – Each blueprint editor has a panel to edit and develop blueprint code. This panel is known as "Event Graph".

Execution Line –The execution line connects blueprint blocks together and execute each from “left to right” in order to perform procedures and functions of those blueprint blocks. It is a white color line which can be connected or disconnected from the execution pin of each blueprint block.

CHAPTER 6

Game Objects and Materials

Levels within UE5 consist of objects, (of which there are many types), and being aware of these objects and how they function is essential to programming or designing in an efficient and effective (object-oriented) manner. Many of the potential components that make up an object can be assigned materials, which change the appearance of the object. Materials can be simple, but they can become very complex.

Structure

In this chapter, we will discuss the following topics:

Game objects

Classes

Inheritance

Components

Variables

Transforms

Components

Events

Construction

Beginplay

Tick

Endplay

Custom events

Event overrides

Material editor

Material nodes

Material instances

Material data

Material Parameter Collections

Dynamic materials

Objectives

After studying this chapter, you should understand the composition of objects within Unreal Engine, object inheritance and classes, common events, and the basic usage of Materials, Material Parameters, and the Material Editor.

Game objects

Every entity in UE5 is, at its core, an object. The UObjectBase class is at the top of every class inheritance hierarchy; everything is based on it. Although the object base class is usually used sparingly as an input for functions/events/macros that can accept any item (such as the GetClass function shown in Figure 6.2), it is important to be aware of its existence because of its importance to the structure of the Unreal Engine.

Classes

Every object has a class, which is used to identify it among the many transmutations of the base object class. Parent classes (among other information) can be quickly seen by hovering over a class in the content browser, as shown in Figure 6.1:

ersonBP
Blueprints
Search Blueprints
ThirdPerson Character
BLUEPRINT CLASS
ThirdPersonCharacter (Blueprint Class)
Character Blueprint that contains movement logic.
Path: /Game/ThirdPersonBP/Blueprints
Asset Filepath Length: 82 / 210
Cooking Filepath Length: 138 / 260
Disk Size: 203.432 KiB
Parent Class: Character
Native Parent Class: Character
Blueprint Type: Normal
Is Data Only: False
Num Replicated Properties: 0
Native Components: 4
Blueprint Components: 2

Figure 6.1: Blueprint Class in the content browser

In blueprint, classes are useful for spawning objects, quickly tracking immediate inheritance, and checking to see if a provided object is of a specific type, as shown in Figure 6.2:

GetClass
Object
Object
Return Value
Actor
==

Figure 6.2: Checking the class of a provided object

Inheritance

The Object is the basis of every class and following the chain of inheritance of any object will always lead back to the base Object class. For example, one of the most used classes in Unreal engine is the Actor class, and like most classes, it follows an inheritance hierarchy leading back to Object (UObjectBase), as illustrated in Figure 6.3. The class immediately above a given class in its inheritance hierarchy is its parent class, while the class below it is a child of the class. A class can have many children, but only one parent.

– Inheritance Hierarchy

UObjectBase

UObjectBaseUtility

UObject

AActor

+ 279 derived classes

Figure 6.3: “Actor” Class inheritance Hierarchy

When an object of a certain class inherits from another class (like the Actor class inherits from the UObject class, it inherits the variables, components, functions, and events of the parent class (the class directly above it in the inheritance hierarchy).

The parent class can be determined by hovering over it in the content browser and viewing its details, as is done in Figure 6.1, or within the blueprint editor, where the parent class is listed in the top-right corner, as shown in Figure 6.4 (selecting the underlined parent class will open it):

Figure 6.4: Parent Class in the blueprint editor

Variables

Variables are data stored in an object that contains either a reference or a value. There are many types of variables, as covered in Chapter 2, Math for Game Design. Child classes inherit all the variables of the parent class, although they are hidden in the blueprint editor by default; to make them visible, click on the gear icon in the My Blueprint panel and enable Show Inherited Variables, as shown in Figure 6.5:

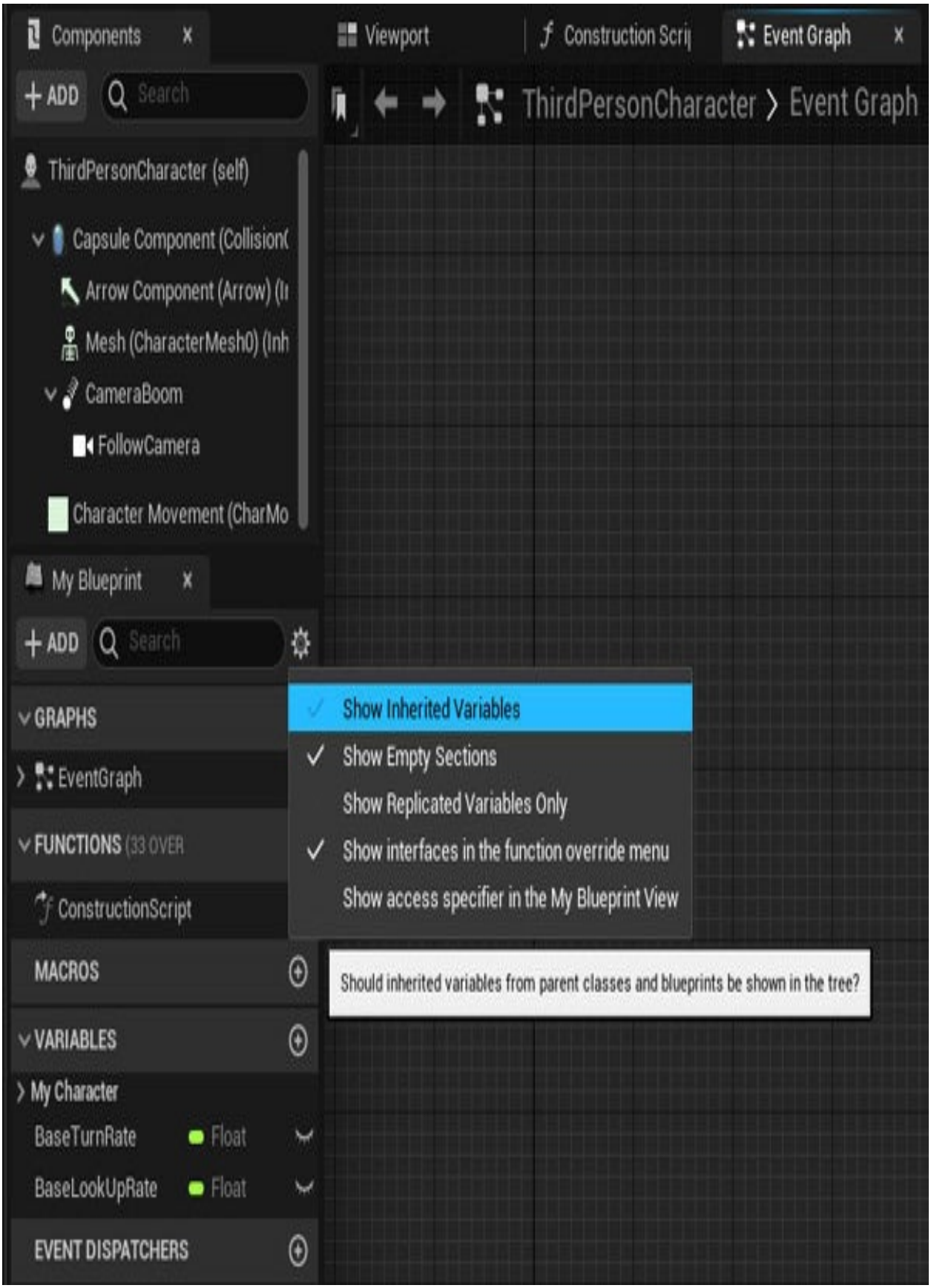

Components
Viewport
Construction Scrij
Event Graph
ADD
Search
ThirdPersonCharacter > Event Graph
ThirdPersonCharacter (self)
Capsule Component (Collision(
Arrow Component (Arrow) (I
Mesh (CharacterMesh0) (Inh
CameraBoom
FollowCamera
Character Movement (CharMo
My Blueprint
ADD
Search
GRAPHS
EventGraph
FUNCTIONS (33 OVER
ConstructionScript
MACROS
VARIABLES
My Character
BaseTurnRate
Float
BaseLookUpRate
Float
EVENT DISPATCHERS
Show Inherited Variables
Show Empty Sections
Show Replicated Variables Only
Show interfaces in the function override menu
Show access specifier in the My Blueprint View
Should inherited variables from parent classes and blueprints be shown in the tree?

Figure 6.5: Showing Inherited Variables

Components

Components are the parts that make up a game object by adding visual presentation, and/or functionalities to it. The types of components are as follows:

Primitive components: Provide a visual form for the object, have a transform, and can have a collision (For interacting physically with other objects).

Scene components: Provide a transform and a means of attaching other components neatly.

Actor components: Give an object additional behavior or provide data management. Actor components can contain events and functions, which can be used within the object they are attached to.

The component panel of the blueprint editor shows all the components in a class; this is shown in Figure 6.6:

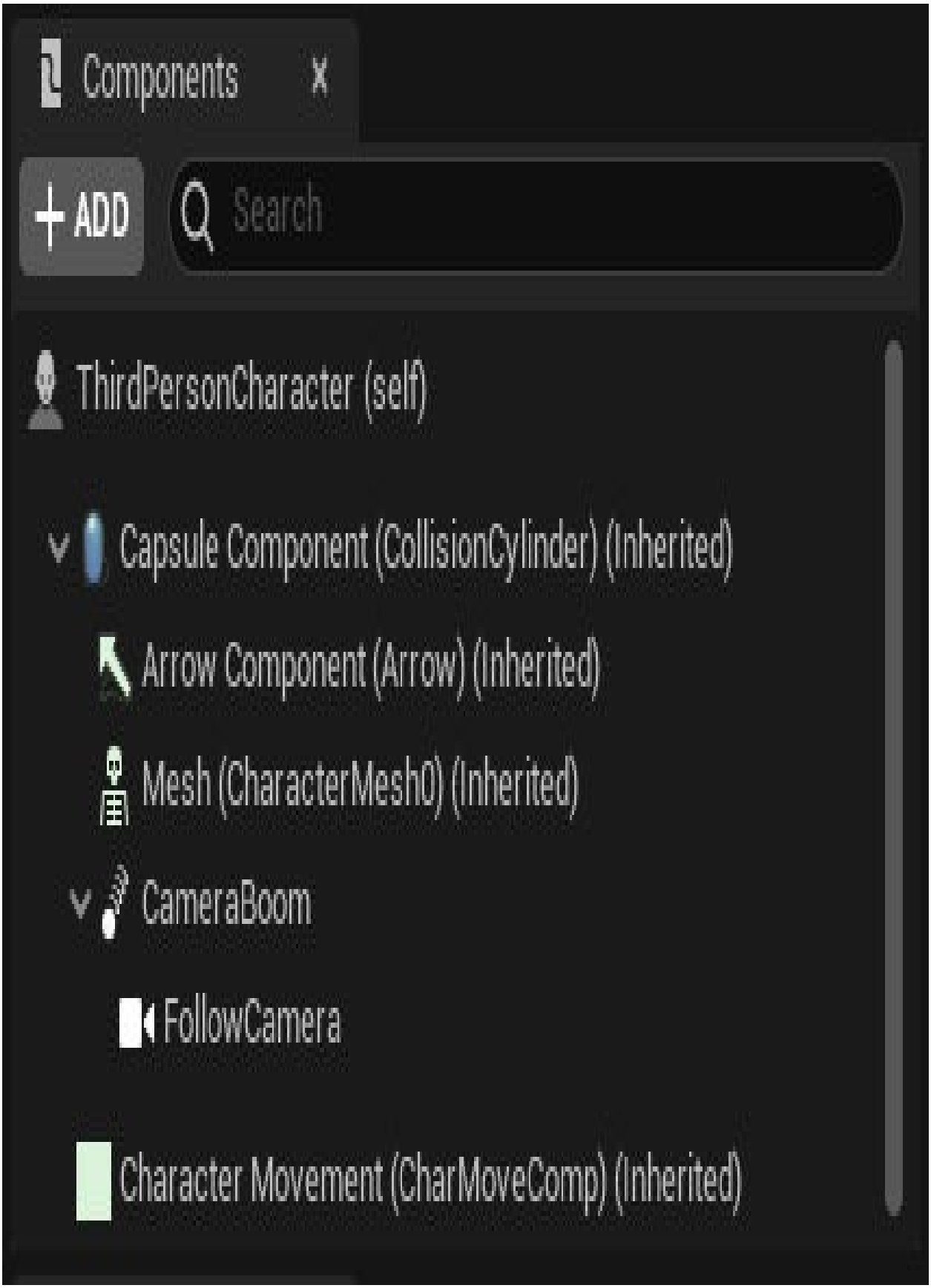

Components
ADD
Search
ThirdPersonCharacter (self)
Capsule Component (CollisionCylinder) (Inherited)
Arrow Component (Arrow) (Inherited)
Mesh (CharacterMesh0) (Inherited)
CameraBoom
FollowCamera
Character Movement (CharMoveComp) (Inherited)

Figure 6.6: Component Panel

Transforms

Transforms are the combination of Location, Rotation, and Scale. The transform of an object or component can be relative to either the root/origin of the world (coordinates 0,0,0), which is a World transform, or relative to the transform of it's parent (component or object), which is a Relative transform. The transform of an object can be edited from the TRANSFORM section of its details panel, as depicted in Figure 6.7:

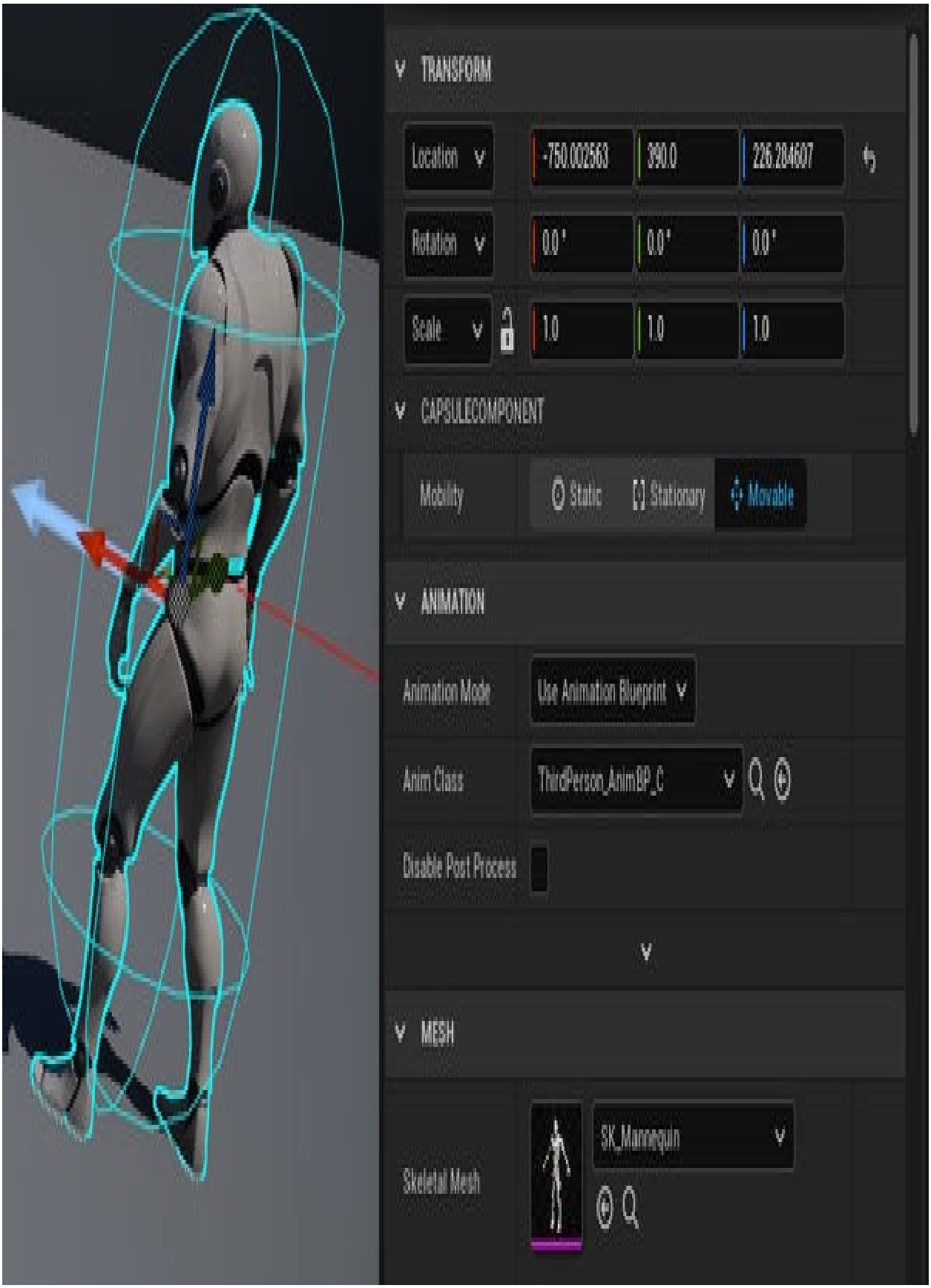

TRANSFORM
Location
-750.002563
390.0
226.204607
Rotation
0.0°
0.0°
0.0°
Scale
1.0
1.0
1.0
CAPSULECOMPONENT
Mobility
Static
Stationary
Movable
ANIMATION
Animation Mode
Use Animation Blueprint
Anim Class
ThirdPerson_AnimBP_C
Disable Post Process
MESH
Skeletal Mesh
SK_Mannequin

Figure 6.7: World Transform of an Object

All component transforms are relative to the parent component or object within the editor, but there are functions to get the world or relative transform of components or objects if needed (Get World Transform and Get Relative Transform). Component transforms can be edited in the “details” panel of the component within the blueprint editor, as shown in Figure 6.8:

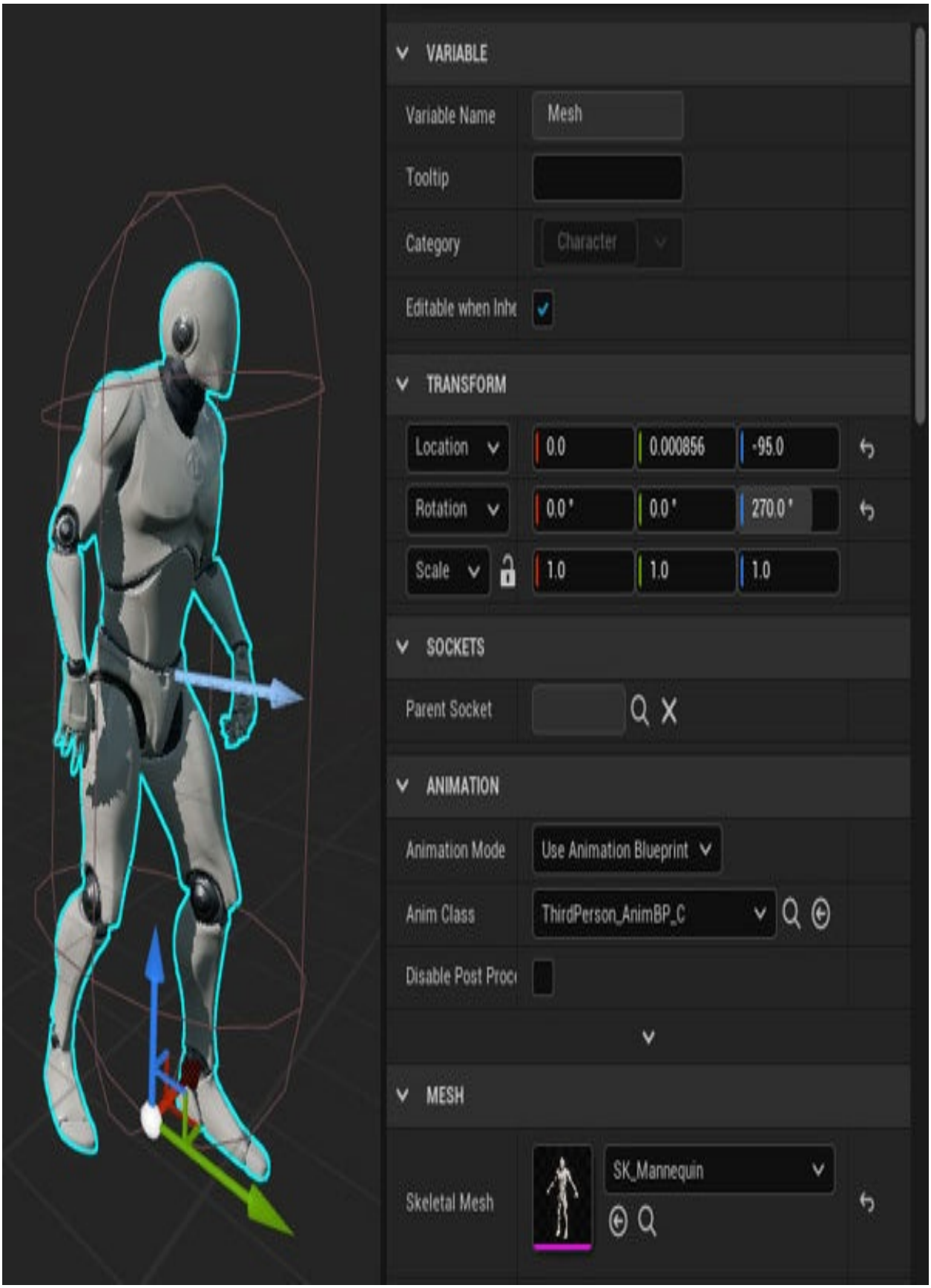

VARIABLE
Variable Name
Mesh
Tooltip
Category
Character
Editable when Inhe
TRANSFORM
Location
0.0
0.000856
-95.0
Rotation
0.0 °
0.0 °
270.0 °
Scale
1.0
1.0
1.0
SOCKETS
Parent Socket
ANIMATION
Animation Mode
Use Animation Blueprint
Anim Class
ThirdPerson_AnimBP_C
Disable Post Proc
MESH
Skeletal Mesh
SK_Mannequin

Figure 6.8: Relative Transform of a component

Events

Events are nodes that are executed at specific times (when the game begins, when it closes, on every tick, or when the editor is compiled, among others), by player input, or from other events or functions. They are the starting point of execution lines, which is how functionality for the game is made to occur.

For further information regarding events, visit this link: https://docs.unrealengine.com/4.27/en-US/ProgrammingAndScripting/Blueprints/UserGuide/Events/

Construction script

This is a special event/function that is separate from all the others, because it only runs when compiling the editor. Construction script is used for performing advanced behavior within an object that cannot be achieved without an execution line before running the game:

ThirdPersonCharacter > Construction Script
BLUEPRINT

Figure 6.9: Construction Script

This can be extremely useful for generating or randomizing map elements or utilizing public variables to modify the object. There are restrictions to the construction script however, such as nodes that occur over time being unusable.

Beginplay

Beginplay is an event that runs as soon as an object is loaded, if it exists when the game or level is first loaded (if the object is placed in the world/level manually before pressing Play). In this situation, the Beginplay event will be executed as soon as the game is ready to play.

If the object is created afterward (the object is spawned into the world after Play is pressed), then the Beginplay event will run as soon as the object is spawned. The Beginplay event can be seen in Figure 6.10:

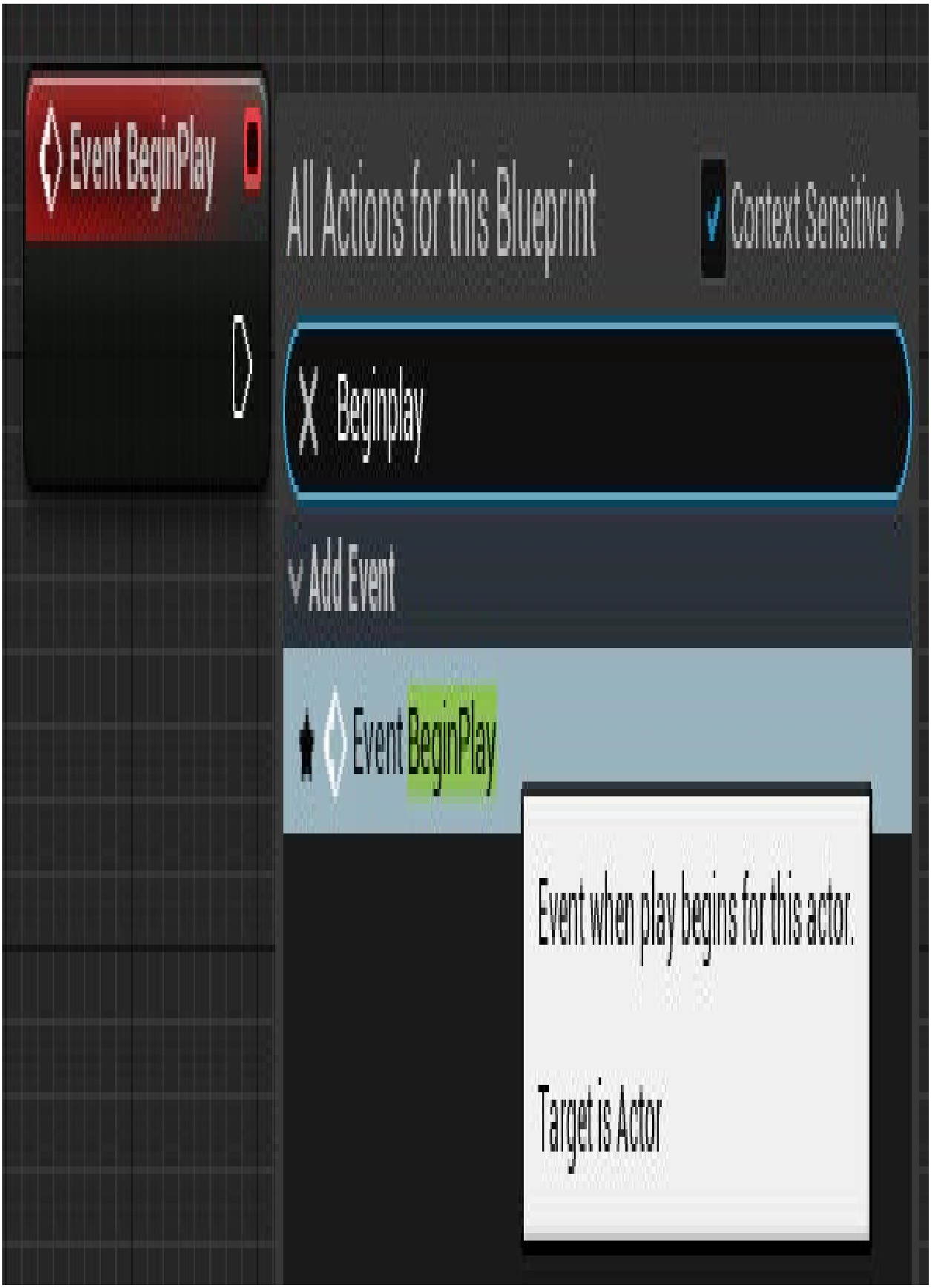

Event BeginPlay
All Actions for this Blueprint
Context Sensitive
Beginplay
Add Event
Event BeginPlay
Event when play begins for this actor.
Target is Actor

Figure 6.10: BeginPlay Event (In graph and search)

Tick

The Tick event is (by default) executed once per tick of the game. A Tick in this context is when the object updates its state, which normally happens many times every second, depending on the frame rate and settings:

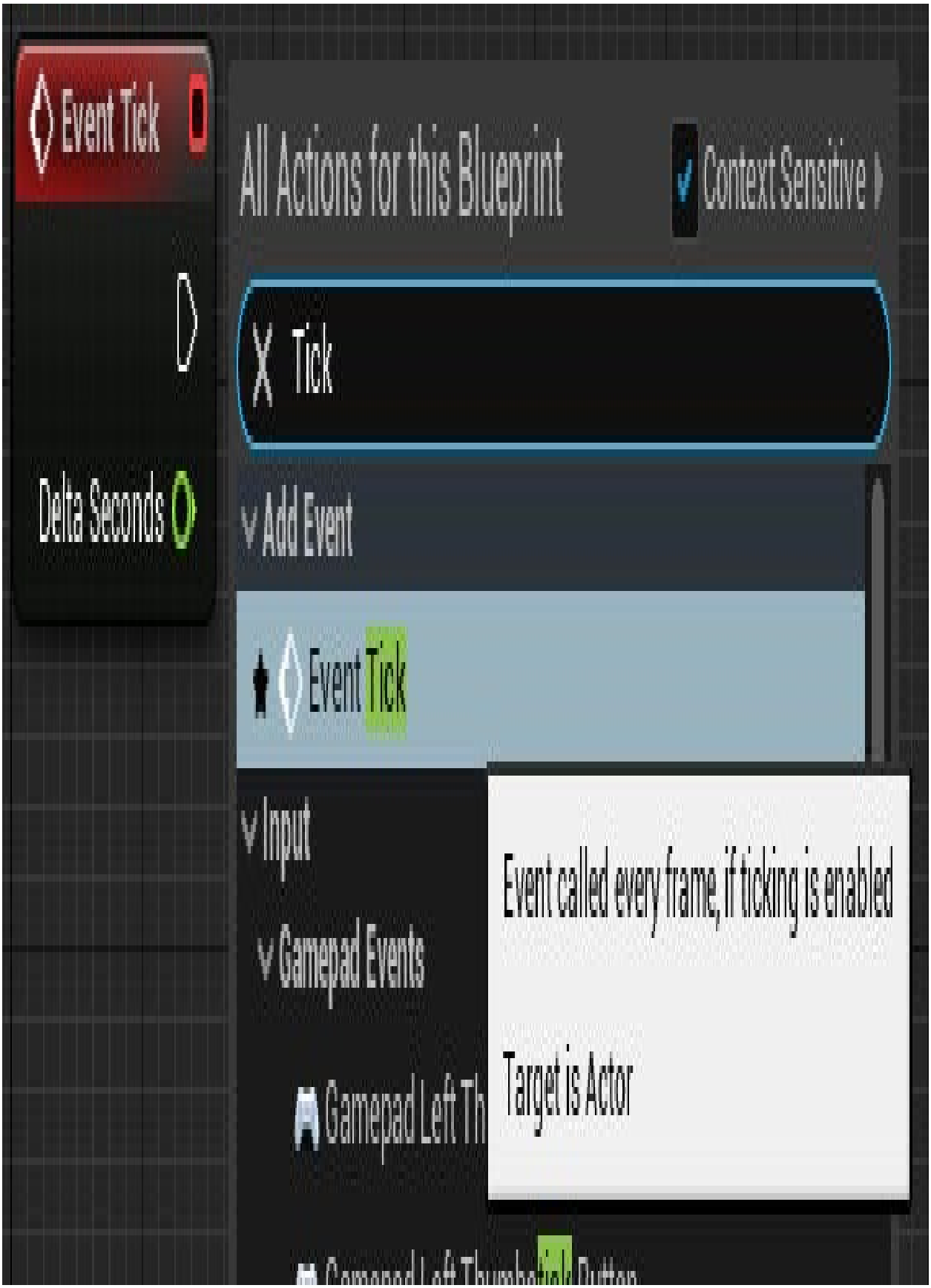

Event Tick
Delta Seconds
All Actions for this Blueprint
Context Sensitive
Tick
Add Event
Event Tick
Input
Gamepad Events
Gamepad Left Th
Event called every frame, if ticking is enabled
Target is Actor

Figure 6.11: Tick Event (In Graph and Search)

Tick has a number of settings, which allow its rate to be slowed, stopped altogether, or set to only occur in certain situations. The Delta Seconds output on the event is the last recorded amount of time between frames, which is very useful for nodes with time inputs that you want to run continuously, such as Print String nodes.

Endplay

The Endplay event runs when an object is destroyed. This event will be executed for every object that exists when the game ends; the game will end once these events are complete. It is very useful for serialization (saving player data/progress) on objects that can only be deleted when the game ends (such as the Game Instance) and for the final functionality for an object before it is removed from play:

Event End Play
All Actions for this Blueprint
Context Sensitive
Endplay
End Play Reason
Add Event
Event End Play
Event to notify blueprints this actor is being deleted or removed from a level.
Target is Actor

Figure 6.12: EndPlay Event (In graph and search)

Custom Events

Custom Events are developer created events that need to be manually called. They can be called from external objects, components, and other events within the same object, although a reference to the object to run the event is required if it is to be called externally (from another object):

MyCustomEvent
Custom Event
All Actions for this Blueprint
Context Sensitive
Custom Event
Add Event
Add Custom Event...
An event with customizable name and parameters.
hold (Ctrl + Alt) for more
Call Fun
My custom event

Figure 6.13: Custom Event (In graph and search)

Like functions, custom events can have custom inputs, which can then be utilized within the event.

Material Editor

Materials are responsible for the surface appearance of a primitive component or UI Element. Unreal Engine has an editor specifically for materials, the Material editor, which has several similarities to the Blueprint Editor and many key differences. The material editor can be seen in Figure 6.14:

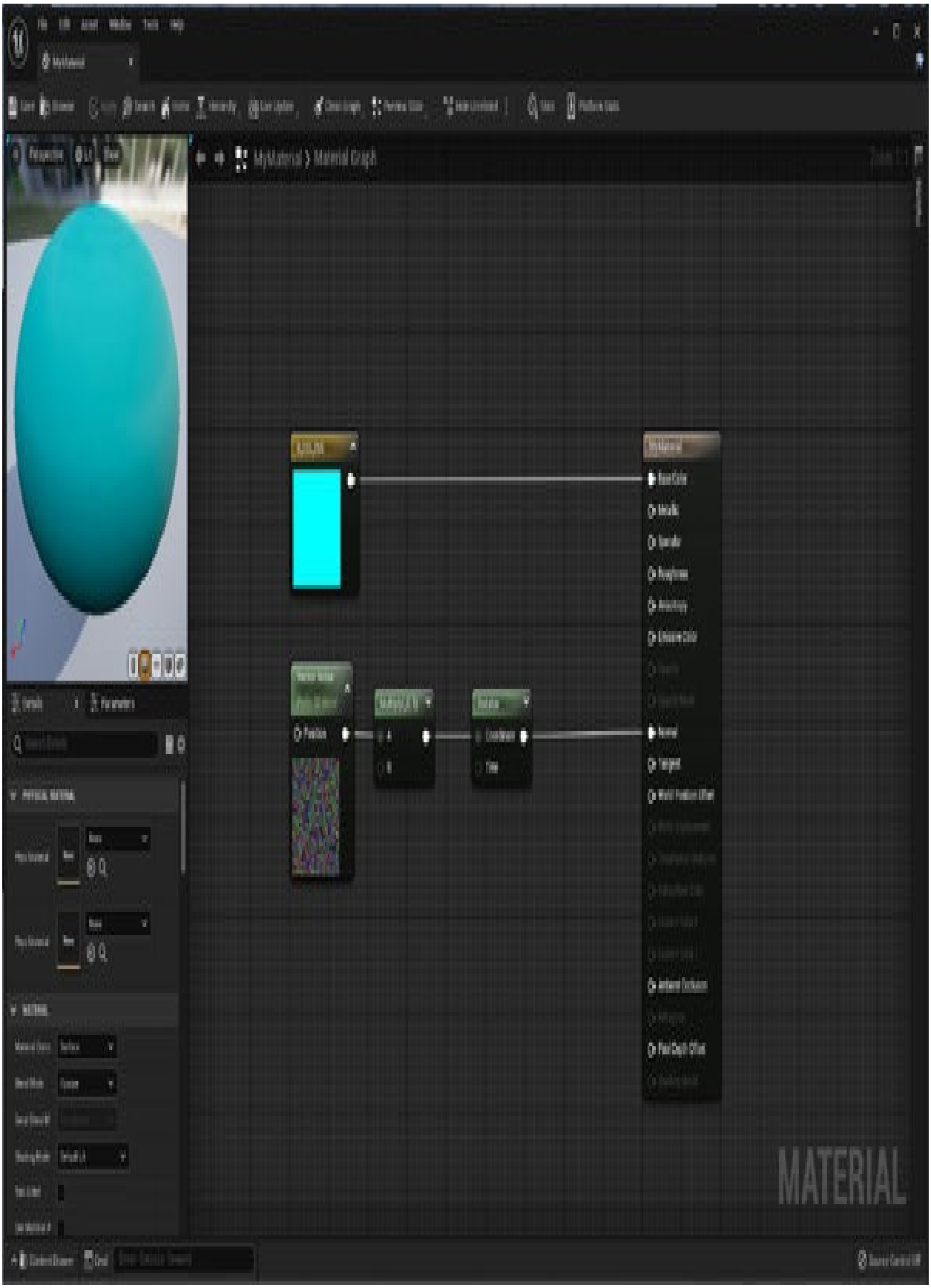

MATERIAL

Figure 6.14: Material Editor

There are many uses for materials, such as decals (think posters or blood stains on walls within a level), as a skin for primitive components, and as light sources for example. However, in order for materials to be used properly for these purposes, they need to be set up correctly in the editor. You can change the type of the material you are editing from the Material Domain selection in the Details panel, as shown in Figure 6.15. This defines where the material will be used and alters the final output node to match the type of material selected:

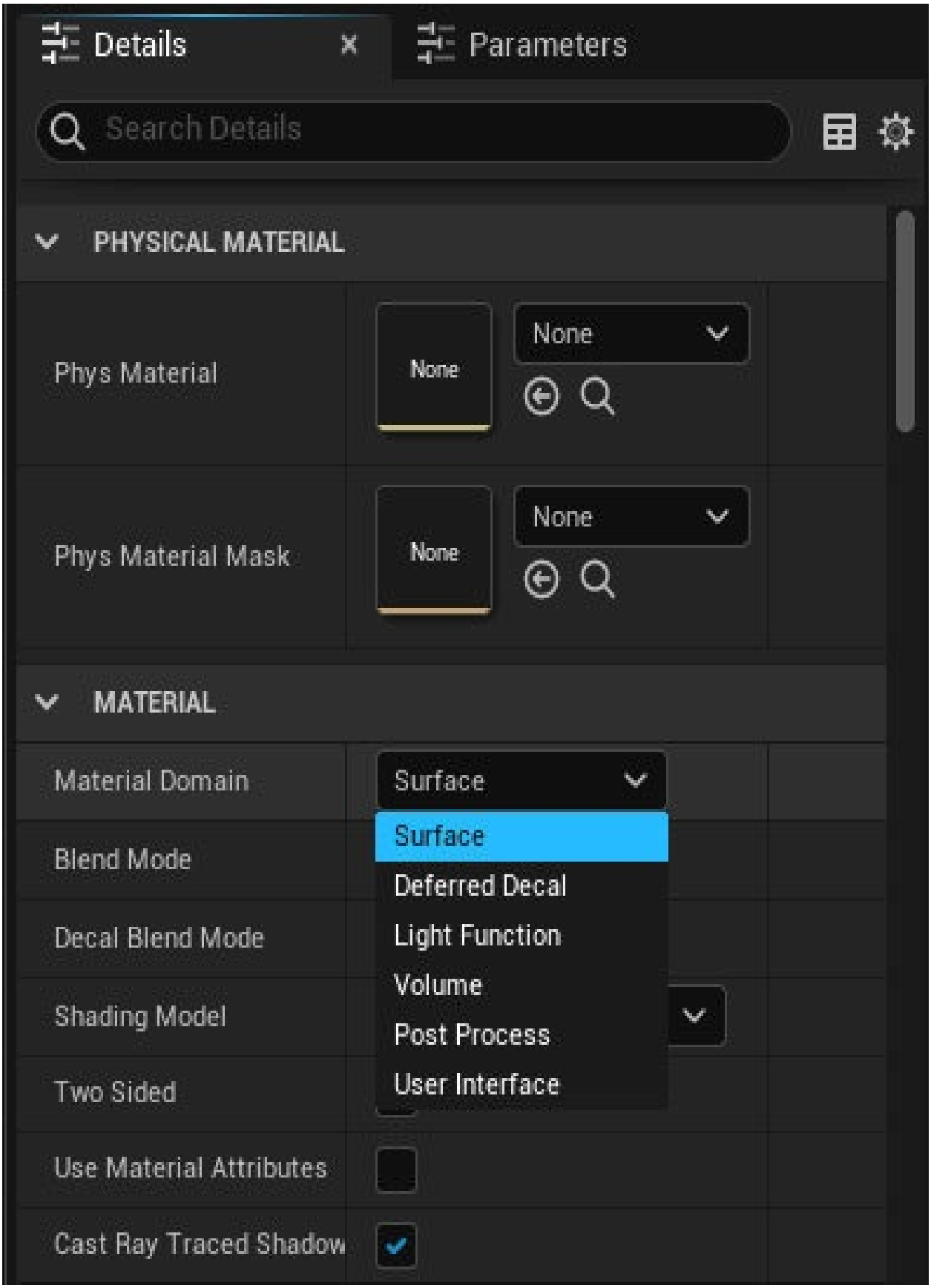

Details
Parameters
Search Details
PHYSICAL MATERIAL
Phys Material
None
None
Phys Material Mask
None
None
MATERIAL
Material Domain
Surface
Surface
Deferred Decal
Light Function
Volume
Post Process
User Interface
Blend Mode
Decal Blend Mode
Shading Model
Two Sided
Use Material Attributes
Cast Ray Traced Shadow

Figure 6.15: Material Domain Selection

Material nodes

Like the Blueprint editor, the material editor uses nodes, but the focus is placed a lot more on the inputs/outputs of each node. This is because depending on the type of material you are editing, it can only have so many features (as shown in Figure 6.16), and there are no execution lines, only the order that nodes are applied to an input:

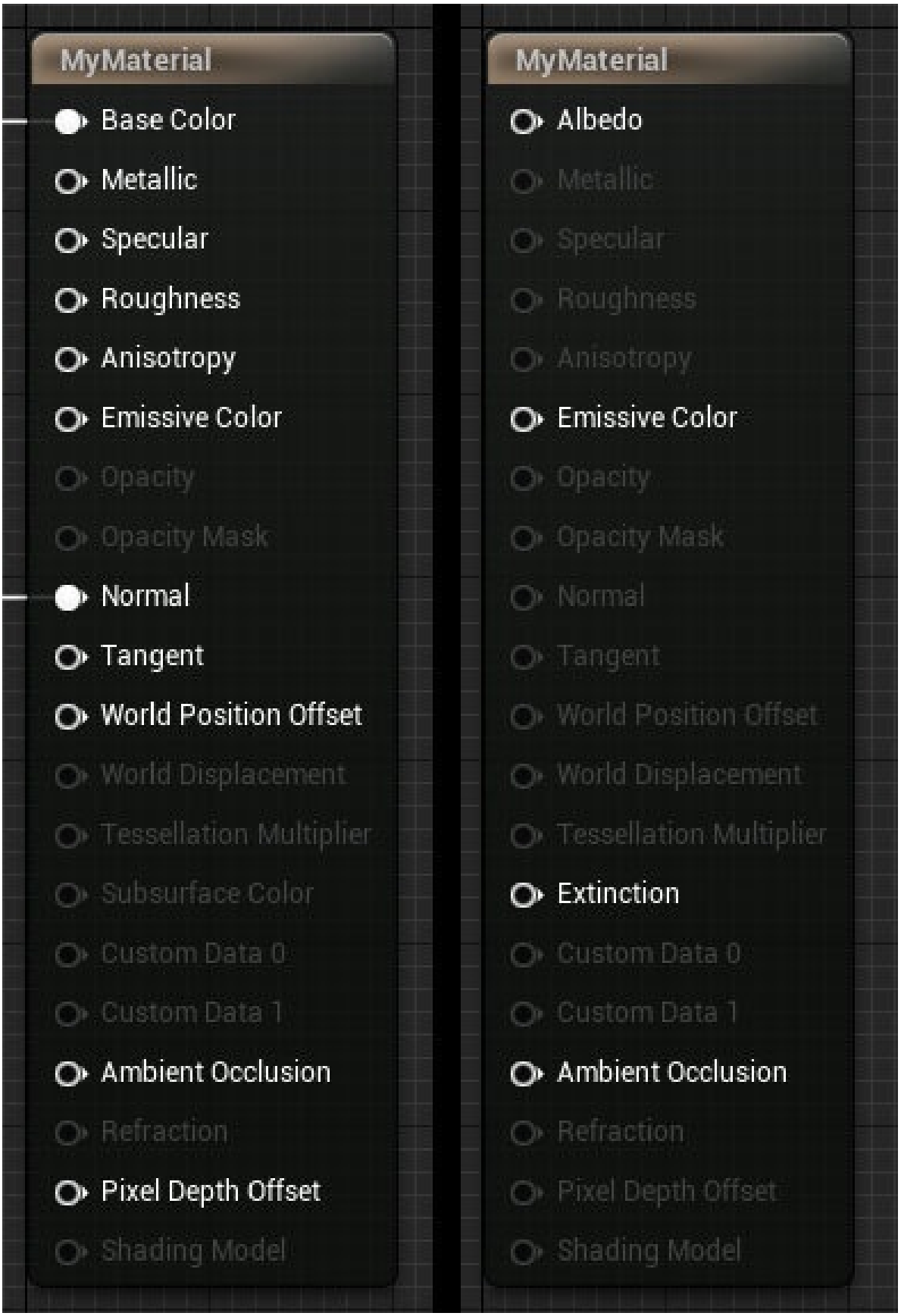

MyMaterial
Base Color
Metallic
Specular
Roughness
Anisotropy
Emissive Color
Opacity
Opacity Mask
Normal
Tangent
World Position Offset
World Displacement
Tessellation Multiplier
Subsurface Color
Custom Data 0
Custom Data 1
Ambient Occlusion
Refraction
Pixel Depth Offset
Shading Model
MyMaterial
Albedo
Metallic
Specular
Roughness
Anisotropy
Emissive Color
Opacity
Opacity Mask
Normal
Tangent
World Position Offset
World Displacement
Tessellation Multiplier
Extinction
Custom Data 0
Custom Data 1
Ambient Occlusion
Refraction
Pixel Depth Offset
Shading Model

Figure 6.16: Material outputs differ for each material Domain (Surface Material on the left, Volume material on the right)

Most material editor nodes take a texture or vector input (consisting of three-color channels (red, green, and blue) and an Alpha Channel, which is the opacity/transparency of the material), modify it in a specific way, and output it with those changes applied, which can then be further modified or applied to the final output node. Some nodes take different inputs, like coordinates or vectors. Some basic material nodes are shown in Figure 6.17:

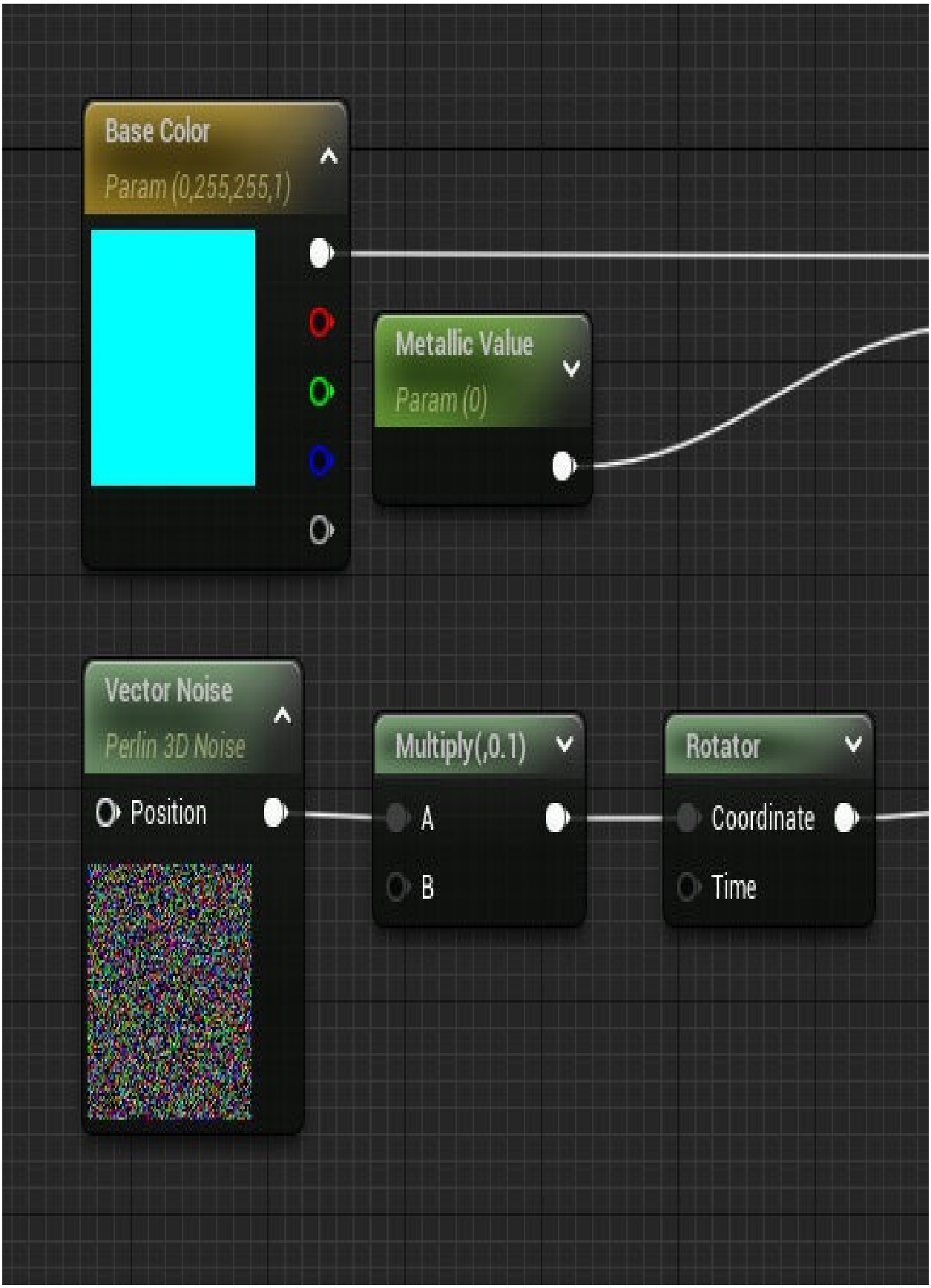

Base Color
Param (0,255,255,1)
Metallic Value
Param (0)
Vector Noise
Perlin 3D Noise
Position
Multiply(,0.1)
A
B
Rotator
Coordinate
Time

Figure 6.17: Material Nodes

Material instances

Material instances are children of a master material that can have values used by the material changed specific to each instance, allowing for several variations of the same base material that the instances are based upon. These values can be Vectors (colors) or Scalars (floats). The creation of a material instance (left) and the Material instance editor (right) is illustrated in Figure 6.18:

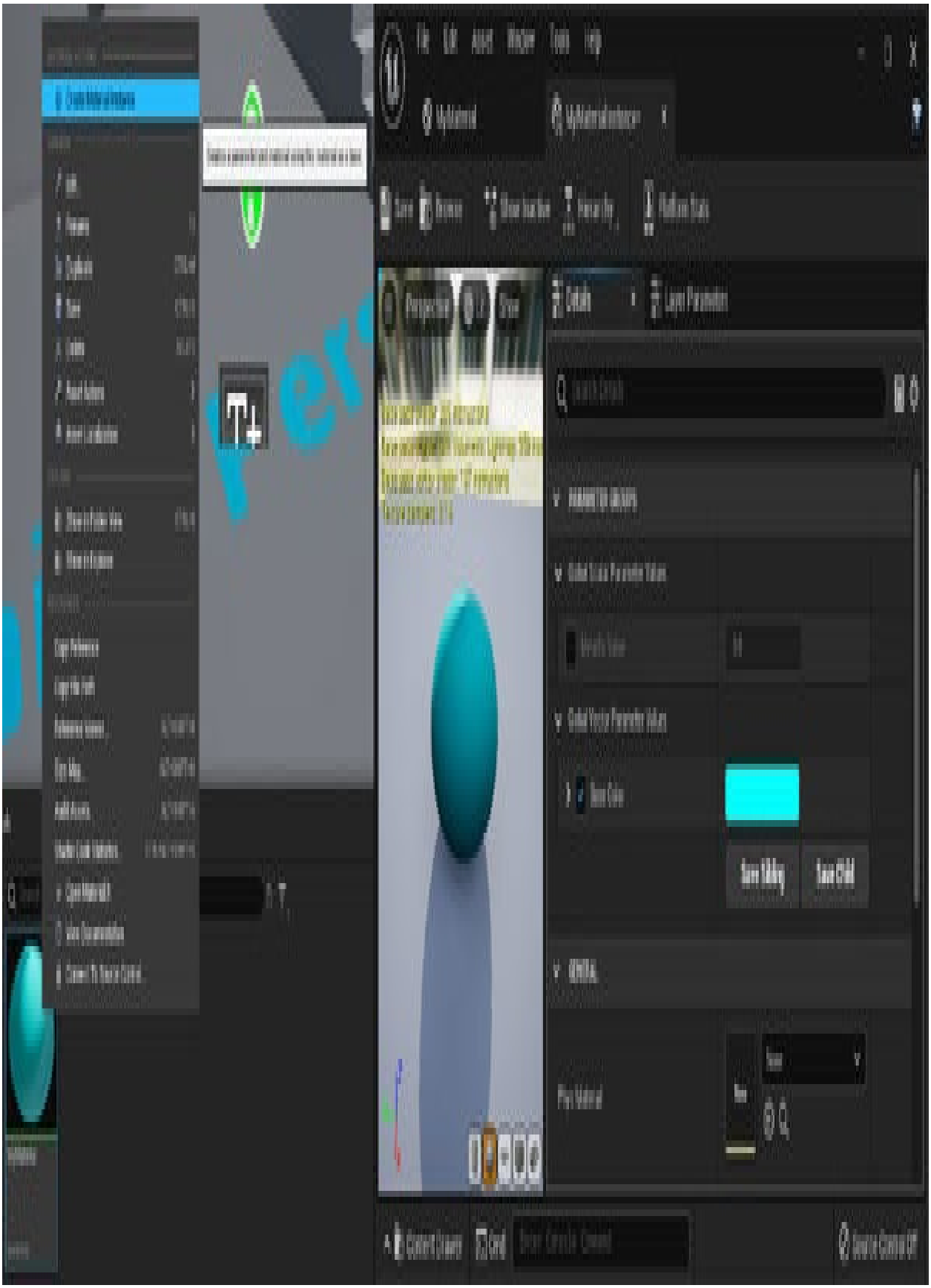


Figure 6.18: Creating a Material Instance & the Material Instance Editor

In order to have these parameters you can change for each instance; they need to be set up in the master material. You can see a Vector (yellow) and Scalar (green) parameter in use in the master material in Figure 6.19:

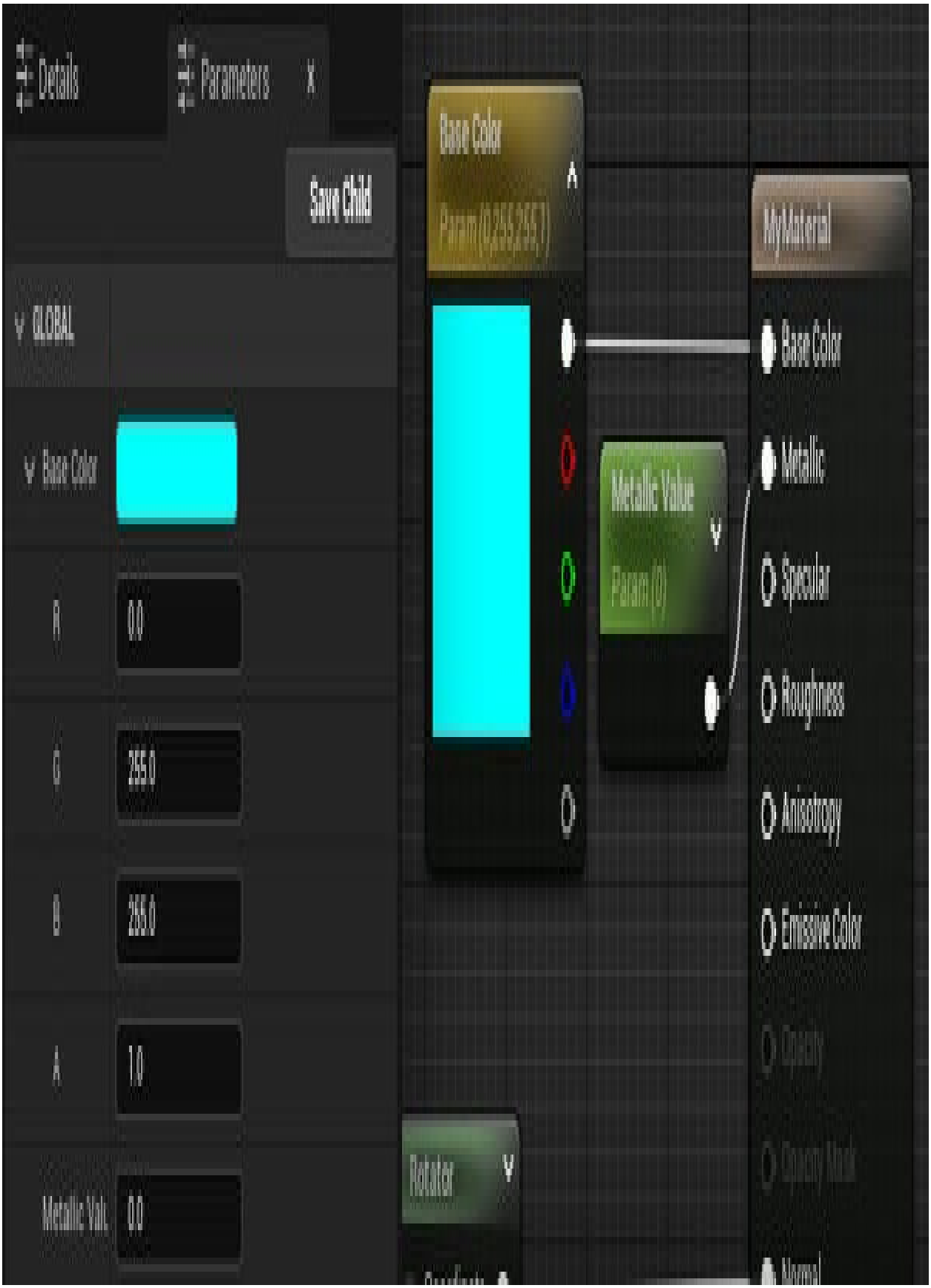

Details
Parameters
Save Child
Base Color
Param (0,255,255)
MyMaterial
GLOBAL
Base Color
Metallic
Metallic Value
Param (0)
Specular
R
0.0
Roughness
G
255.0
Anisotropy
B
255.0
Emissive Color
A
1.0
Metallic Val.
0.0
Normal

Figure 6.19: Vector and Scalar Material Parameters

These parameters will appear in the Parameters panel of the Material Editor (shown in Figure 6.18), where you can preview the effects of modifying these values and confirm that they will be accessible when modifying instances of this material.

Material data

Materials can have dynamic elements, meaning that they can be altered by modifying a value that they are tied to while the game is running. This can be done by modifying a value in a Material Parameter collection, which is global and can be accessed by many materials or by modifying a value in a specific Dynamic Material.

Material Parameter Collections

Material Parameter Collections (MPCs) are a set of global variables that can be altered while the project is running, and these variables can be utilized by materials via special nodes within the Material Editor. MPCs are under the Materials & Textures section when creating a new asset via the content browser.

MPCs can contain Vector Parameters and Scalar Parameters. Changing the value of a parameter in an MPC will alter every material that uses that parameter accordingly. The MPC Editor can be seen in Figure 6.20:

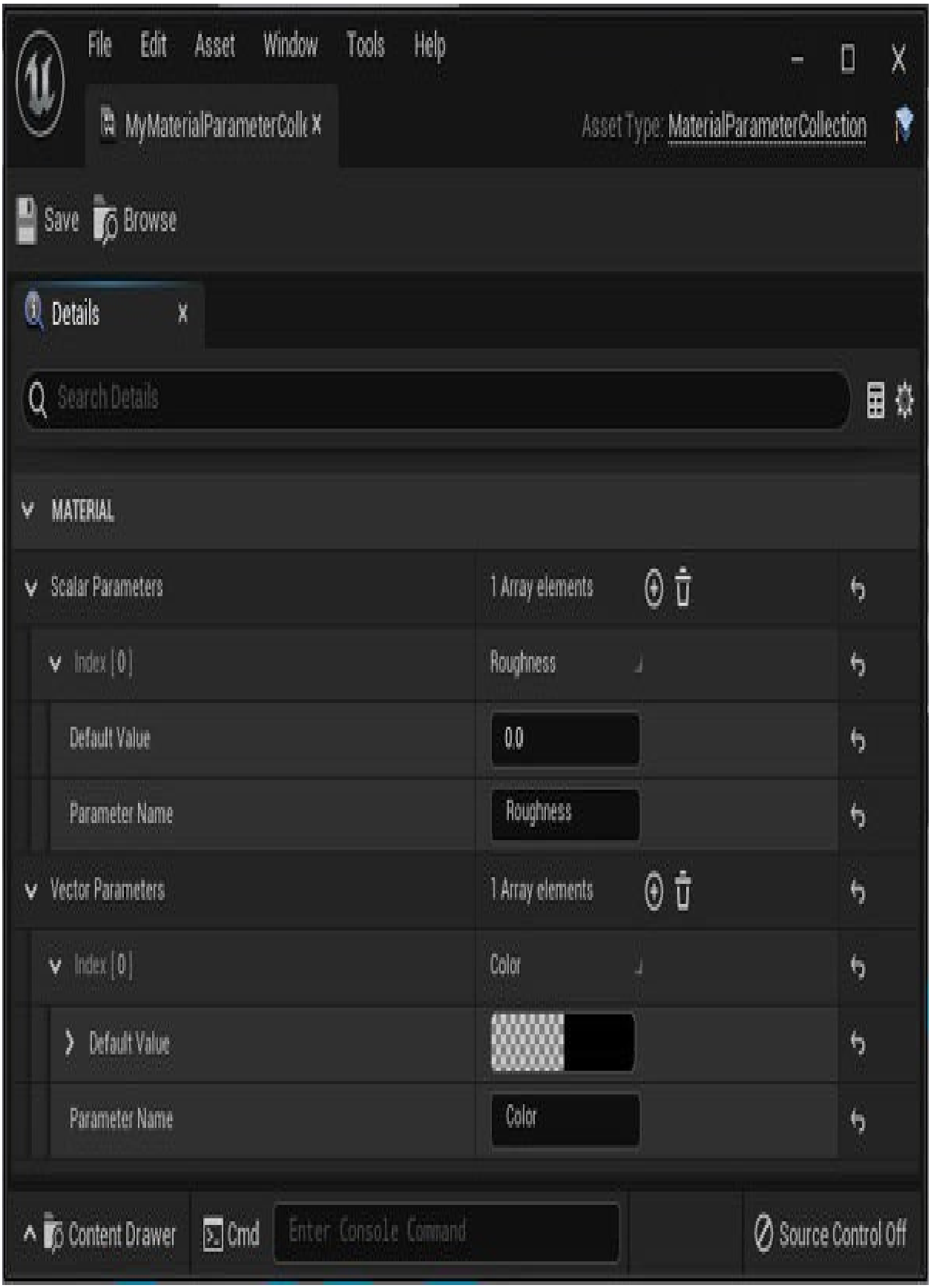

File
Edit
Asset
Window
Tools
Help
MyMaterialParameterColle
Asset Type: MaterialParameterCollection
Save
Browse
Details
Search Details
MATERIAL
Scalar Parameters
1 Array elements
Index [0]
Roughness
Default Value
0.0
Parameter Name
Roughness
Vector Parameters
1 Array elements
Index [0]
Color
Default Value
Parameter Name
Color
Content Drawer
Cmd
Enter Console Command
Source Control Off

Figure 6.20: Material Parameter Collection One Scalar and One Vector Parameter

To use a MPC parameter within a material, you need to use a Collection Parameter node (as illustrated in Figure 6.21):

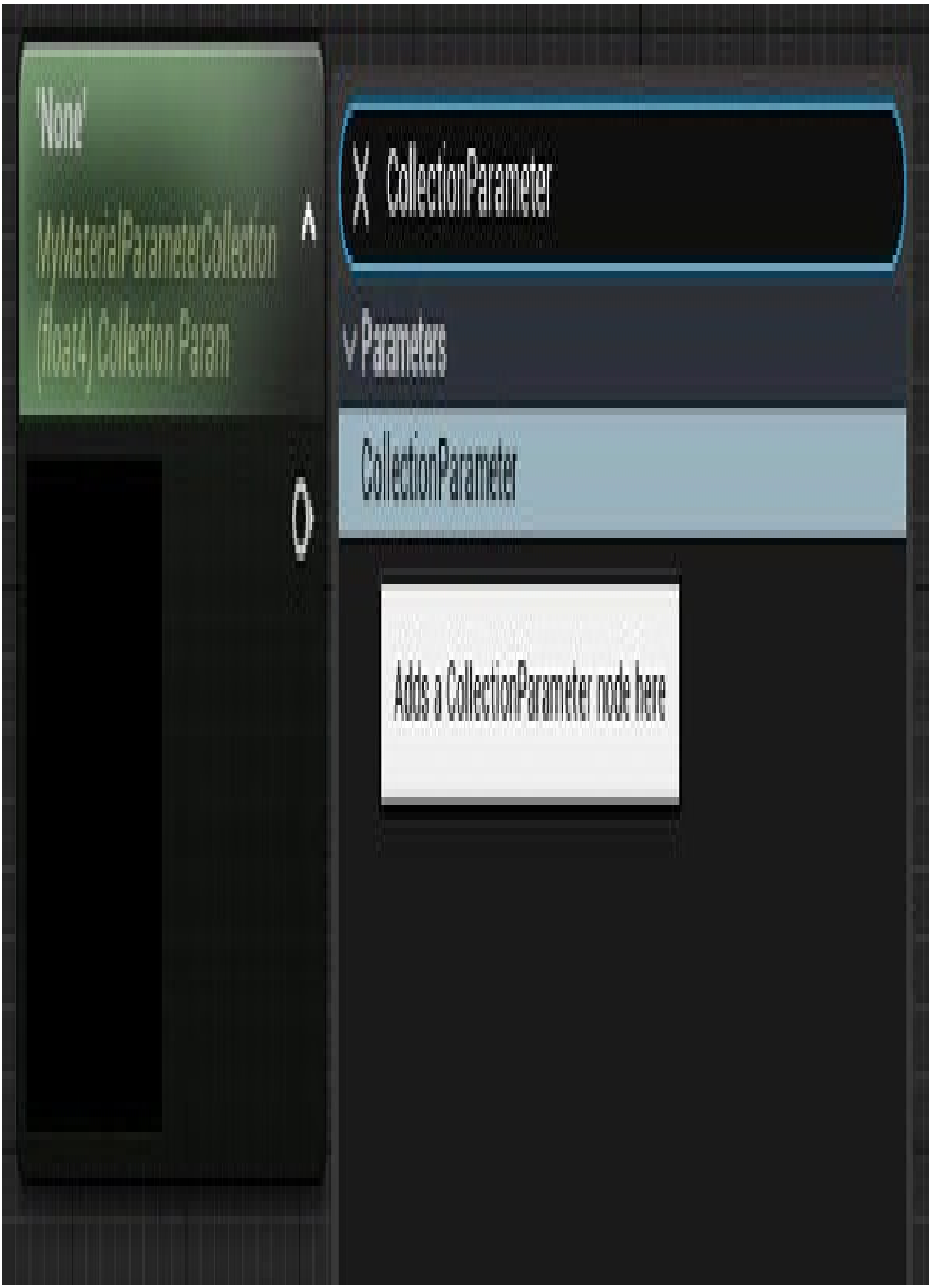

'None'
MyMaterialParameterCollection
(Node4) Collection Param
CollectionParameter
Parameters
CollectionParameter
Adds a CollectionParameter node here

Figure 6.21: Collection Parameter Node creation

Then, select the MPC and specific parameter you would like the node to represent in the Details panel while the node is selected, as shown in Figure 6.22:

Details
Parameters
Search Details
'None'
MyMaterialParameterCollection
(float4) Collection Param
GENERAL
Collection
MyMaterialParameterCollection
Parameter Name
None
Color
Roughness
Choose a parameter from the collection
MATERIAL EXPRE
Stats

Figure 6.22: Collection Parameter Node setup

Once the Node is set up and used within the material, the Parameter within the collection can be modified through blueprint via the Set Scalar Parameter Value and Set Vector Parameter Value nodes. These nodes and their inputs are shown in Figure 6.23:

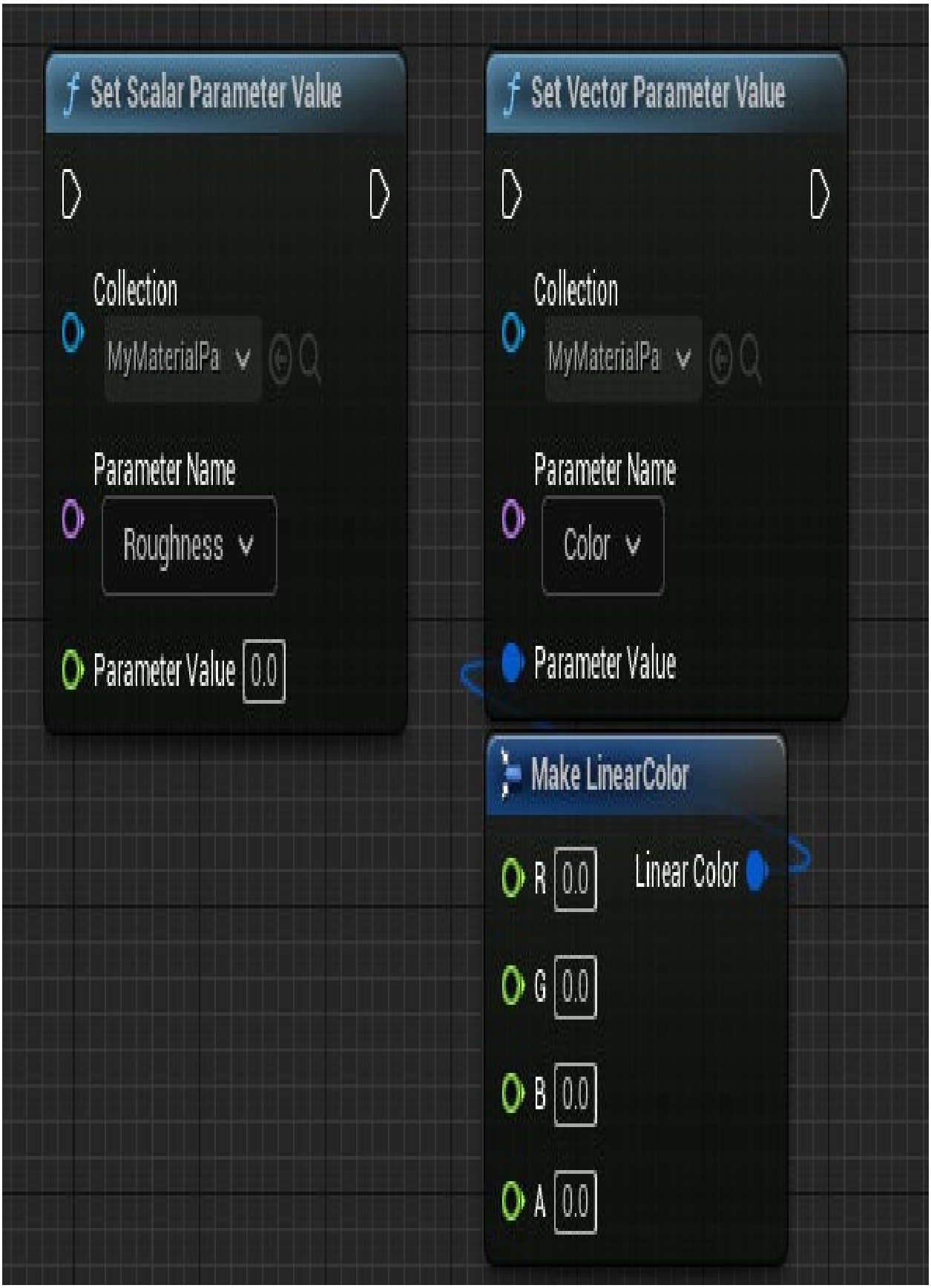

Set Scalar Parameter Value
Collection
MyMaterialPa
Parameter Name
Roughness
Parameter Value
0.0
Set Vector Parameter Value
Collection
MyMaterialPa
Parameter Name
Color
Parameter Value
Make LinearColor
R
0.0
Linear Color
G
0.0
B
0.0
A
0.0

Figure 6.23: Set Scalar and Vector Parameter value blueprint nodes

Dynamic Materials

A Dynamic Material is one that has been initialized and is stored as a reference within a blueprint; the reference to it permits altering parameters used by the material. A Dynamic Material is set up using the Create Dynamic Material Instance node, which outputs a reference to the Dynamic Material to be stored, as shown in Figure 6.24:

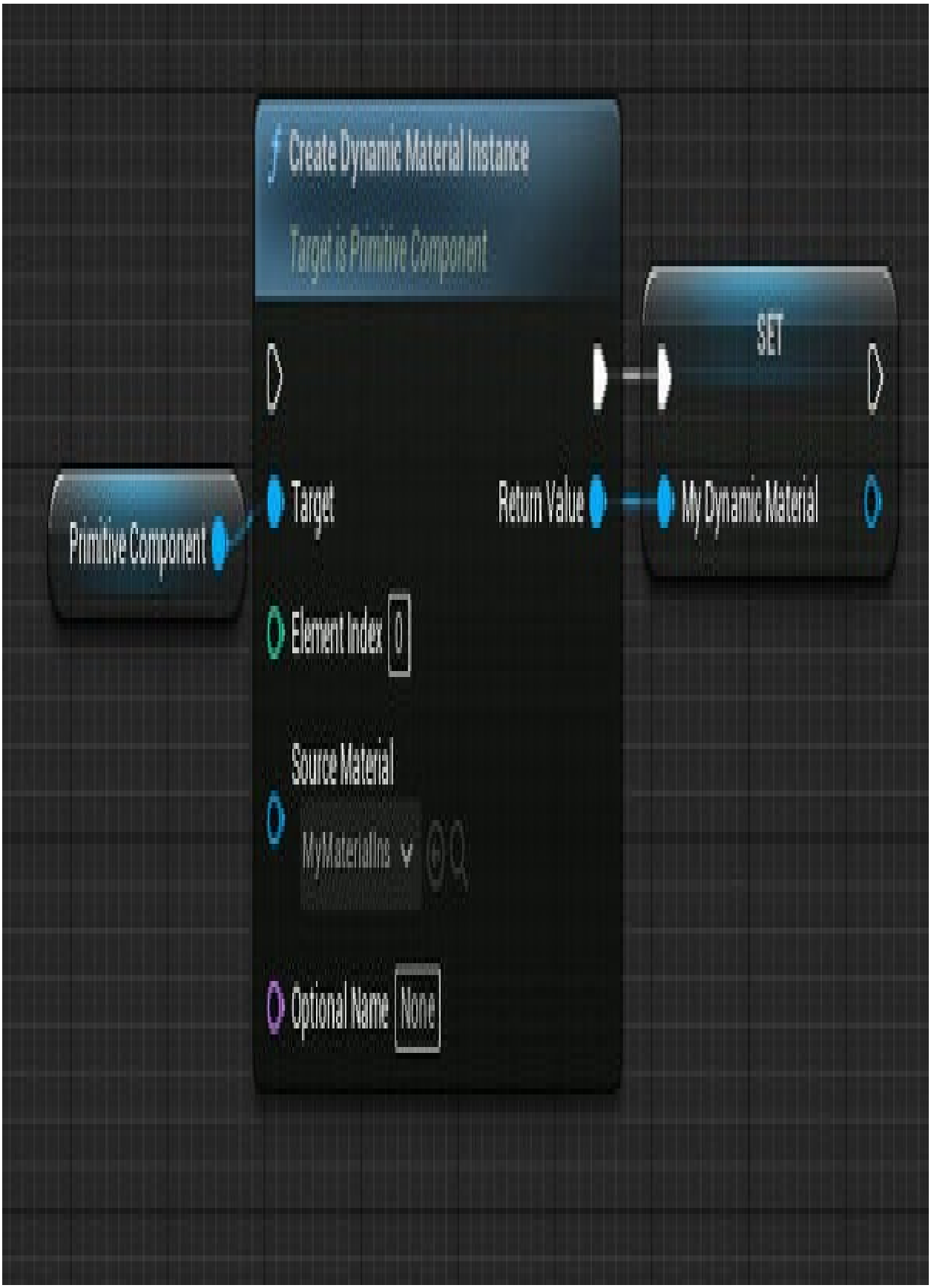

Create Dynamic Material Instance
Target is Primitive Component
SET
Primitive Component
Target
Return Value
My Dynamic Material
Element Index
0
Source Material
MyMaterialInst
Optional Name
None

Figure 6.24: Creating a Dynamic Material

Once a Dynamic Material is set up, the reference to it can be used to alter parameters within the material using targeted versions of the Set Scalar Parameter Value and Set Vector Parameter Value nodes, as shown in Figure 6.25:

Set Scalar Parameter Value
Target is Material Instance Dynamic
Set Vector Parameter Value
Target is Material Instance Dynamic
My Dynamic Material
Target
Parameter Name
MyScalarParameter
Value 1.0
My Dynamic Material
Target
Parameter Name
MyVectorParameter
Value

Figure 6.25: Changing a Dynamic Material Parameter

Dynamic Materials work in a manner similar to Material Parameter Collections, with the main difference being that Dynamic Materials' parameters are specific to each Dynamic Material Instance; the parameters are not shared globally like Material Parameter Collection parameters.

Conclusion

The structure and inheritance of Game Objects is very important to understanding how to use UE5 effectively and creating functionality for your games in the appropriate places. Inheritance is very useful for creating variations of an object that each branch out into different behaviors while maintaining (at least) elements of the original. The components that make up objects each have their uses. Specific events are used to perform functionality at the appropriate times. Materials are an incredibly useful way of getting the visuals of a game to look exactly as desired, and they are not static; they can be changed throughout the game as desired, although Materials need to be set up correctly to use this behavior. Variables are a very complex topic and were briefly covered regarding inheritance in this chapter.

The next chapter will go further into detail about variables, including the types of variables and their uses.

Points to remember

Everything in UE5 is an object in addition to its derivation of the base object class.

Every class in UE5 inherits the functions, events, components and variables of its parent.

Functionality in UE5 is performed mostly through events.

The Material Editor has many similarities to the Blueprint editor, and it also has many differences.

Material Parameter Collection parameters are global and affect every material that uses them; Dynamic Material Parameters do not.

The Beginplay event runs when an object is initialized.

Tick occurs once every frame (by default).

Custom events can have custom input variables.

Actor components do not have valid transforms.

Multiple choice questions

What types of parameters do Material Parameter Collections use?

Vector and Transform

Float and Rotator

Enumerator and Scalar

Scalar and Vector

When does the Endplay event run?

When an object initializes

When an object is deleted

Once every frame

Every 10 seconds

What do you call the class immediately above another in the inheritance hierarchy?

The Parent Class

The Uncle Class

The Child Class

The Base Class

Answers

d

b

a

Questions

What can you not do within the construction script?

How do you set up a Dynamic Material?

What are the Material Domains?

Key terms

Blueprint Editor: The window used to edit a blueprint class

Material Editor: The window used to edit a material

Parameter: A variable used within a material

CHAPTER 7

Simple Data

This chapter will cover the basic types of data (ones that see regular use) used in UE5 (and programming in general), explain what each type is exactly, provide additional information about each type, and also discuss their uses and benefits, along with use cases. It will also cover how they can interact with each other (pin splitting and conversions).

Structure

In this chapter, we will discuss the following topics:

Variables in blueprint

Integers

Integer 64

Floats

Doubles

Booleans

Strings

Name

Text

Vectors

Axes

Rotators

Pin splitting

Conversions

Objectives

After studying this chapter, you should know all the variables commonly used in UE5, how to set up variables within blueprints, and how these variables can be converted and broken down.

Variables in blueprint

Blueprint objects can contain variables within themselves. They are displayed/accessible in the Variables section of the My Blueprint panel in the blueprint editor (in the bottom left by default), as shown in Figure 7.1:

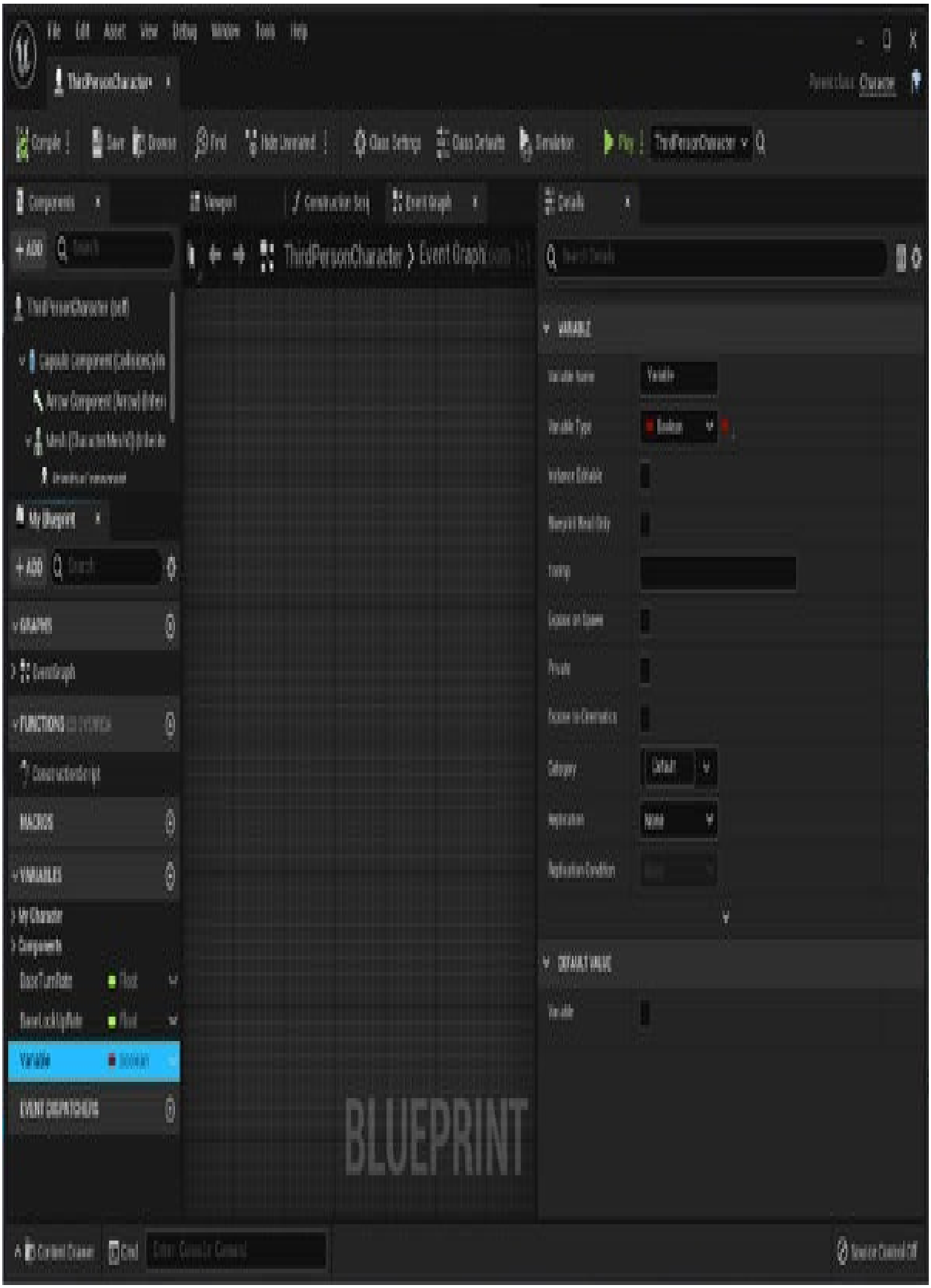

File Edit Asset View Debug Window Tools Help
ThirdPersonCharacter
Compile
Save
Browse
Find
Hide Unrelated
Class Settings
Class Defaults
Simulation
Play
Components
Viewport
Construction Script
Event Graph
Details
ADD
ThirdPersonCharacter > Event Graph
My Blueprint
GRAPHS
EventGraph
FUNCTIONS
MACROS
VARIABLES
My Character
Components
Variable
EVENT DISPATCHERS
VARIABLE
Variable Name
Variable Type
Boolean
Category
Default
Replication
None
DEFAULT VALUE
BLUEPRINT

Figure 7.1: Blueprint Editor with a variable selected

Once a variable is selected, it can be modified in the “Details” Panel. Things that you can change include the name of the variable, the type of variable it is, whether it is public or private, whether or not it can be changed through blueprints, and its default value.

Integers (Ints)

An integer is a variable with a positive or negative whole numerical value. Integers are useful for situations where amounts (of whole numbers) are to be denoted. There are several mathematical operators for altering a provided integer, some of which are shown in Figure 7.2:

Integer
All Actions for this Blueprint
Context Sensitive
VARIABLE
Integer
Integer
% (integer)
Absolute (integer)
Bitwise AND
Bitwise NOT
Bitwise OR
Bitwise XOR
Clamp (integer)
Compare Int
Decrement Int
Increment Int
InRange (integer)
Make Literal Int
Make Literal Int 64
Variable Name
Integer
Variable Type
Integer
Instance Editable
Blueprint Read Only
Tooltip
Expose on Spawn
Private
Expose to Cinematics
Category
Default
Slider Range
Value Range
Bitmask
Bitmask Enum
Replication
None
Replication Condition
Compiler Results
DEFAULT VALUE
Integer
0
Clear

Figure 7.2: Integer Variable and some operators

Integer 64

When utilizing integers, you may notice another type of variable called Integer 64, which is rarely needed but is good to be aware of. Integer 64 is the same as a standard integer, with two key differences: integer 64 takes up more memory space than a standard integer but has a much larger maximum value (both positive and negative).

You likely won’t use Integer 64 variables often, but you may need to when you are dealing with incredibly high values. The additional memory cost mentioned is negligible with modern hardware, but the majority of UE5’s nodes still use Integers instead of Integer 64s (where applicable), so using an integer means that a conversion is not needed to use these nodes, which keeps things neater.

Floats

A float is another numerical variable, which, like integers, can be positive or negative. However, unlike integers, floats can contain decimal values. They are very commonly used as inputs in many nodes within UE5, particularly where time is involved. Figure 7.3 shows a float variable and two of the most common nodes that utilize the float variable type for inputs:

Event Tick
Delta Seconds
Delay
Completed
Duration 0.2
Float
Print String
In String Hello
Print to Screen
Print to Log
Text Color
Duration 2.0
Development Only
BLUEPRINT
VARIABLE
Variable Name
Float
Variable Type
Float
Instance Editable
Blueprint Read Only
Tooltip
Expose on Spawn
Private
Expose to Cinematics
Category
Default
Slider Range
Value Range
Replication
None
Replication Condition
DEFAULT VALUE
Float
0.0
3.61] Compile of ThirdPersonCharacter successful! [in 285 ms] (/Game/T

Figure 7.3: Float Variable and some nodes that use it

Doubles

Like integers, floats have a variable that is almost identical with a few exceptions: the Double. Floats can contain up to 7 digits, whereas a double can contain up to 15, meaning that Doubles are more accurate than Floats are, but at a slightly increased performance/memory cost.

As with Integers and Integer 64s, Floats are used much more commonly than Doubles, but Doubles may be required when dealing with incredibly small/accurate numbers. As with Integer 64s, the additional memory cost mentioned is negligible with modern hardware, but the majority of UE5's nodes still use floats instead of Doubles (where applicable), so using a float means that a conversion is not needed to use these nodes.

Booleans (Bools)

A Boolean variable can only contain one of two values: True and False. Booleans are very useful for having functionality branch into different potential outcomes based on the state of the game, and an example of this logic is shown in Figure 7.4:

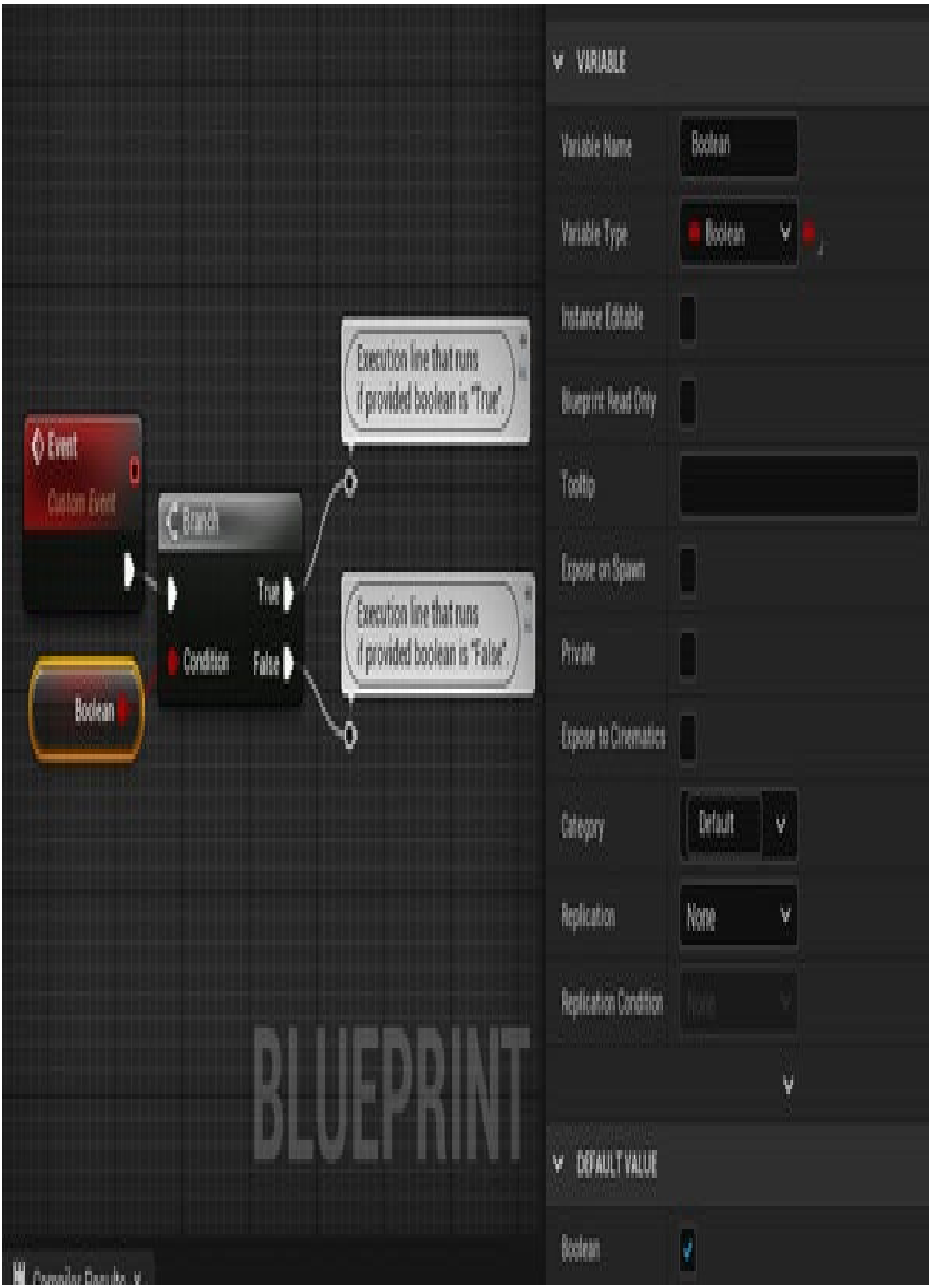

VARIABLE
Variable Name
Boolean
Variable Type
Boolean
Instance Editable
Blueprint Read Only
Tooltip
Expose on Spawn
Private
Expose to Cinematics
Category
Default
Replication
None
Replication Condition
Event
Custom Event
Branch
True
Condition
False
Boolean
Execution line that runs if provided boolean is "True".
Execution line that runs if provided boolean is "False".
BLUEPRINT
DEFAULT VALUE
Boolean

Figure 7.4: Bool Variable used with a branch node

Using Boolean operators covered in Chapter 2, Math For Game Design, Boolean conditions can become rather complex to accommodate multiple conditions within a game, as is done in Figure 7.5:

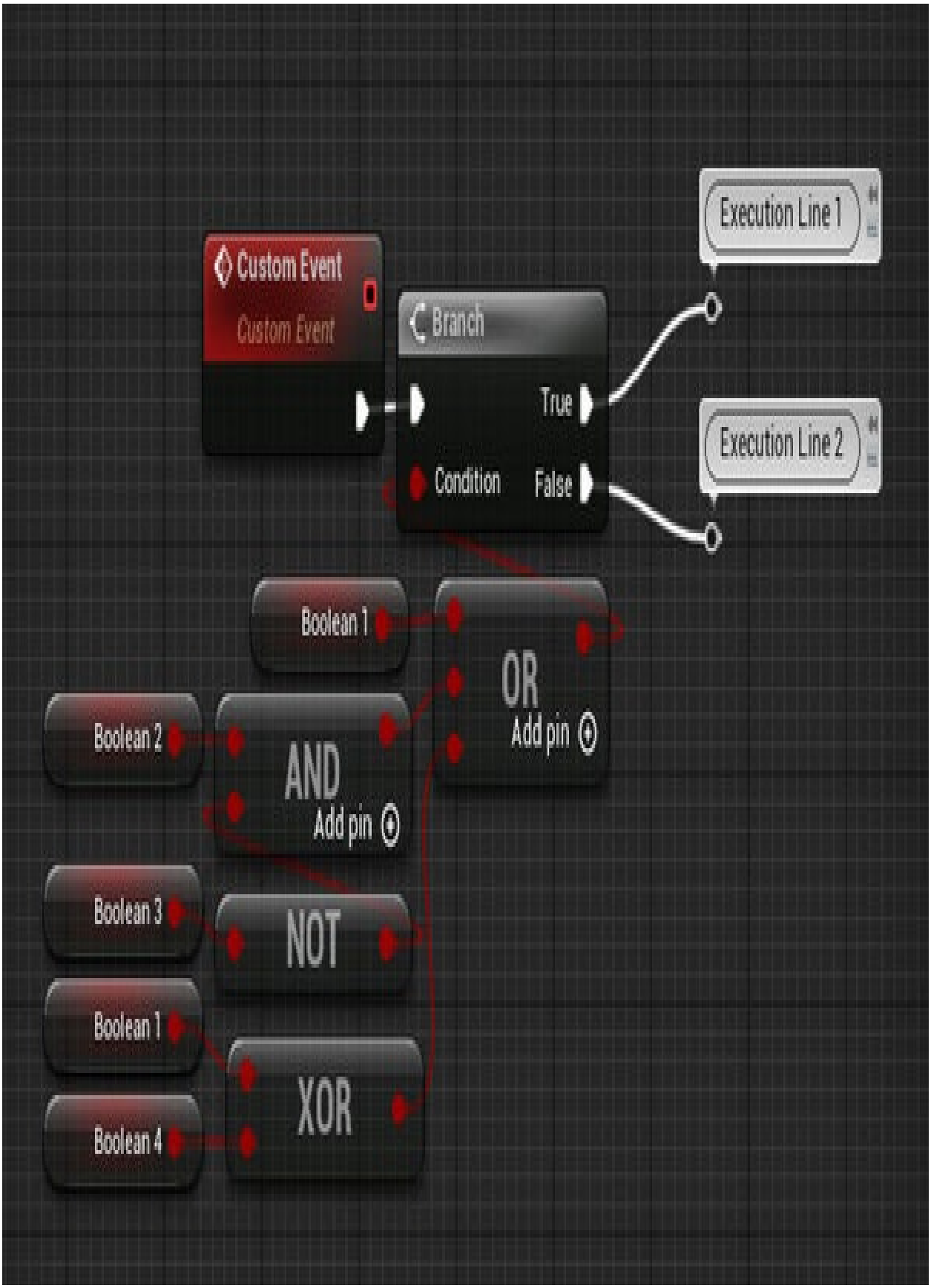

Custom Event
Custom Event
Branch
True
Condition
False
Execution Line 1
Execution Line 2
Boolean 1
Boolean 2
Boolean 3
Boolean 1
Boolean 4
AND
Add pin
NOT
XOR
OR
Add pin

Figure 7.5: Bool Variables and some operators in use

Strings

A string is a variable that can contain any combination of characters. Strings are most commonly used for printing information out to an output log and/or viewports via the Print String node, getting certain data regarding provided objects, and dealing with serialization, all of which can be seen in Figure 7.6:

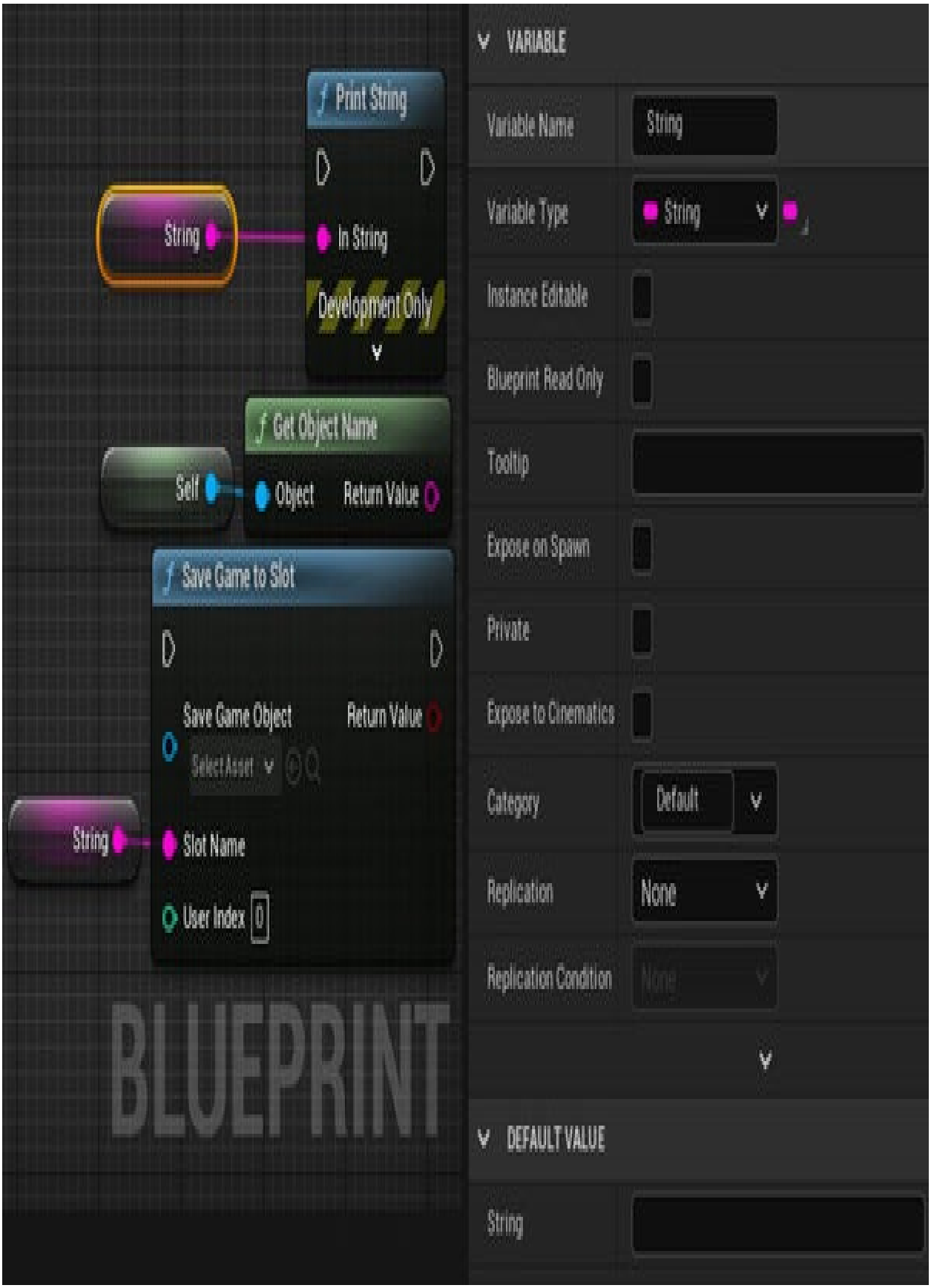

Print String
In String
Development Only
String
Get Object Name
Object
Return Value
Self
Save Game to Slot
Save Game Object
Return Value
Select Asset
Slot Name
User Index
0
String
BLUEPRINT
VARIABLE
Variable Name
String
Variable Type
String
Instance Editable
Blueprint Read Only
Tooltip
Expose on Spawn
Private
Expose to Cinematics
Category
Default
Replication
None
Replication Condition
None
DEFAULT VALUE
String

Figure 7.6: String variable and its common uses

While strings are the standard for text-based variables, there are two other similar variables, i.e., Name and Text, which have more specialized uses; they are mentioned below.

Name

Name variables are mostly used as descriptors within assets, such as bone or socket names in a skeleton asset, but they are also used in nodes directly involved with those assets, such as the Get all Socket names node.

Text

Text is similar to string, but Text variables are set up for localization, meaning it is very easy to have Text variables differ based on the user’s selected language.

Vector

A Vector is a variable consisting of three float values, each with an assigned axis (X, Y, or Z), which represents a location in a 3D space, but is sometimes used to represent directions, such as with the Get Forward Vector node:

Vector
Get Forward Vector
Target is Scene Component
Target
self
Return Value
Get Actor Forward Vector
Target is Actor
Target
self
Return Value
RotateVectorAroundAxis
In Vect
Return Value
X 0.0 Y 0.0 Z 0.0
Angle Deg 0.0
Axis
X 0.0 Y 0.0 Z 0.0
VectorLength
A
Return Value
X 0.0 Y 0.0 Z 0.0
Get Max Element
A
Return Value
X 0.0 Y 0.0 Z 0.0
BLUEPRINT
VARIABLE
Variable Name
Vector
Variable Type
Vector
Instance Editable
Blueprint Read Only
Tooltip
Show 3D Widget
Expose on Spawn
Private
Expose to Cinematics
Category
Default
Slider Range
Value Range
Replication
None
Replication Condition
None
DEFAULT VALUE
Vector
0.0
0.0
0.0

Figure 7.7: Vector variable and some nodes that use it

In addition to standard Vectors that have three dimensions, there are also two- and four-dimensional Vector variable types available for use, which may be more appropriate to use depending on the situation.

Rotator

A Rotator is a variable consisting of three float values, each with an assigned axis (X, Y, or Z), which represents a three-dimensional Rotation. The X-Axis is Roll, the Y-Axis is Pitch, and the Z-Axis is Yaw. Each axis has a value between -180 and 180 degrees. This can be seen in the blueprint editor in addition to some nodes utilizing rotators in Figure 7.8:

Rotator
Find Look at Rotation
Start
Return Value
Target
Lerp (Rotator)
A
Return Value
X 0.0 Y 0.0 Z 0.0
B
X 0.0 Y 0.0 Z 0.0
Alpha 0.0
Shortest Path
To Rotation (Vector4)
In Vec
Return Value
RotateVector
A
Return Value
X 0.0 Y 0.0 Z 0.0
B
X 0.0 Y 0.0 Z 0.0
BLUEPRINT
VARIABLE
Variable Name
Rotator
Variable Type
Rotator
Instance Editable
Blueprint Read Only
Tooltip
Expose on Spawn
Private
Category
Default
Slider Range
Value Range
Replication
None
Replication Condition
None
DEFAULT VALUE
Rotator
0.0
0.0
0.0

Figure 7.8: Rotator variable and some nodes that use it

A visual representation of a rotator can be seen in Figure 7.9; Blue represents the Z-axis (Yaw), Red represents the X-axis (Roll), and Green represents the Y-axis (Pitch):

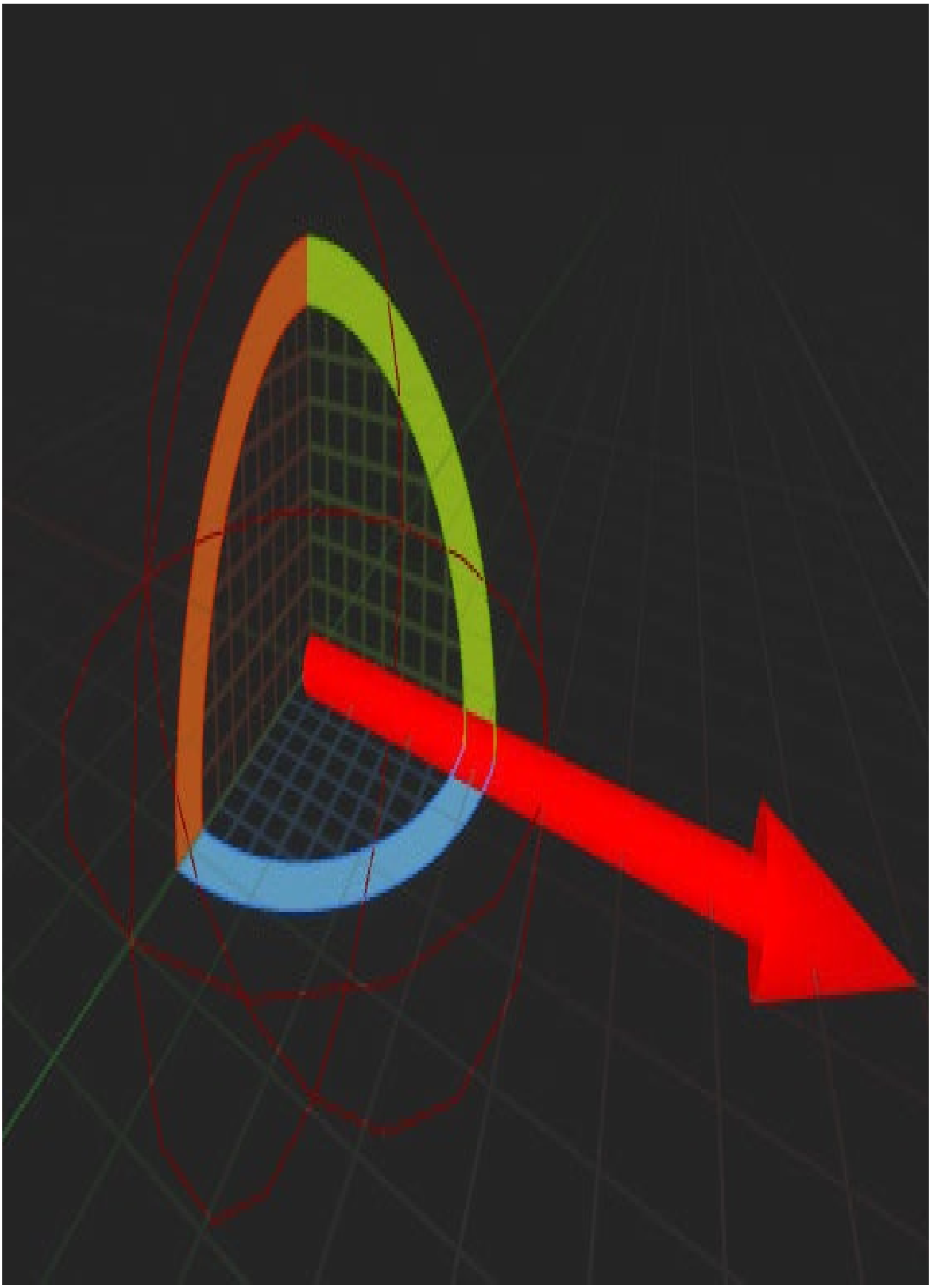


Figure 7.9: Rotator Axes (Blue= Z/Yaw, Red = X/Roll, Green = Y/Pitch)

Pin splitting

Variables that consist of multiple values can be split into the values that comprise it, allowing each one to be dealt with separately. This is done by right-clicking on the output of such a variable and selecting Split Struct Pin, as shown in Figure 7.10:

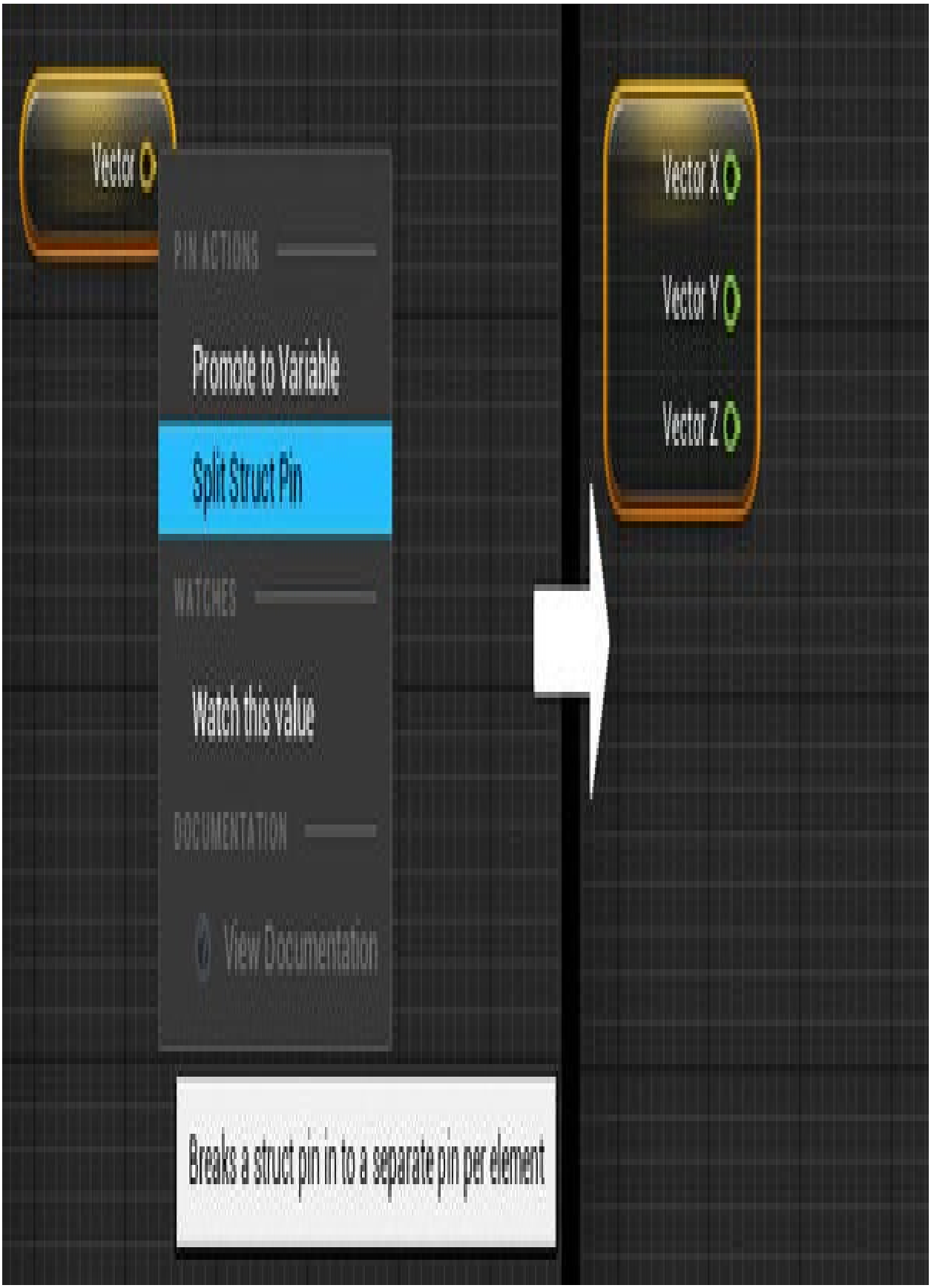

Vector
PIN ACTIONS
Promote to Variable
Split Struct Pin
WATCHES
Watch this value
DOCUMENTATION
View Documentation
Breaks a struct pin in to a separate pin per element
Vector X
Vector Y
Vector Z

Figure 7.10: Split Struct Pin on a Vector

Once a Struct pin has been split, they can be recombined by right-clicking on an element of the split Struct and selecting Recombine Struct Pin.

Conversions

Variable types that contain similar data, such as floats and ints, can be converted into each other by using a conversion node or by applying whatever mathematical processes are necessary to do so, such as rounding a float (Removing its decimals) to convert it to an int where necessary; both of these can be seen in Figure 7.11:

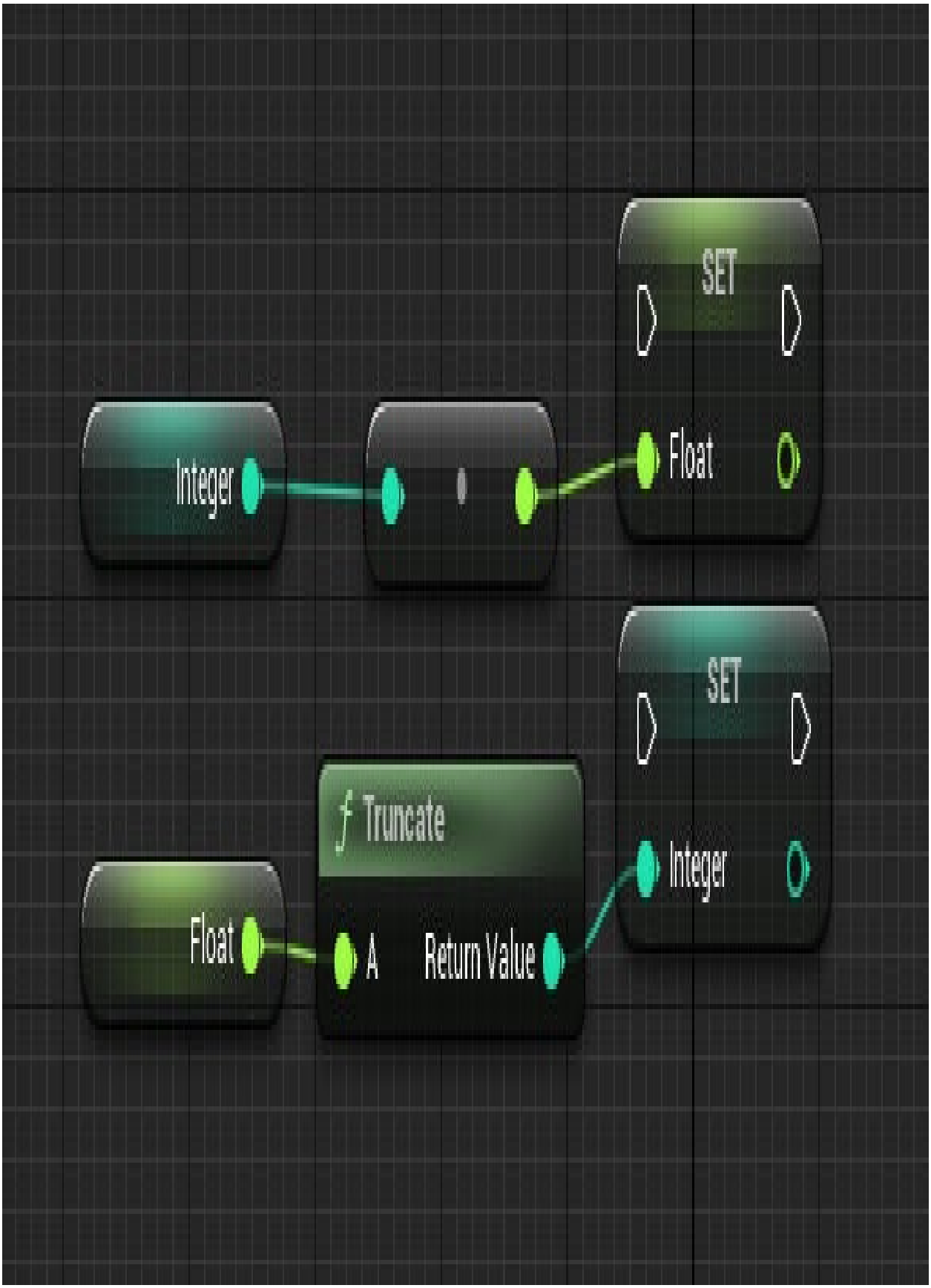

SET
Integer
Float
SET
Truncate
Integer
Float
A
Return Value

Figure 7.11: Converting Variables

Conclusion

There are many types of variables available to use in Unreal Engine, and they can be made to interact with each other through math, conversions, and splitting. These variables have traits specific to them that need to be known to utilize them properly, and many have similar variable types that may be better suited to a specific situation. Programming relies on mathematical knowledge and aptitude because of the large number of different variable types and the functions required in order to use them to suit your needs.

Variables can be rather large, being composed of multiple sub-variables as in the case of vectors and rotators, or they can be simple single numeric values, as with integers. Knowing which specific variable type to use in a given situation is incredibly important for keeping a project neat and not overcomplicating any mathematics you do while programming. Mathematical errors and inefficiencies often lead to instability and poor performance, and thus, must be avoided.

The next chapter will cover interfaces and event handling, which is a method of communication between objects.

Points to remember

Programming relies heavily on mathematics.

There are several functions for each specific variable type.

Integer 64s take up more memory than standard Integer but can have larger values.

Doubles take up more memory space than floats but are more accurate.

Many variable types have similar variable types for more specific uses.

Some variables are composed of other variable types.

Poor mathematical work when programming will cause issues.

Multiple choice questions

How many digits can a double contain?

7

17

14

15

What variable type are the axes in a vector?

Integer

Double

Float

Boolean

What axis represents theYawof a rotator?

The X axis

The Y axis

The Z axis

Answers

d

c

c

Questions

What is a struct?

What is localization?

What might you use a four-dimensional vector for?

Key terms

Struct: A collection of variables

Pin: The input/output instance of a variable on a node

Degrees: The unit used to measure rotations

CHAPTER 8

Interface and Event Handling

This chapter is all about understanding and using events in Unreal Engine 5. The event handlining knowledge and programming is a skill in game programming and directly works on the Timing and Actions that players observe when running game on their machine. A simple example of event is pressing space bar to jump in Tomb Raider. The Jump event is a code, which will run after a player presses the space bar and the character animation responds to it. You, (as an event programmer) need to define this code in Unreal Engine and run proper procedure after player fire it.

To learn this, we will go through the basics of event programming in engine and then learn ab advanced topic in event programming: interface.

At the end, we will go over the basics of physical-based events in the engine, which is one of the most magnificent features of Unreal Engine 5.

Structure

In this chapter, we will discuss the following topics:

What is the event in Unreal Engine 5?

Using event dispatchers

Using interface

Using physics (advanced)

Objectives

After studying this chapter, you should be able to make custom event in blueprint and directly call them with an instance of belonged actor class. You should also know how to use casting and call events on target objects by using Line Trace tool in the engine. Additionally, you should be familiar with the basics of interface implementations in blueprint by making examples. We will also go through using and apply physical impulse to spawned objects in this chapter, and we will learn how to make ice cubes out of cube objects in the scene. The last one is supported by physical material simulation in Unreal Engine 5.

To learn the topics covered in this chapter, make a new third-person template project as mentioned in the previous chapters. Then, we will expand this project step by step with coding and features involved in blueprint programming.

What is the event in Unreal Engine 5?

Let’s say, everything is working with events in Unreal Engine. The event is like a caller or beginner that you can assign and address to a series of Actions in you game. Very simple example, you press mouse and it causes the gun shoot in Fortnight, or you press Spacebar and the player jumps in Tomb Raider. Both the click of a mouse and pressing the space bar are firing an event each inside the engine, and then the engine Activates the proper procedure, like shoot or jump.

Well, you may be surprised of how simple events like Collision or Begin Play and Tick can handle everything in engine, and you are right: the true power of a blueprint programmer is how to create new events inside the engine and address them to control the sequence of Actions in game during runtime. The Collision event and Tick and Begin Play are Default events on each blueprint, which are fired by default. The developer needs to add new events to blueprint object and design the sequence of running the scenario of game. We will practice this during the most part of this chapter by making simple interaction between blueprint objects.

To make a new event, right-click in event graph and type custom event; then, select the Custom Event block from the list, as shown in Figure 8.1:

ThirdPersonCharacter > Event Graph
first right click and type “custom”
All Actions for this Blueprint
Context Sensitive
custom
Add Component
Custom
Add Steam VRTracking References
Rendering
Add Custom Mesh Component
Add Event
Add Custom Event...
Event UpdateCustomMovement
Custom
Add Data WithLayer
Add Data WithSelector
Custom Attributes
Get Float Attribute (Mesh)
Get Float Attribute Ref (Mesh)
Get Integer Attribute (Mesh)
Then click on “Add Custom Event”

Figure 8.1: Make new custom event in Unreal Engine 5

After you click on Custom Event in the list, the engine automatically makes a new event block and places it on event graph, as shown in Figure 8.2. Press the Compile button at the top:

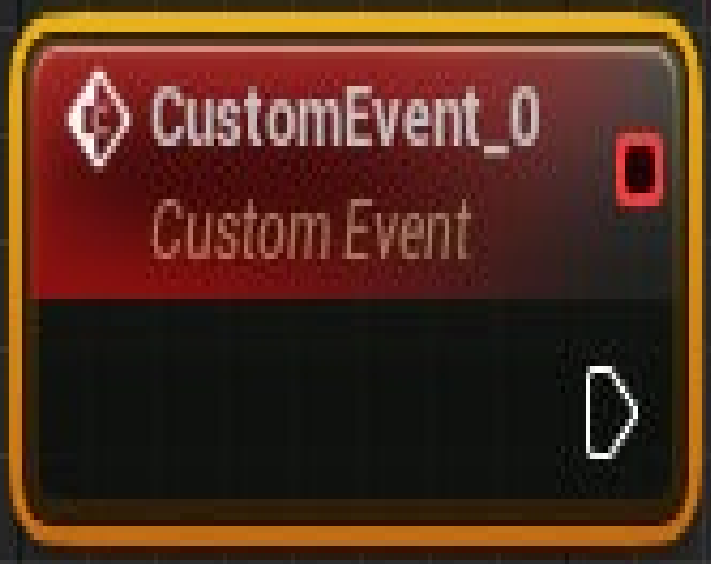

CustomEvent_0
Custom Event

Figure 8.2: Default new custom event block which placed in event graph

You can rename this event from the Details panel in the Name field, as shown in Figure 8.3:

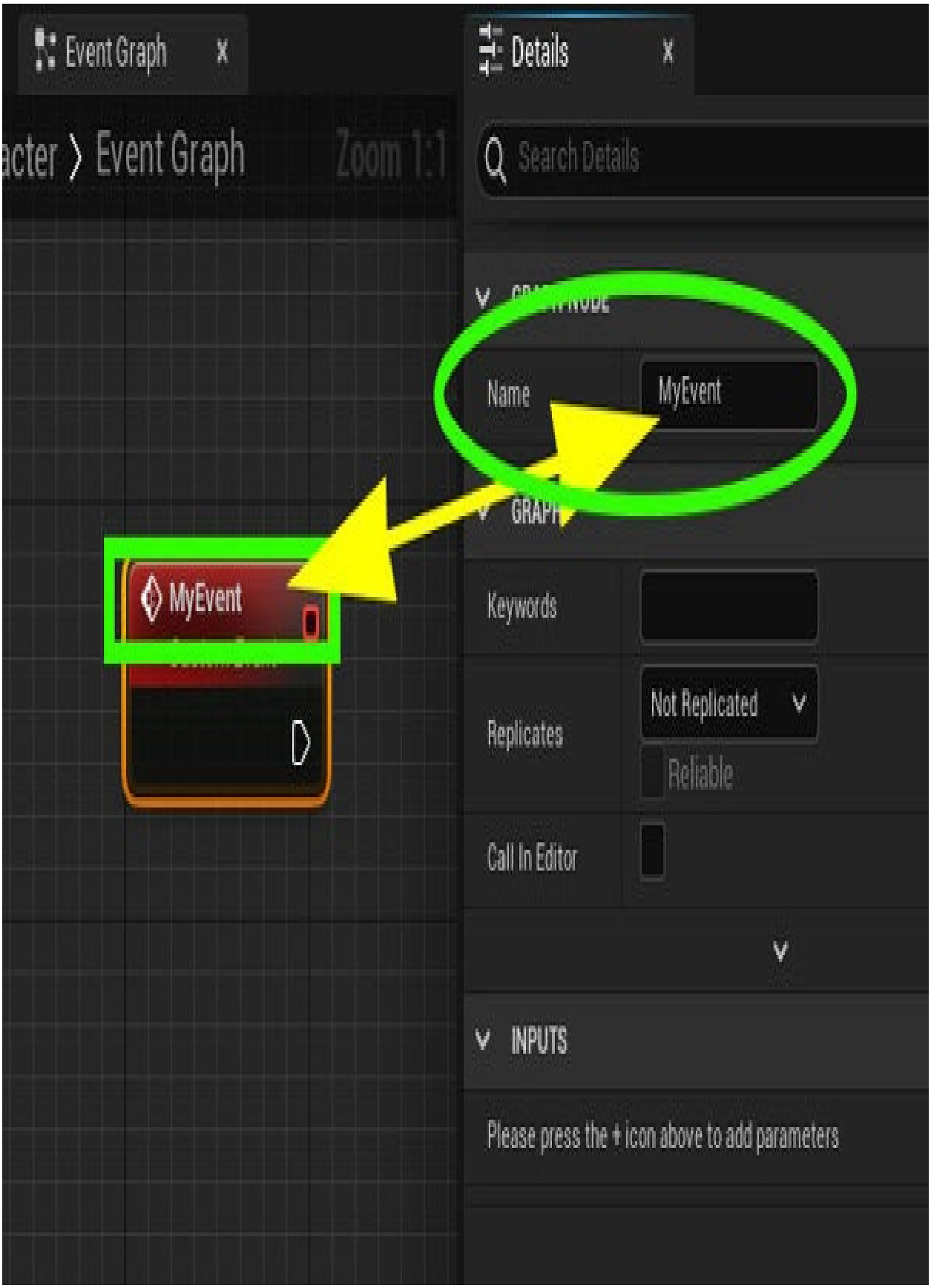

Event Graph
Details
acter 〉 Event Graph
Zoom 1:1
Search Details
Name
MyEvent
GRAPH
MyEvent
Keywords
Replicates
Not Replicated
Reliable
Call In Editor
INPUTS
Please press the + icon above to add parameters

Figure 8.3: Rename custom event from “CustomEvent_0” to “MyEvent” by using “Name” field in Details panel

Now, let’s try using events by creating two different game assets, a light source, and a switch to control it. Refer to Chapter 5, Project Templates and User Interaction; let’s make a simple game asset as an actor blueprint that contains a light source, as illustrated in Figure 8.4. BP_Light_01 is an actor blueprint and has a PointLight blueprint component with intensity 2400, which makes a source of red light in the scene, and it has two Plane static mesh components:

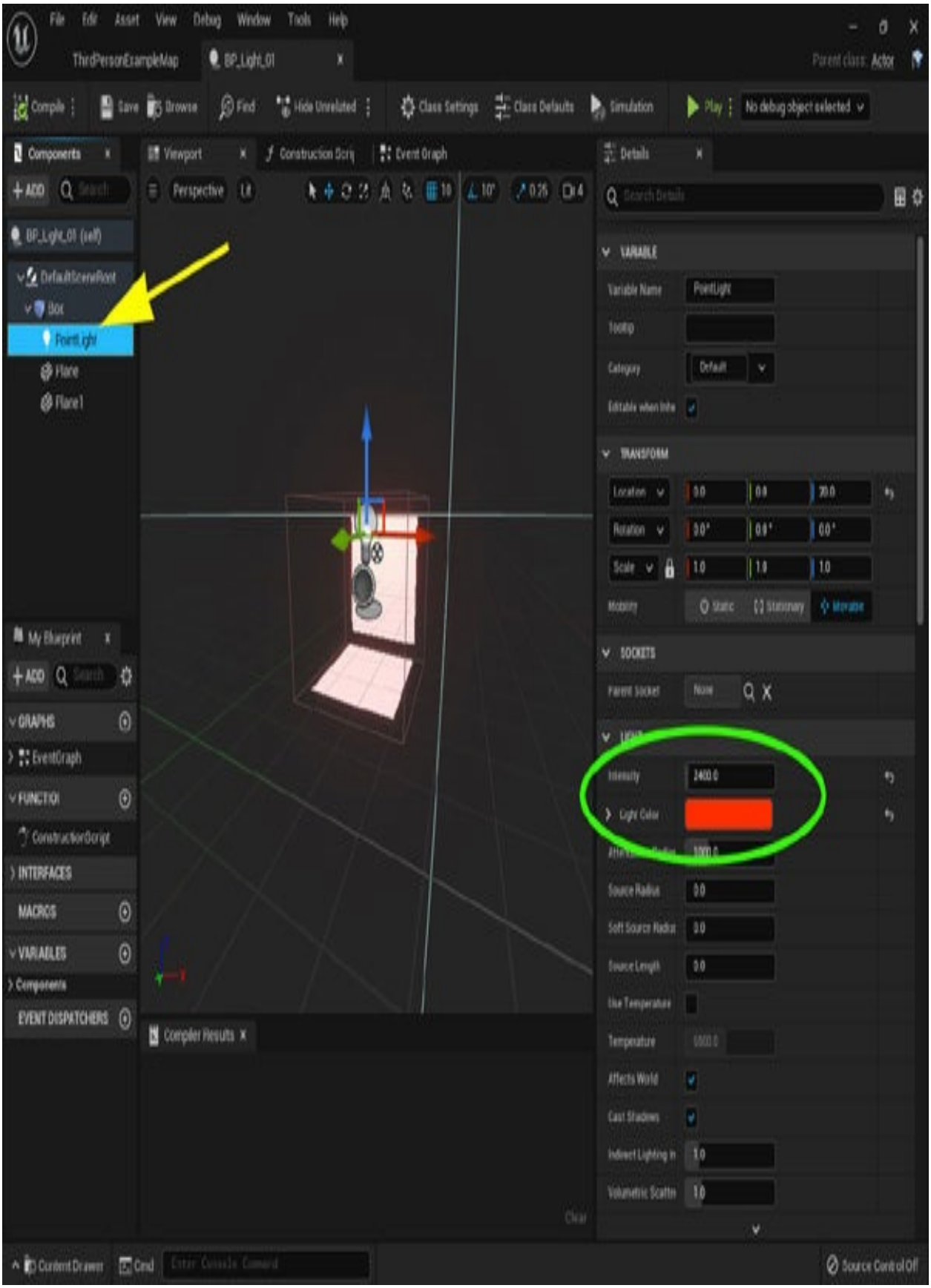

File
Edit
Asset
View
Debug
Window
Tools
Help
ThirdPersonExampleMap
BP_Light_01
Parent class: Actor
Compile
Save
Browse
Find
Hide Unrelated
Class Settings
Class Defaults
Simulation
Play
No debug object selected
Components
Viewport
Construction Script
Event Graph
Details
Perspective
BP_Light_01 (self)
DefaultSceneRoot
Box
PointLight
Flare
Flare1
VARIABLE
Variable Name
PointLight
Tooltip
Category
Default
Editable when Inhe
TRANSFORM
Location
Rotation
Scale
Mobility
Static
Stationary
Movable
SOCKETS
Parent Socket
None
LIGHT
Intensity
2400.0
Light Color
Source Radius
Soft Source Radius
Source Length
Use Temperature
Temperature
Affects World
Cast Shadows
Indirect Lighting In
Volumetric Scatte
My Blueprint
GRAPHS
EventGraph
FUNCTIO
ConstructionScript
INTERFACES
MACROS
VARIABLES
Components
EVENT DISPATCHERS
Compiler Results
Clear
Content Drawer
Cmd
Enter Console Command
Source Control Off

Figure 8.4: Point Light component properties in BP_Light_01 blueprint components

To support switching light source, as shown in Figure 8.5, we make two custom events LightSwitch_ON and LightSwitch_OFF in the event graph; these events change the intensity of PointLight from 2400 to 0 by using the Set Intensity blueprint command:

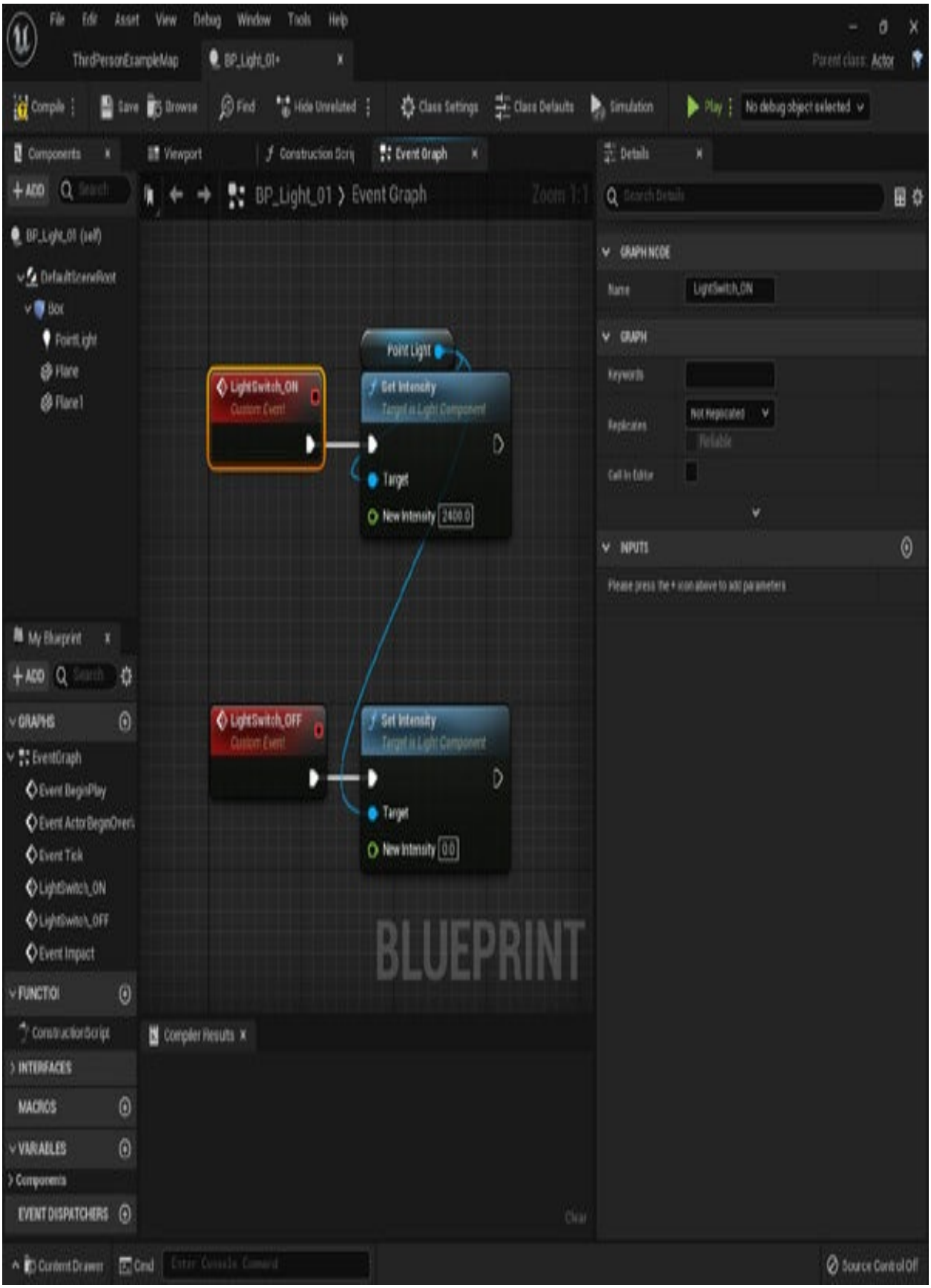

File Edit Asset View Debug Window Tools Help
ThirdPersonExampleMap
BP_Light_01*
Parent class: Actor
Compile
Save
Browse
Find
Hide Unrelated
Class Settings
Class Defaults
Simulation
Play
No debug object selected
Components
Viewport
Construction Script
Event Graph
Details
BP_Light_01 (self)
DefaultSceneRoot
Box
PointLight
Flare
Flare1
BP_Light_01 > Event Graph
Zoom 1:1
LightSwitch_ON
Custom Event
Point Light
Set Intensity
Target is Light Component
Target
New Intensity
2400.0
LightSwitch_OFF
Custom Event
Set Intensity
Target is Light Component
Target
New Intensity
0.0
BLUEPRINT
GRAPH NODE
Name
LightSwitch_ON
GRAPH
Keywords
Replicates
Not replicated
Reliable
Call In Editor
INPUTS
Please press the + icon above to add parameters
My Blueprint
GRAPHS
EventGraph
Event BeginPlay
Event ActorBeginOver
Event Tick
LightSwitch_ON
LightSwitch_OFF
Event Impact
FUNCTIONS
ConstructionScript
INTERFACES
MACROS
VARIABLES
Components
EVENT DISPATCHERS
Compiler Results
Clear
Content Drawer
Cmd
Enter Console Command
Source Control Off

Figure 8.5: Using two custom events to switch point light component

The next blueprint BP_Switch_01 is a switch to control light source; as shown in Figure 8.6, it has a Text Render component to show its name and a Box Collision that covers a Plane static mesh component in which a user can walk in and out:

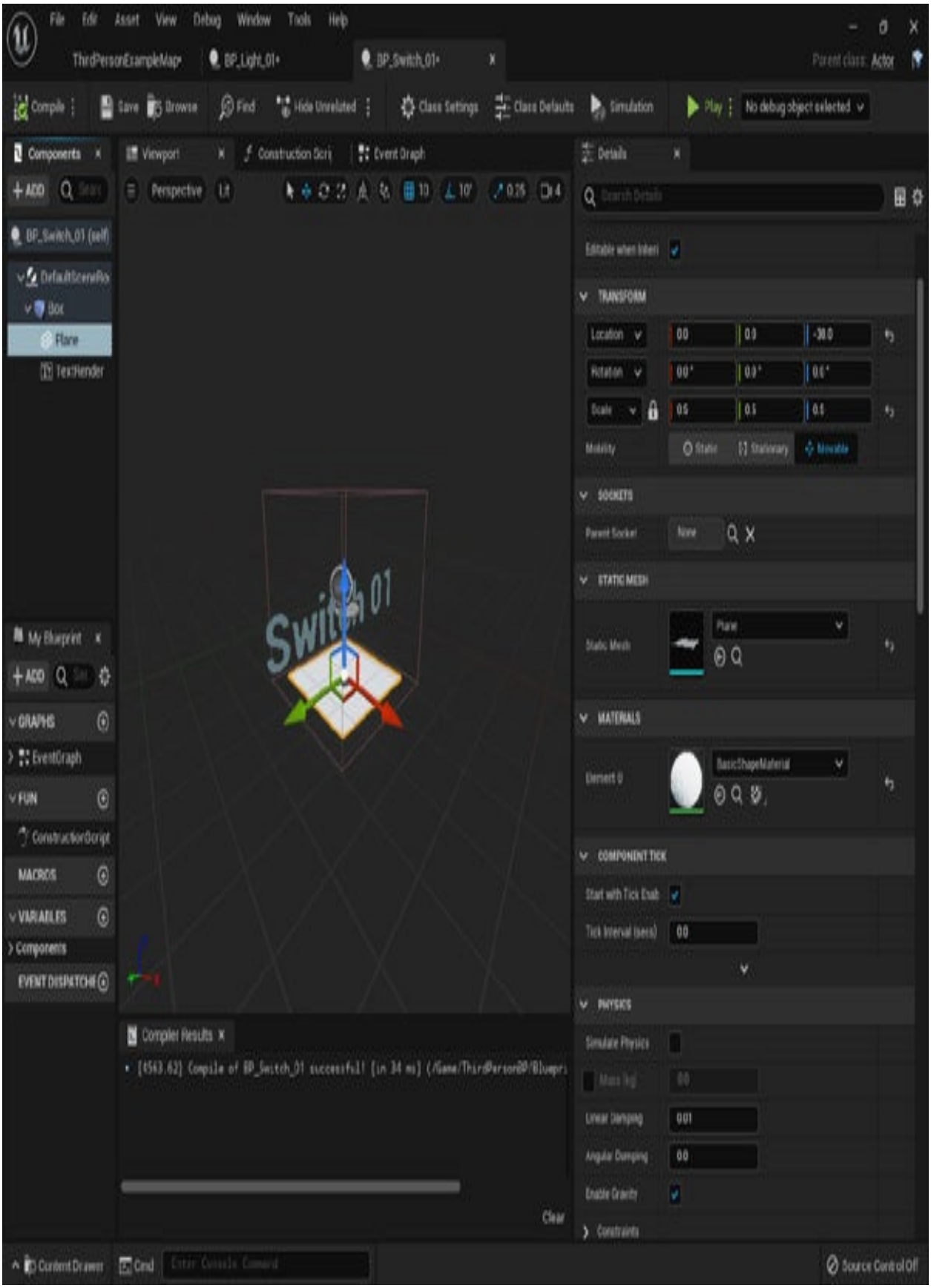

File Edit Asset View Debug Window Tools Help
ThirdPersonExampleMap
BP_Light_01*
BP_Switch_01*
Parent class: Actor
Compile
Save
Browse
Find
Hide Unrelated
Class Settings
Class Defaults
Simulation
Play
No debug object selected
Components
Viewport
Construction Scri
Event Graph
Details
ADD
BP_Switch_01 (self)
DefaultSceneRo
Box
Flare
TextRender
Perspective
Lit
Editable when Inheri
TRANSFORM
Location
Rotation
Scale
Mobility
Static
Stationary
Movable
SOCKETS
Parent Socket
None
STATIC MESH
Static Mesh
Plane
MATERIALS
Element 0
BasicShapeMaterial
COMPONENT TICK
Start with Tick Enab
Tick Interval (secs)
PHYSICS
Simulate Physics
Linear Damping
Angular Damping
Enable Gravity
Constraints
My Blueprint
GRAPHS
EventGraph
FUN
ConstructionScript
MACROS
VARIABLES
Components
EVENT DISPATCHE
Switch 01
Compiler Results
[4563.62] Compile of BP_Switch_01 successful! [in 34 ms] (/Game/ThirdPersonBP/Bluepri
Clear
Content Drawer
Cmd
Enter Console Command
Source Control Off

Figure 8.6: Actor "BP_Switch_01" components

The event graph for this blueprint, as Figure 8.7 shows, has two events from Box Collision for begin overlap and end overlap. When the user collides with box collision component in the game, each of these events will get fired. On each, we grab the BP_Light_01 blueprint object from scene by using the Get All Actor from Class blueprint node, and then fire the proper event each to turn the light source on and off:

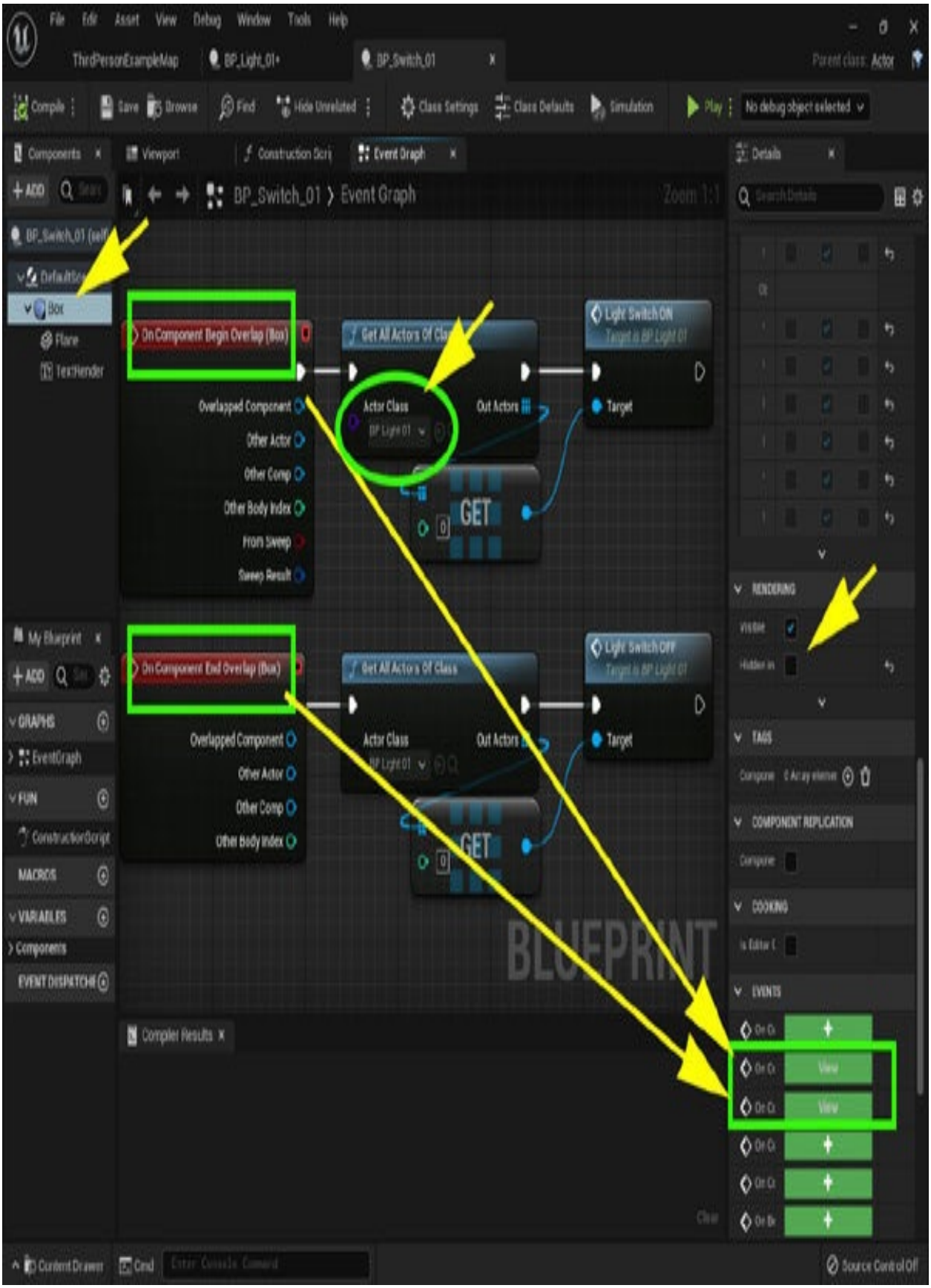

File Edit Asset View Debug Window Tools Help
ThirdPersonExampleMap
BP_Light_01+
BP_Switch_01
Parent class: Actor
Compile
Save
Browse
Find
Hide Unrelated
Class Settings
Class Defaults
Simulation
Play
No debug object selected
Components
Viewport
Construction Scri
Event Graph
Details
BP_Switch_01 > Event Graph
Zoom 1:1
BP_Switch_01 (self)
DefaultSc
Box
Flare
TextRender
On Component Begin Overlap (Box)
Overlapped Component
Other Actor
Other Comp
Other Body Index
From Sweep
Sweep Result
Get All Actors Of Cla
Actor Class
BP Light 01
Out Actors
GET
Light Switch ON
Target is BP Light 01
Target
RENDERING
Visible
Hidden in
My Blueprint
On Component End Overlap (Box)
Get All Actors Of Class
Light Switch OFF
Target is BP Light 01
GRAPHS
EventGraph
FUN
ConstructionScript
MACROS
VARIABLES
Components
EVENT DISPATCHE
TAGS
COMPONENT REPLICATION
COOKING
EVENTS
View
BLUEPRINT
Compiler Results
Clear
Content Drawer
Cmd
Enter Console Command
Source Control Off

Figure 8.7: Actor BP_Switch_01 event graph has two collision events from box collision. Each collision grabs an instance of "BP_Light_01" and activates custom events to switch the lights.

This is the most direct way of calling events on other blueprints, but there is a much easier way to make it. Now add one instance of each actor in the scene and run the game. When you collide with switch actor, the light source actor will activate and deactivate light, as shown in Figure 8.8:

Show
10
10°
0.25
4
Switch off
Third person

Figure 8.8: Making a simple scene in third person template and add light source and switch actors to the scene

Make another blueprint actor, BP_Light_02, like BP_Light_01 and change the light color to green, as shown in Figure 8.9:

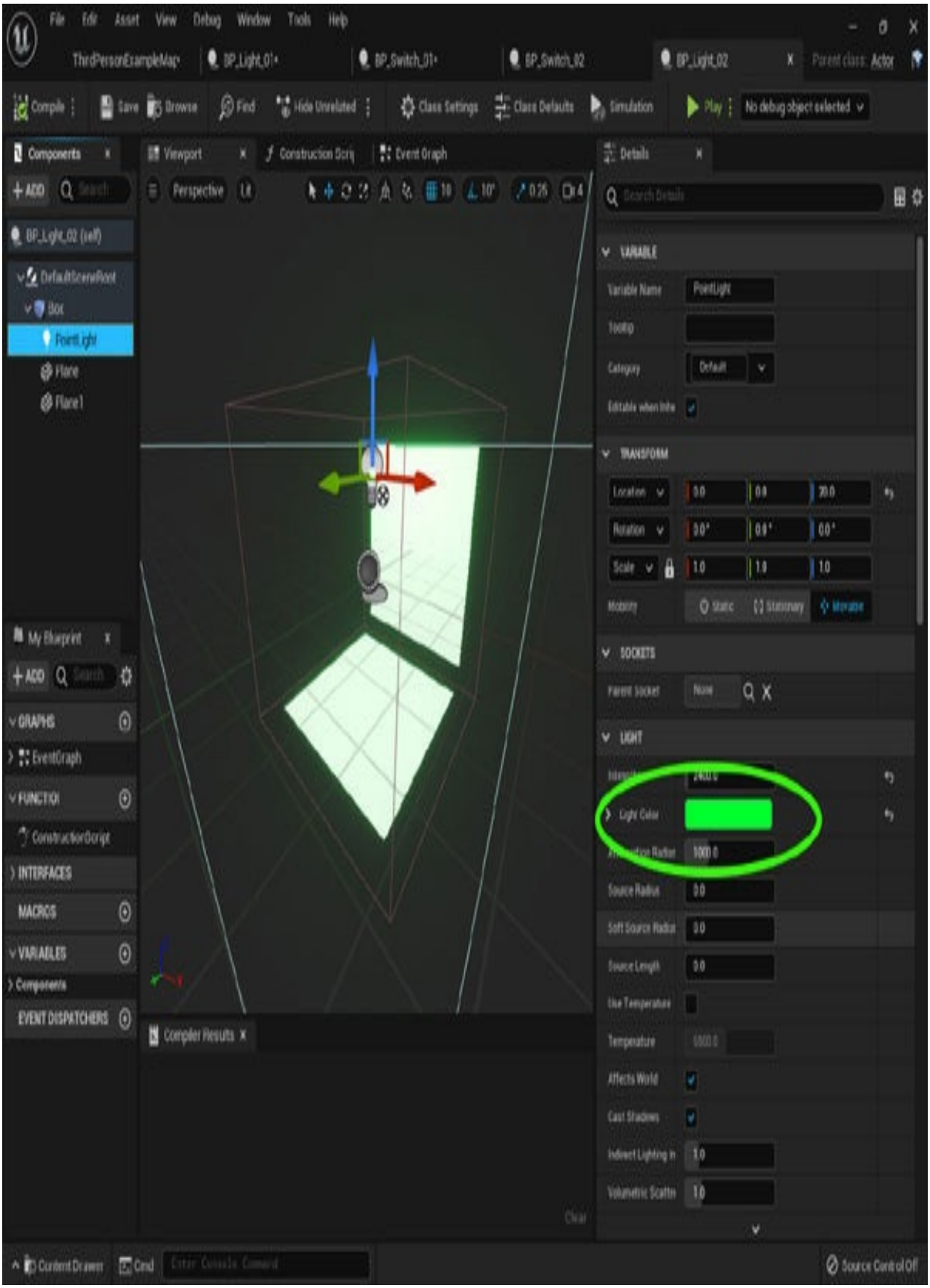

File Edit Asset View Debug Window Tools Help
ThirdPersonExampleMap
BP_Light_01
BP_Switch_01
BP_Switch_02
BP_Light_02
Parent class: Actor
Compile
Save
Browse
Find
Hide Unrelated
Class Settings
Class Defaults
Simulation
Play
No debug object selected
Components
Viewport
Construction Script
Event Graph
Details
Perspective
BP_Light_02 (self)
DefaultSceneRoot
Box
PointLight
Flare
Flare1
VARIABLE
Variable Name
PointLight
Tooltip
Category
Default
Editable when Inhe
TRANSFORM
Location
Rotation
Scale
Mobility
Static
Stationary
Movable
SOCKETS
Parent Socket
None
LIGHT
Light Color
Source Radius
Soft Source Radius
Source Length
Use Temperature
Temperature
Affects World
Cast Shadows
Indirect Lighting In
Volumetric Scatte
My Blueprint
GRAPHS
EventGraph
FUNCTIO
ConstructionScript
INTERFACES
MACROS
VARIABLES
Components
EVENT DISPATCHERS
Compiler Results
Clear
Content Drawer
Cmd
Enter Console Command
Source Control Off

Figure 8.9: Actor "BP_Light_02" viewport tab

Now let's make a different switch to control this light source. This technique is useful for simplifying blueprint code and design tools for designers. Right-click and duplicate BP_Switch_01 in the content browser and rename it as BP_Switch_02. Now, open its event graph and make a new public variable from BP_Light_02 in it; name it LightSource. We like to save an instance of BP_Light_02 in this variable. Keep in mind that you can make variables of all blueprint actors you made and use them in the blueprint code. Press the Compile button at the top, and then drag and drop an instance of this variable to event graph; as shown in Figure 8.10, you can directly call events from each one to control the light:

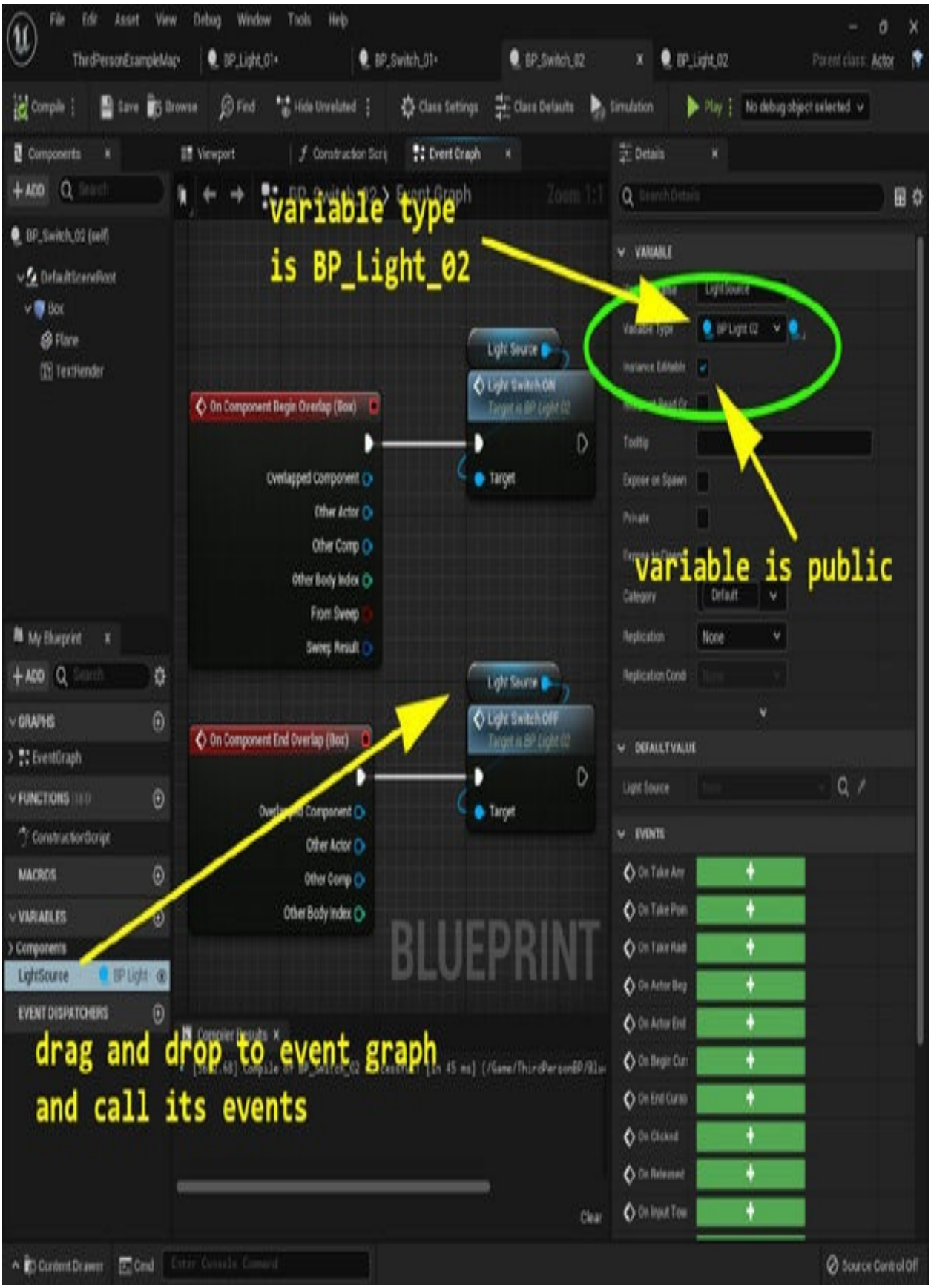

variable type
is BP_Light_02
variable is public
drag and drop to event graph
and call its events
BLUEPRINT

Figure 8.10: Make a public variable in "BP_Switch_02" to hold an instance of BP_Light_02 actor blueprint. Then use it to call events which control light.

After this, drag and drop BP_Switch_02 to the scene; as shown in Figure 8.11 and Figure 8.12, it has a public variable LightSource. Then, click on the Picker icon and then on BP_Light_02; now LightSource is assigned to BP_Light_02 on the scene, so the code will switch the light source on Box Collision. Play the game and check the results:

second, click on object
from that variable type
in the scene
Light 02
first click on
picker icon on the
right side of your
public variable

Figure 8.11: Assign value to a public variable in the scene

After clicking on object, double-check the name of picked object in your public variable LightSource:

DEFAULT
Light Source
BP_Light_02
RENDERING

Figure 8.12: The public variable would show the object name if it assigned correctly

If you forget to assign variable to LightSource, the engine will mostly throw an error message for None reference values, as shown in Figure 8.13, so keep in mind that you must “Always” address and assign your public blueprint variables in the scene or at begin play event inside that blueprint:

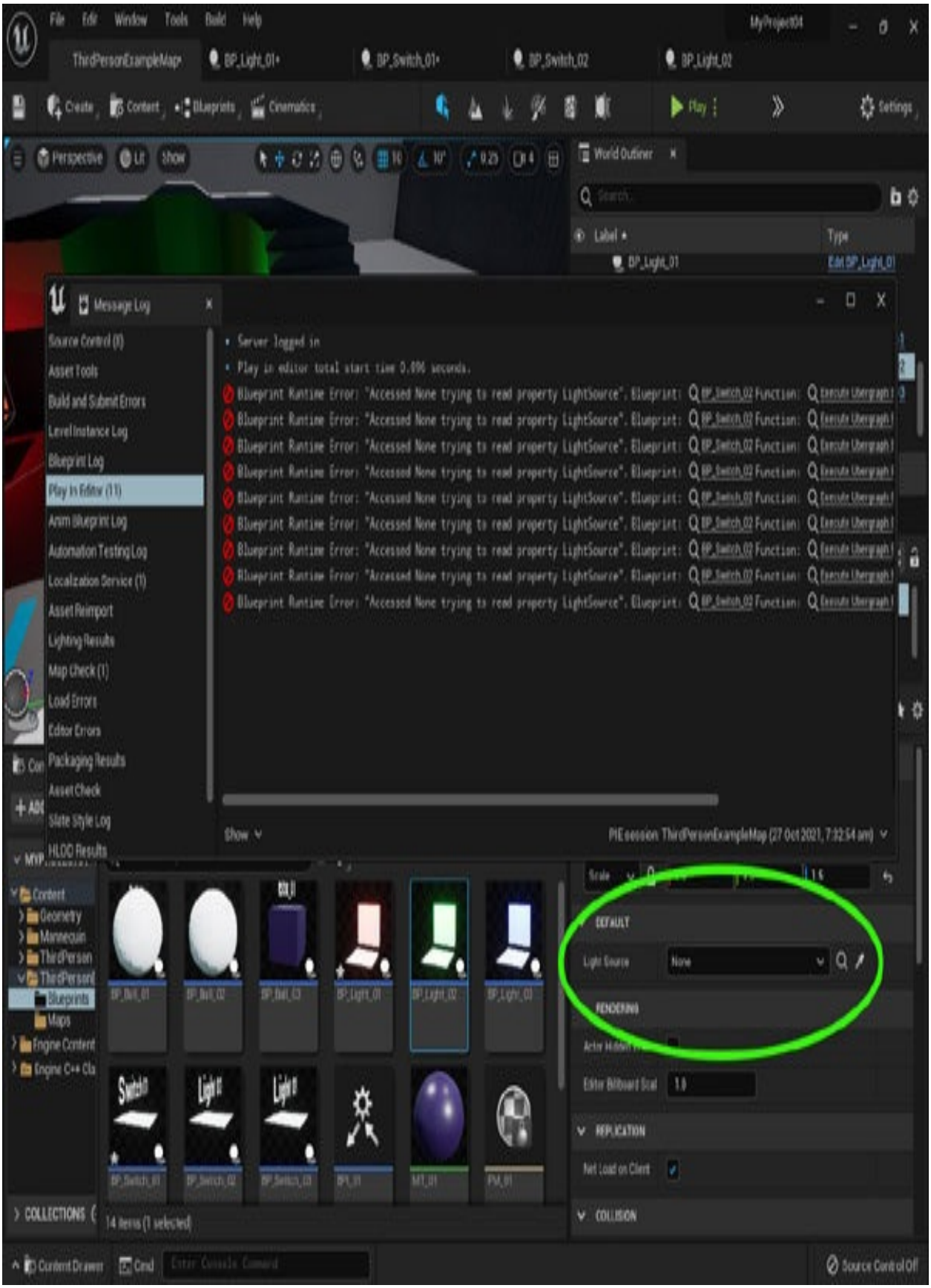

File Edit Window Tools Build Help
MyProject04
ThirdPersonExampleMap
BP_Light_01*
BP_Switch_01*
BP_Switch_02
BP_Light_02
Create
Content
Blueprints
Cinematics
Play
Settings
Perspective
Lit
Show
World Outliner
Label
Type
BP_Light_01
Edit BP_Light_01
Message Log
Source Control (0)
Asset Tools
Build and Submit Errors
Level Instance Log
Blueprint Log
Play In Editor (11)
Anim Blueprint Log
Automation Testing Log
Localization Service (1)
Asset Reimport
Lighting Results
Map Check (1)
Load Errors
Editor Errors
Packaging Results
Asset Check
Slate Style Log
HLOD Results
Server logged in
Play in editor total start time 0.096 seconds.
Blueprint Runtime Error: "Accessed None trying to read property LightSource". Blueprint: BP_Switch_02 Function: Execute Ubergraph
Show
PIEsession ThirdPersonExampleMap (27 Oct 2021, 7:32:54 am)
Content
Geometry
Mannequin
ThirdPerson
ThirdPerson
Blueprints
Maps
Engine Content
Engine C++ Cla
DEFAULT
Light Source
None
RENDERING
Editor Billboard Scal
REPLICATION
Net Load on Client
COLLISION
COLLECTIONS
14 items (1 selected)
Content Drawer
Cmd
Enter Console Command
Source Control Off

Figure 8.13: Error message when there is "None" assigned to public variable

Using event dispatchers

So far, we have learned how to create and use events very similar to functions. Now, let's learn another method of using events in Unreal Engine known as event dispatchers. In this method, the engine will Dispatch (or run) an event in the background from the object who broadcast it. This event is handled by the engine as a C++ delegate event, which means the engine assigned processing and memory resources for running it by compiler in the background. At the receiver of this event, a user has to assign a custom event to detect broadcasting of the event and handle the actions required for it.

To practice this, duplicate BP_Switch_02 in the content browser and rename it as BP_Switch_03. Then, open the event graph of this actor, locate EVENT DISPATCHERS in the My Blueprint tab, and as Figure 8.14 shows, add two new event dispatchers ActivateLight and DeActivateLight. Press the Compile button at the top. Then, drag and drop each of event dispatchers to the event graph and select Call from list. As you can see in Figure 8.14, the event dispatcher has a special icon attached to blueprint box. This makes it easier for developers to find event dispatchers in the code. Connect these two event dispatchers to begin overlap and end overlap events of the Box Collision component. Now, on each collision event with the Box Collision component, the BP_Switch_03 will dispatch a proper event:

3- connect events
to event dispatchers
1- click here to make
new event dispatcher
2- drag and drop event dispatcher
to event graph and choose "Call"

Figure 8.14: Making new event dispatchers and "call" them on Box collision component events

Now, event dispatchers from BP_Switch_03 need a little bit more work to activate light sources. Duplicate BP_Light_02 in content browser and change its name to BP_Light_03. Open it and change the light source color to blue. Then, switch to event graph and grab an instance of BP_Switch_03 by using the Get All Actors Of Class blueprint node in begin play and assign it to a variable named Switch, as shown in Figure 8.15:

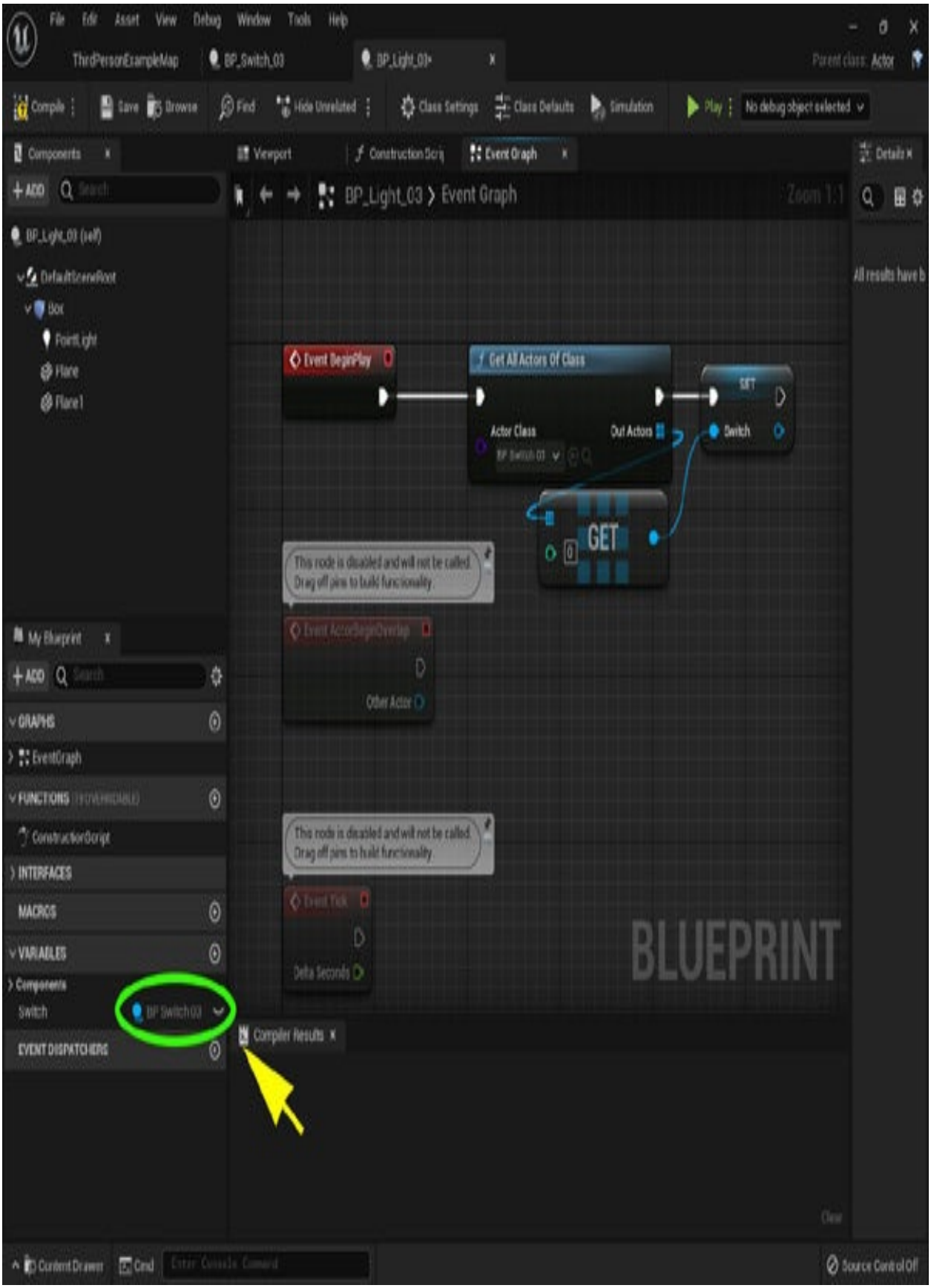

File Edit Asset View Debug Window Tools Help
ThirdPersonExampleMap
BP_Switch_03
BP_Light_03*
Parent class: Actor
Compile
Save
Browse
Find
Hide Unrelated
Class Settings
Class Defaults
Simulation
Play
No debug object selected
Components
Viewport
Construction Scrip
Event Graph
Details
BP_Light_03 > Event Graph
Zoom 1:1
BP_Light_03 (self)
DefaultSceneRoot
Box
PointLight
Flare
Flare1
Event BeginPlay
Get All Actors Of Class
Actor Class
Out Actors
SET
Switch
GET
This node is disabled and will not be called. Drag off pins to build functionality.
Event ActorBeginOverlap
Other Actor
This node is disabled and will not be called. Drag off pins to build functionality.
Event Tick
Delta Seconds
BLUEPRINT
My Blueprint
GRAPHS
EventGraph
FUNCTIONS
ConstructionScript
INTERFACES
MACROS
VARIABLES
Components
Switch
BP_Switch03
EVENT DISPATCHERS
Compiler Results
Content Drawer
Cmd
Enter Console Command
Source Control Off

Figure 8.15: Make a new variable from BP_Switch_03 type and grab a reference to it at event begin play

Then, drag an instance of the Switch variable to event graph, click on the blue pin, drag the blue line and release the mouse, and then type bind event to activate light. The engine automatically shows the Bind Event to Activate Light command, as shown in Figure 8.16. Please do “Not” press the Compile button at the top at this stage. (The engine may show error title on blueprint block, and the game will not run):

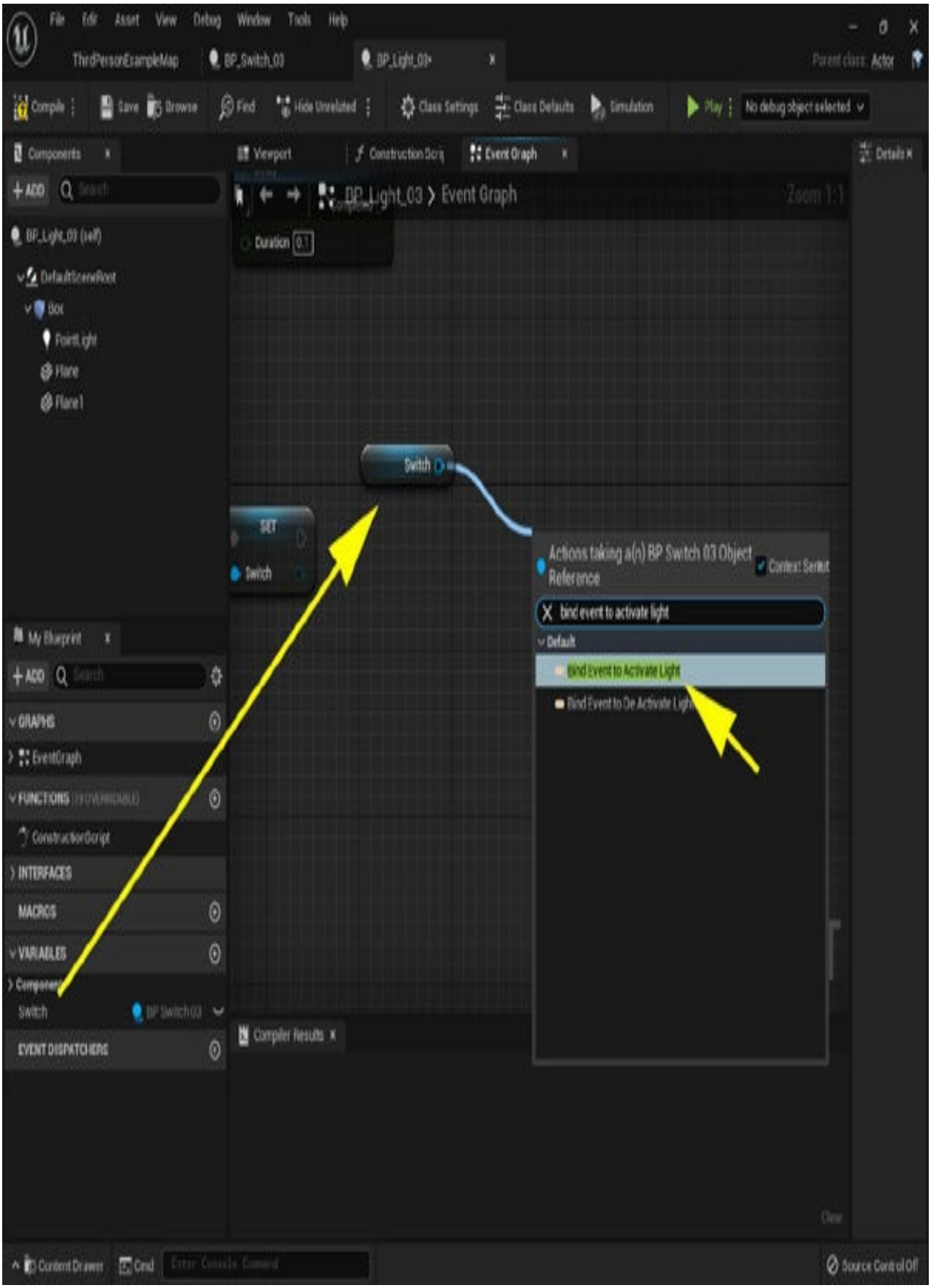

File Edit Asset View Debug Window Tools Help
ThirdPersonExampleMap
BP_Switch_03
BP_Light_03*
Parent class: Actor
Compile
Save
Browse
Find
Hide Unrelated
Class Settings
Class Defaults
Simulation
Play
No debug object selected
Components
Viewport
Construction Script
Event Graph
Details
BP_Light_03 > Event Graph
Zoom 1:1
Duration 0.1
BP_Light_03 (self)
DefaultSceneRoot
Box
PointLight
Flare
Flare1
Switch
SET
Switch
Actions taking a(n) BP Switch 03 Object Reference
Context Sensitive
bind event to activate light
Default
Bind Event to Activate Light
Bind Event to De Activate Light
My Blueprint
GRAPHS
EventGraph
FUNCTIONS
ConstructionScript
INTERFACES
MACROS
VARIABLES
Switch
BP Switch 03
EVENT DISPATCHERS
Compiler Results
Content Drawer
Cmd
Enter Console Command
Source Control Off

Figure 8.16: Drag and drop "Switch" variable to the event graph and bind an event to its event dispatchers

Select the Bind Event to ActivateLight, and the engine will automatically add the Bind Event to ActivateLight blueprint command to event graph. Then, click on and drag a red line from event pin, as shown in Figure 8.17, and then connect the red line to red pin of the LightSwitch_ON event. Now, press the Compile button at the top:

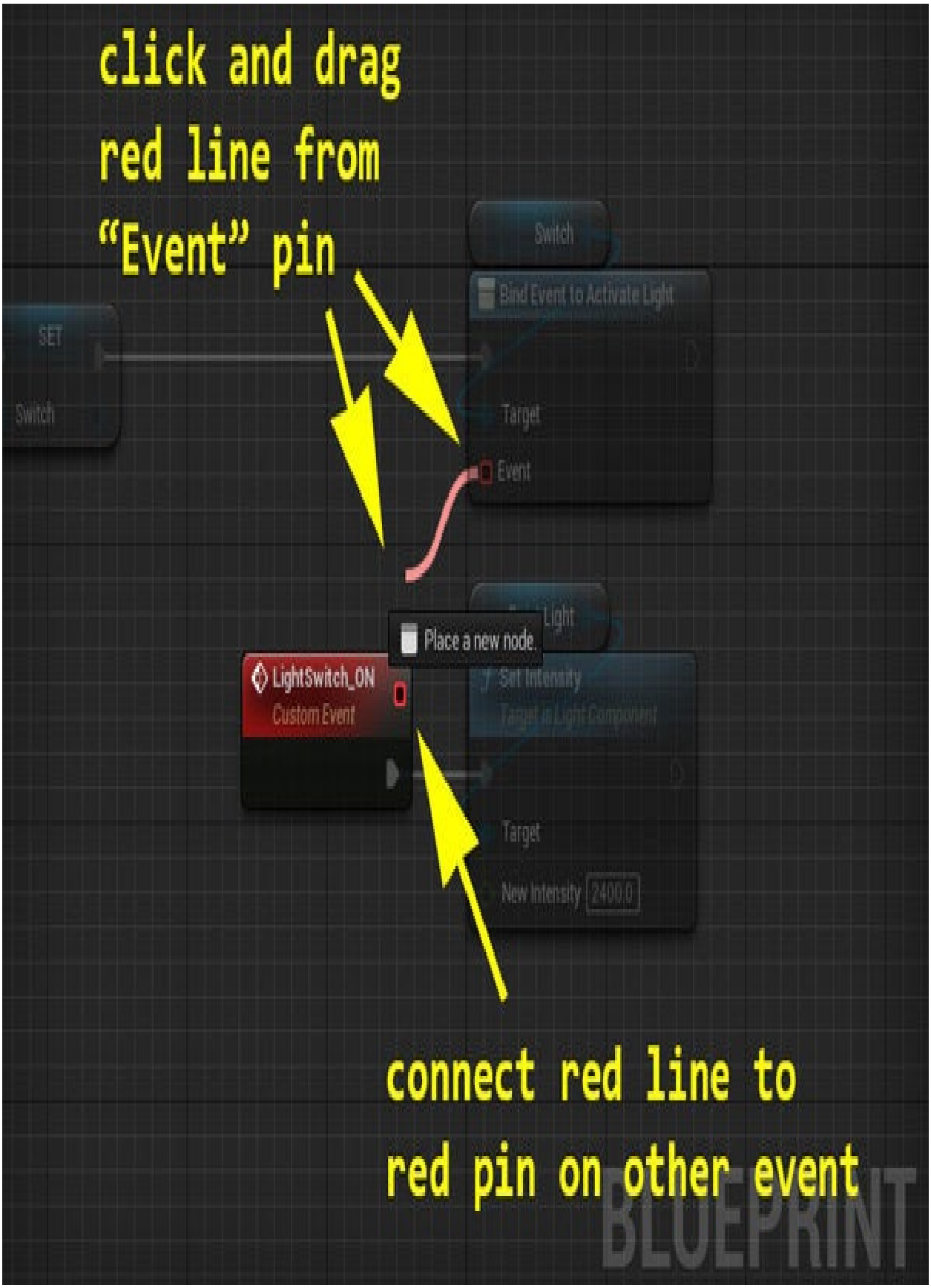

click and drag
red line from
"Event" pin
Switch
Bind Event to Activate Light
SET
Switch
Target
Event
Light
Place a new node.
LightSwitch_ON
Custom Event
Set Intensity
Target is Light Component
Target
New Intensity
2400.0
connect red line to
red pin on other event
BLUEPRINT

Figure 8.17: Drag and drop "Switch" variable to the event graph and bind an event to its event dispatchers

Follow the same procedure for Bind Event to DeActivateLight and Bind it (or connect events by using the red line) to the LightSwitch_OFF event. Your code should look like Figure 8.18 at the end of this procedure. When you run the code, BP_Switch_03 is dispatching an event on collision and the BP_Light_03, which already bind events to handle those event dispatchers from BP_Switch_03, will change the light source intensity:

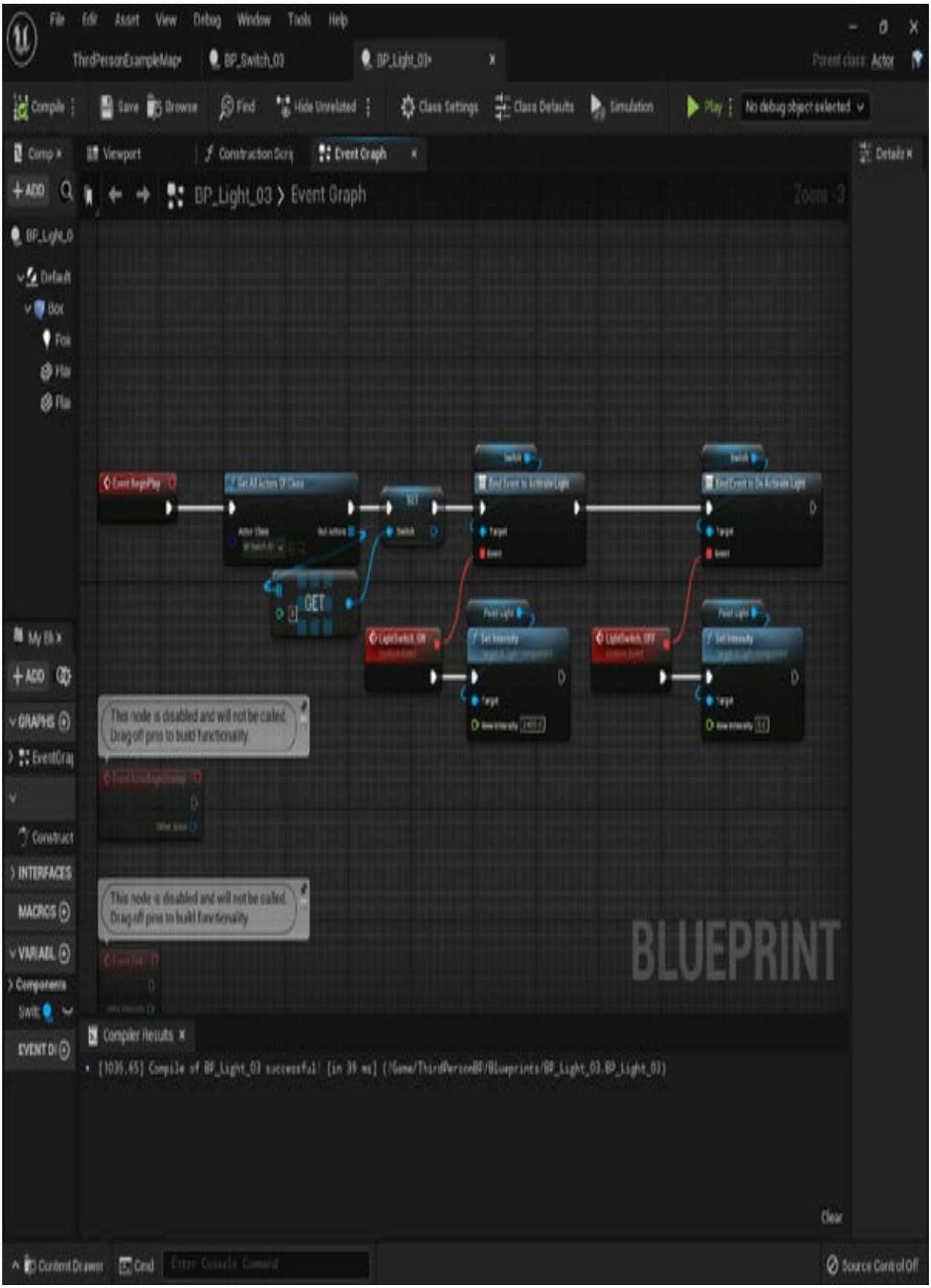

File Edit Asset View Debug Window Tools Help
ThirdPersonExampleMap
BP_Switch_03
BP_Light_03
Parent class: Actor
Compile
Save
Browse
Find
Hide Unrelated
Class Settings
Class Defaults
Simulation
Play
No debug object selected
Viewport
Construction Script
Event Graph
Details
BP_Light_03 > Event Graph
Zoom -3
Event BeginPlay
Set All Actors Of Class
Actor Class
Out Actors
GET
Switch
Find Event to Activate Light
Find Event to De Activate Light
Target
Event
Point Light
Set Intensity
LightSwitch_ON
LightSwitch_OFF
This node is disabled and will not be called. Drag off pins to build functionality
BLUEPRINT
GRAPHS
INTERFACES
MACROS
VARIABLES
Components
Compiler Results
[1036.65] Compile of BP_Light_03 successful! [in 39 ms] (/Game/ThirdPersonBP/Blueprints/BP_Light_03.BP_Light_03)
Clear
Content Drawer
Cmd
Enter Console Command
Source Control Off

Figure 8.18: Actor “BP_Light_03” event graph

Event dispatchers gave developers a nice way to broadcast events and data with all game objects in the scene at runtime. To communicate with the event dispatchers, you just need to bind your own events to the source of event dispatcher, as we did in the previous example. In the previous methods, used in BP_Switch_01 and BP_Switch_02, the sender directly grabs light source object in the scene and runs an event inside it, which means the sender must have a reference of target. However, when event despatcher runs an event, it doesn’t matter who the target is, each target can grab a copy of sender, bind an event to event dispatcher of it, and respond properly. This is the most important difference between direct call of an event and bind to event in Unreal Engine.

Using interface

Before looking at this topic in depth, we need to talk about how to use line trace and what casting is in blueprint programming.

Line Trace in blueprint

Using Line Tracing in game development is a powerful tool and has many usages, depending on the scenario of the game and the nature of the problem the developer wants to solve. Imagine that you have a laser pointer in your hand, as shown in Figure 8.19. Each time a user turns it on, a laser light goes from your hand to the object that the laser pointer is pointed at:

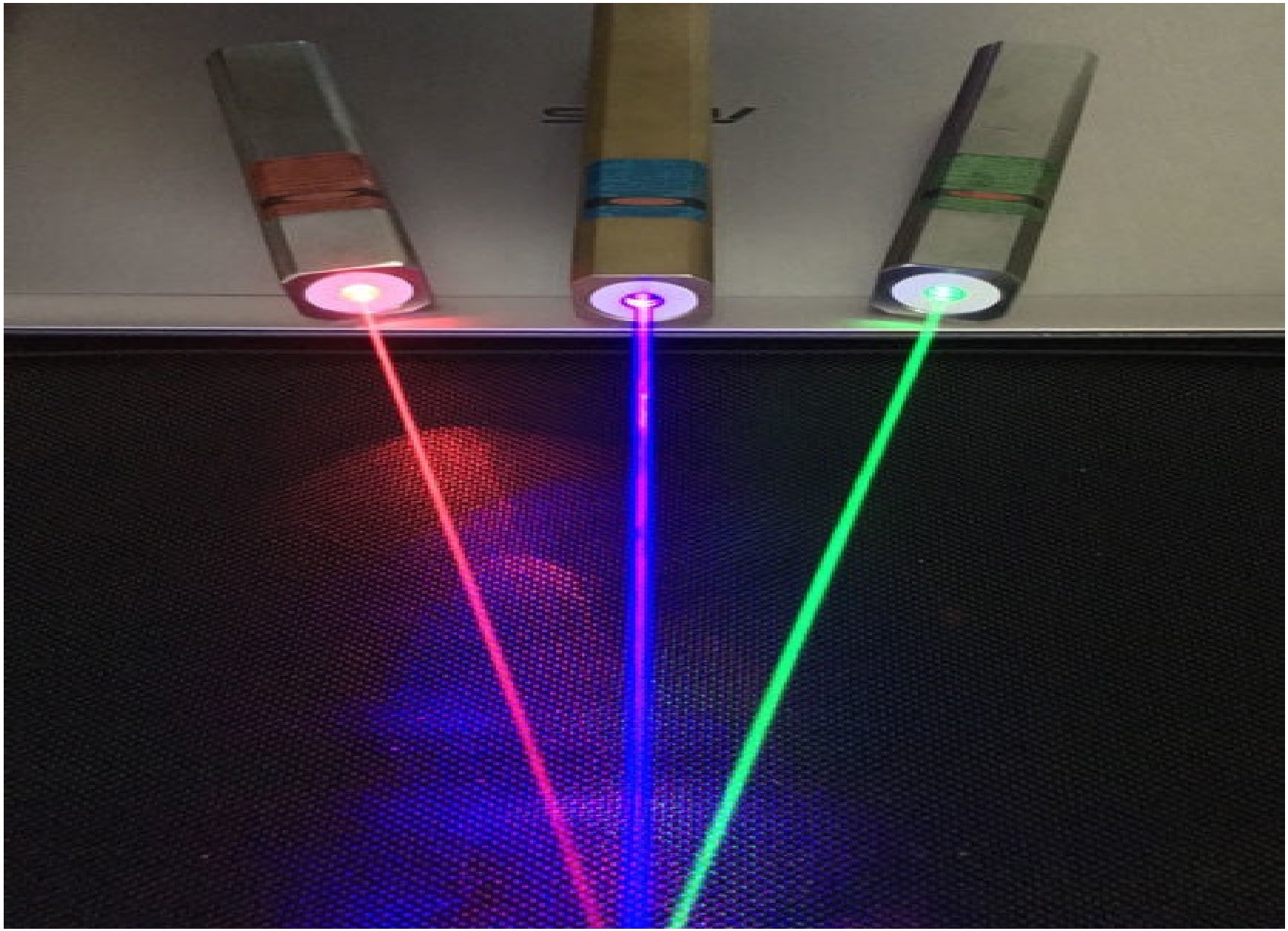


Figure 8.19: “Laser Pointers” devices with a power supply which generate laser beam of visible light.

In most game engines, there are tools for developers to simulate and show such an effect inside the level. Unreal Engine 5 uses the Line Trace By Channel blueprint command, which performs a collision trace along a given line and returns the first object that the trace hits. Let’s try this in the current project by using the third-person character’s camera as shooting object for laser light. Refer to Chapter 5, Project Templates and User Interaction, and make a keyboard input action event for E key called Trace_ON in Third Person Character blueprint, as shown in Figure 8.20. We will use this key to directly call events on game objects in the stage during runtime:

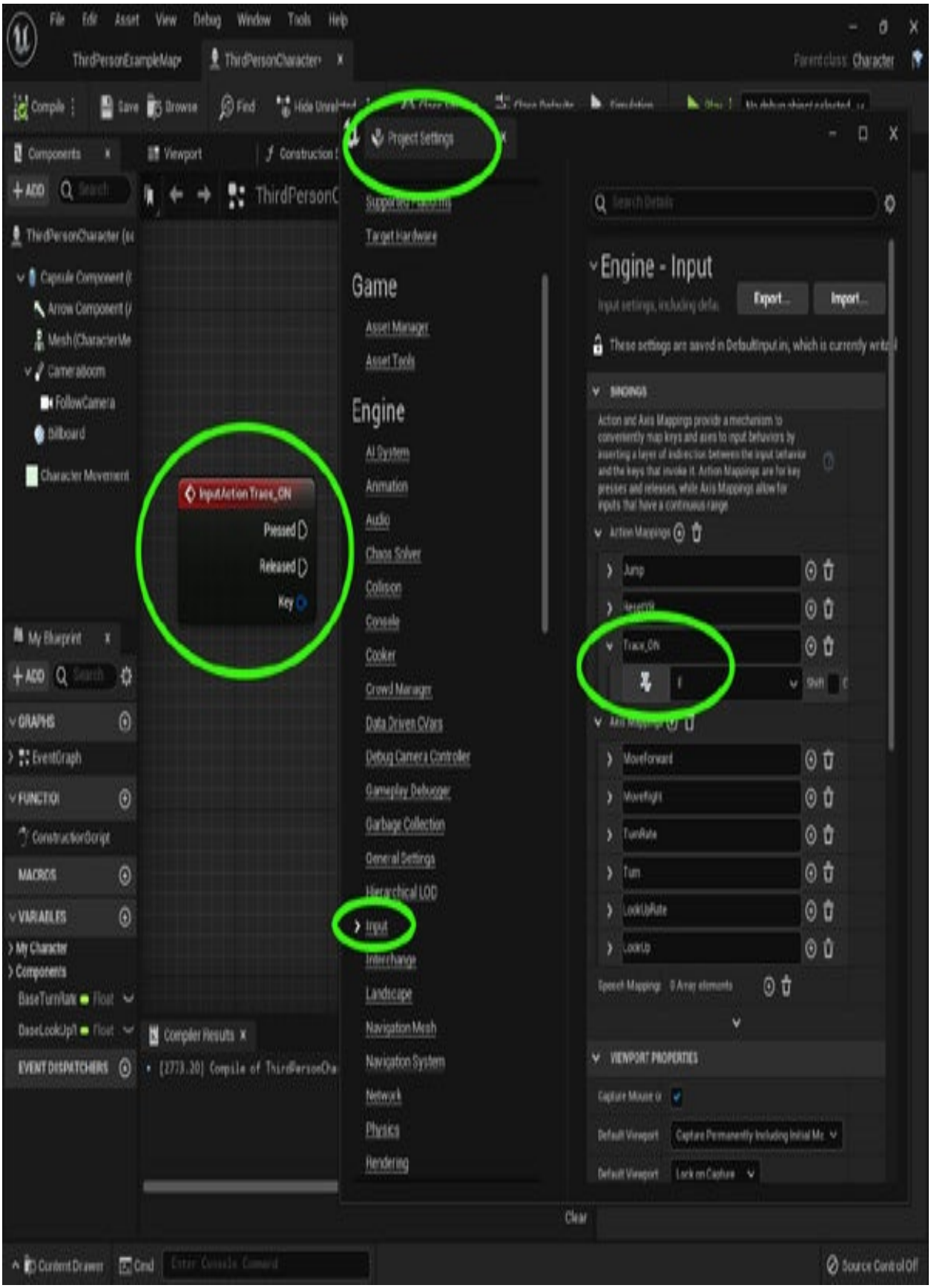

File Edit Asset View Debug Window Tools Help
ThirdPersonExampleMap
ThirdPersonCharacter
Parent class: Character
Compile
Save
Browse
Find
Components
Viewport
Construction
ADD
ThirdPersonCharacter
Capsule Component
Arrow Component
Mesh (CharacterMe
CameraBoom
FollowCamera
Billboard
Character Movement
InputAction Trace_ON
Pressed
Released
Key
My Blueprint
GRAPHS
EventGraph
FUNCTIONS
ConstructionScript
MACROS
VARIABLES
My Character
Components
BaseTurnRate
Float
BaseLookUpR
Float
EVENT DISPATCHERS
Compiler Results
[2773.20] Compile of ThirdPersonCha
Project Settings
Supported Platforms
Target Hardware
Game
Asset Manager
Asset Tools
Engine
AI System
Animation
Audio
Chaos Solver
Collision
Console
Cooker
Crowd Manager
Data Driven CVars
Debug Camera Controller
Gameplay Debugger
Garbage Collection
General Settings
Hierarchical LOD
Input
Interchange
Landscape
Navigation Mesh
Navigation System
Network
Physics
Rendering
Engine - Input
Export...
Import...
These settings are saved in DefaultInput.ini, which is currently writ
BINDINGS
Action and Axis Mappings provide a mechanism to conveniently map keys and axes to input behaviors by inserting a layer of indirection between the input behavior and the keys that invoke it. Action Mappings are for key presses and releases, while Axis Mappings allow for inputs that have a continuous range.
Action Mappings
Jump
Trace_ON
I
Shift
Axis Mappings
MoveForward
MoveRight
TurnRate
Turn
LookUpRate
LookUp
Speech Mapping 0 Array elements
VIEWPORT PROPERTIES
Capture Mouse o
Default Viewport
Capture Permanently Including Initial Mo
Default Viewport
Lock on Capture
Clear
Content Drawer
Cmd
Enter Console Command
Source Control Off

Figure 8.20: Add new input mapping for “E” key on keyboard

Now, right-click on the third-person character blueprint event graph and type line trace by channel; then, click on the LineTraceByChannel blueprint command and connect it by execution line to the Trace_ON event. As Figure 8.21 shows, each LineTraceByChannel blueprint command needs some input values and has some options. Additionally, a user can click on the little arrow in the blueprint block to expand its properties:

LineTraceByChannel
Start
Out Hit
Return Value
End
Trace Channel
Visibility
Trace Complex
Actors to Ignore
Draw Debug Type
For Duration
Ignore Self
click to expand
Trace Color
Trace Hit Color
Draw Time
5.0
BLUEPRINT

Figure 8.21: "Line trace By Channel" blueprint block

The Start and End pins represent the beginning and end points of the laser pointer; to make them, add a billboard blueprint component to the Capsule Component of the third-person character blueprint and relocate it to 0,0,50, as shown in Figure 8.22:

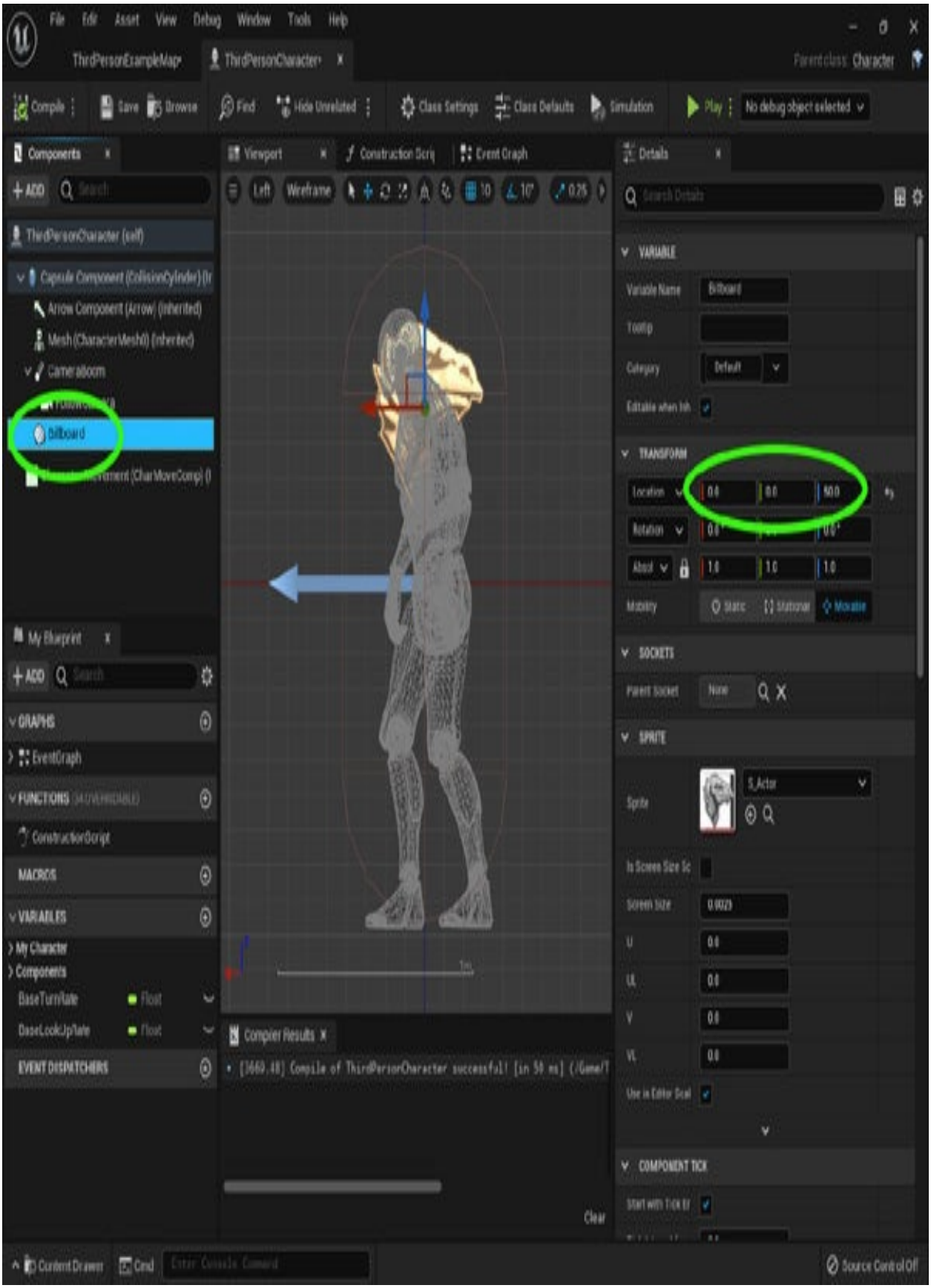

File Edit Asset View Debug Window Tools Help
ThirdPersonExampleMap
ThirdPersonCharacter
Parent class: Character
Compile
Save
Browse
Find
Hide Unrelated
Class Settings
Class Defaults
Simulation
Play
No debug object selected
Components
ADD
ThirdPersonCharacter (self)
Capsule Component (CollisionCylinder)
Arrow Component (Arrow) (inherited)
Mesh (CharacterMesh0) (inherited)
CameraBoom
Billboard
Viewport
Construction Script
Event Graph
Left
Wireframe
Details
VARIABLE
Variable Name
Billboard
Tooltip
Category
Default
Editable when Inh.
TRANSFORM
Location
0.0
0.0
60.0
Rotation
Absol.
1.0
1.0
1.0
Mobility
Static
Stationary
Movable
SOCKETS
Parent Socket
None
SPRITE
Sprite
S_Actor
Is Screen Size Sc
Screen Size
0.0025
U
0.0
UL
0.0
V
0.0
VL
0.0
Use in Editor Scal
COMPONENT TICK
Start with Tick Er
My Blueprint
GRAPHS
EventGraph
FUNCTIONS
ConstructionScript
MACROS
VARIABLES
My Character
Components
BaseTurnRate
Float
BaseLookUpRate
Float
EVENT DISPATCHERS
Compiler Results
[3669.48] Compile of ThirdPersonCharacter successful! [in 50 ms] (/Game/T
Clear
Content Drawer
Cmd
Enter Console Command
Source Control Off

Figure 8.22: Use a billboard component to set start point of line trace

Then, drag and drop the Billboard and Follow Camera components into the event graph. For the Start pin, which is a vector, we use Billboard world location by using the Get World Location blueprint command. For the End pin, we need to find Forward Vector of the camera; it is the direction we like to shoot the laser pointer in. After that, the Forward Vector must be multiplied by any number to increase the range. For doing this, use Get Forward Vector to get forward vector of follow camera component, and then use the Multiply blueprint operator to multiply a vector by a float value. After this, the value is ready to add to start point, which is the billboard location. Use the Add blueprint operator for vectors and connect it to the End pin. Finally, click on Draw Debug Type and change the option to For Duration. This shows the Line Trace on the screen for 5 seconds. To change the duration and color of the line trace, click on the little arrow in the LineTraceByChannel blueprint block and change the values. Your final code should look like Figure 8.23:

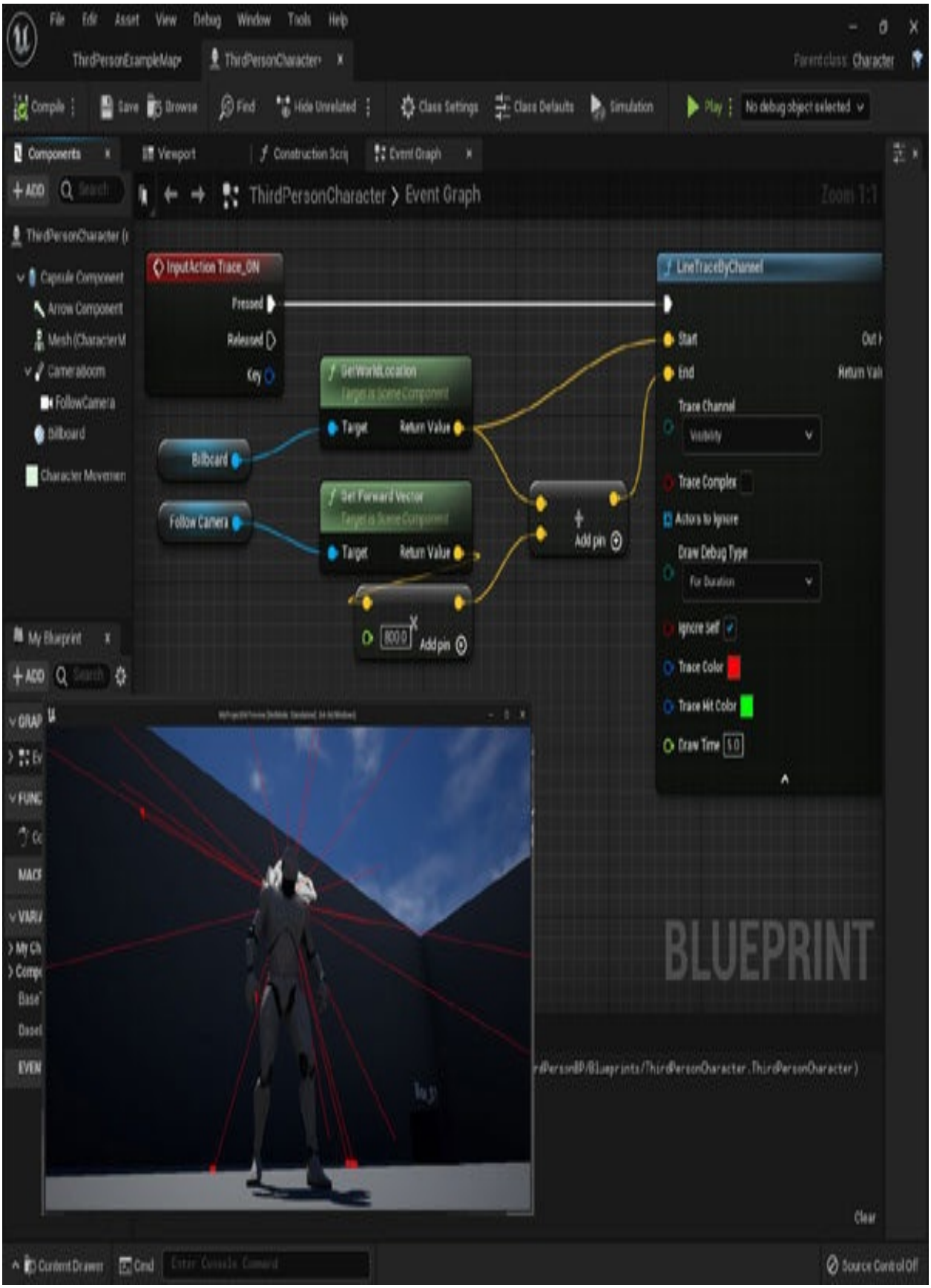

File Edit Asset View Debug Window Tools Help
ThirdPersonExampleMap
ThirdPersonCharacter
Parent class: Character
Compile
Save
Browse
Find
Hide Unrelated
Class Settings
Class Defaults
Simulation
Play
No debug object selected
Components
Viewport
Construction Script
Event Graph
ThirdPersonCharacter > Event Graph
Zoom 1:1
Capsule Component
Arrow Component
Mesh (CharacterM
CameraBoom
FollowCamera
Billboard
Character Movemen
InputAction Trace_ON
Pressed
Released
Key
GetWorldLocation
Target is Scene Component
Target
Return Value
Billboard
Follow Camera
Get Forward Vector
Target is Scene Component
Target
Return Value
800.0
Add pin
Add pin
LineTraceByChannel
Start
End
Trace Channel
Visibility
Trace Complex
Actors to Ignore
Draw Debug Type
For Duration
Ignore Self
Trace Color
Trace Hit Color
Draw Time
5.0
My Blueprint
BLUEPRINT
Clear
Content Drawer
Cmd
Enter Console Command
Source Control Off

Figure 8.23: Final blueprint code and result on using E key, to activate line trace from third person player toward camera angle

Now play the game and press E to activate line trace. You can change the location of Billboard to customize line trace start, and change multiplier value to change the laser bin range.

Now, how about we get rid of all switch actors and just use our laser light to control the light sources? This way, we don’t need to use collision from switch actors at all, so we can remove them from stage.

For this, we need to learn Casting in blueprint first.

Casting in blueprint

So far, we have learned that line trace is a tool that draws a straight line between two points during runtime in a game based on begin and end point. Open the third-person blueprint and find the LineTraceByChannel blueprint command you already made. Then use mouse to drag an execution line form Out Hit pin and type break, and then select Break Hit Results to add this blueprint block to event graph and expand it by clicking on the small arrow on it, as shown in Figure 8.24:

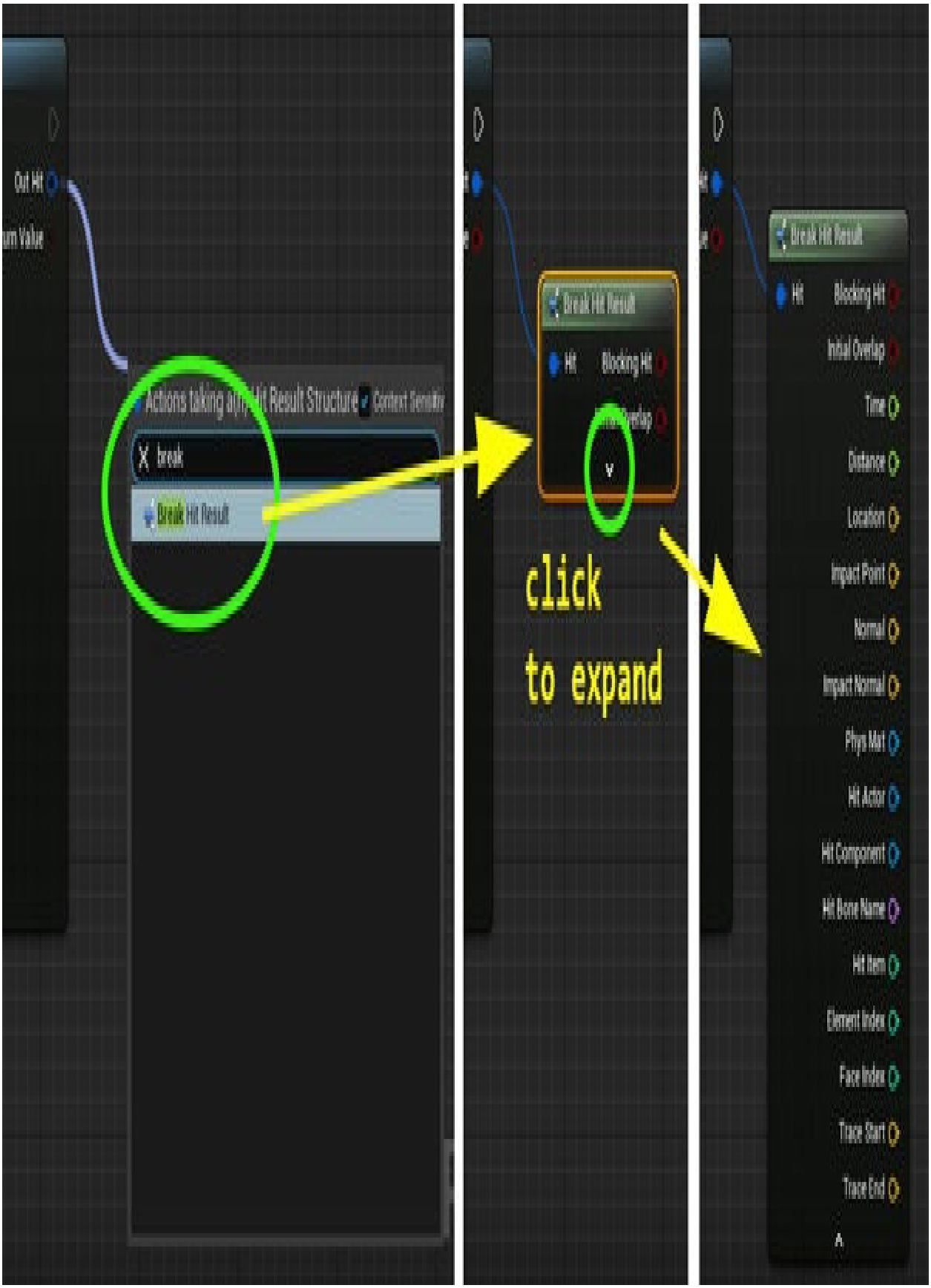

Out Hit
Actions taking a
Hit Result Structure
Context Sensitive
break
Break Hit Result
Break Hit Result
Hit
Blocking Hit
click
to expand
Break Hit Result
Hit
Blocking Hit
Initial Overlap
Time
Distance
Location
Impact Point
Normal
Impact Normal
Phys Mat
Hit Actor
Hit Component
Hit Bone Name
Hit Item
Element Index
Face Index
Trace Start
Trace End

Figure 8.24: Make "Break Hit result/" blueprint node from line trace "Out Hit" pin

As you can see, when we break the Out Hit pin, it returns several pieces of data. One of them is a reference to Hit Actor, which is the actor the laser light has impact with. This actor can be stage items, other blueprint actors or nothing, which means laser light did not impact with any object at the End of its tracing line. So, the first thing we have to do is check if the Hit Actor exists, which can be done by checking the Return Value Boolean pin of the LineTraceByChannel block with an if statement, as shown in Figure 8.25:

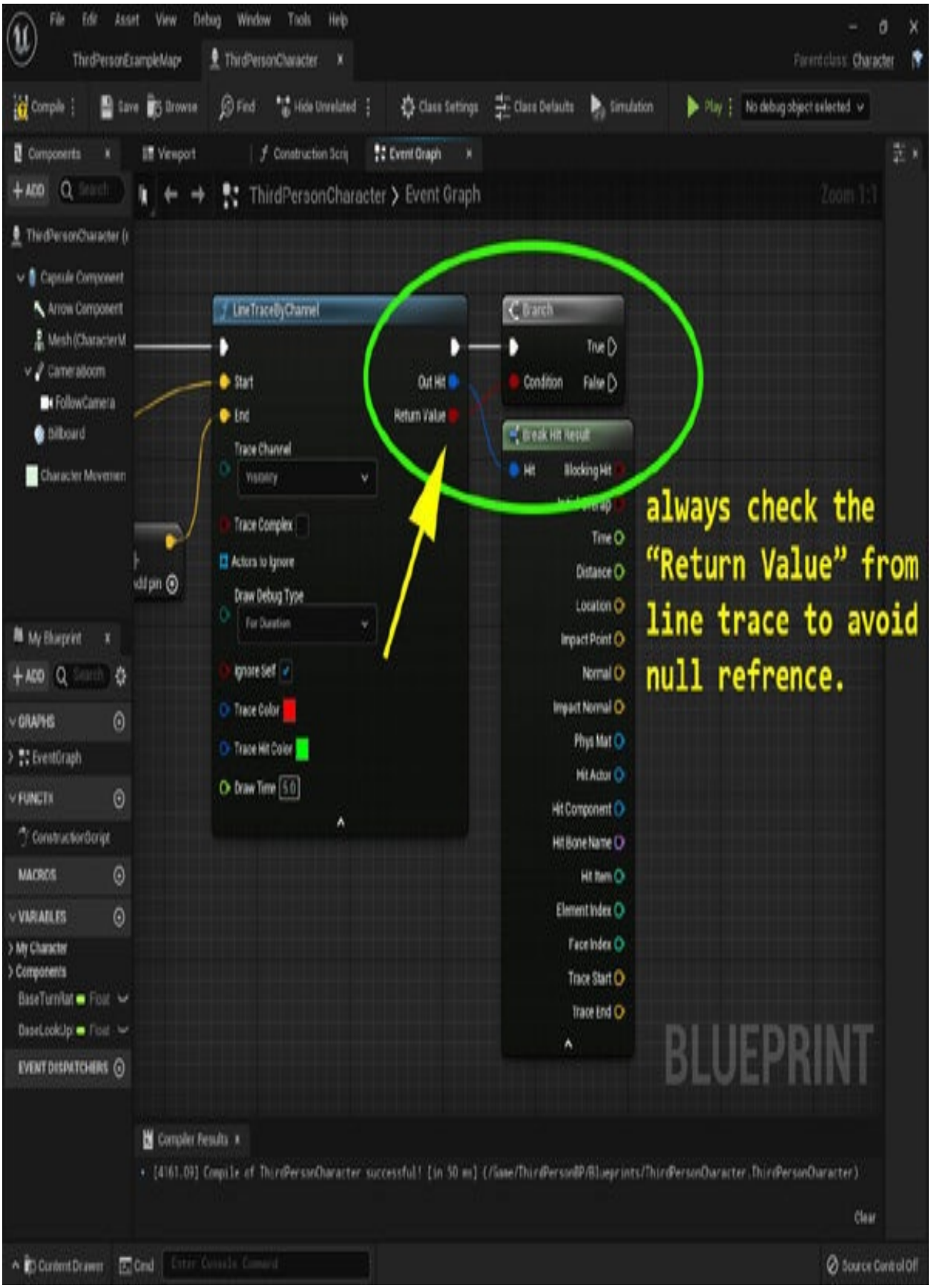

ThirdPersonCharacter > Event Graph
LineTraceByChannel
Start
End
Trace Channel
Trace Complex
Actors to Ignore
Draw Debug Type
Ignore Self
Trace Color
Trace Hit Color
Draw Time
Out Hit
Return Value
Branch
True
Condition
False
Break Hit Result
Hit
Blocking Hit
Time
Distance
Location
Impact Point
Normal
Impact Normal
Phys Mat
Hit Actor
Hit Component
Hit Bone Name
Hit Item
Element Index
Face Index
Trace Start
Trace End
always check the "Return Value" from line trace to avoid null refrence.
BLUEPRINT

Figure 8.25: Sometimes line trace returns "null" reference, and you have to check it before using hit result values

The next step is to know what the Hit Actor is; if the Hit Actor is BP_Light_01, then we can run events on this actor and control light source. So, to discover the actor type, we need to use a method in programming, known as casting. Casting is a common communication method where you take a reference to an actor and try to convert it to a different class. If the conversion is successful, we can directly use this actor as a reference to access its properties and events (like we did in BP_Switch_01 and BP_Switch_02).

Click and drag blueline from Hit Actor, then release and type BP_Light, and then choose the Cast to BP_Light_01 blueprint block, as shown in Figure 8.26:

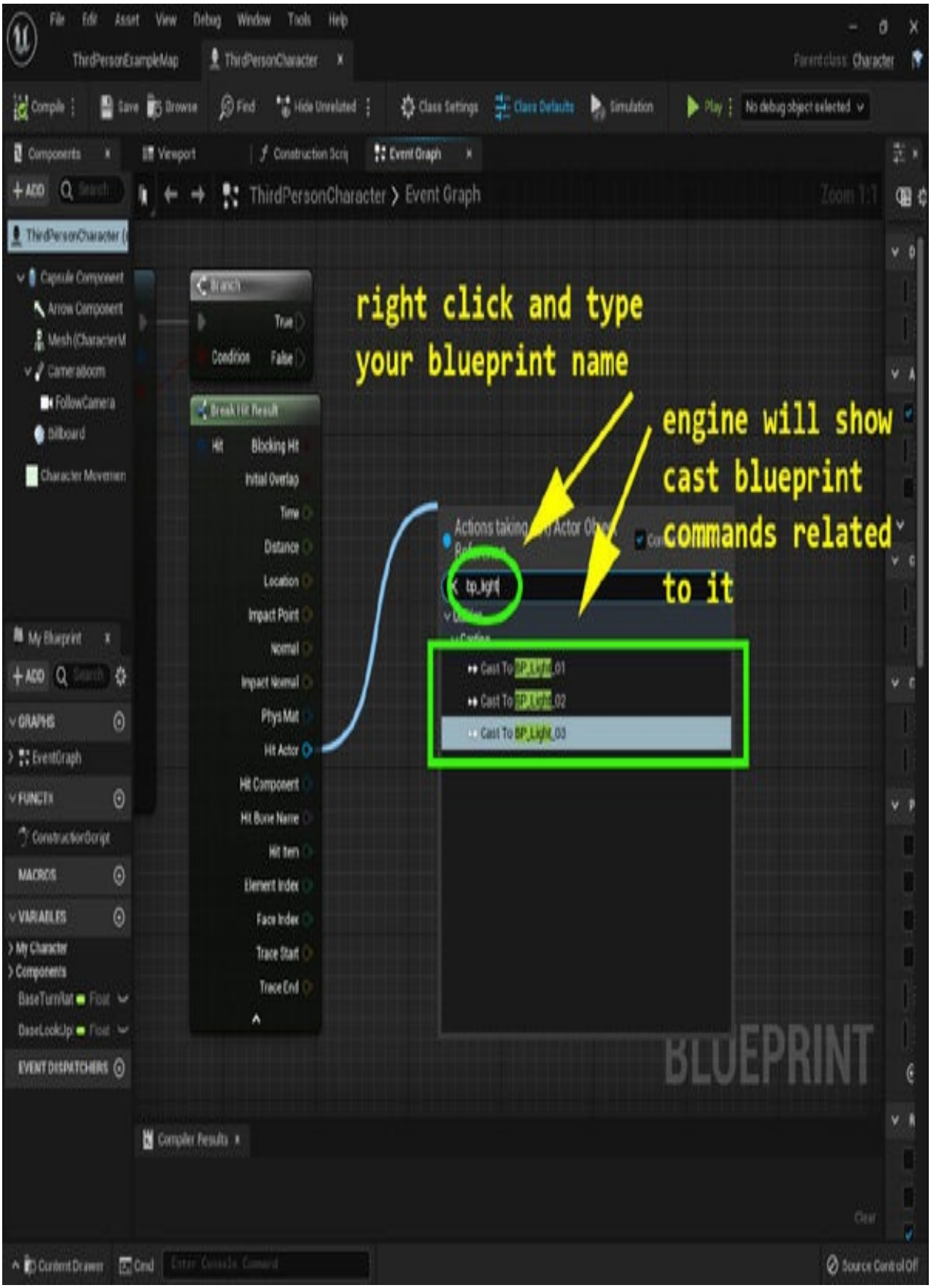

right click and type
your blueprint name
engine will show
cast blueprint
commands related
to it
ThirdPersonExampleMap
ThirdPersonCharacter
Event Graph
Branch
Break Hit Result
Cast To BP_Light_01
Cast To BP_Light_02
Cast To BP_Light_03
BLUEPRINT

Figure 8.26: Casting in blueprint

Then, click on its As BP Light 01 blue pin, drag blueline, release and type light switch, and then choose the Light Switch OFF blueprint event from the list, as shown in Figure 8.27. Press the Compile button at the top and run the game:

Cast To BP_Light_01
True
False
Object
Cast Failed
As BP Light 01
Actions taking a(n) BP Light 01 Object
light switch
Light Switch OFF
Light Switch ON
My Blueprint
GRAPHS
EventGraph
FUNCTI
ConstructionScript
MACROS
VARIABLES

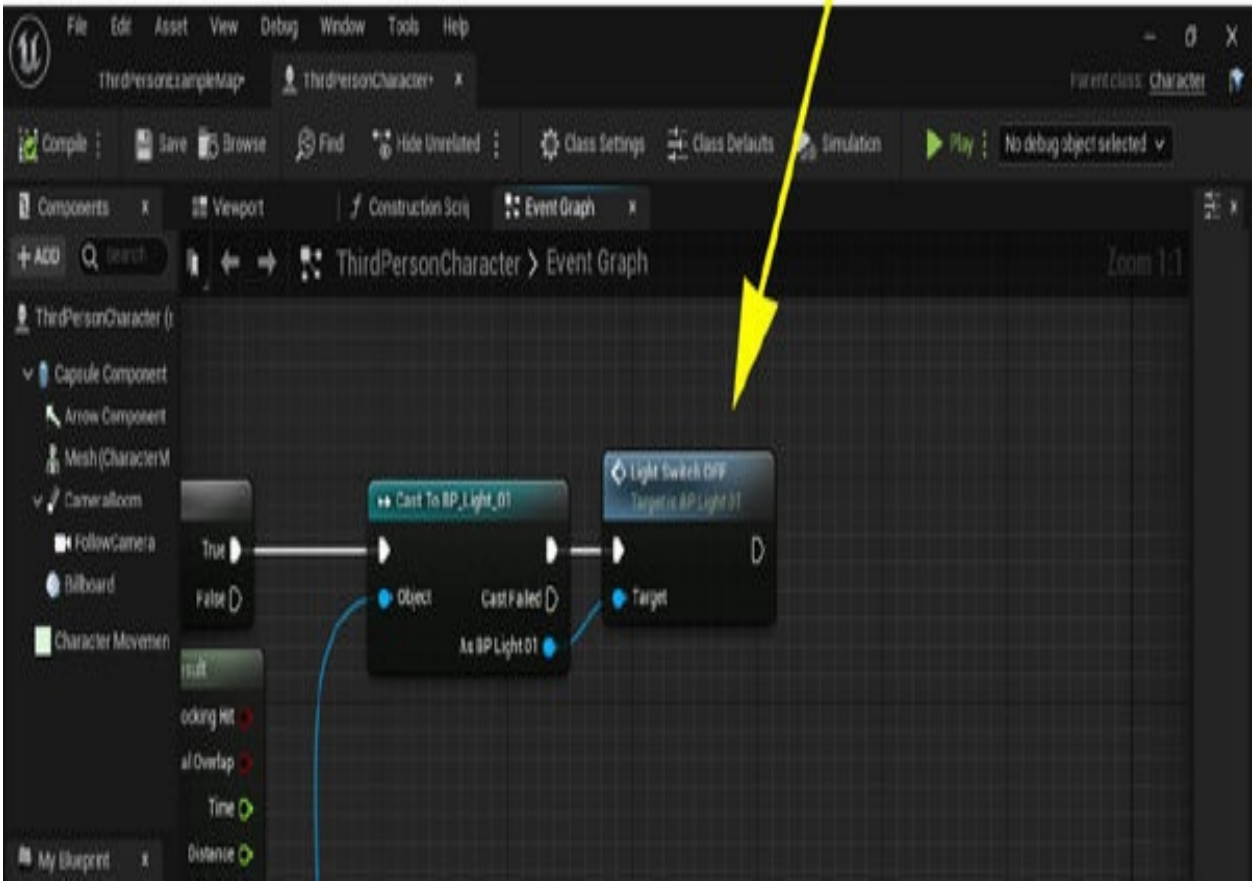

File Edit Asset View Debug Window Tools Help
Compile
Save
Browse
Find
Hide Unrelated
Class Settings
Class Defaults
Simulation
Play
No debug object selected
Components
Viewport
Construction Scrip
Event Graph
ThirdPersonCharacter > Event Graph
Zoom 1:1
Capsule Component
Arrow Component
Mesh (CharacterM
CameraBoom
FollowCamera
Billboard
Character Movemen
Cast To BP_Light_01
Object
Cast Failed
As BP Light 01
Light Switch OFF
Target
True
False
Time
Distance
My Blueprint

Figure 8.27: The "As BP Light 01" returns a reference to BP Light 01 actor on the stage. So, we can call "Light Switch OFF "event from this object to control light.

When the user presses E on the keyboard, a line trace in drawn by the engine inside the game; then, the code checks the Return Value of line trace. If the laser impacts with an object, then Return Value will be true, and then the code tries to cast the Hit Actor to the BP_Light_01 blueprint actor. When we say try to cast, it means the engine grabs Hit Actor and compares it to the BP_Light_01 source class in the content browser. If these two are the same, then the engine executes the top execution pin in the blueprint, which will run the Light Switch OFF event from light source actor. If the objects are not the same, the Cast Failed execution pin will be activated.

Now, follow the same procedure and add two more cast blueprint blocks to support the Light Switch OFF function on both BP_Light_02 and BP_Light_03. As shown in Figure 8.28, we can use the Cast Failed execution pin to execute multiple casts. This way, the engine will run first cast, and if that fails, it will check for the next one; if both of those cast fails, it will check the last cast, and on each one, the Light Switch OFF function will be executed if the cast is successful:

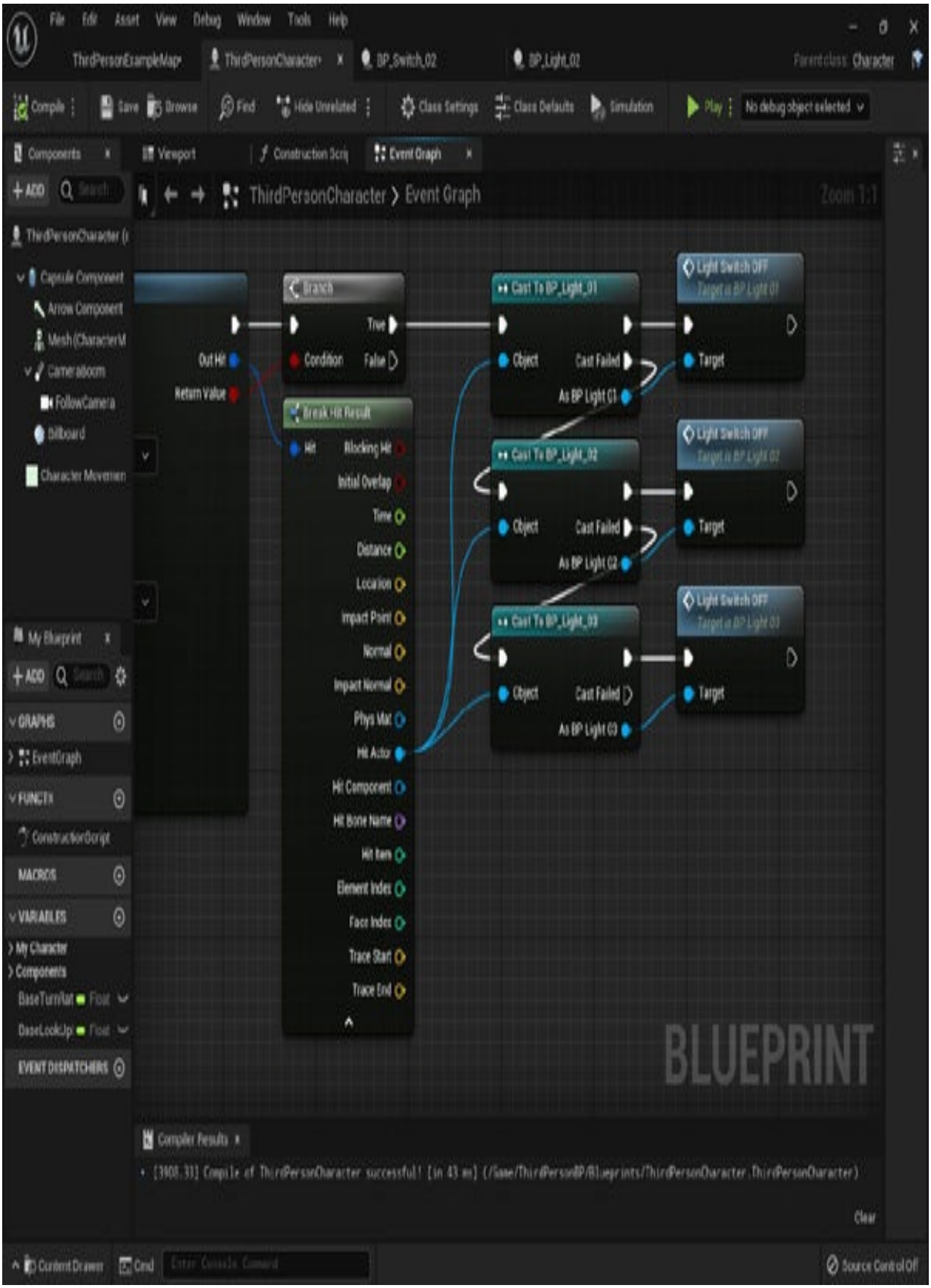

File Edit Asset View Debug Window Tools Help
ThirdPersonExampleMap
ThirdPersonCharacter
BP_Switch_02
BP_Light_02
Parent class: Character
Compile
Save
Browse
Find
Hide Unrelated
Class Settings
Class Defaults
Simulation
Play
No debug object selected
Components
Viewport
Construction Script
Event Graph
ThirdPersonCharacter > Event Graph
Zoom 1:1
Capsule Component
Arrow Component
Mesh (CharacterM
CameraBoom
FollowCamera
Billboard
Character Movemen
Out Hit
Return Value
Branch
True
Condition
False
Break Hit Result
Hit
Blocking Hit
Initial Overlap
Time
Distance
Location
Impact Point
Normal
Impact Normal
Phys Mat
Hit Actor
Hit Component
Hit Bone Name
Hit Item
Element Index
Face Index
Trace Start
Trace End
Cast To BP_Light_01
Object
Cast Failed
As BP Light 01
Cast To BP_Light_02
As BP Light 02
Cast To BP_Light_03
As BP Light 03
Light Switch OFF
Target is BP Light 01
Target is BP Light 02
Target is BP Light 03
Target
My Blueprint
GRAPHS
EventGraph
FUNCTI
ConstructionScript
MACROS
VARIABLES
My Character
Components
BaseTurnRat
BaseLookUp
EVENT DISPATCHERS
BLUEPRINT
Compiler Results
[3908.33] Compile of ThirdPersonCharacter successful! [in 43 ms] (/Game/ThirdPersonBP/Blueprints/ThirdPersonCharacter.ThirdPersonCharacter)
Clear
Content Drawer
Cmd
Enter Console Command
Source Control Off

Figure 8.28: Using cast on three actors to activate an event

When the game is running, the third-person player can switch off all light sources. But there's one problem: assume that we have 16 different light source actors on the scene in game. To switch off any of them, we have to do 16 cast(s) in third-person character and run similar event to light_switch_off on each. Imagine that the light source objects are huge blueprints with a number of elements and details, and when you are casting to each in runtime, the engine should load them into memory, compare them to what Line Trace returns as Hit Actor, and if the cast fails, free the memory used for loading and load the next object in memory; this will go on until it finds the right object to cast and then run the event on it. This is not only unprofessional but also abuses engine processing and system resources during running game.

To solve this issue, we need to use a technology in programming known as interface implementation.

Interface implementation in blueprint

Using interface is an advanced knowledge in developing applications. It works like magic and simplifies the code and solutions. The interface itself is a programming syntax/structure that allows the computer to use certain properties and functions on an object/class. Imagine that you have a robot that can speak fluently in five different languages. This means your robot's brain (like a computer application) has five different input and output structures to receive and send data in each of those languages. Consider this example: it can detect the message Good Morning in five languages and respond properly in a specific language, as it's brain (like a computer application) has the interface of that language to receive it and respond to it. So, if you upgrade this robot with a new interface of a different language and plug it into its brain (add that to its computer application), your robot can communicate in that language as well.

Having interface is a very expensive technology not many programming languages can support to compile and implement. The Unreal Engine blueprint programming language provides in-depth support for development and use Interface in the code. We will describe the basics of Interface development in this section.

Right-click in the content browser and select Blueprint Interface from the Blueprint menu, as shown in Figure 8.29. Rename the blueprint interface as BPI_01. The BPI prefix stands for Blueprint Interface, and following this naming convention is an industry standard:

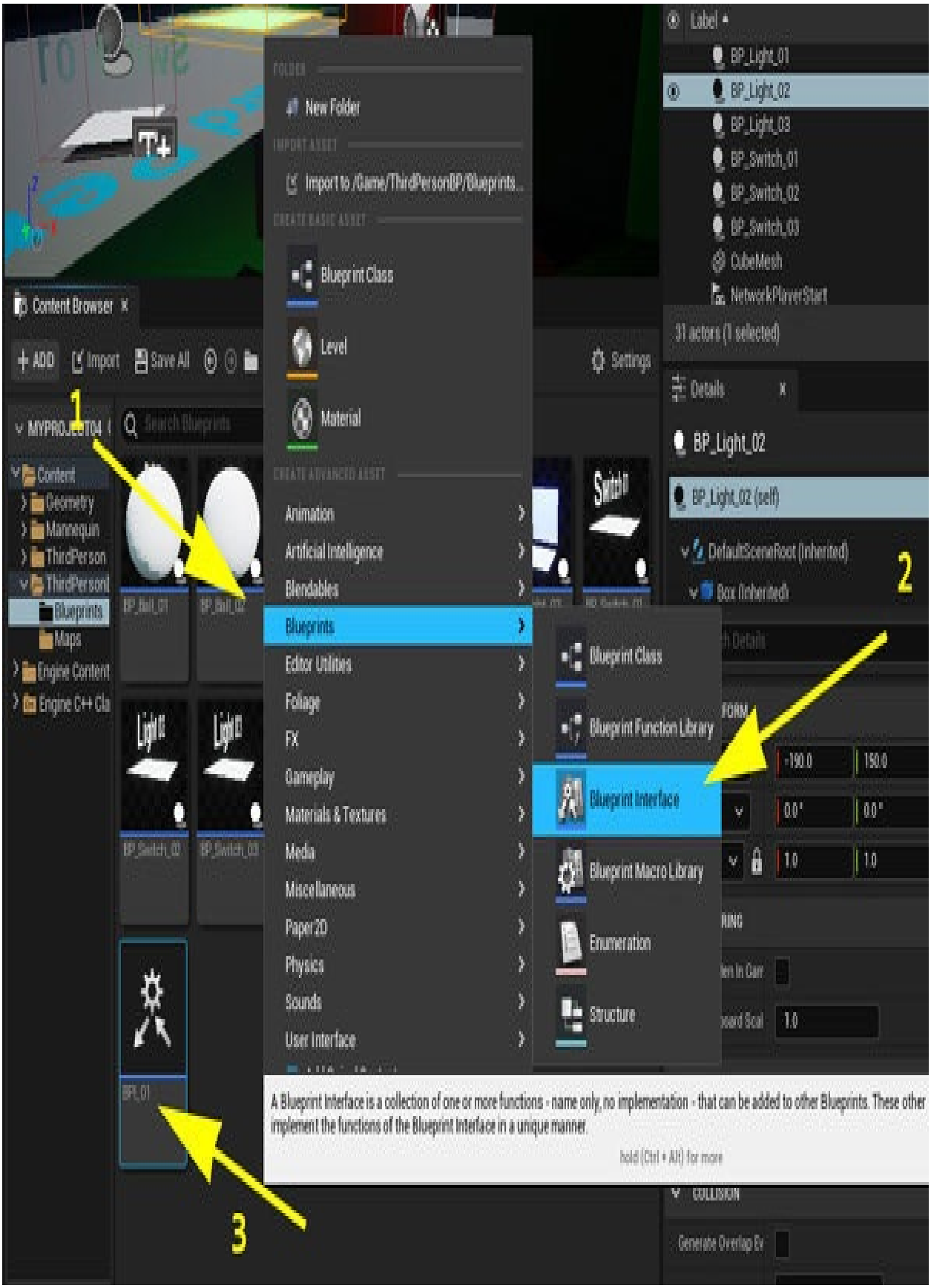

Content Browser
ADD
Import
Save All
Settings
MYPROJECT04
Content
Geometry
Mannequin
ThirdPerson
ThirdPersonBP
Blueprints
Maps
Engine Content
Engine C++ Cla
BP_Ball_01
BP_Ball_02
BP_Switch_02
BP_Switch_03
BPI_01
FOLDER
New Folder
IMPORT ASSET
Import to /Game/ThirdPersonBP/Blueprints...
CREATE BASIC ASSET
Blueprint Class
Level
Material
CREATE ADVANCED ASSET
Animation
Artificial Intelligence
Blendables
Blueprints
Editor Utilities
Foliage
FX
Gameplay
Materials & Textures
Media
Miscellaneous
Paper2D
Physics
Sounds
User Interface
Blueprint Class
Blueprint Function Library
Blueprint Interface
Blueprint Macro Library
Enumeration
Structure
A Blueprint Interface is a collection of one or more functions - name only, no implementation - that can be added to other Blueprints. These other implement the functions of the Blueprint Interface in a unique manner.
hold (Ctrl + Alt) for more
Label
BP_Light_01
BP_Light_02
BP_Light_03
BP_Switch_01
BP_Switch_02
BP_Switch_03
CubeMesh
NetworkPlayerStart
31 actors (1 selected)
Details
BP_Light_02
BP_Light_02 (self)
DefaultSceneRoot (Inherited)
Box (Inherited)
COLLISION
Generate Overlap Ev
1
2
3

Figure 8.29: 1-Right click and select "Blueprint" from content browser. 2-Locate "Blueprint Interface" and left click on it. 3- Rename new interface to "BPI_01".

Double-click on BPI_01 in the content browser to open its editor. The blueprint interface editor, as shown in Figure 8.30, is very simple compared to previous blueprints we made. Click on the +ADD button, and the engine will add a new function in the FUNCTIONS section. Rename this function to Impact and save it:

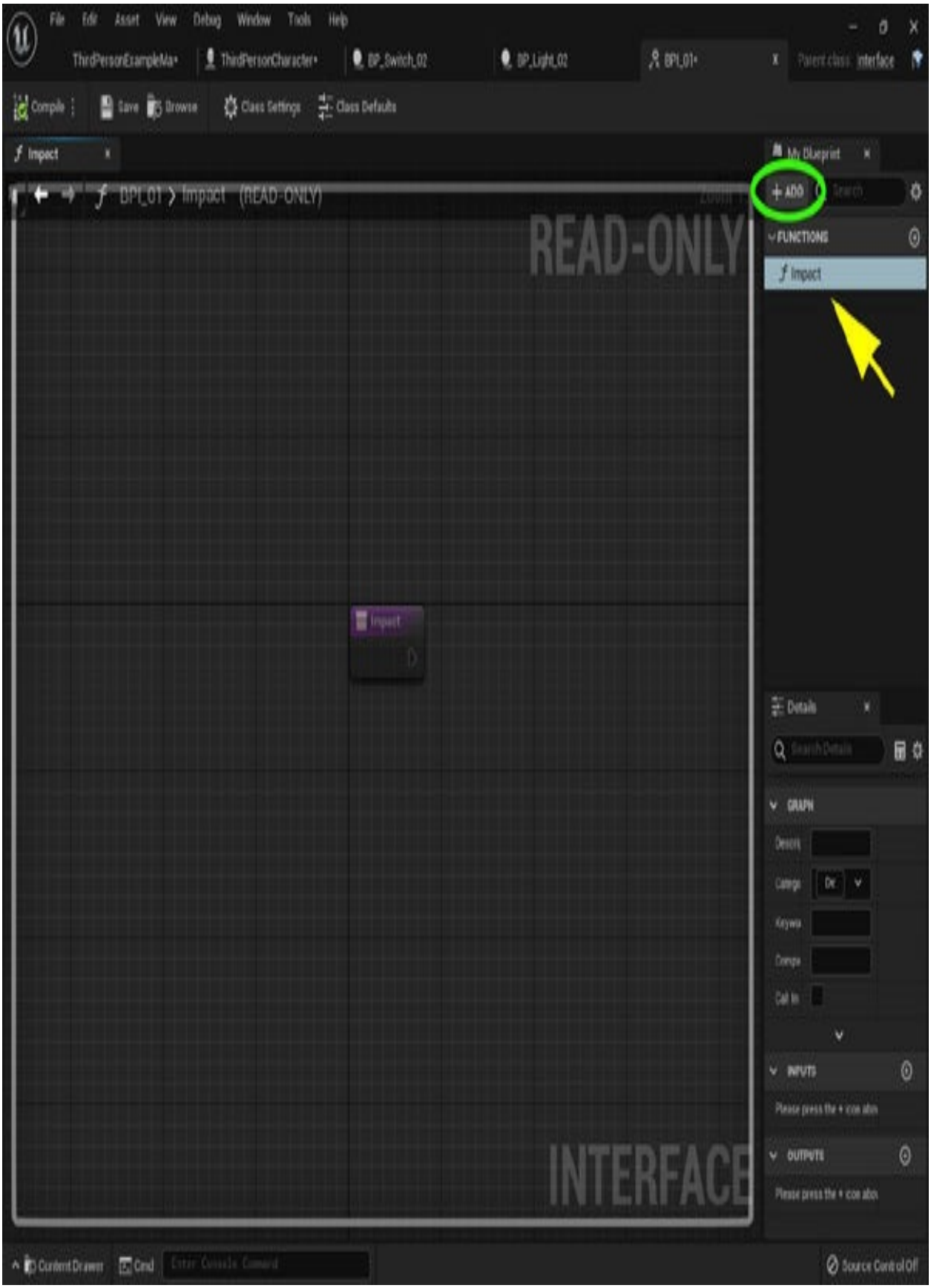

File Edit Asset View Debug Window Tools Help
ThirdPersonExampleMa*
ThirdPersonCharacter*
BP_Switch_02
BP_Light_02
BPI_01*
Parent class: Interface
Compile
Save
Browse
Class Settings
Class Defaults
Impact
My Blueprint
BPI_01 > Impact (READ-ONLY)
READ-ONLY
+ ADD
Search
FUNCTIONS
Impact
Impact
Details
Search Details
GRAPH
Inputs
Please press the + icon also
OUTPUTS
Please press the + icon also
INTERFACE
Content Drawer
Cmd
Enter Console Command
Source Control Off

Figure 8.30: Click on +ADD to add new functions in blueprint interface editor

Now we need to upgrade our game objects with this interface to control light. Open each light source blueprint, click on Class Setting and locate INTERFACES in the Details panel. Then, click on the Add drop-down button, as shown in Figure 8.31, and locate the BPI_01 interface you made and click on it. Press the Compile button at the top, and the actor will be upgraded with interface and can use the BPI_01 interface for communication:

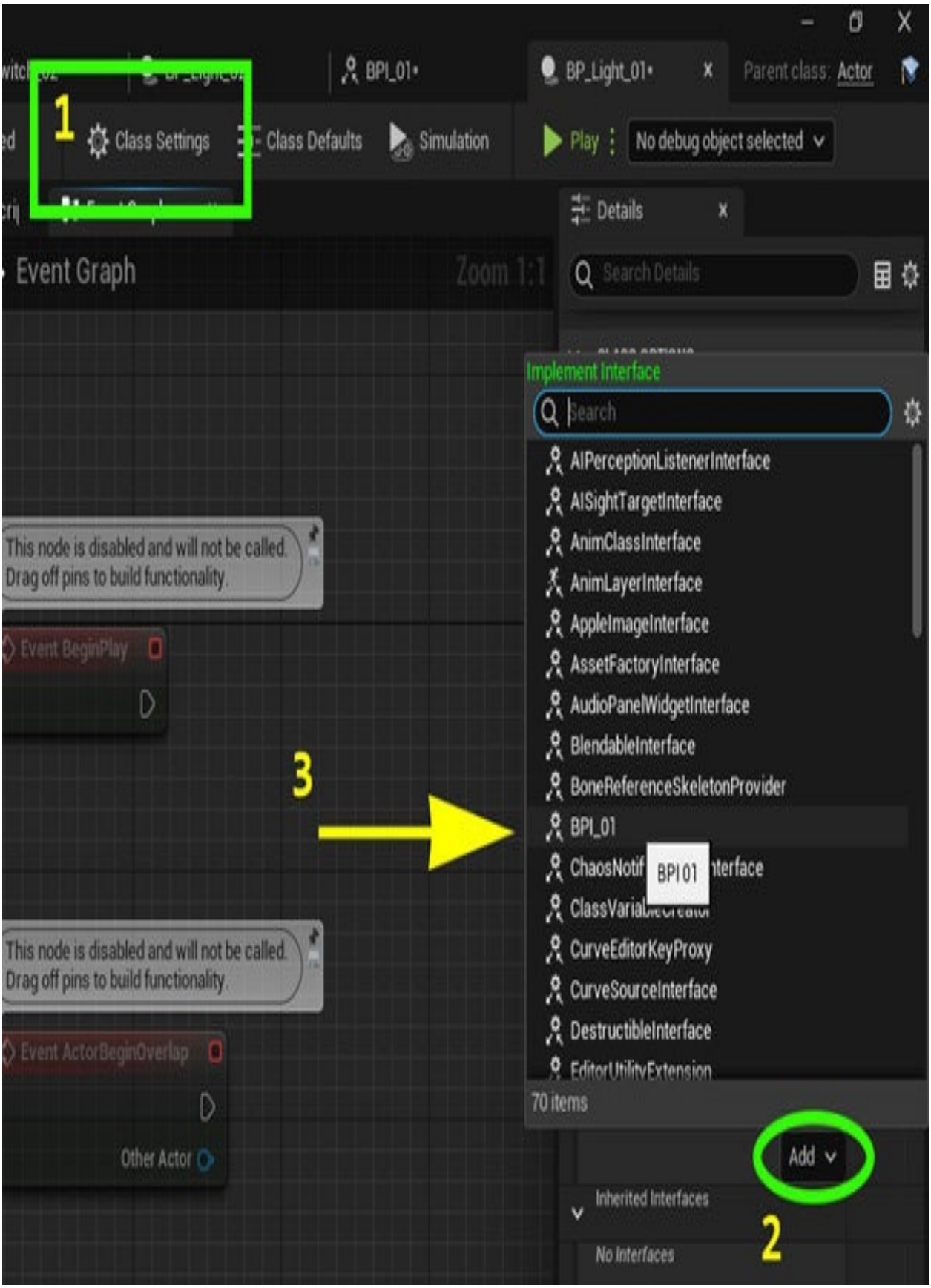

BPI_01
BP_Light_01
Parent class: Actor
1
Class Settings
Class Defaults
Simulation
Play
No debug object selected
Details
Search Details
Event Graph
Zoom 1:1
Implement Interface
Search
AIPerceptionListenerInterface
AISightTargetInterface
AnimClassInterface
AnimLayerInterface
AppleImageInterface
AssetFactoryInterface
AudioPanelWidgetInterface
BlendableInterface
BoneReferenceSkeletonProvider
BPI_01
CurveEditorKeyProxy
CurveSourceInterface
DestructibleInterface
70 items
This node is disabled and will not be called.
Drag off pins to build functionality.
Event BeginPlay
3
Event ActorBeginOverlap
Other Actor
Add
Inherited Interfaces
No Interfaces
2

Figure 8.31: 1- Locate and click on Class Setting tab on each light source actor, 2- Click +ADD in details panel. 3- Find BPI_01 interface and click on it.

After assigning interface to all light sources, save the project, close it and open it again. Then, open the third-person character blueprint and locate the LineTraceByChannel blueprint command. Disconnect the casts and then click and drag blueline from Hit Actor; then, type Impact, which is the name of the function you already made in the BPI_01 blueprint interface, as shown in Figure 8.32. Then, click on the execution line to this function. As you see, the interface's function has a different icon in its blueprint block, which makes it easier to detect during development code in event graph. Press the Compile button at the top:

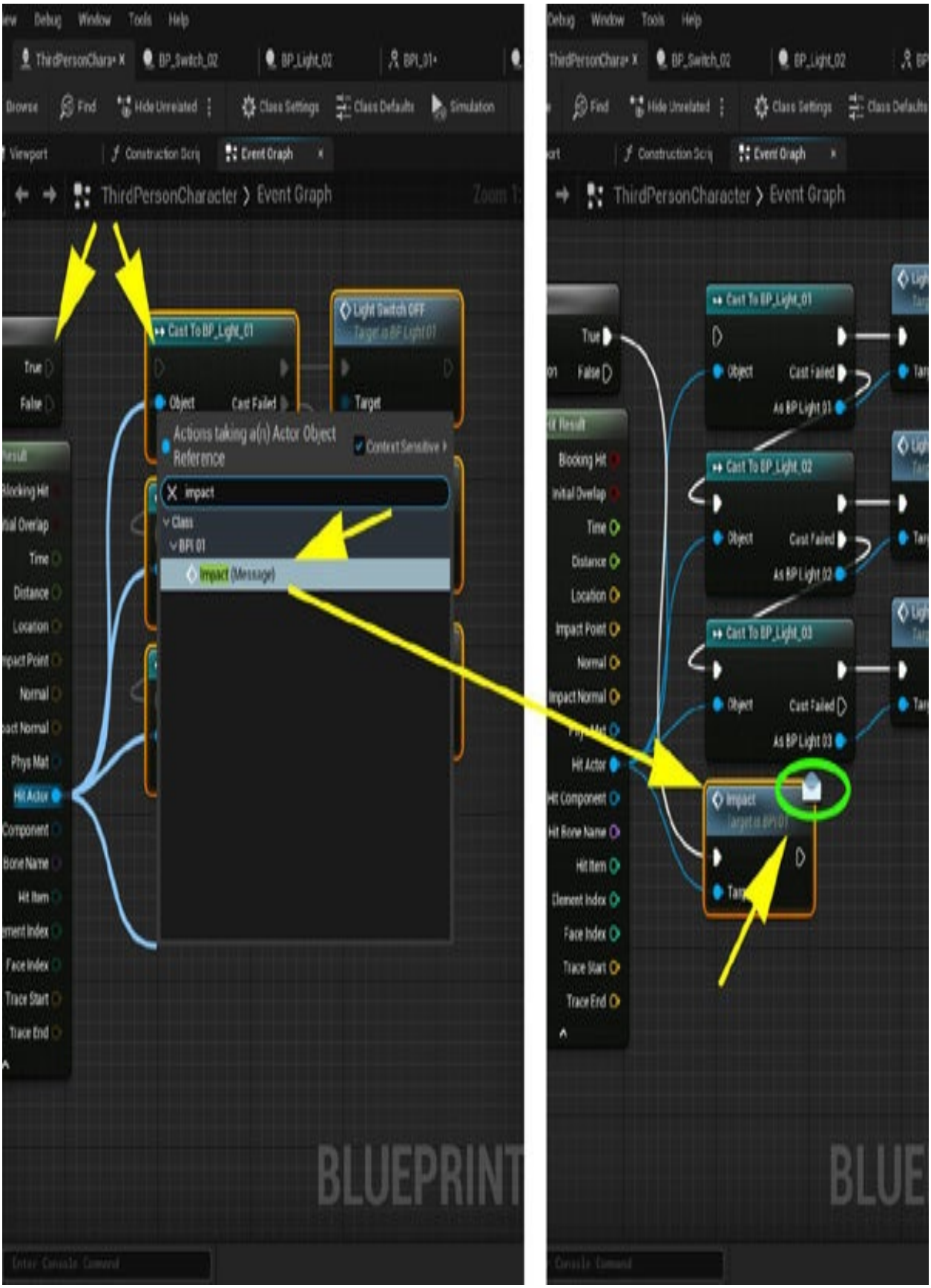

Debug
Window
Tools
Help
ThirdPersonChara
BP_Switch_02
BP_Light_02
Browse
Find
Hide Unrelated
Class Settings
Class Defaults
Simulation
Viewport
Construction Scrip
Event Graph
ThirdPersonCharacter 〉 Event Graph
Cast To BP_Light_01
Object
Cast Failed
Light Switch OFF
Target is BP Light 01
Target
Actions taking a(n) Actor Object Reference
Context Sensitive
impact
Class
BPI 01
Impact (Message)
True
False
Time
Distance
Location
Impact Point
Normal
Phys Mat
Hit Actor
Face Index
Trace Start
Trace End
Cast To BP_Light_01
As BP Light 01
Cast To BP_Light_02
As BP Light 02
Cast To BP_Light_03
As BP Light 03
Impact
Target is BPI 01
Blocking Hit
Initial Overlap
Hit Component
Hit Bone Name
Hit Item
Element Index
BLUEPRINT
BLUE

Figure 8.32: 1- Open the third-person character blueprint and disconnect cast commands. Then, drag the "Impact" function from Hit Actor and connect it to execution line. The blueprint interface functions have special icon on their blueprint block, like event dispatchers in switch actors. IF you don't have "Impact" name on the list, save project, close it and open it again and then try one more time.

Now, open each light source, and right-click in event graph and type Impact; select Event Impact in the Add Event section in the list, as shown in Figure 8.33. (If you don't have Impact name on the list, press Compile, save project, close it, open it again and then try):

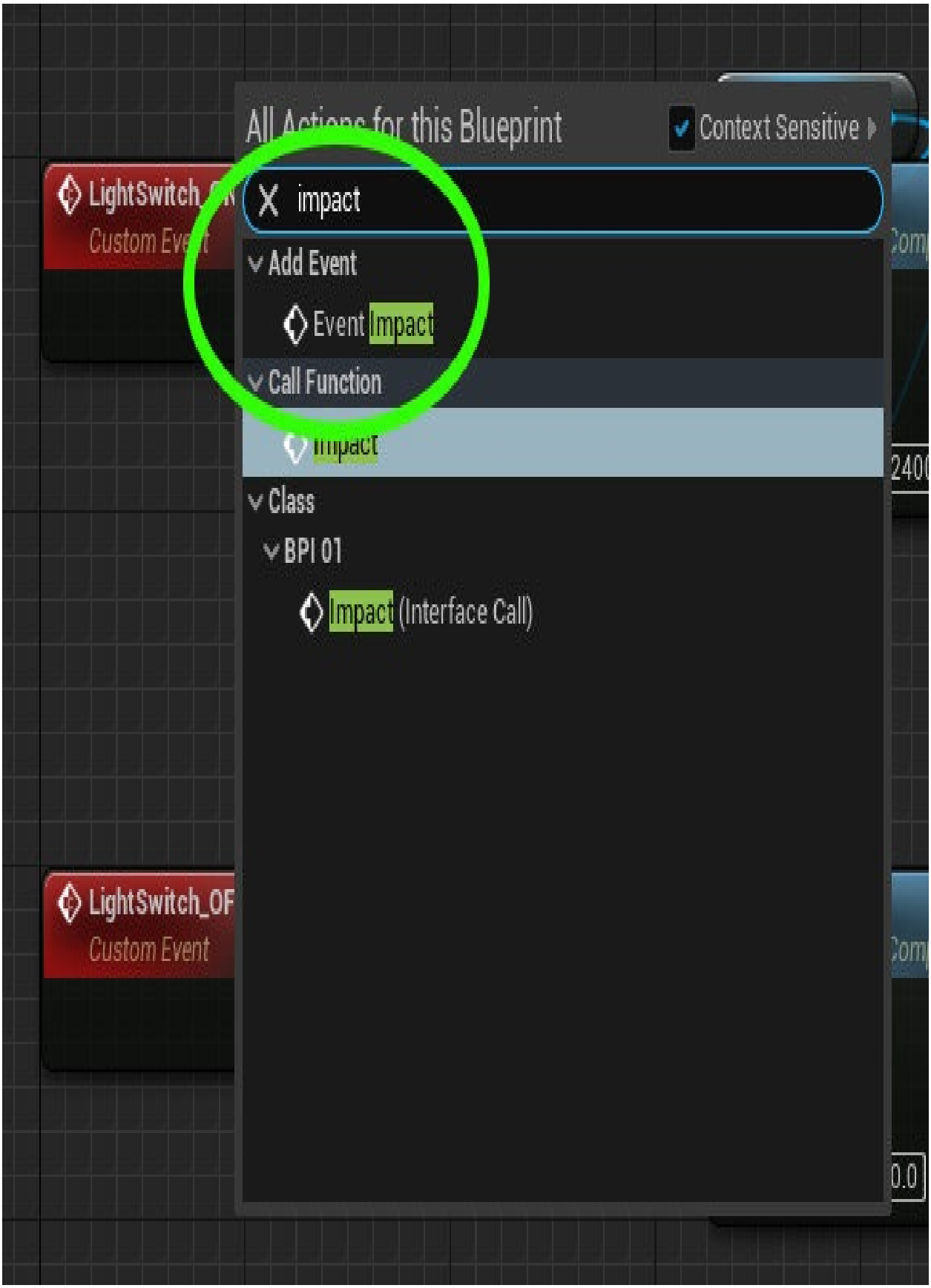

All Actions for this Blueprint
Context Sensitive
impact
Add Event
Event Impact
Call Function
Impact
Class
BPI 01
Impact (Interface Call)
LightSwitch_ON
Custom Event
LightSwitch_OF
Custom Event

Figure 8.33: Right-click in event graph and type "Impact". The interface function which we made will come in the list multiple times. Choose "Event Impact" from the list.

The event belonging to interface has a special icon, which makes it easier to detect in event graph. Now, disconnect other events in blueprints, add a FlipFlop to interface event (Impact) and connect it to source light events, as shown in Figure 8.34. We also use a Flip Flop to switch light between on and off. Flip Flop node is switched execution line between A and B that leads to different events in the light source. Run the game and check the magic of using interface by pressing E on each light source:

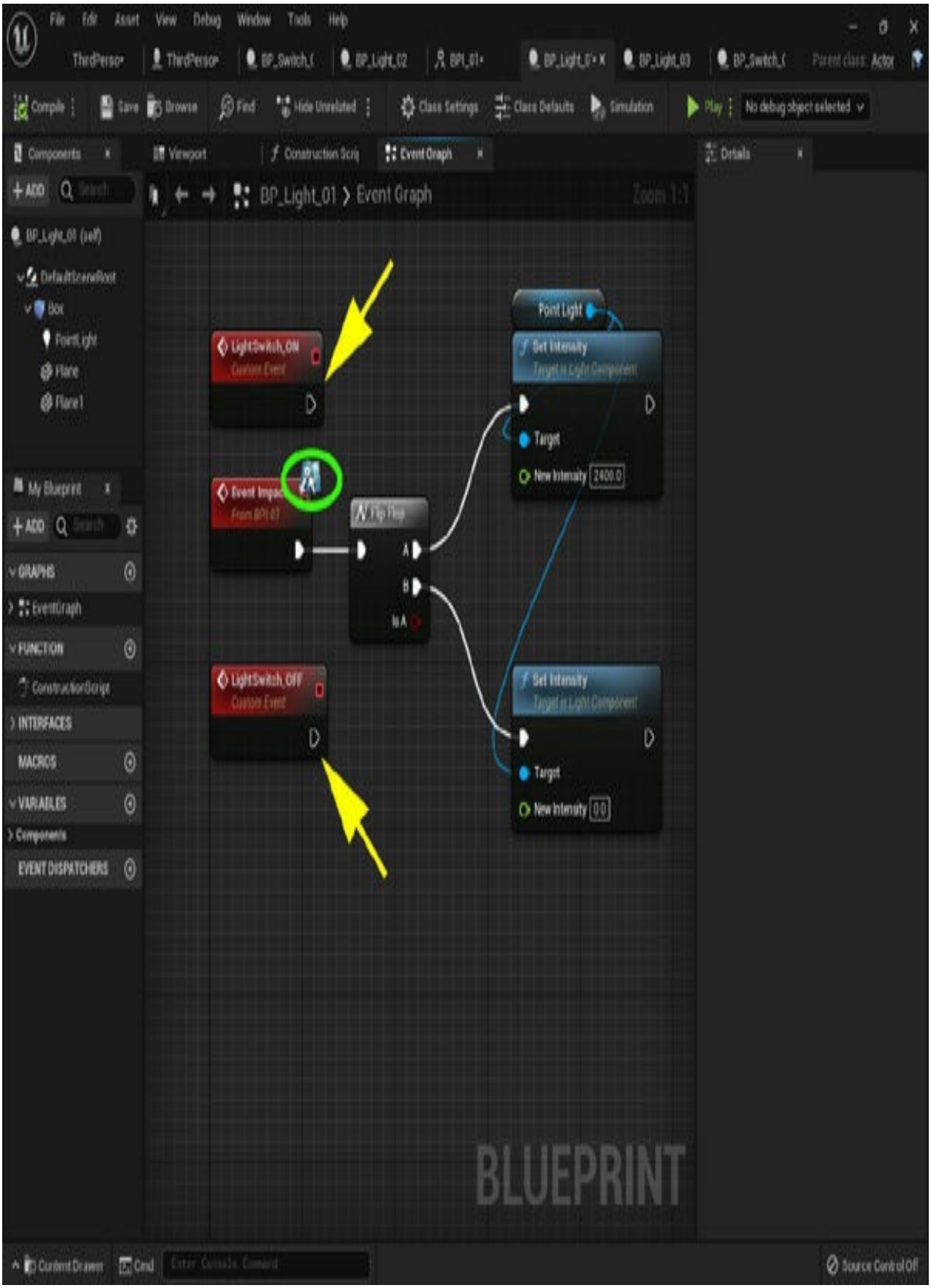

File Edit Asset View Debug Window Tools Help
Compile
Save
Browse
Find
Hide Unrelated
Class Settings
Class Defaults
Simulation
Play
No debug object selected
Components
Viewport
Construction Script
Event Graph
Details
BP_Light_01 > Event Graph
BP_Light_01 (self)
DefaultSceneRoot
Box
PointLight
Flare
Flare1
My Blueprint
GRAPHS
EventGraph
FUNCTION
ConstructionScript
INTERFACES
MACROS
VARIABLES
Components
EVENT DISPATCHERS
LightSwitch_ON
Custom Event
Event Impact
From BP_01
Flip Flop
A
B
IsA
LightSwitch_OFF
Custom Event
Point Light
Set Intensity
Target is Light Component
Target
New Intensity
2400.0
Set Intensity
Target is Light Component
Target
New Intensity
0.0
BLUEPRINT
Content Drawer
Cmd
Enter Console Command
Source Control Off

Figure 8.34: Disconnect previous events and calling light source events by "Impact" interface event. The interface event has a special icon on its blueprint block.

Each time a user presses the E key, the line trace hits an actor in the scene and then checks if the actor has the BPI_01 interface; if it has the interface, the engine will run it immediately. In other languages, we don't need to cast anymore; we just check if an interface exists at the destination and then activate it. On each light source, the blueprint interface runs its event, which is implemented as Impact in the interface.

Using physics (advanced)

Unreal Engine uses PhysX by default to drive a physical simulation calculation to perform all collision calculations and physical rules. So far, we have learned about physical constrains and used collision events to track the third-person character; now, it’s time to learn more about some physical tools in engine.

Using physical gravity

Make a new actor blueprint called BP_Ball_01, which has a Sphere collision component with Sphere static mesh component resized inside it and a text render component to show its title, as shown in Figure 8.35:

File Edit Asset View Debug Window Tools Help
Compile
Save
Browse
Find
Hide Unrelated
Class Settings
Class Defaults
Simulation
Play
No debug object selected
Components
Viewport
Construction Script
Event Graph
Details
Perspective
Lit
BP_Ball_01 (self)
DefaultSceneRoot
Sphere
Sphere1
TextRender
Ball_01
My Blueprint
GRAPHS
EventGraph
FUNCTION
ConstructionScript
MACROS
VARIABLES
Components
EVENT DISPATCHERS
VARIABLE
TRANSFORM
SOCKETS
STATIC MESH
MATERIALS
COMPONENT TICK
PHYSICS
Content Drawer
Cmd
Source Control Off

Figure 8.35: Ball_01 actor with Sphere collision component, Sphere static mesh component and Text render component

Now, switch to event graph and refer to the beginning of this chapter, make a new custom event and name it ActivateGravity, drag and drop a reference from the sphere collision component, and get the Set Simulate Physics blueprint block from it, check the Simulate pin to true and connect this block to the custom event, as shown in Figure 8.36. Press the Compile button at the top:

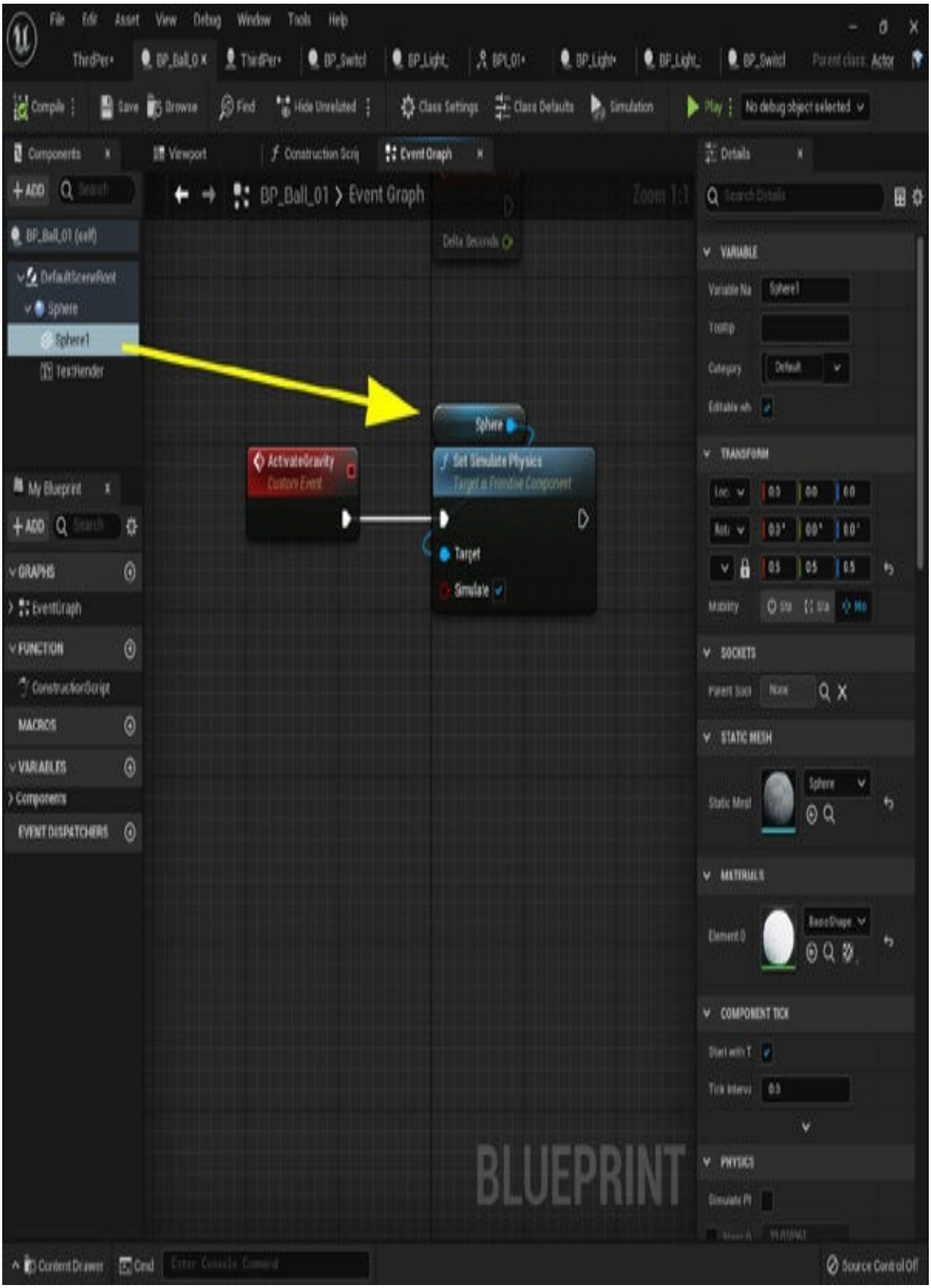

File Edit Asset View Debug Window Tools Help
Compile
Save
Browse
Find
Hide Unrelated
Class Settings
Class Defaults
Simulation
Play
No debug object selected
Components
Viewport
Construction Script
Event Graph
Details
BP_Ball_01 > Event Graph
Zoom 1:1
BP_Ball_01 (self)
DefaultSceneRoot
Sphere
Sphere1
TextRender
Delta Seconds
ActivateGravity
Custom Event
Sphere
Set Simulate Physics
Target is Primitive Component
Target
Simulate
My Blueprint
GRAPHS
EventGraph
FUNCTION
ConstructionScript
MACROS
VARIABLES
Components
EVENT DISPATCHERS
VARIABLE
TRANSFORM
SOCKETS
STATIC MESH
MATERIALS
COMPONENT TICK
PHYSICS
BLUEPRINT
Content Drawer
Cmd
Source Control Off

Figure 8.36: Ball_01 actor event graph

Now, open the third-person character blueprint and execute the ActivateGravity event from this object with a simple cast in line trace, as shown in Figure 8.37 (we can assign and use interface to ball_01 for this, but for now, let's make it simple with cast):

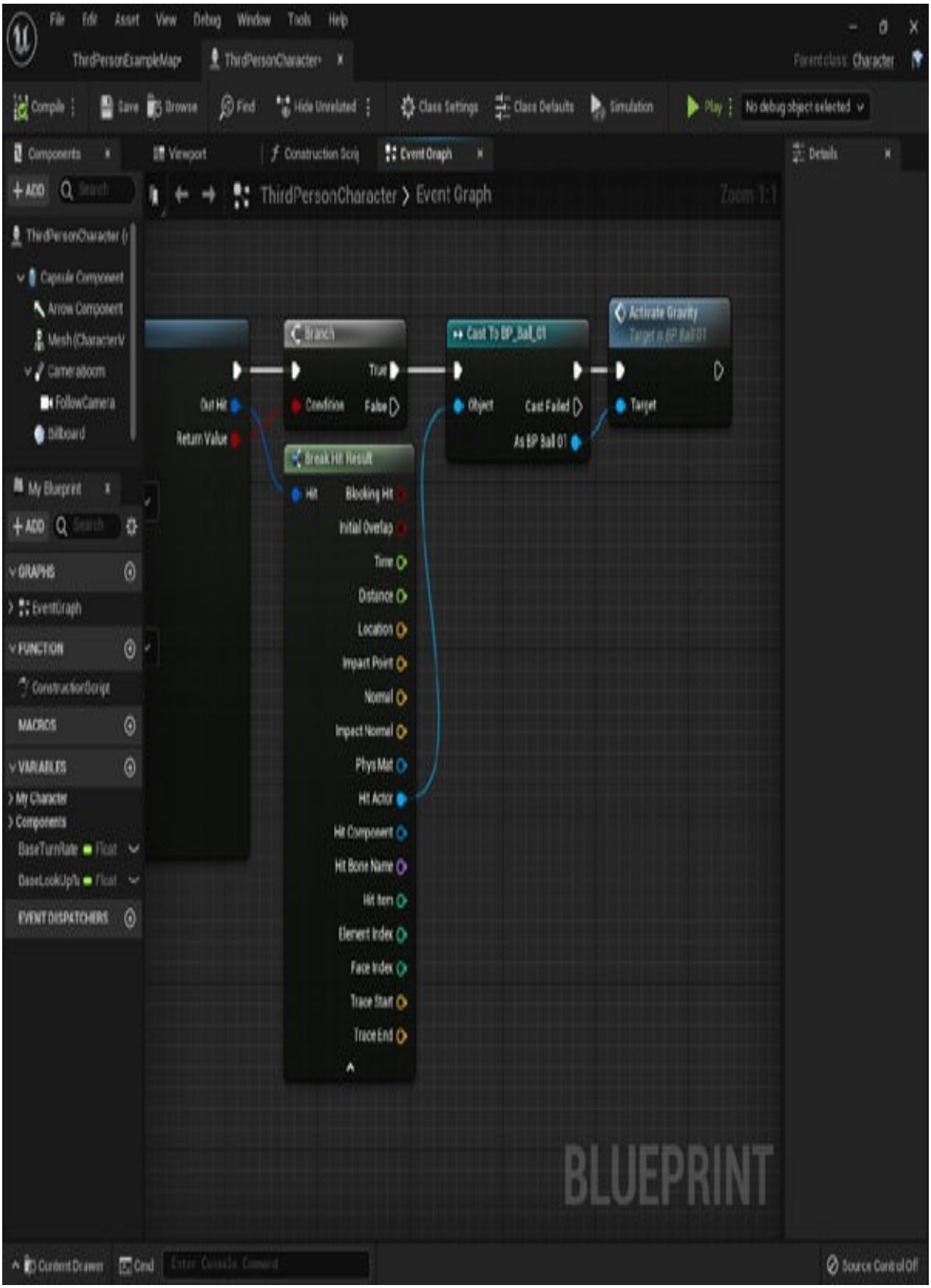
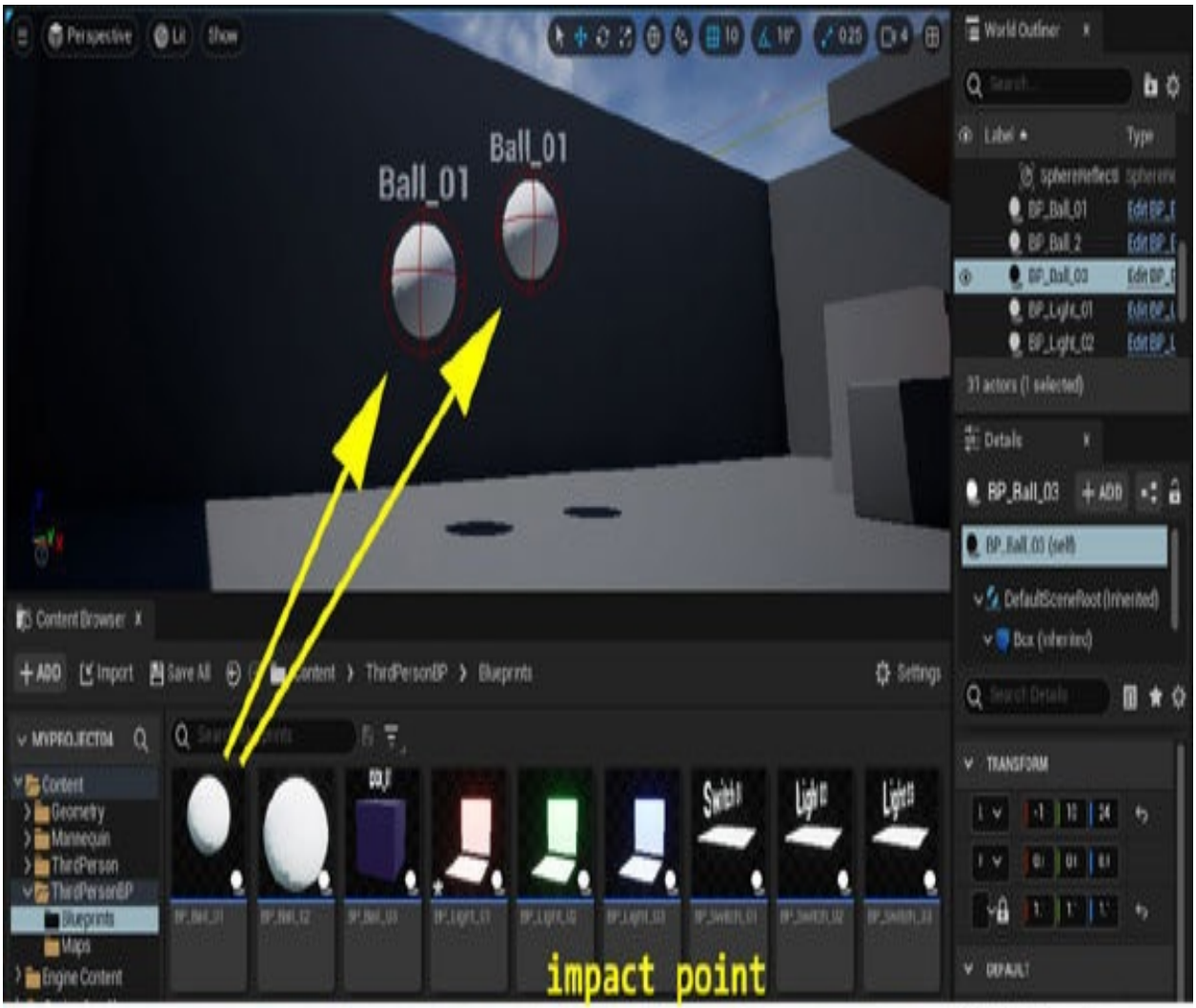

File Edit Asset View Debug Window Tools Help
ThirdPersonExampleMap
ThirdPersonCharacter
Parent class: Character
Compile
Save
Browse
Find
Hide Unrelated
Class Settings
Class Defaults
Simulation
Play
No debug object selected
Components
Viewport
Construction Script
Event Graph
Details
ThirdPersonCharacter > Event Graph
Zoom 1:1
ADD
ThirdPersonCharacter (I
Capsule Component
Arrow Component
Mesh (CharacterV
CameraBoom
FollowCamera
Billboard
Out Hit
Return Value
Branch
True
Condition
False
Break Hit Result
Hit
Blocking Hit
Initial Overlap
Time
Distance
Location
Impact Point
Normal
Impact Normal
Phys Mat
Hit Actor
Hit Component
Hit Bone Name
Hit Item
Element Index
Face Index
Trace Start
Trace End
Cast To BP_Ball_01
Object
Cast Failed
As BP Ball 01
Activate Gravity
Target is BP Ball 01
Target
My Blueprint
GRAPHS
EventGraph
FUNCTION
ConstructionScript
MACROS
VARIABLES
My Character
Components
BaseTurnRate
Float
BaseLookUpRa
Float
EVENT DISPATCHERS
BLUEPRINT
Content Drawer
Cmd
Enter Console Command
Source Control Off

Figure 8.37: Remove previous code, and then Cast to ball_01 actor and run activate gravity event from it with line trace in third person character blueprint

Now we need to make the scene to test the physics. Drag and drop two instances of BP_Ball_01 to the scene from content browser and locate them in the middle of air. When you run the game as presented in Figure 8.38, by shooting laser light (line trace) to each BP_Ball_01, it will fall to the ground, and you can move them by pushing these objects with the third-person character:


Ball_01
Ball_01
impact point

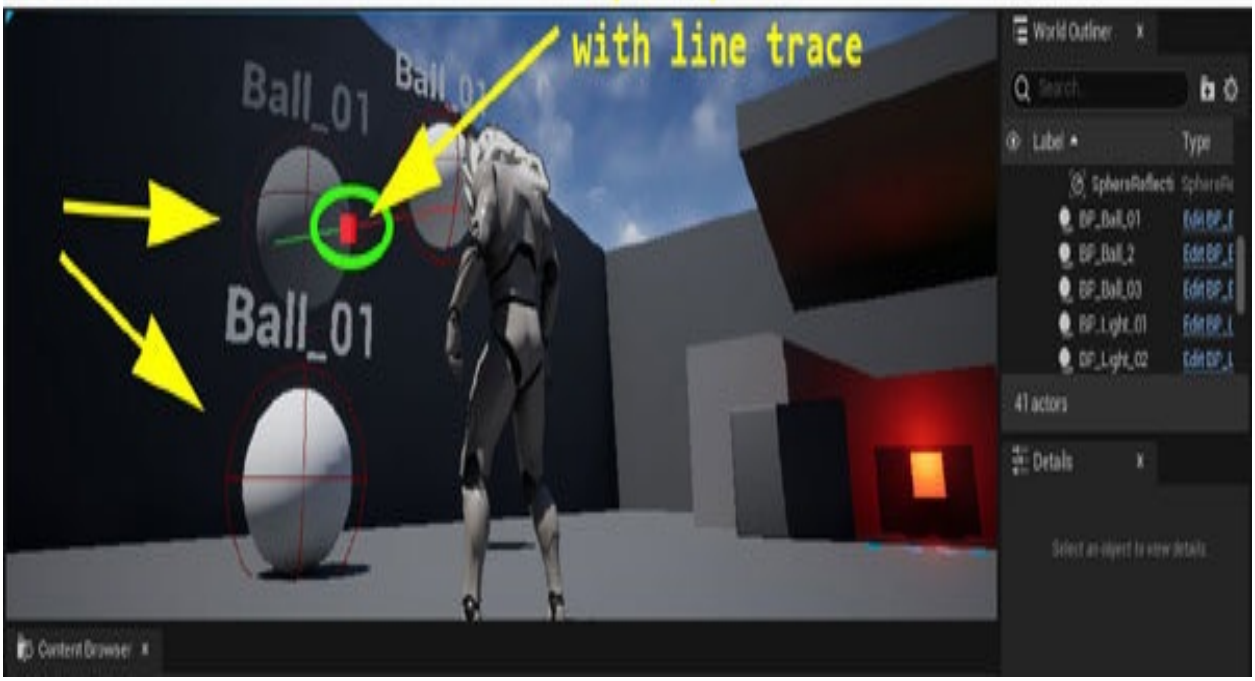

with line trace
Ball_01
Ball_01

Figure 8.38: Top: Drag and drop to the scene some instances of Ball_01 and put them in the air.

Bottom: Run the game and shoot line trace to each.

Add physical force with impulse

Now, let's make shooting object functionality for this actor by pressing E on the keyboard (sounds exciting, isn't it!). For this action, we first need to spawn the ball actor in the world and then add physical force to move it in the direction we like. Duplicate BP_Ball_01 in the content browser, rename it as BP_Ball_02 blueprint and navigate to event graph. Make a new vector variable called Direction and then make a float variable called Speed. For each variable, make sure to tick Expose on Spawn in their details panel and make them public, as shown in Figure 8.39. Press the Compile button at the top. Now, drag and drop an instance from sphere collision component to the event graph, and grab the Add Impulse blueprint block out of it. As you see, this block accepts an input vector known as Impulse that represents a three-dimensional force value each on the X, Y and Z axes. We can increase force on each axis by using high values on that axis, so as a simple practice, we use Speed to represent force and Direction as input variables, and by multiply speed to direction, we can simply make an Impulse input.

Then, use Set Simulate Physics to activate physic simulation, and connect the Add Impulse node to Event Begin Play and press the Compile button at the top. Now, everything is ready; we just need to spawn this actor by shooting it from third-person character:

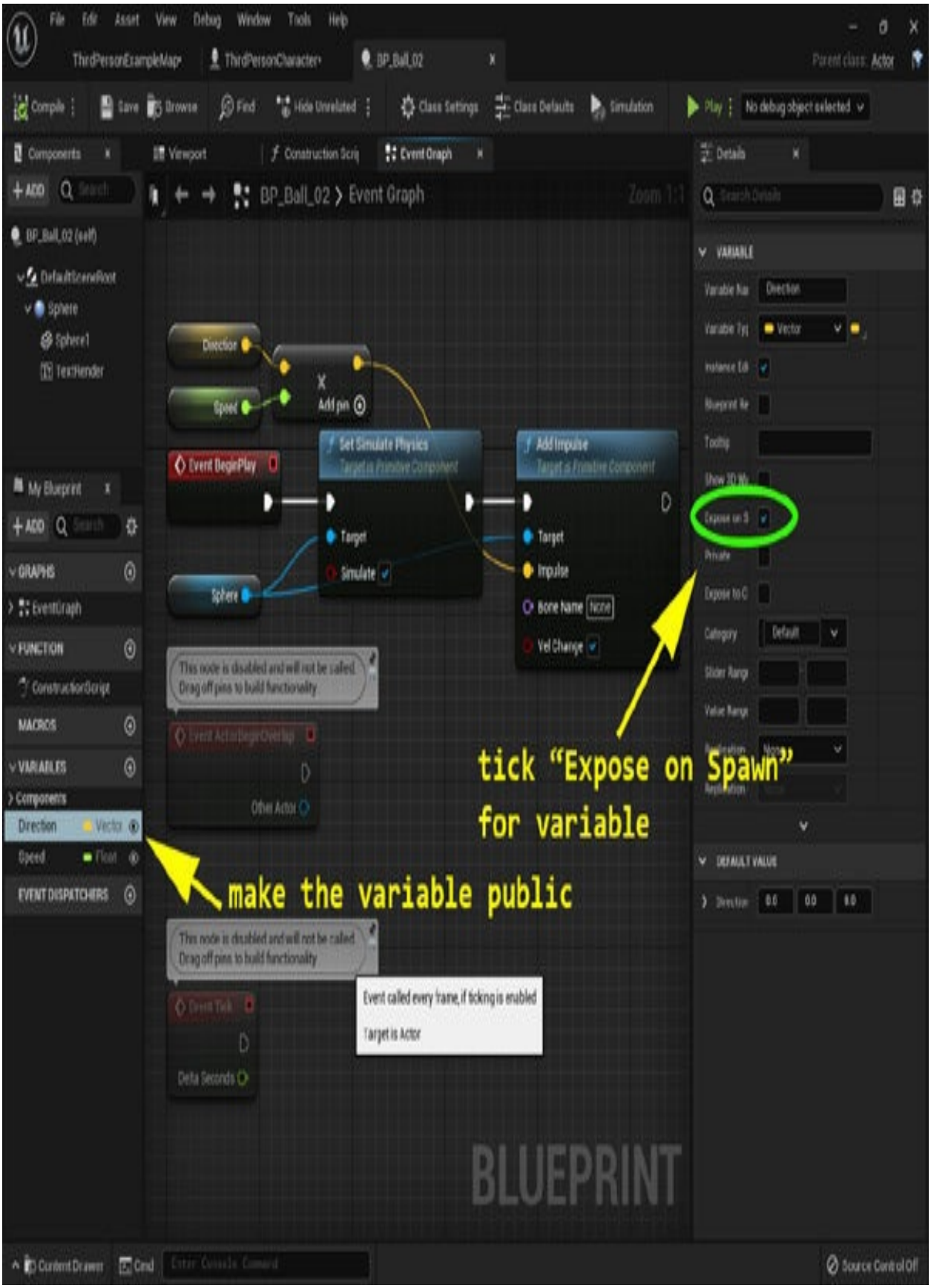

BP_Ball_02 > Event Graph
Direction
Speed
Add pin
Event BeginPlay
Set Simulate Physics
Target is Primitive Component
Target
Simulate
Sphere
Add Impulse
Target is Primitive Component
Target
Impulse
Bone Name
Vel Change
This node is disabled and will not be called. Drag off pins to build functionality
Event ActorBeginOverlap
Other Actor
Event Tick
Delta Seconds
Event called every frame, if ticking is enabled
Target is Actor
tick "Expose on Spawn"
for variable
make the variable public
BLUEPRINT
VARIABLE
DEFAULT VALUE
Direction
Speed
EVENT DISPATCHERS

Figure 8.39: Ball_02 actor blueprint event graph

Open third-person character blueprint and locate your keyboard event. Then, right-click on the event graph, type spawn Actor from class, and then select the blueprint block, as shown in Figure 8.40:

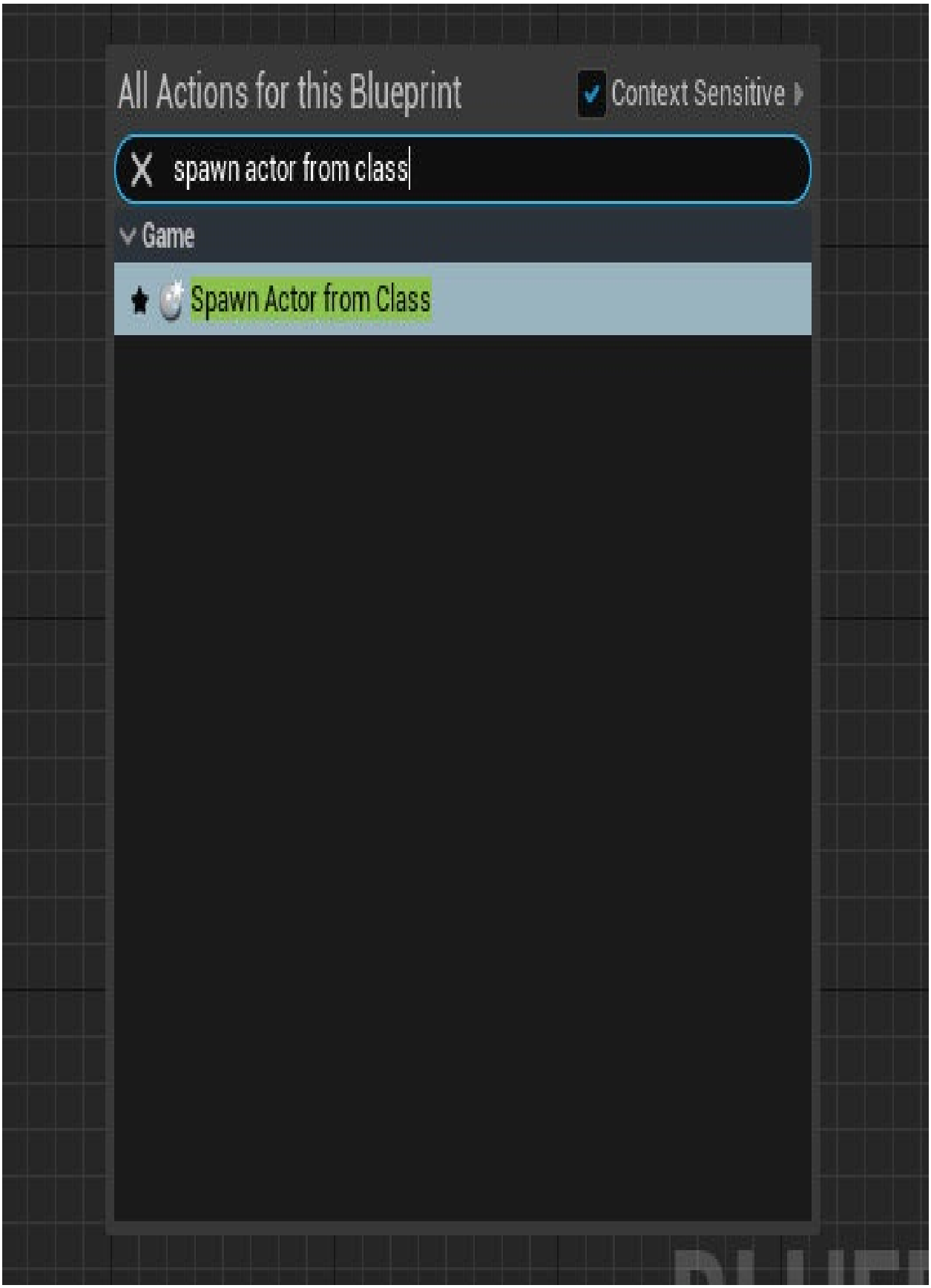

All Actions for this Blueprint
Context Sensitive
spawn actor from class
Game
Spawn Actor from Class

Figure 8.40: "Spawn Actor From Class" blueprint command

The engine will automatically add the Spawn Actor blueprint block to the event graph; then, select BP_Ball_02 from the Class drop-down menu and the blueprint block will automatically change and show your public variables Direction and Speed, as shown in Figure 8.41. Now, we need couple of input values in this block, like Direction and Speed variables, which are references to the public variables we made in the Ball_02 blueprint object:

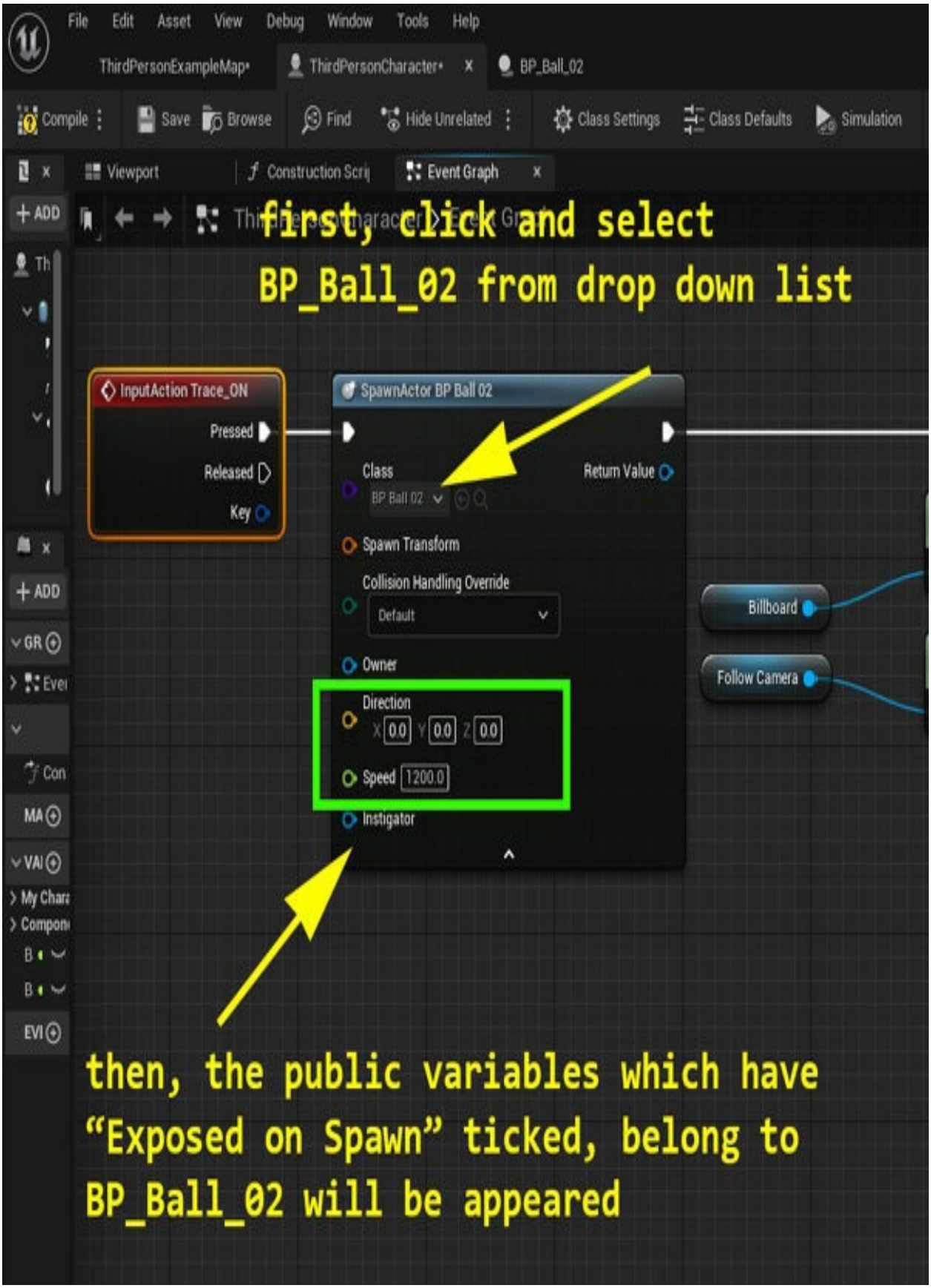

File Edit Asset View Debug Window Tools Help
ThirdPersonExampleMap*
ThirdPersonCharacter*
BP_Ball_02
Compile
Save
Browse
Find
Hide Unrelated
Class Settings
Class Defaults
Simulation
Viewport
Construction Scri
Event Graph
ADD
first, click and select
BP_Ball_02 from drop down list
InputAction Trace_ON
Pressed
Released
Key
SpawnActor BP Ball 02
Class
BP Ball 02
Return Value
Spawn Transform
Collision Handling Override
Default
Owner
Direction
X 0.0 Y 0.0 Z 0.0
Speed 1200.0
Instigator
Billboard
Follow Camera
then, the public variables which have
"Exposed on Spawn" ticked, belong to
BP_Ball_02 will be appeared

Figure 8.41: "Spawn Actor From Class" which the "Class" pin is set to "BP_Ball_01"

To make a value for Spawn Transform, we use same data we used for line trace, by using Make Transform blueprint block. This block can also change the scale of the spawn object. For Direction, we can use follow camera component's forward vector, and it will give the exact directions, like a camera, to the spawned object; finally, for the speed, let's experience with 750. The final code should look like Figure 8.42:

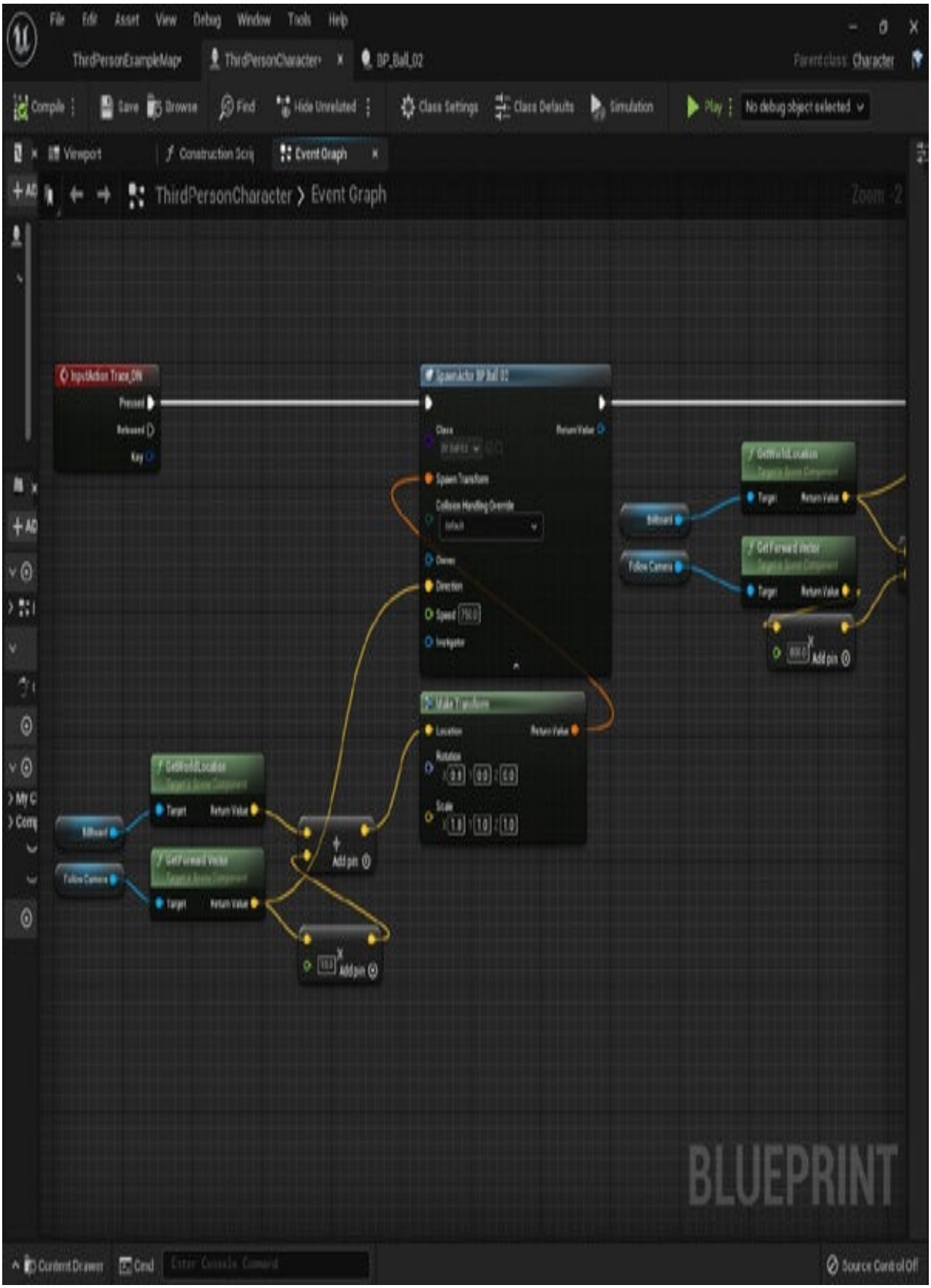

File Edit Asset View Debug Window Tools Help
ThirdPersonExampleMap
ThirdPersonCharacter
BP_Ball_02
Parent class: Character
Compile
Save
Browse
Find
Hide Unrelated
Class Settings
Class Defaults
Simulation
Play
No debug object selected
Viewport
Construction Scrip
Event Graph
ThirdPersonCharacter > Event Graph
Zoom -2
InputAction Trace_ON
Pressed
Released
Key
SpawnActor BP_Ball_02
Class
Return Value
Spawn Transform
Collision Handling Override
Owner
Direction
Speed
Instigator
Billboard
Follow Camera
GetWorldLocation
Target
Return Value
GetForwardVector
Add pin
MakeTransform
Location
Rotation
Scale
BLUEPRINT
Content Drawer
Cmd
Enter Console Command
Source Control Off

Figure 8.42: This code represents shooting functionality by using key event, camera and billboard components. The code will spawn actors from the blueprint class BP_Ball_02

Now, run the code and press E in a different camera direction. Voila! The ball object is shooting in the camera direction on each key press, as shown in Figure 8.43. Now, press Esc, change Speed to 200 and check the results. As you see, the impulse force has decreased slightly on the shooting object:

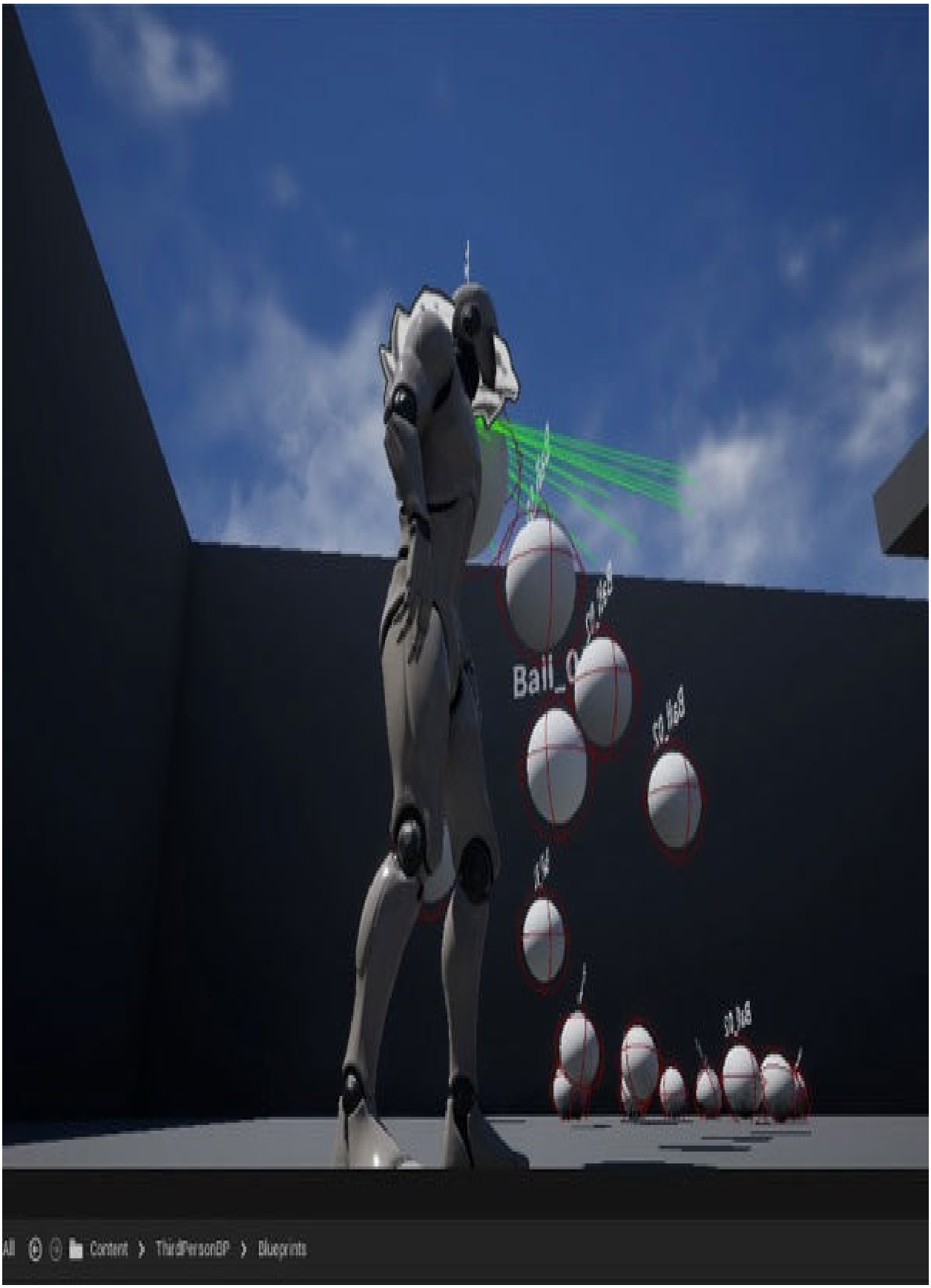
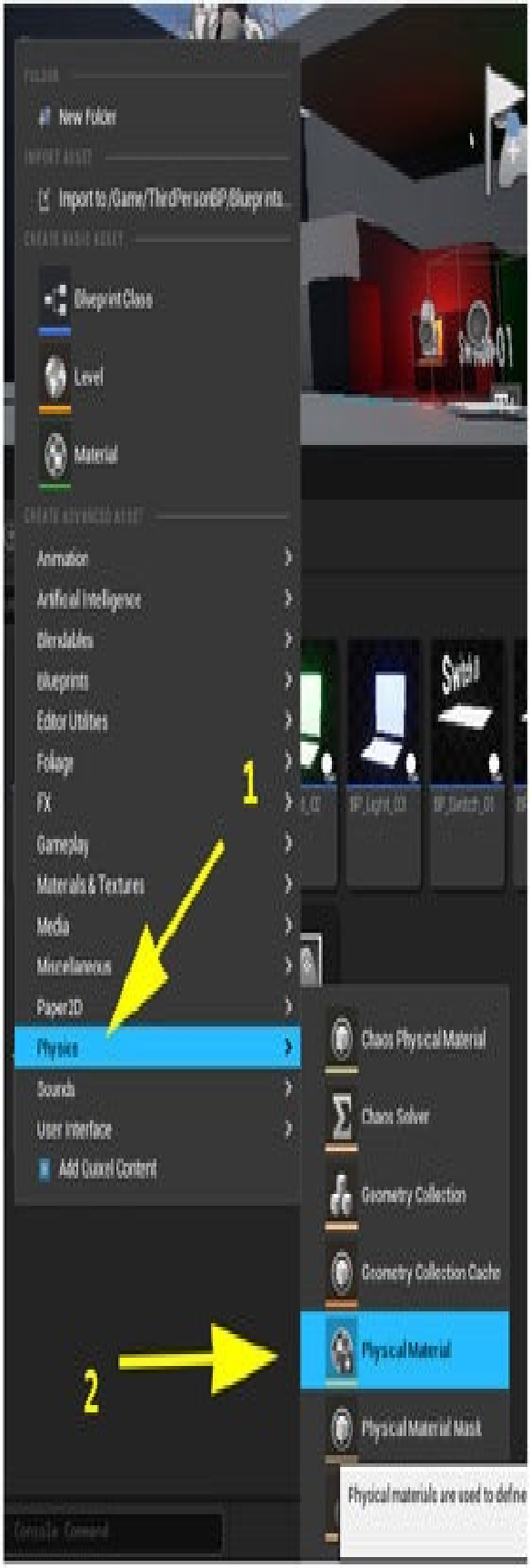

Ball_C
All
Content
ThirdPersonBP
Blueprints

Figure 8.43: Shooting BP_Ball_02 from third person character with speed set to 750

Make physical behavior as material

Unreal Engine also has an advanced system to simulate physics through materials. Right-click on content browser, click on Physics in the menu, and then select Physical Material from the list. The engine will show the Pick Physical Material Class windows; choose the Physical Material class in there, and then click on the Select button, as shown in Figure 8.44. Rename the new physical material as PM_01:


New Folder
Import to /Game/ThirdPersonBP/Blueprints...
Blueprint Class
Level
Material
Animation
Artificial Intelligence
Blendables
Blueprints
Editor Utilities
Foliage
FX
Gameplay
Materials & Textures
Media
Miscellaneous
Paper2D
Physics
Sounds
User Interface
Add Quixel Content
1
Chaos Physical Material
Chaos Solver
Geometry Collection
Geometry Collection Cache
Physical Material
Physical Material Mask
2
Physical materials are used to define

4

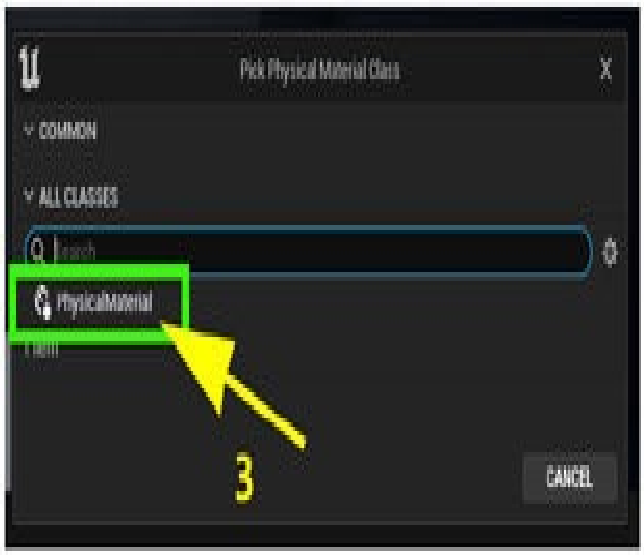

Pick Physical Material Class
COMMON
ALL CLASSES
PhysicalMaterial
3
CANCEL

Figure 8.44: Right-click in the content browser (1) and from Physics in the list (2) select Physical Material. Then (3) click on "PhysicalMaterial" from "Pick Physical Material Class" windows and (4) rename the new physical material to "PM_01"

Now, we need a material to handle our physical material. Make a simple material called MT_01 and assign the PM_01 physical material that we made to it at the PHYSICAL MATERIAL section in its event graph, as shown in Figure 8.45:

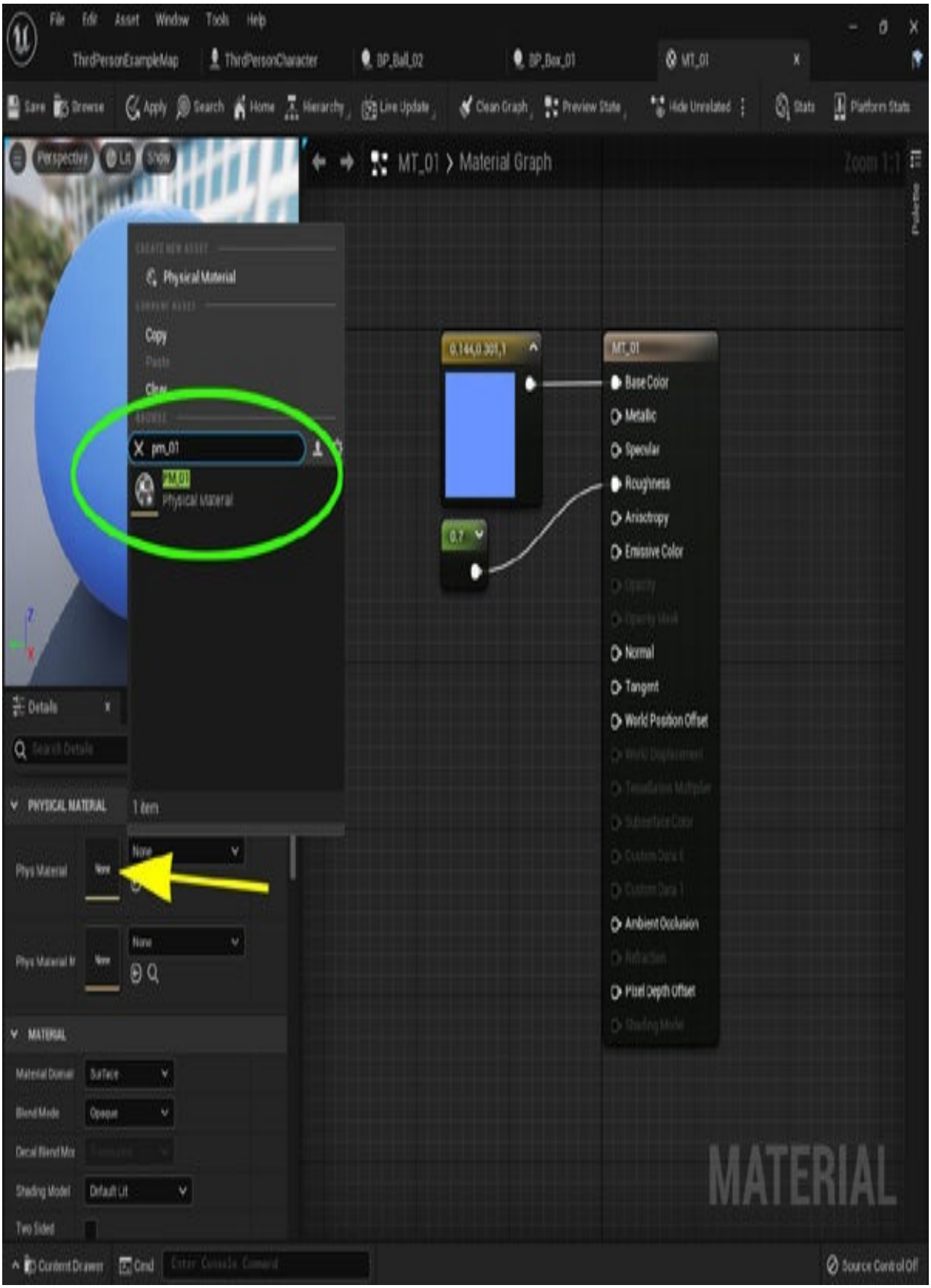

File Edit Asset Window Tools Help
ThirdPersonExampleMap
ThirdPersonCharacter
BP_Ball_02
BP_Box_01
MT_01
Save Browse Apply Search Home Hierarchy Live Update Clean Graph Preview State Hide Unrelated Stats Platform Stats
Perspective Lit Show
MT_01 > Material Graph
Zoom 1:1
Physical Material
Copy
Paste
Clear
pm_01
PM_01
Physical Material
0.144,0.301,1
0.7
MT_01
Base Color
Metallic
Specular
Roughness
Anisotropy
Emissive Color
Normal
Tangent
World Position Offset
Ambient Occlusion
Pixel Depth Offset
Details
PHYSICAL MATERIAL
1 item
Phys Material
None
MATERIAL
Material Domain
Surface
Blend Mode
Opaque
Decal Blend Mode
Shading Model
Default Lit
Two Sided
MATERIAL
Content Drawer
Cmd
Enter Console Command
Source Control Off

Figure 8.45: Add physical material from materials editor in Unreal Engine 5

Now, we need an actor to test this material. Make a new actor called BP_Box_01 with a box collision component that has Simulate Physics ticked in its details panel, a Cube static mesh component and a Text render component, as shown in Figure 8.46. Assign the MT_01 material to cube static mesh component:

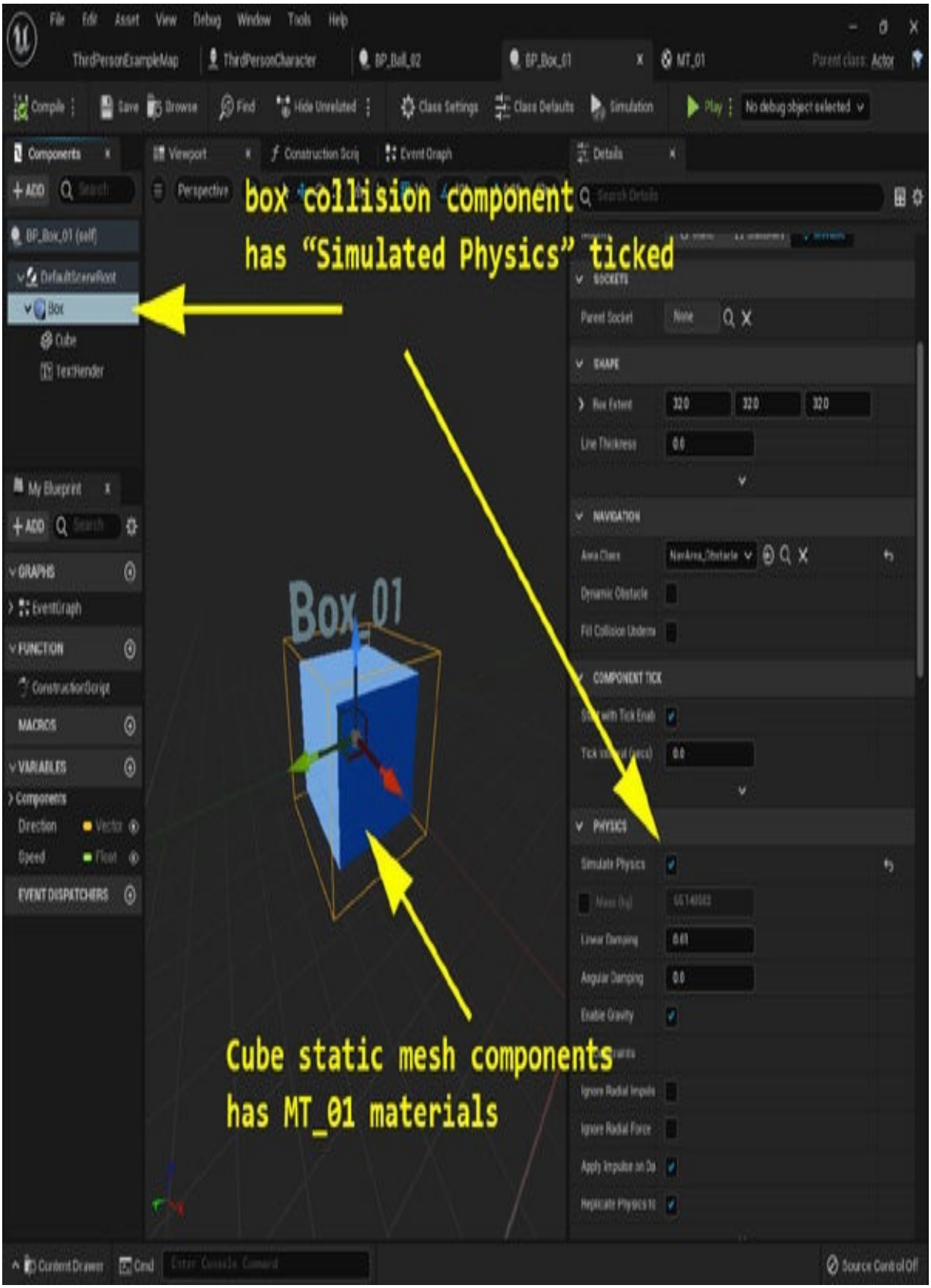

box collision component
has "Simulated Physics" ticked
Cube static mesh components
has MT_01 materials
Box_01
Simulate Physics

Figure 8.46: BP_Box_01 blueprint actor

Now, place an instance of this actor on stage. Then, press play and try to push the cube with the third person character, as shown in Figure 8.47. It moves, but not easy, is it?

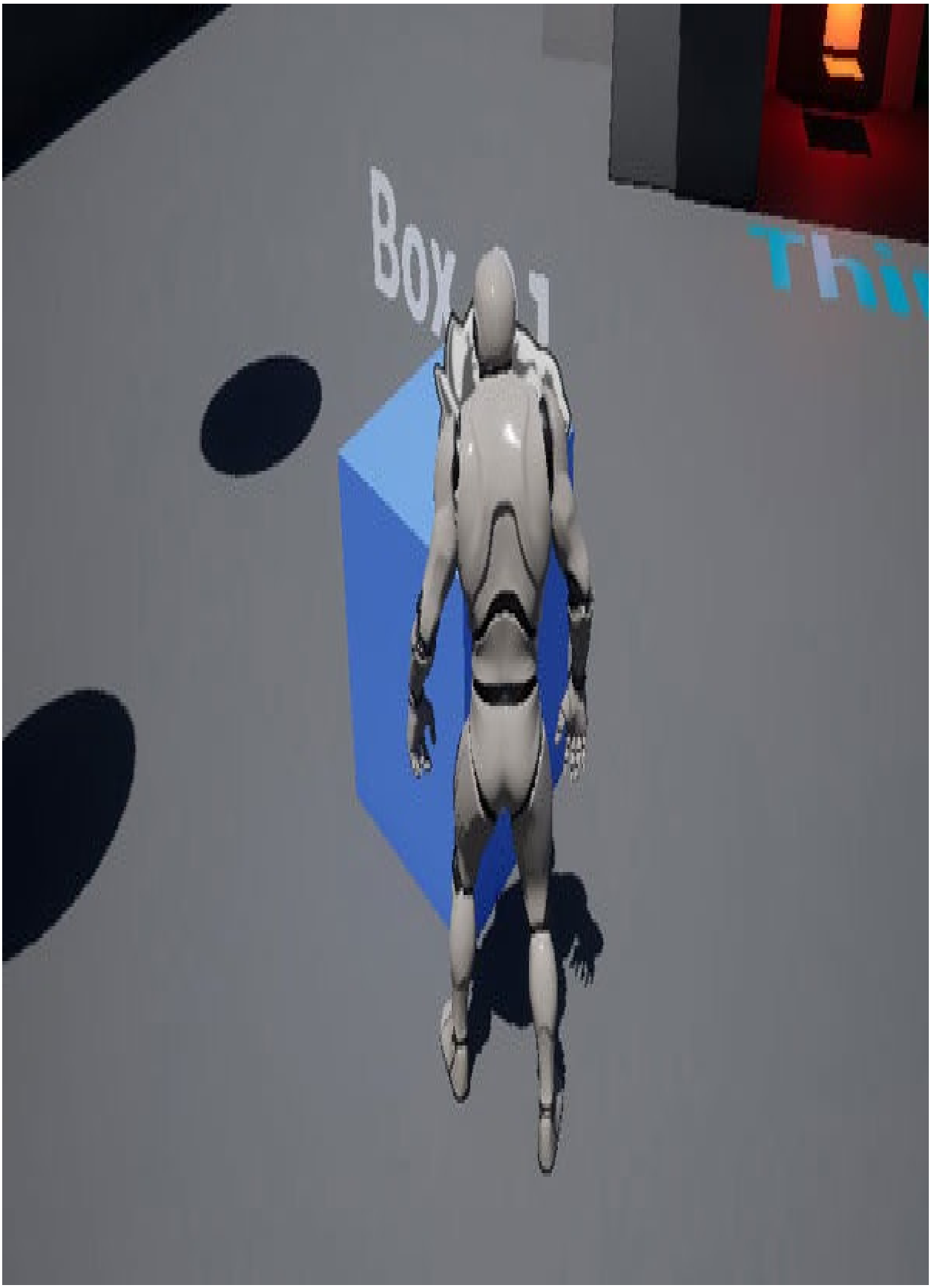

Box 01

Figure 8.47: Add BP_Box_01 blueprint actor to stage and try to push it with the third person character

Now, press Esc to exit the game, and then open PM_01 by double-clicking on it in the content browser. Physical material, as shown in Figure 8.48, has a number of parameters that directly change the behavior of the static mesh object using this material. For now, change the Friction value from 0.3 to 0 and click on Save:

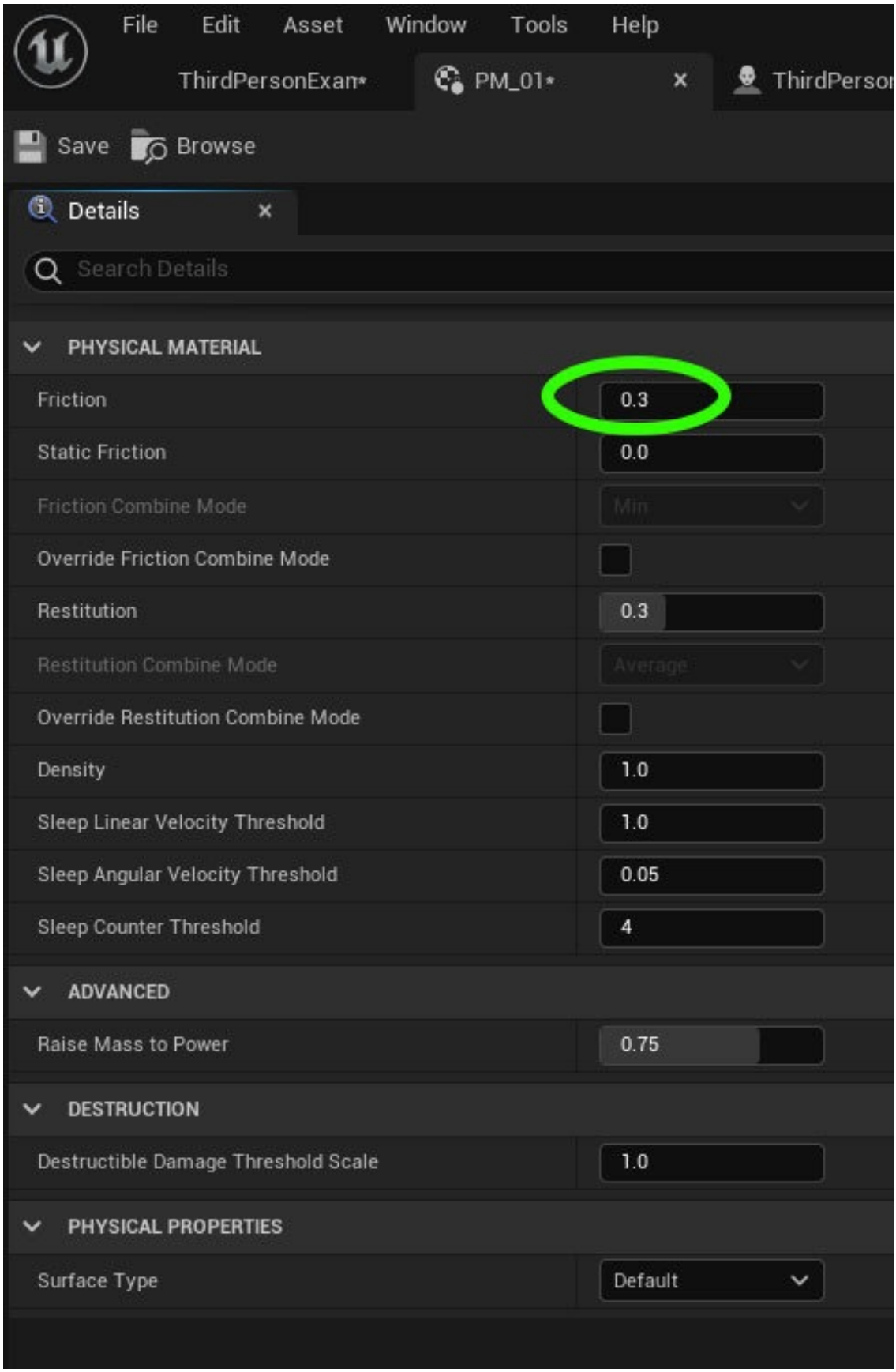

File
Edit
Asset
Window
Tools
Help
ThirdPersonExan*
PM_01*
ThirdPerso
Save
Browse
Details
Search Details
PHYSICAL MATERIAL
Friction
0.3
Static Friction
0.0
Friction Combine Mode
Min
Override Friction Combine Mode
Restitution
0.3
Restitution Combine Mode
Average
Override Restitution Combine Mode
Density
1.0
Sleep Linear Velocity Threshold
1.0
Sleep Angular Velocity Threshold
0.05
Sleep Counter Threshold
4
ADVANCED
Raise Mass to Power
0.75
DESTRUCTION
Destructible Damage Threshold Scale
1.0
PHYSICAL PROPERTIES
Surface Type
Default

Figure 8.48: Physical material parameters

Now, run the game again and try to push the cube again. Voila! It sounds like the cube behaves like a big ice cube and moves with a simple push by the player character:

Create
Content
Blueprints
Cinematics

Figure 8.49: Looks like the BP_Box_01 behaves like a big block of ice after get pushed by third person character

What you have on screen now is a physical material simulation, which runs by engine in real time. There are a number of situations you can simulate through physical materials in the engine; while that is out of scope of this section, keep in mind that this is one of the most powerful tools in the engine to simulate real physics over each static mesh object when the game is running.

Conclusion

In this chapter, we learned how to use event handling by making a number of game assets and connecting them to each other as a simple switch button for a source light. Event handling is an art of developing applications with Unreal Engine, so as much as you can experience and learn in this area, the quality of your final work will show bright features. At the same time, the engine has implemented interface support for blueprint programming. The interface, as we learn, works like a common gateway to send and receive events between objects in an extremely simple way.

At the end, we learned how to shoot physical objects based on physical impulse simulation and change the physical features of each material to make them behave like real-world objects.

For making much in depth custom functionalities for actors on the scene, developers need to use and process different data types at the same time. To do that, developers mostly use groups of variables which are organized in data containers. These data containers simplify the process and organized the code which is very useful in order to develop complex functionalities.

The Unreal Engine 5 has a complete support for a majority of data types that can be used to control game flow, animation, and game mechanics. Learning that is essential knowledge for each game programmer.

Points to remember

When you make a new interface and assign it to your objects, it is better to save the project and open it again. The reason for this is technically complicated, but in simple words, the engine needs to grab the new interface code and compile it a little bit different from compiling normal blueprints. Sometimes, this process is not fully running after users make new interface blueprint in editor and then assign it to objects. So, after saving and restarting, the engine will fully compile all new game objects again, which, in turn, will mean that the interface will be applied and ready to use.

Event and interface in Unreal Engine can accept variables to send and receive data.

When Simulate Physics is ticked on an object, remember that you can tick mass and assign values as kilograms to your object and simulate physics based on it. This property is compatible with physical material features belonging to object.

Multiple choice questions

For what do we use events in Unreal Engine 5?

To develop communication between blueprint game objects in the scene

To handle collision and address user input

To implement interface function support on blueprint objects

Options a, b and c are correct

Answer

d

Questions

How can you send and receive a variable with an event?

How can you receive values from blueprint interface?

What is the difference between LineTraceByChannel and LineTracebyObject in blueprint programming?

Can you force engine’s line trace to bypass an object in the scene? How?

Key terms

Blueprint interface - Blueprint Interface is a collection of one or more functions, without implementations (name only) that can be added to other Blueprints for send and receive data.

Blueprint event - Executive nodes in blueprint that are called during runtime for execution of an individual network of procedures, are known as blueprint event.

Line trace – Traces functions, “shoot” out an invisible ray/line which can detect geometry between two points. In case that geometry is hit by this ray/line, the trace function (line trace) will return data related to hit point.

Cast - Casting is a common programming method where you take a reference to an object and try to compare with or convert into a different class.

Blueprint collision – Every object that can collide can use procedures(events/functions) to detect and manage its behavior based on collide type.

Physical material – They are special type of materials used to define the behavior, respond and possible actions of a physical object when interacting dynamically with the world based on physical parameters.

Impulse - An impulse is an “instantaneous physical force” which usually applied once to the object.

Simulate physics – To activate physical behaviors on an object, find and check “Simulate Physics” property which is mostly located on detail panel of each actor blueprint.

Light source - Unreal Engine has four default light types: Point, Directional, Spot and Sky. Directional lights are used as primary outdoor light or any light that needs to appear as extreme or located very far distances. Point lights are like classic “light bulb”, emitting light in all directions from a single point. Spot lights emit light from a single point, but have their light limited by a set of cones. Sky lights capture the background of the game scene and apply it as lighting to meshes located in the scene.

CHAPTER 9

Data Processing (Enum, Struct, Map, Data Tables) and Animation Instances

There are several complicated types of variables that aren't used as much as the simpler ones but are arguably more important, as they are generally used for creating larger, core systems that the simpler variables are used within. This chapter will also cover animation instances (changing animations using data within blueprint).

Structure

In this chapter, we will discuss the following topics:

Object based variables

Enumerators (Enums)

Byte

Enumerator editor

Structures (structs)

Nested structs

Structure editor

Arrays

Maps

Data tables

Data table editor

CSV/JSON export

Data table usage in blueprint

Animation instances

Multi-variable type operators

Objectives

After studying this chapter, you should know of some of the more advanced variable types, their uses, how to set them up for use, some of the blueprint nodes that utilize them, the basic concept of animation instances, how to use them to animate skeletal meshes via blueprint, and how to use multi-variable math operators.

Object-based variables

Enumerators, structures, and data tables are predefined; although they are used within blueprints, their traits are defined outside of the blueprint editor within an object that stores this information:

Level
Material
Variables
CREATE ADVANCED ASSET
Search Variables
Animation
Artificial Intelligence
Blendables
Blueprints
Editor Utilities
Foliage
FX
Gameplay
Materials & Textures
Media
Miscellaneous
Paper2D
Physics
Sounds
User Interface
Add Quixel Content
Blueprint Class
Blueprint Function Library
Blueprint Interface
Blueprint Macro Library
Enumeration
Structure
Data_Table
Enumerator
Structure
DATA TABLE
ENUMERATION
STRUCTURE

Figure 9.1: Object Based Variables in Content Browser

Each of these variables have an editor specific to them, which is accessed by opening them through the content browser. Within these editors, the associated variable can be modified. Creating these assets is done by right-clicking in the content browser; structure and enumeration are found under the Blueprints category, and Data Tables are found under Miscellaneous.

Enumerators (Enums)

Enumerator variables contain a list of named values from a predefined list of possible values, which are defined within an enumerator object in the project files. :

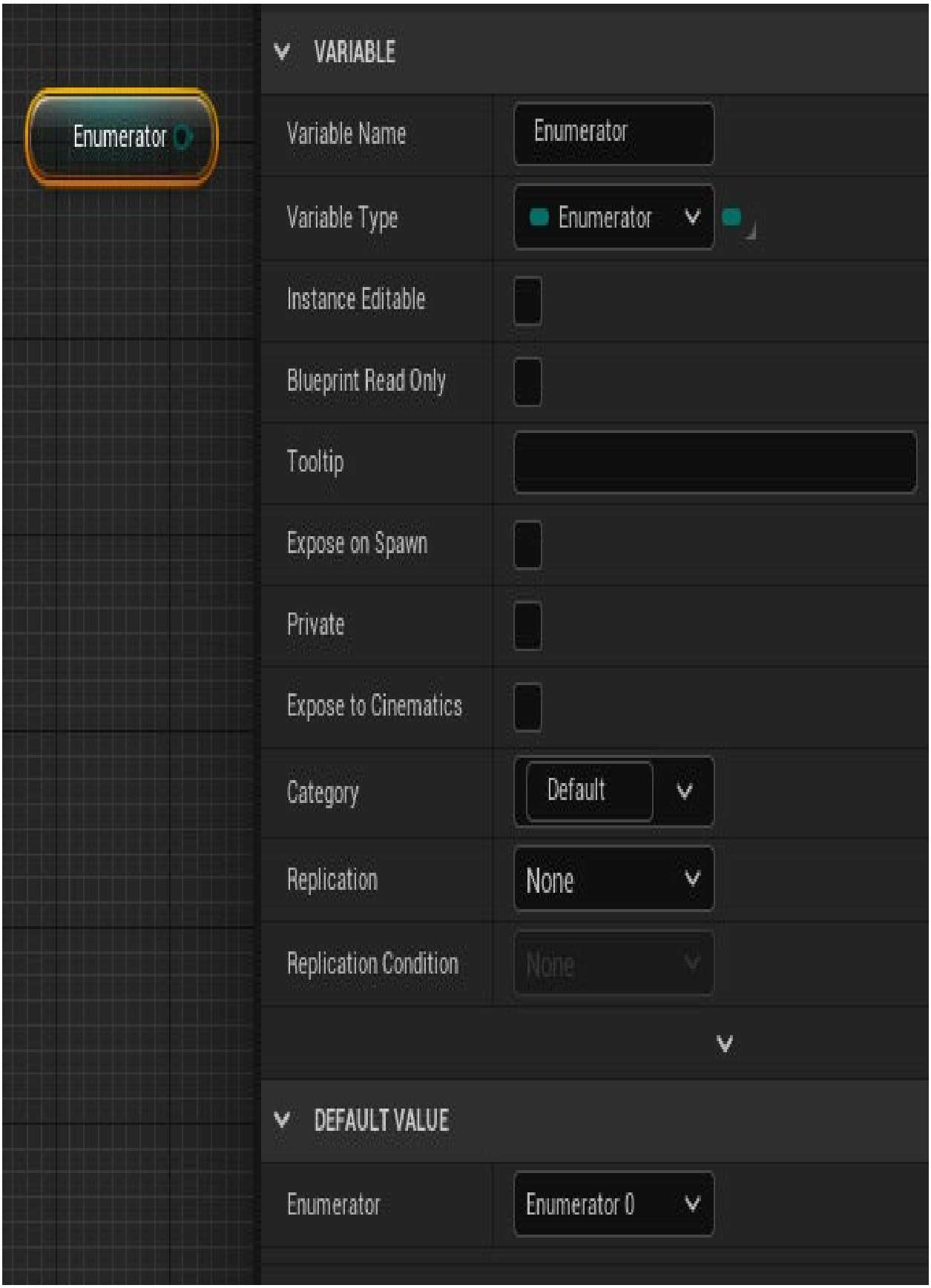

Enumerator
VARIABLE
Variable Name
Enumerator
Variable Type
Enumerator
Instance Editable
Blueprint Read Only
Tooltip
Expose on Spawn
Private
Expose to Cinematics
Category
Default
Replication
None
Replication Condition
None
DEFAULT VALUE
Enumerator
Enumerator 0

Figure 9.2: Enumerator Variable

Enumerators are used to hold a value from a set list of potential values, so they are useful for defining states, usually within (or accessed by) an animation blueprint as shown in image below.

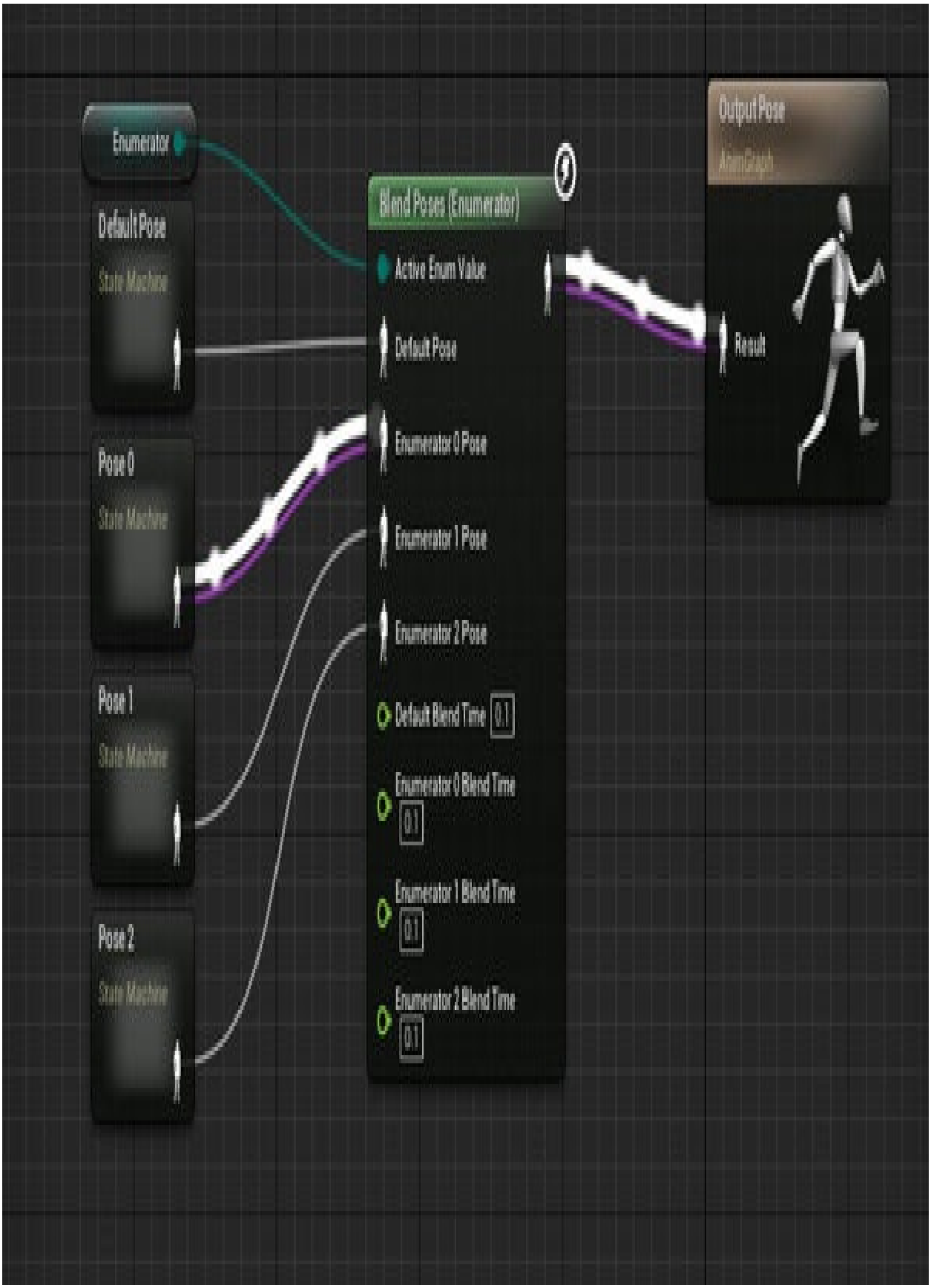

Enumerator
Default Pose
State Machine
Pose 0
State Machine
Pose 1
State Machine
Pose 2
State Machine
Blend Poses (Enumerator)
Active Enum Value
Default Pose
Enumerator 0 Pose
Enumerator 1 Pose
Enumerator 2 Pose
Default Blend Time
0.1
Enumerator 0 Blend Time
0.1
Enumerator 1 Blend Time
0.1
Enumerator 2 Blend Time
0.1
Output Pose
AnimGraph
Result

Figure 9.3: Enumerator in Animation Graph

Bytes

Enumerators can also be converted to and from Byte variables, which allows reference to enumerator values via the index value (place in the list of possible enumerator values):

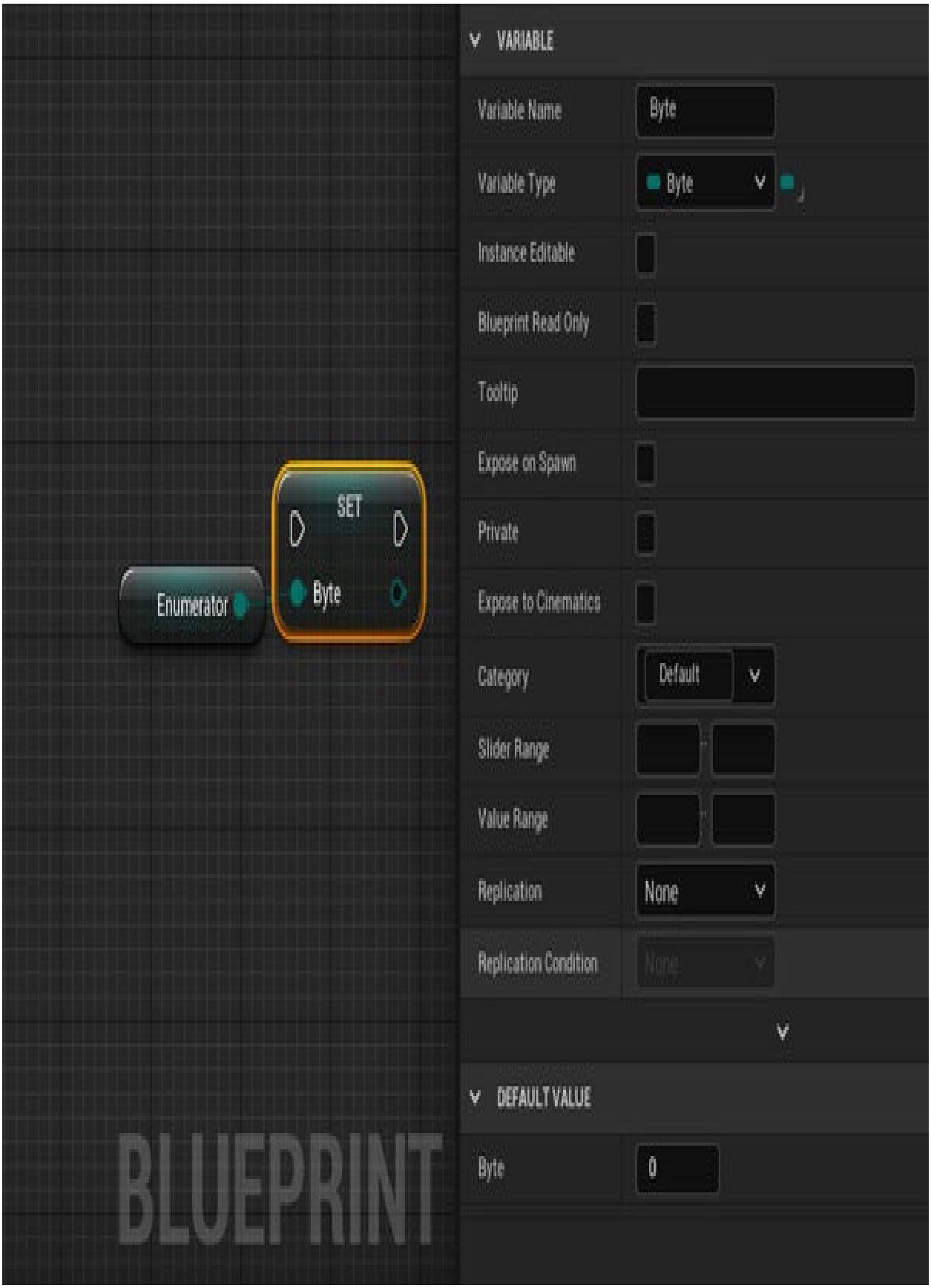

VARIABLE
Variable Name
Byte
Variable Type
Byte
Instance Editable
Blueprint Read Only
Tooltip
Expose on Spawn
Private
Expose to Cinematics
Category
Default
Slider Range
Value Range
Replication
None
Replication Condition
None
DEFAULT VALUE
Byte
0
SET
Byte
Enumerator
BLUEPRINT

Figure 9.4: Byte variable

Bytes are similar to integers, but they can only contain whole numbers up to 255, making them perfect for usage alongside lists like enumerators because you can’t have negative or partial entries.

Enumerator editor

Enumerators are modified via an Enumerator specific editor, where entries can be added, modified and defined:

File
Edit
Asset
Window
Tools
Help
Enumerator
Save
Browse
Enumerators
ENUMERATORS
New
Display Name
Enumerator 0
Description
Converts to a Byte with value of 0
Display Name
Enumerator 1
Description
Converts to a Byte with value of 1
Display Name
Enumerator 2
Description
Converts to a Byte with value of 2
DESCRIPTION
Enum Description
Custom Enumerator
Content Drawer
Cmd
Enter Console Command
Source Control Off

Figure 9.5: Enumerator Variable Editor

Each entry has a couple of text boxes; the one labeled Display Name allows you to set the name displayed for that particular entry when using the enumerator, and the Description box text will be displayed when hovering over that entry in a drop-down menu (Setting Default value or comparing values, as shown in Figure 9.6). Entries can also be rearranged, but be aware that changing the order of entries may cause issues in logic utilizing the enumerator:

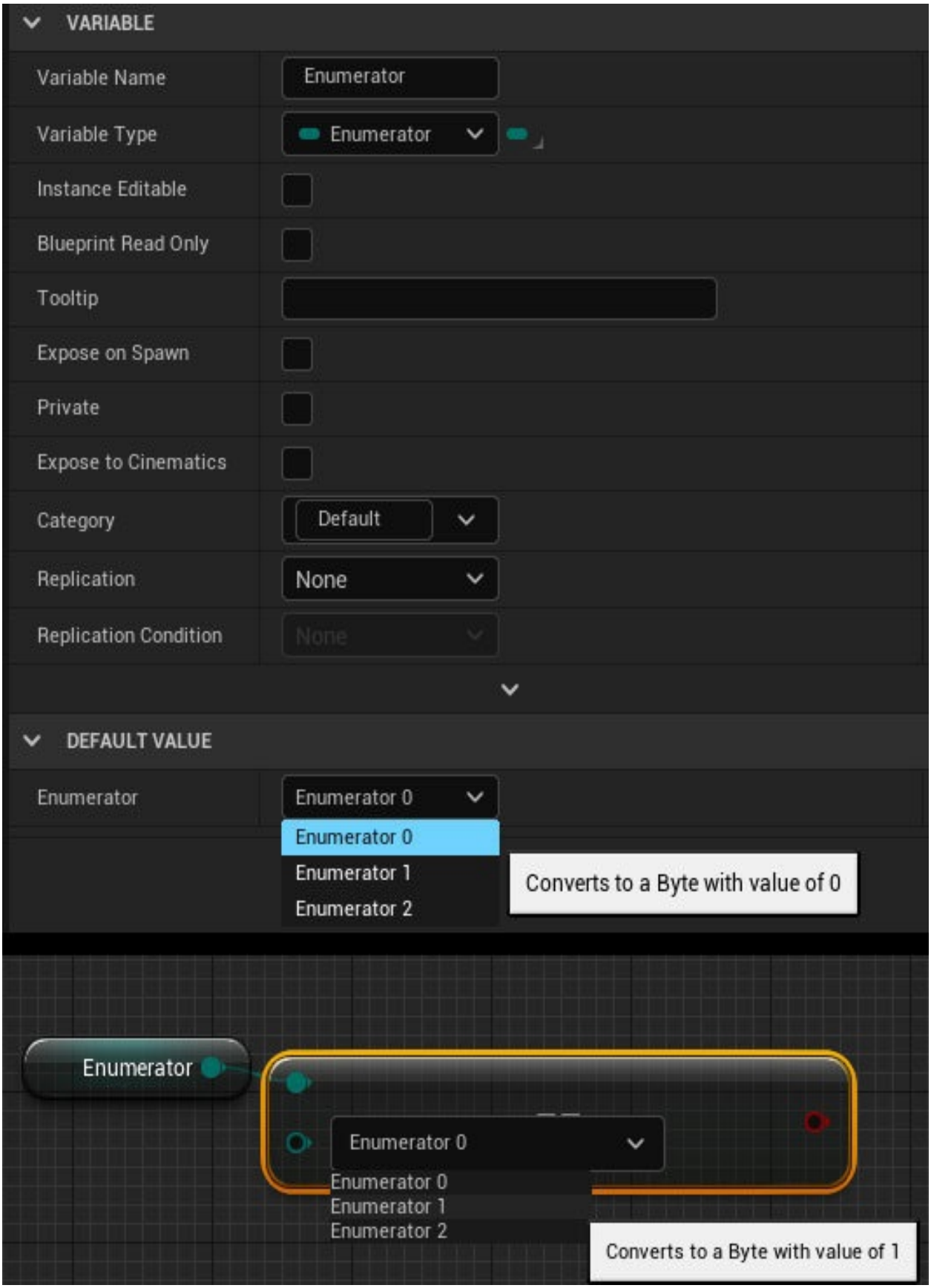

VARIABLE
Variable Name
Enumerator
Variable Type
Enumerator
Instance Editable
Blueprint Read Only
Tooltip
Expose on Spawn
Private
Expose to Cinematics
Category
Default
Replication
None
Replication Condition
None
DEFAULT VALUE
Enumerator
Enumerator 0
Enumerator 0
Enumerator 1
Enumerator 2
Converts to a Byte with value of 0
Enumerator
Enumerator 0
Enumerator 0
Enumerator 1
Enumerator 2
Converts to a Byte with value of 1

Figure 9.6: Enumerator Descriptions

Structures (structs)

Structures are collections of variables, which can include other structs. This means they can be used to neatly contain a large amount of varied information.

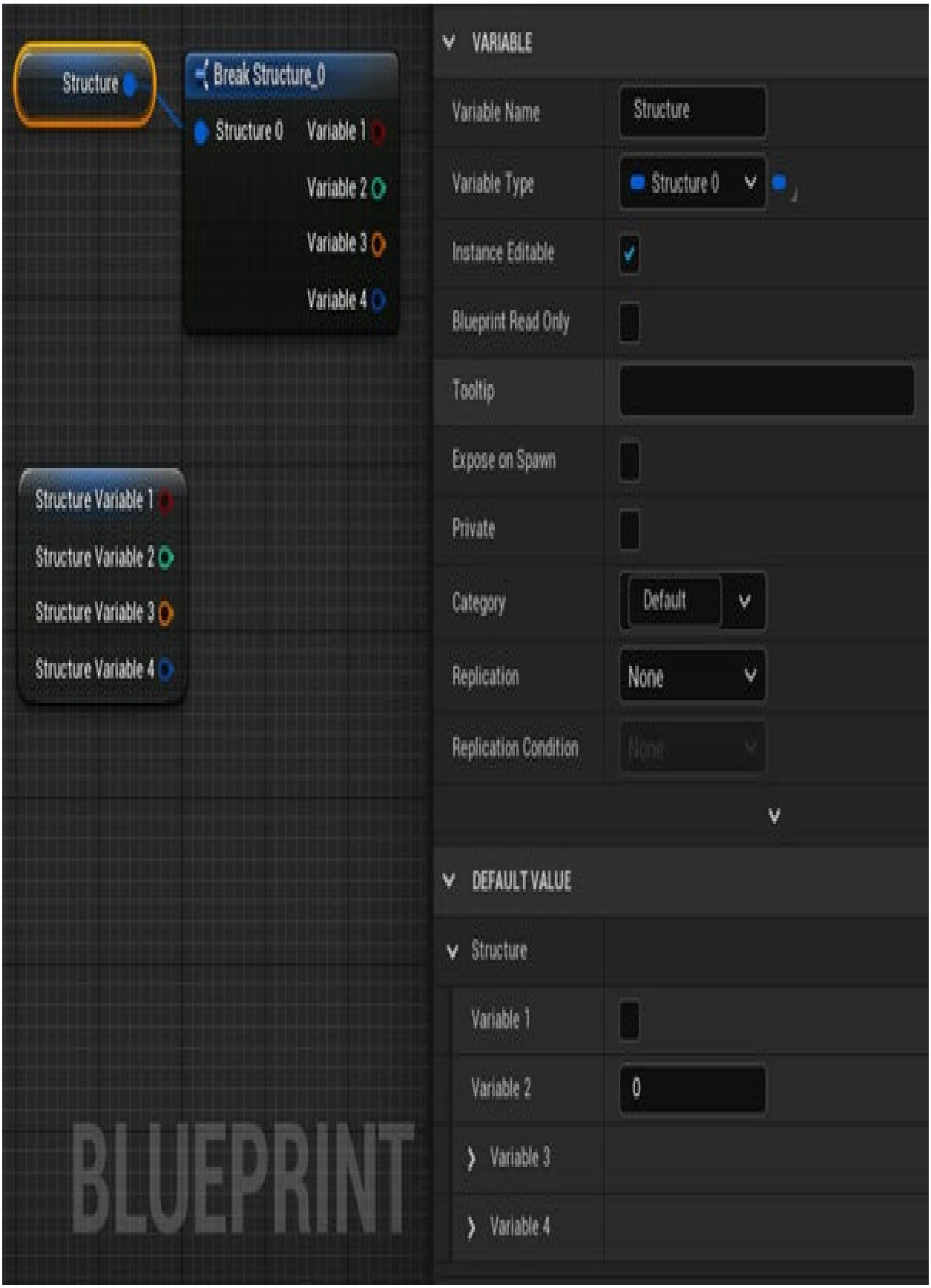

Structure
Break Structure_0
Structure 0
Variable 1
Variable 2
Variable 3
Variable 4
Structure Variable 1
Structure Variable 2
Structure Variable 3
Structure Variable 4
BLUEPRINT
VARIABLE
Variable Name
Structure
Variable Type
Structure 0
Instance Editable
Blueprint Read Only
Tooltip
Expose on Spawn
Private
Category
Default
Replication
None
Replication Condition
None
DEFAULT VALUE
Structure
Variable 1
Variable 2
0
Variable 3
Variable 4

Figure 9.7: Structure variable

Structures are used for grouping together related data neatly into a single variable; for example, you could contain information about an item that can be placed within some type of inventory system by the player, likely containing a static mesh variable to be used when the item is placed in the world, an icon to display the item within the player's inventory, some type of item ID (Integer) for fast reference on what specific item it is, a name, and possibly also a description:

Name
String
ID
Integer
Description
String
Mesh
Static Mesh
Icon
Texture 2D

Figure 9.8: Structure Example

When using structs in blueprints, using pin splitting (as covered in Chapter 7, Simple Data) or break nodes (as shown in Figure 9.7) is a necessity to access the variables within the struct.

Structure editor

Structures are modified via a structure specific editor, where variables can be added, modified, and defined in the top half of the editor, and the default values for the variables used within the struct can be set in the bottom half of the editor:

File Edit Asset Window Tools Help

Structure_0 | Structure_1

Save Browse

STRUCTURE

New Variable

Tooltip

Variable 1 — Boolean

Tooltip

Editable

Save Game

Variable 2 — Integer

Variable 3 — Transform

Variable 4 — Structure 1

DEFAULT VALUES

Variable 1

Variable 2 — 0

Variable 3

Location — 0.0 0.0 0.0

Rotation — 0.0 0.0 0.0

Scale — 1.0 1.0 1.0

Variable 4

Variable 5 — 0.0 0.0 0.0

Variable 6 — 0.0 0.0 0.0

Variable 7

Content Drawer | Cmd | Enter Console Command | Source Control Off

Figure 9.9: Structure Editor

Each entry in the top section of the editor contains a text box for naming the variable, a drop-down menu for selecting the variable type, a few buttons for reordering the entries, and a cross for removing the entry.

Each entry can also be expanded by clicking on the arrow to the left of its name (as seen in Figure 9.9), which allows access to the tooltip for that entry. A Boolean to set whether that entry's variable can be modified on an instance of a blueprint using the struct, and a Boolean to set whether the variable will be serialized if the struct is used in a save file.

Nested structs

Structures can contain structures within themselves, although not a struct of the same type, so no infinite loops:

Structure
Break Structure_0
Structure 0
Variable 1
Variable 2
Variable 3
Variable 4
Break Structure_1
Structure 1
Name
ID
Description
Mesh
Icon

Figure 9.10: Nested Struct

This allows for structs to contain subcategories within themselves, which is extremely useful for defining complex objects that require many variables.

Arrays

A list of values of a specific variable type is called an array. Arrays can be made by selecting an existing variable and changing it from a single value to an array, as shown in Figure 9.11:

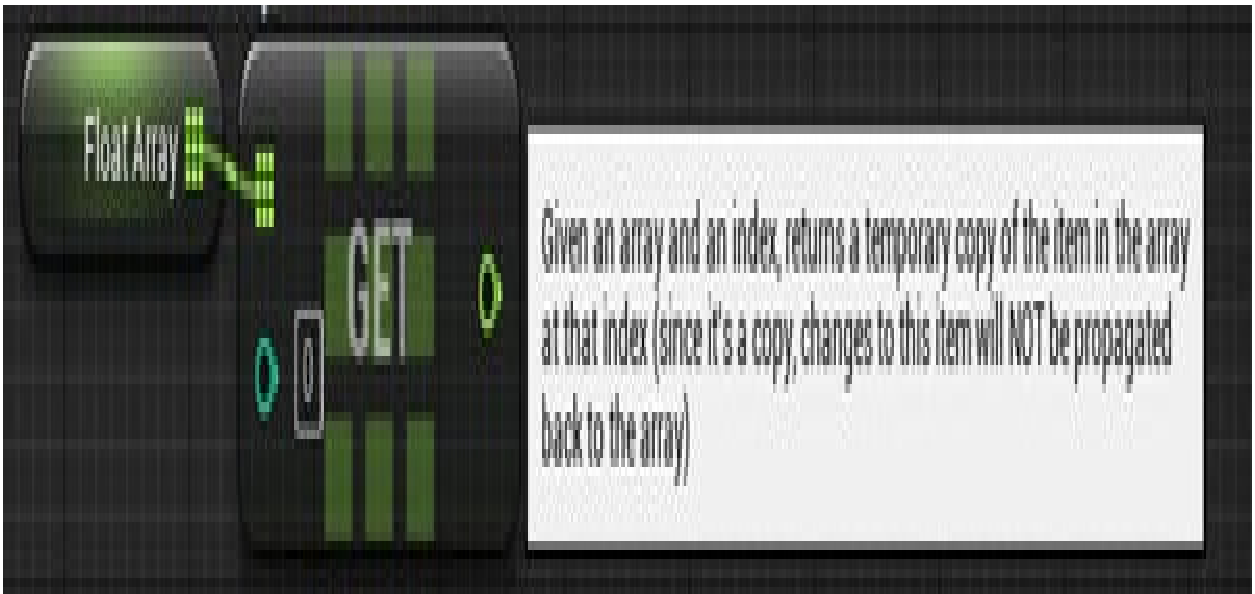
Details
Search Details
VARIABLE
Variable Name
Float
Variable Type
Float
Instance Editable
Blueprint Read Only
Tooltip
Expose on Spawn
Private
Expose to Cinematics
Category
Default
Slider Range
Value Range
Replication
None
Replication Condition
None
Single
Array
Set
Map
Make this variable a container (array, set, or map) of selected type.
DEFAULT VALUE
Float
0.0

Figure 9.11: Change container type

Arrays have nodes specifically for them, including ones that allow getting values from a specific entry in an array, removing or altering entries, and more.

Get

In order to get a value for a specific entry in an array, one of two variations of the Get node will need to be used:


Float Array
GET
Given an array and an index, returns a temporary copy of the item in the array at that index (since it's a copy, changes to this item will NOT be propagated back to the array)

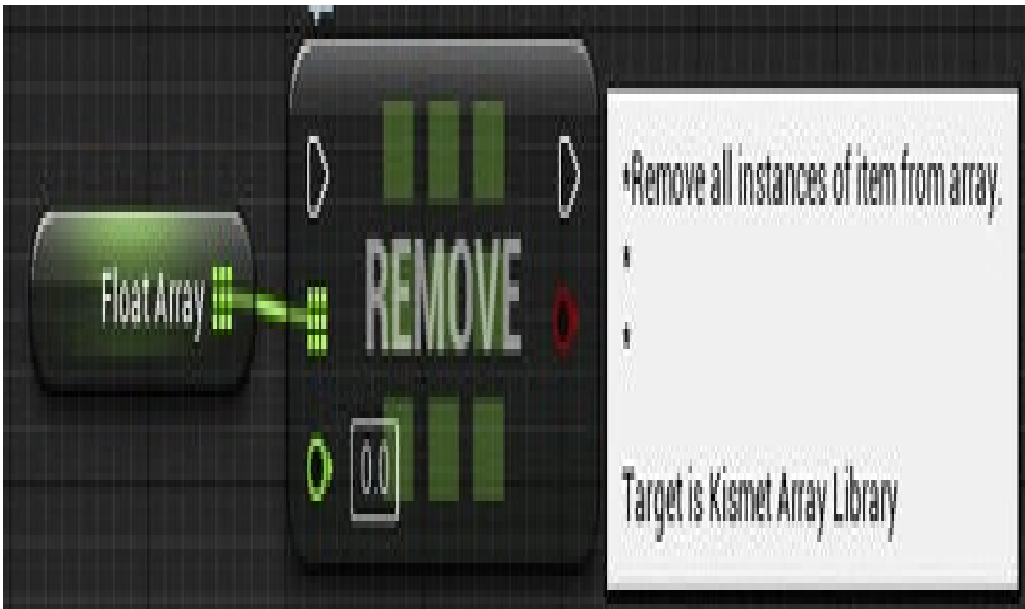
Float Array
GET
Given an array and an index, returns the item in the array at that index (since it's a direct reference, you can operate directly on the item and changes made to it will be reflected back in the array)

Figure 9.12: Get Array Value

When creating a Get node, you will have a choice between a node that gets a copy of the value and a node that gets a reference to the value. The key difference between the two is that the reference allows you to change the output value in the array by altering the output value, whereas the copy only gives you the value with no capacity for altering it.

Remove

In order to remove one or more values from an array, one of two remove nodes will need to be used. The Remove node will take a value and remove all entries matching that value from the array, while the Remove Index node will remove a specific entry:


Float Array
REMOVE
0.0
•Remove all instances of item from array.
Target is Kismet Array Library

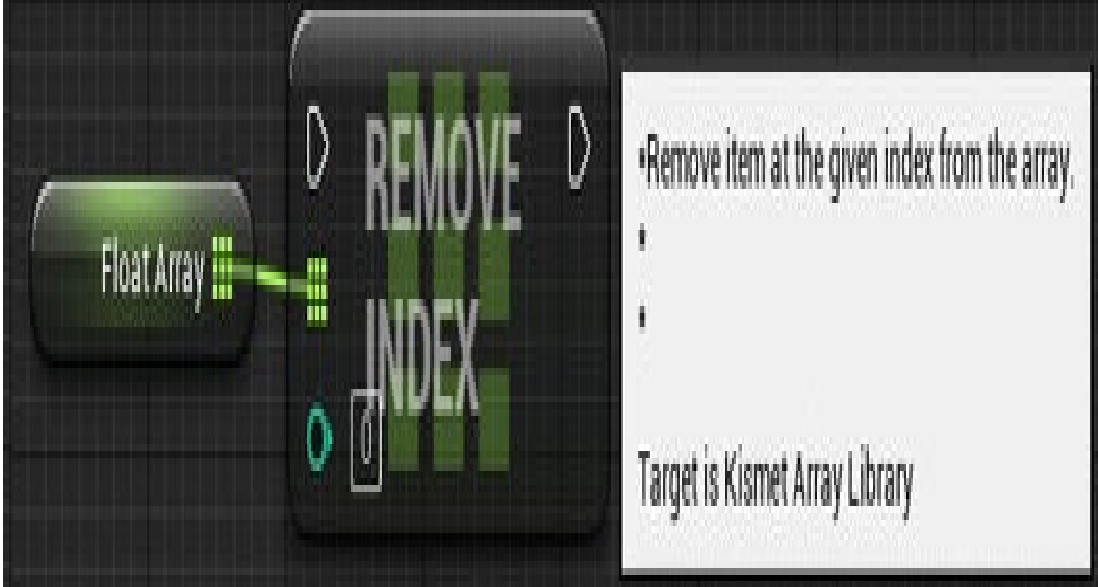

Float Array
REMOVE
INDEX
0
•Remove item at the given index from the array.
Target is Kismet Array Library

Figure 9.13: Remove from Array nodes

Add

In order to add a value to an array, one of two Add nodes (or the Set Array Element node) will need to be used. The Add node will add any value to an existing array as the last entry, whereas AddUnique will only add values that are not already present in the array:

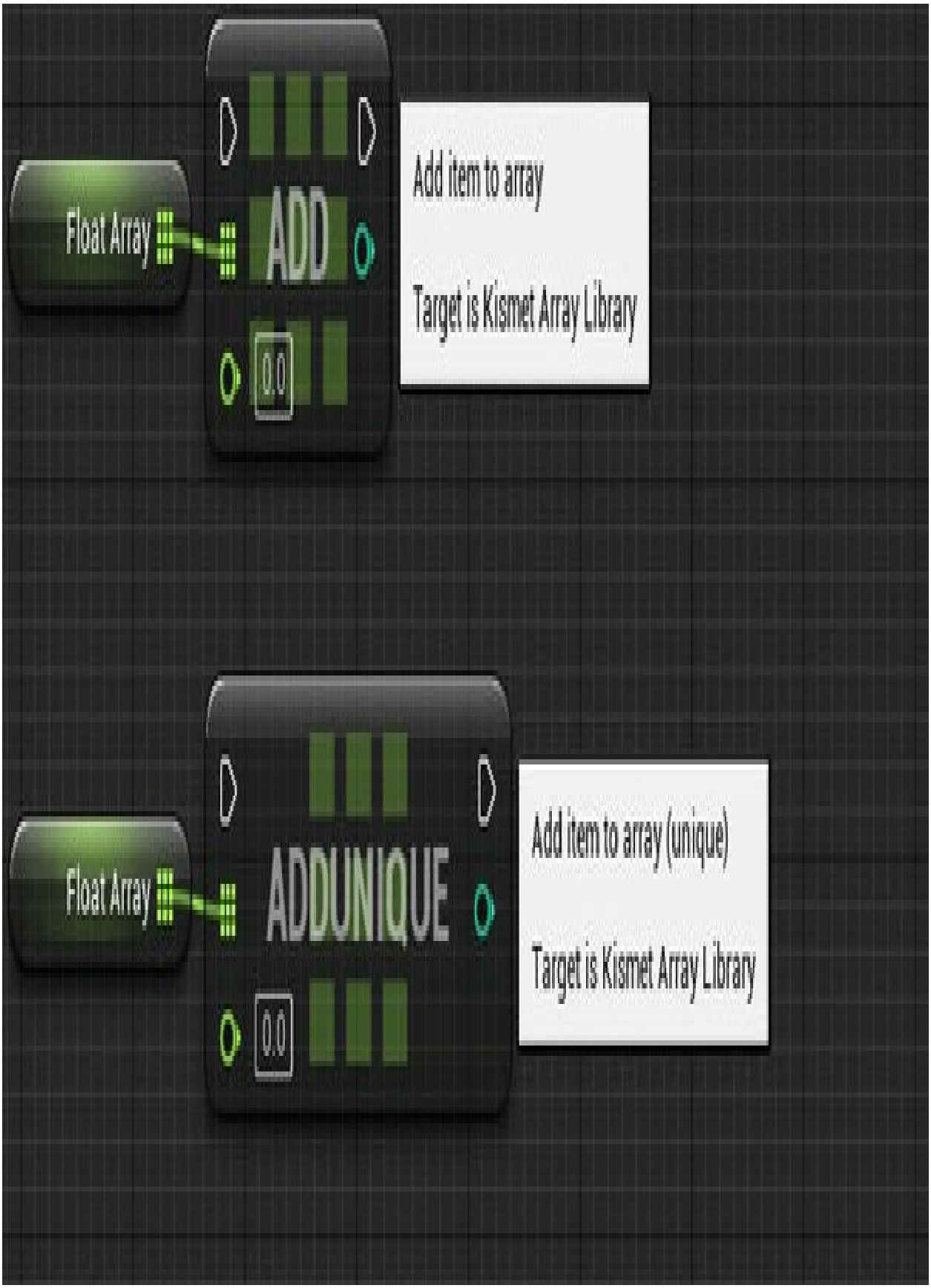

Float Array
ADD
0.0
Add item to array
Target is Kismet Array Library
Float Array
ADDUNIQUE
0.0
Add item to array (unique)
Target is Kismet Array Library

Figure 9.14: Add to Array nodes

Set Array Element

This node allows you to either change an existing entry in an array or add one if the input index is not a currently existing entry in the array, and Size to Fit is set to true:

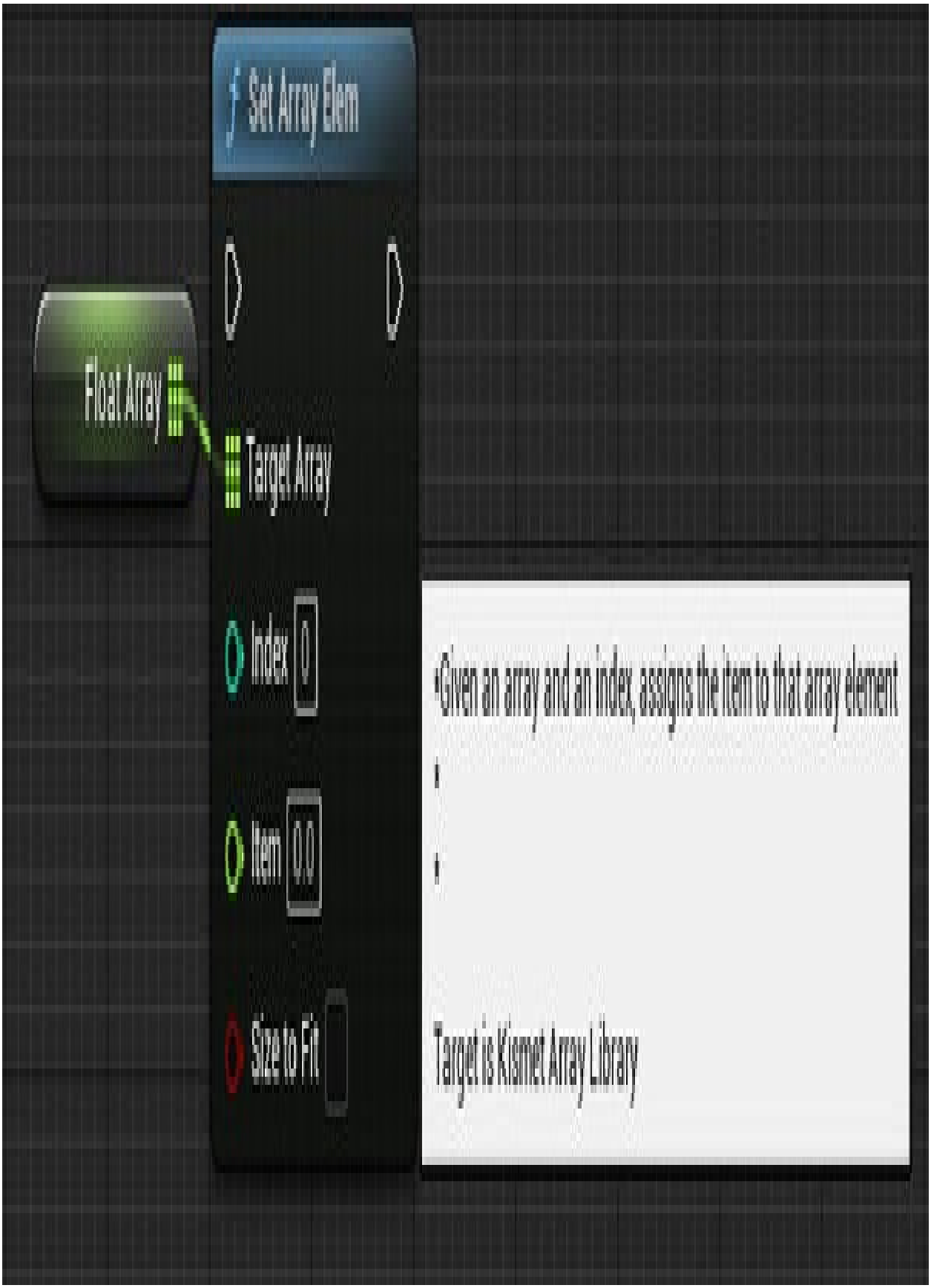

Set Array Elem
Float Array
Target Array
Index 0
Item 0.0
Size to Fit
"Given an array and an index, assigns the item to that array element
"
"
"Target is Kismet Array Library

Figure 9.15: Set Array Element nodes

Clear

This node allows you to completely empty an array by removing all entries:

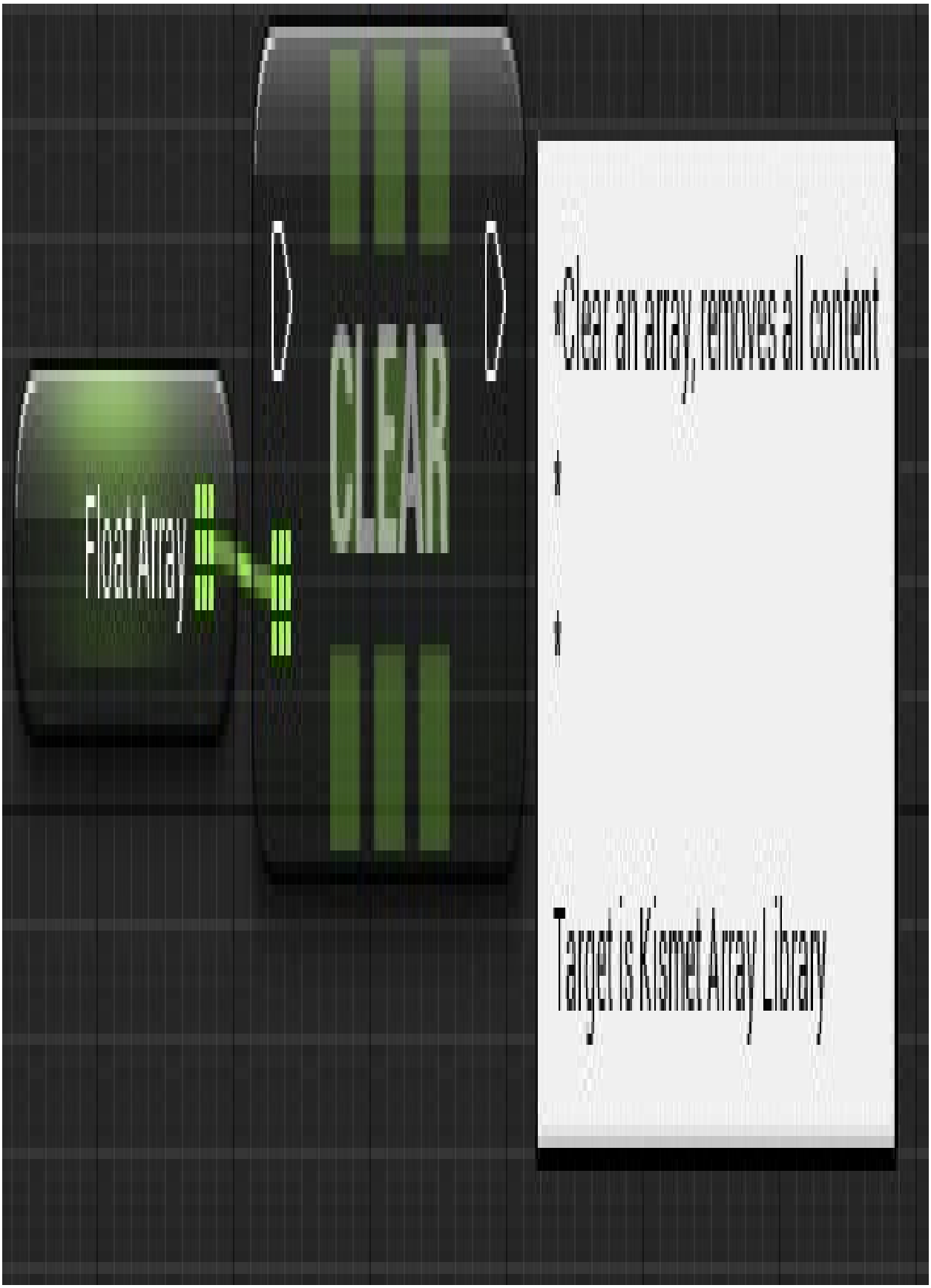

Float Array
CLEAR
Clear an array, removes all content
Target is Kismet Array Library

Figure 9.16: Clear Array node

Length

This node allows you to get the number of entries in the provided array:

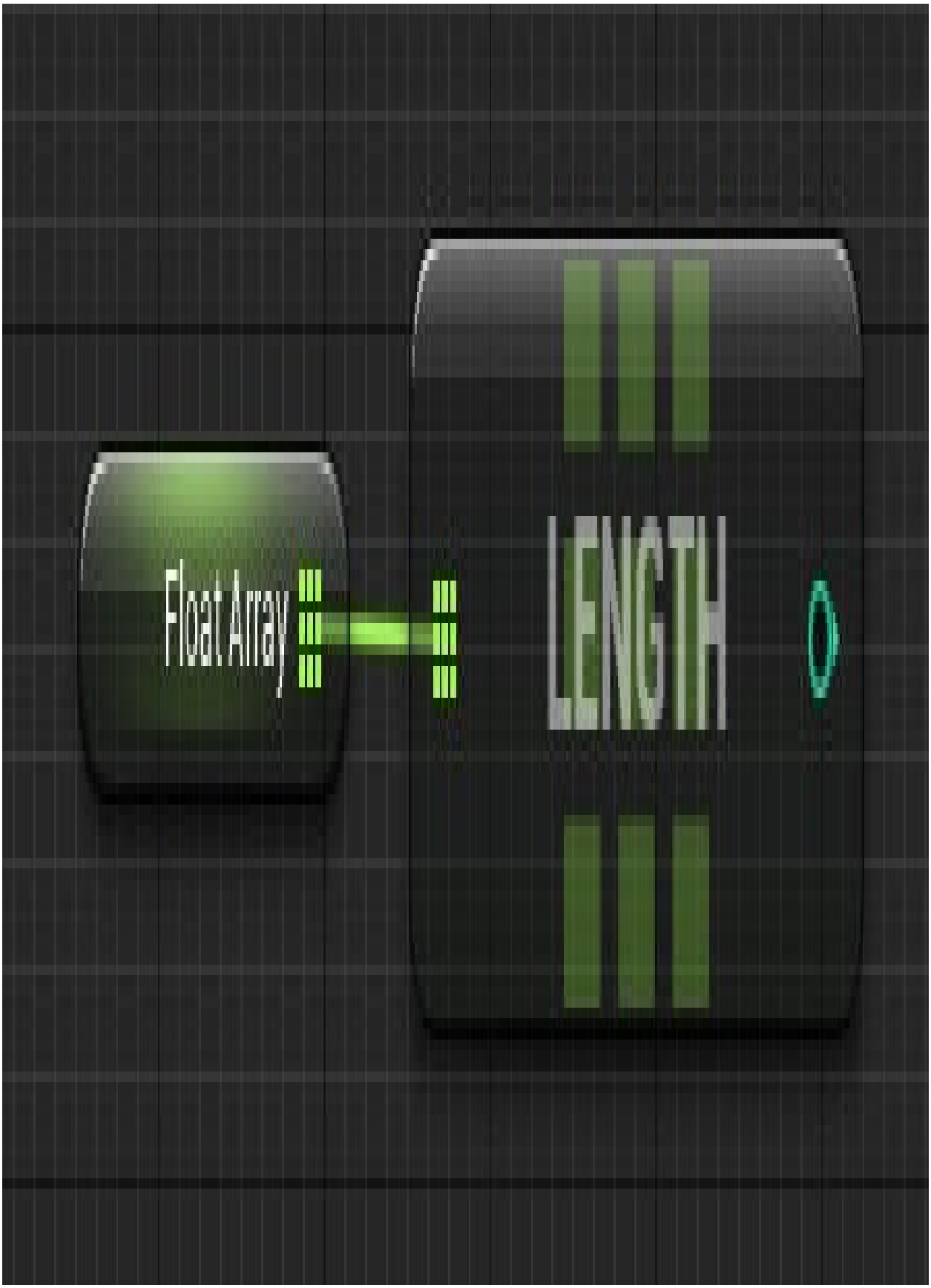

FloatArray
LENGTH
0

Figure 9.17: Length node

Maps

Maps are similar to arrays in that they are a list, but instead of it being a number of entries with an index value corresponding to their place in the list, a map consists of a number of variable values and a corresponding value of an entirely different variable type. The left variable type in a Map entry is called a Key, and the corresponding value on the right is referred to as a Value, both of which can be seen in Figure 9.14. Maps are also created through the same method as arrays, but by choosing the Map option instead of the Array option, as seen in Figure 9.11:

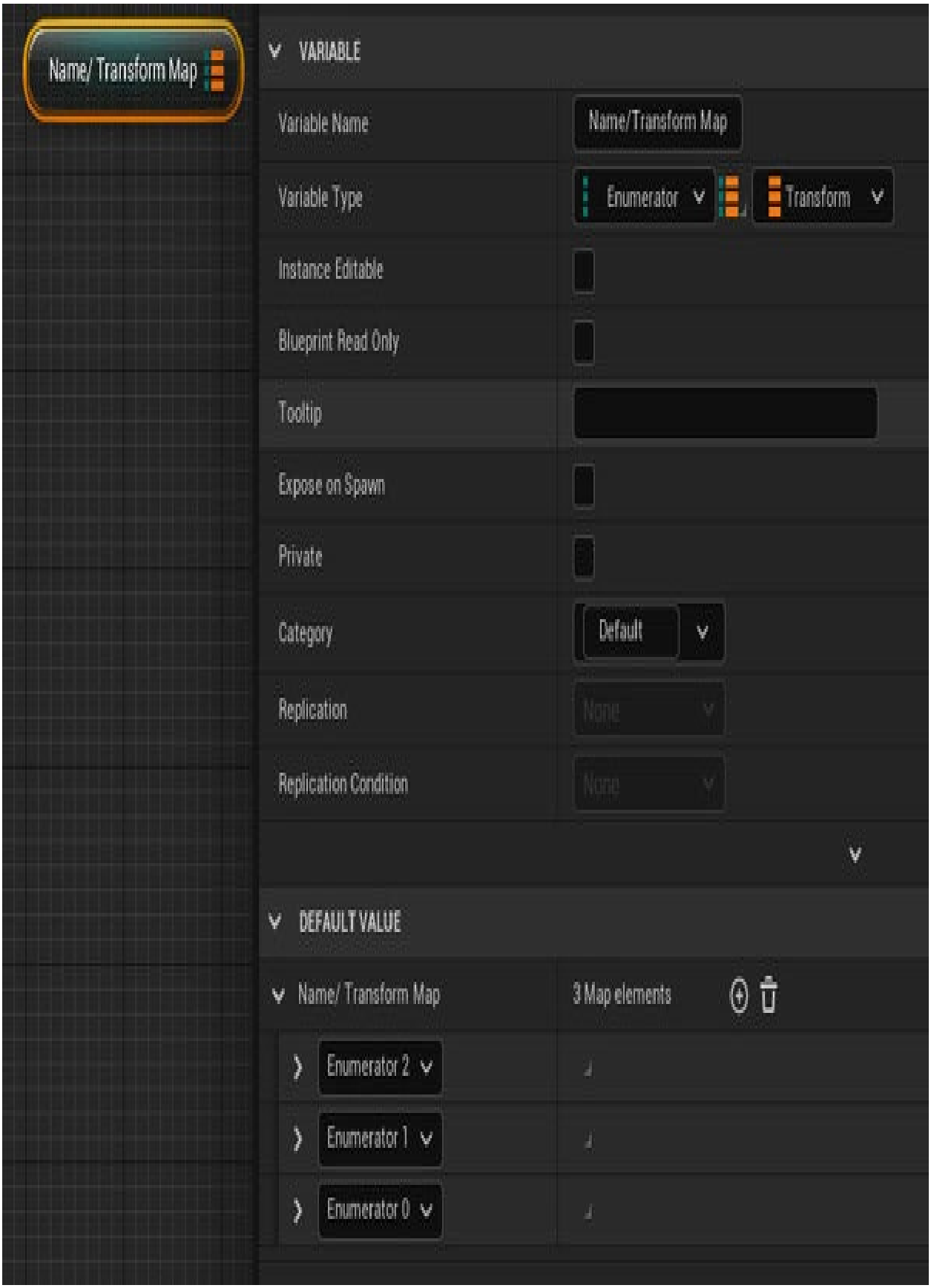

Name/ Transform Map
VARIABLE
Variable Name
Name/Transform Map
Variable Type
Enumerator
Transform
Instance Editable
Blueprint Read Only
Tooltip
Expose on Spawn
Private
Category
Default
Replication
None
Replication Condition
None
DEFAULT VALUE
Name/ Transform Map
3 Map elements
Enumerator 2
Enumerator 1
Enumerator 0

Figure 9.18: Map Variable

Get keys and values

These nodes will allow you to get all the keys and values used in the map, respectively:

KEYS
Name/ Transform Map

VALUES
Name/ Transform Map

Figure 9.19: Get Keys and Values Nodes

Find

This node will search the provided map for the provided key, and if it finds it, it will return the corresponding value:

Figure 9.20: Find Node

Length

This node will search the provided map for the provided key, and if it finds it, it will return the corresponding value:

Name/ Transform Map
LENGTH

Figure 9.21: Length Node

Clear

This node will completely clear the map:

CLEAR
Name/Transform Map

Figure 9.22: Clear Node

Contains

This node will return a Boolean stating whether the provided key can be found in the provided map:

Figure 9.23: Contains Node

Is Empty and Is Not Empty

These nodes will return a Boolean stating whether the map contains any entries:

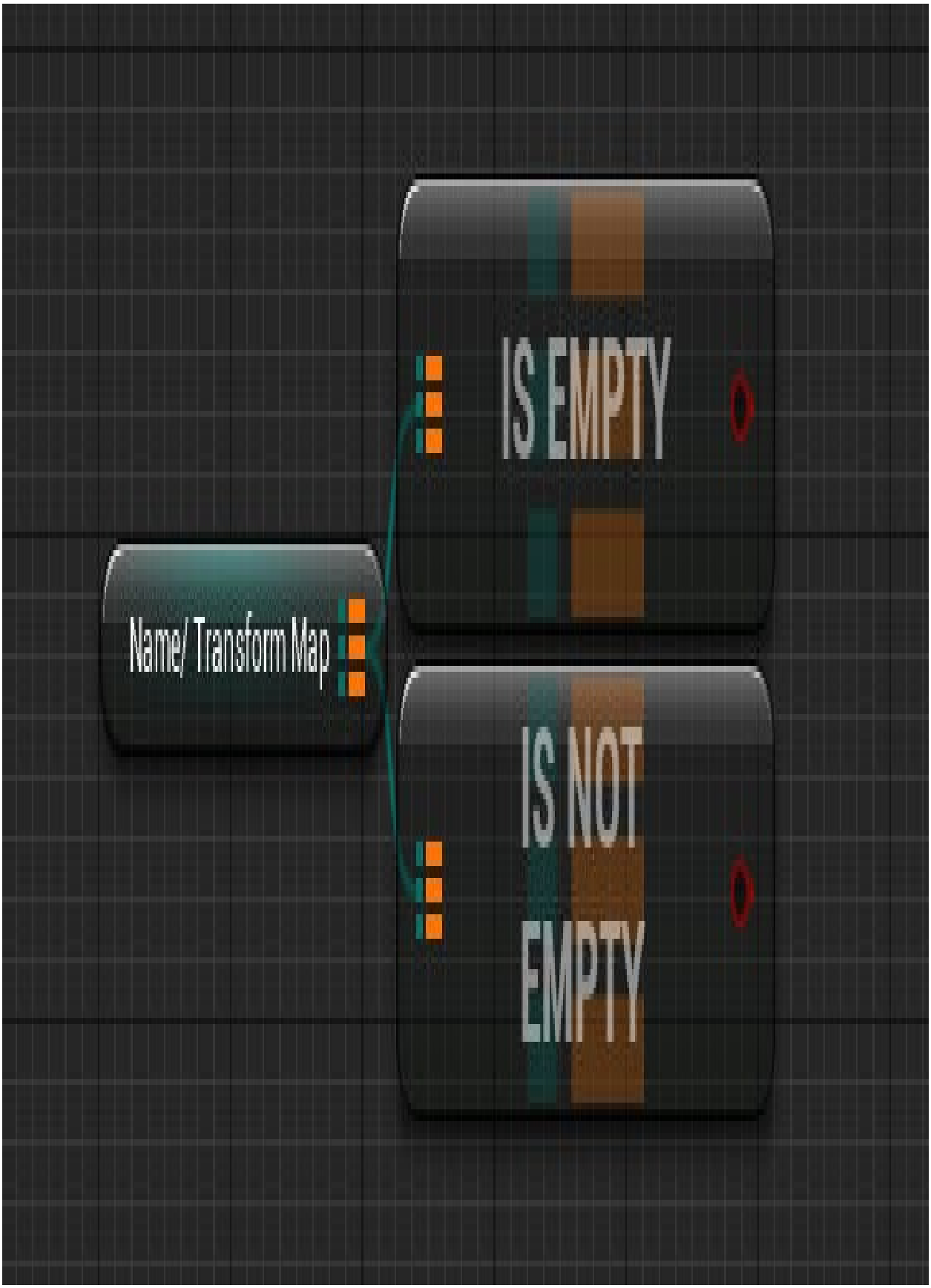

IS EMPTY
Name/ Transform Map
IS NOT EMPTY

Figure 9.24: Is Empty and Is Not Empty Node

Data tables

Data tables are a predefined list of entries using a structure to define entries. They are used in cases where a project contains a large number of similar objects that are defined by structs. A reference to a data table may be used as a variable within a blueprint:

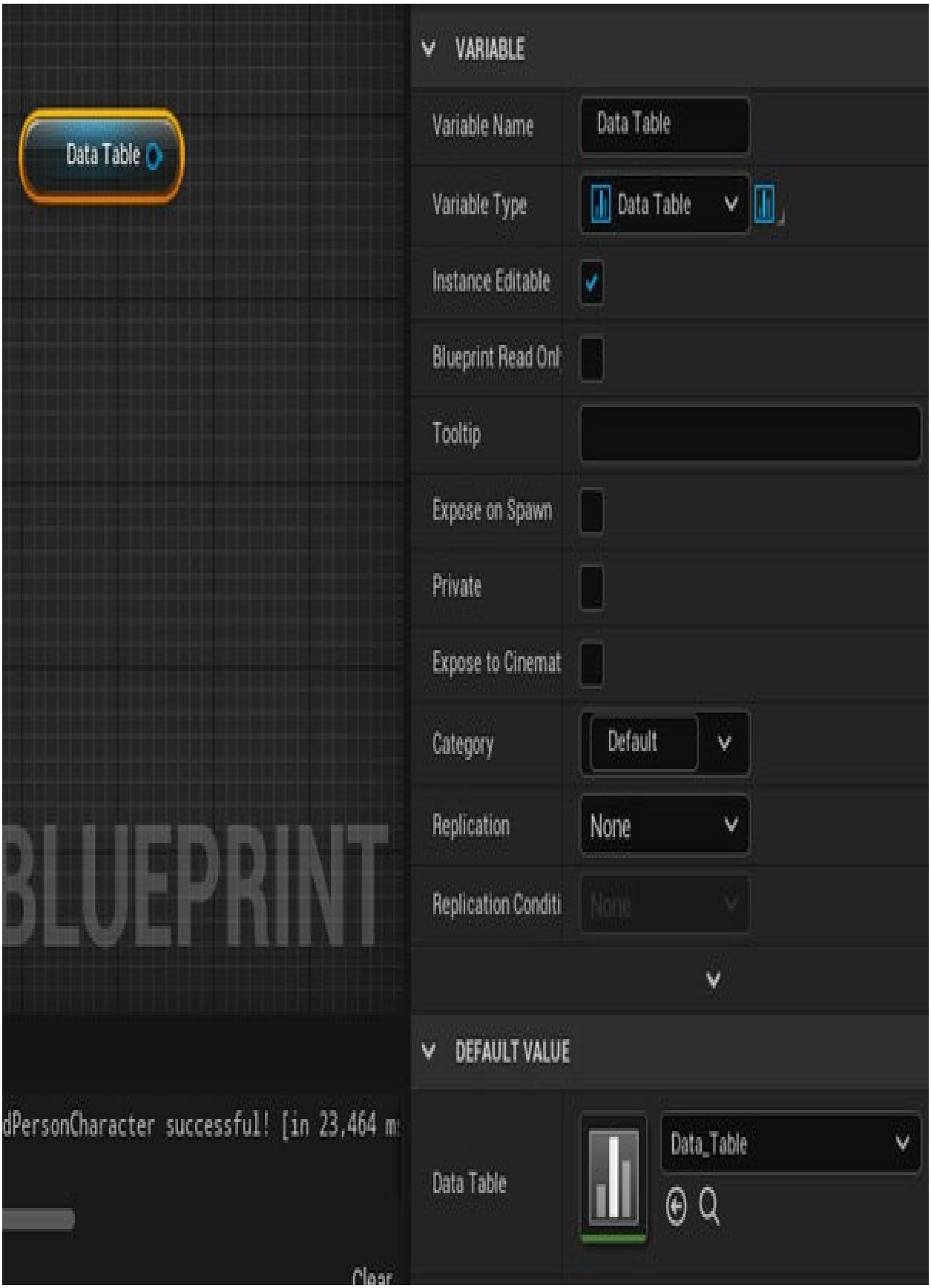

Data Table
BLUEPRINT
dPersonCharacter successful! [in 23,464 m
Clear
VARIABLE
Variable Name
Data Table
Variable Type
Data Table
Instance Editable
Blueprint Read Onl
Tooltip
Expose on Spawn
Private
Expose to Cinemat
Category
Default
Replication
None
Replication Conditi
None
DEFAULT VALUE
Data Table
Data_Table

Figure 9.25: Data Table

Data tables are essentially spreadsheets. When creating a Data Table, you will be asked to choose which structure the Data Table will use for its rows, as seen in Figure 9.26:

Pick Row Structure
X
Structure
v
OK
Cancel

Figure 9.26: Data Table Creation

Data table editor

Like enumerators and structures, data tables have their own editor. Rows can be added, modified, removed, and rearranged as needed. To add a new row, select the Add button at the top of the editor, or right-click on an entry and add a new row above or below the selected entry from the context menu. To modify a row, select it from the list of rows in the Data Table panel, and then alter its data in the Row editor panel, as follows:

File Edit Asset Window Tools Help

Data_Table x

Row Type: Structure_0

Save Browse Reimport Add Copy Paste Duplicate Remove

Data Table x Data Table Details

Search

	Row Name	Variable 1	Variable 2	Variable 3	Variable 4
1	Row_1	False	0	{"Rotation":{"X":0,"Y":0,"Z":0,"W":1},"Translation":{"X":0,"Y":0,"Z":	{"Name":"","ID":0,"Description":"","Mesh":"None","Icon":"None"}
2	Row_2	False	0	{"Rotation":{"X":0,"Y":0,"Z":0,"W":1},"Translation":{"X":0,"Y":0,"Z":	{"Name":"","ID":0,"Description":"","Mesh":"None","Icon":"None"}
3	Row_3	False	0	{"Rotation":{"X":0,"Y":0,"Z":0,"W":1},"Translation":{"X":0,"Y":0,"Z":	{"Name":"","ID":0,"Description":"","Mesh":"None","Icon":"None"}
4	Row_4	False	0	{"Rotation":{"X":0,"Y":0,"Z":0,"W":1},"Translation":{"X":0,"Y":0,"Z":	{"Name":"","ID":0,"Description":"","Mesh":"None","Icon":"None"}
5	Row_5	False	0	{"Rotation":{"X":0,"Y":0,"Z":0,"W":1},"Translation":{"X":0,"Y":0,"Z":	{"Name":"","ID":0,"Description":"","Mesh":"None","Icon":"None"}
6	Row_6	False	0	{"Rotation":{"X":0,"Y":0,"Z":0,"W":1},"Translation":{"X":0,"Y":0,"Z":	{"Name":"","ID":0,"Description":"","Mesh":"None","Icon":"None"}

Row Editor x

Row_1

ROW_1

Variable 1

Variable 2 0

Variable 3

Variable 4

Content Drawer Cmd Enter Console Command Source Control Off

Figure 9.27: Data Table Editor

The data table editor is very simple to use and is a great way to keep projects neat and organized.

CSV/JSON export

As data tables are spreadsheets, they can be exported/imported to/from CSV or JSON files for alteration or viewing in external spreadsheet editing software. To export a data table to a .CSV or a .JSON file, right-click on it within the content browser, and then select either Export as CSV or Export as JSON, as shown in Figure 9.28:

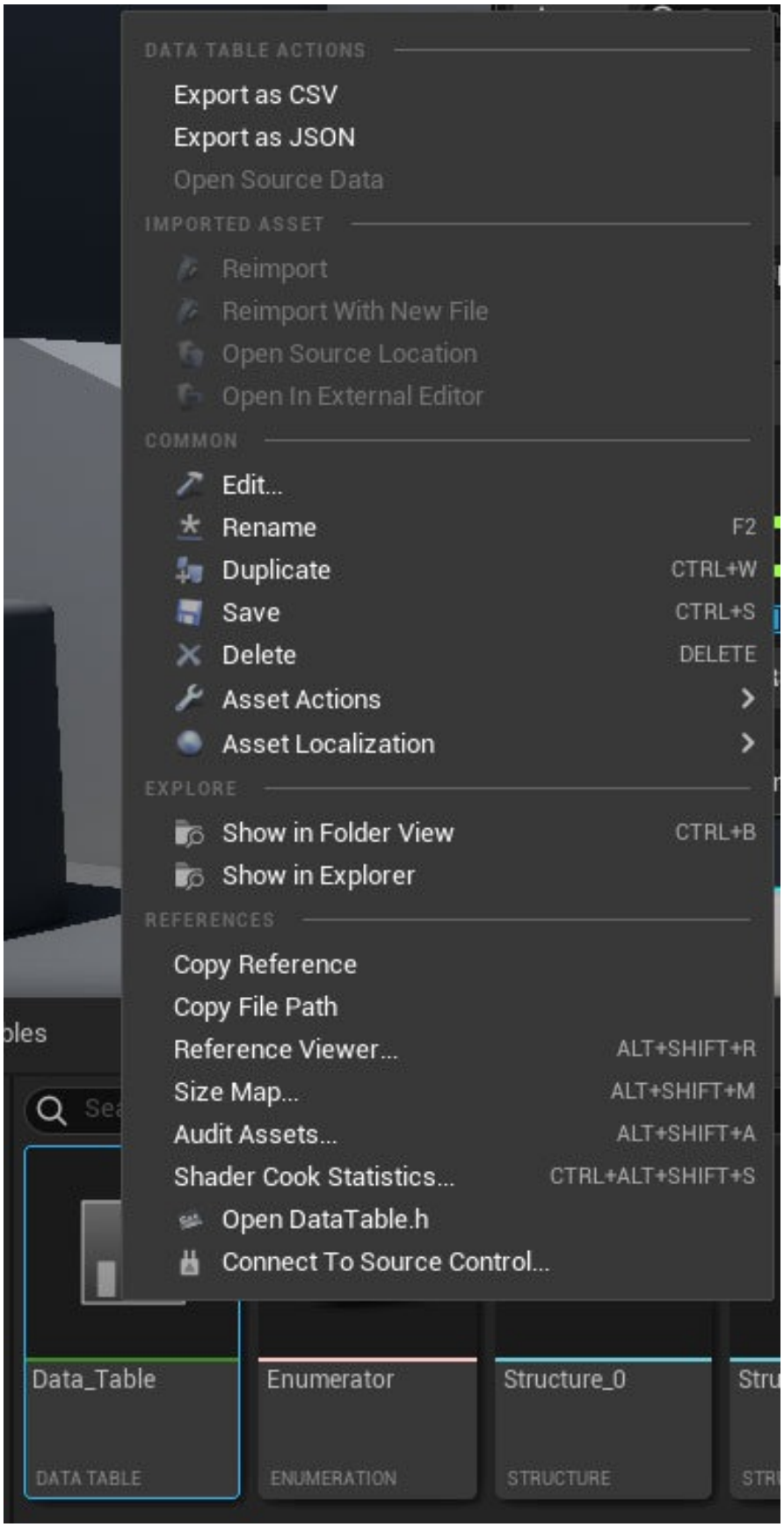

DATA TABLE ACTIONS
Export as CSV
Export as JSON
Open Source Data
IMPORTED ASSET
Reimport
Reimport With New File
Open Source Location
Open In External Editor
COMMON
Edit...
Rename F2
Duplicate CTRL+W
Save CTRL+S
Delete DELETE
Asset Actions
Asset Localization
EXPLORE
Show in Folder View CTRL+B
Show in Explorer
REFERENCES
Copy Reference
Copy File Path
Reference Viewer... ALT+SHIFT+R
Size Map... ALT+SHIFT+M
Audit Assets... ALT+SHIFT+A
Shader Cook Statistics... CTRL+ALT+SHIFT+S
Open DataTable.h
Connect To Source Control...
Data_Table
DATA TABLE
Enumerator
ENUMERATION
Structure_0
STRUCTURE

Figure 9.28: Data Table export options

Data Table usage in blueprint

Data tables can be referenced using variables in blueprints, but specific nodes need to be used to read data from a blueprint. These nodes can be seen in Figure 9.29:

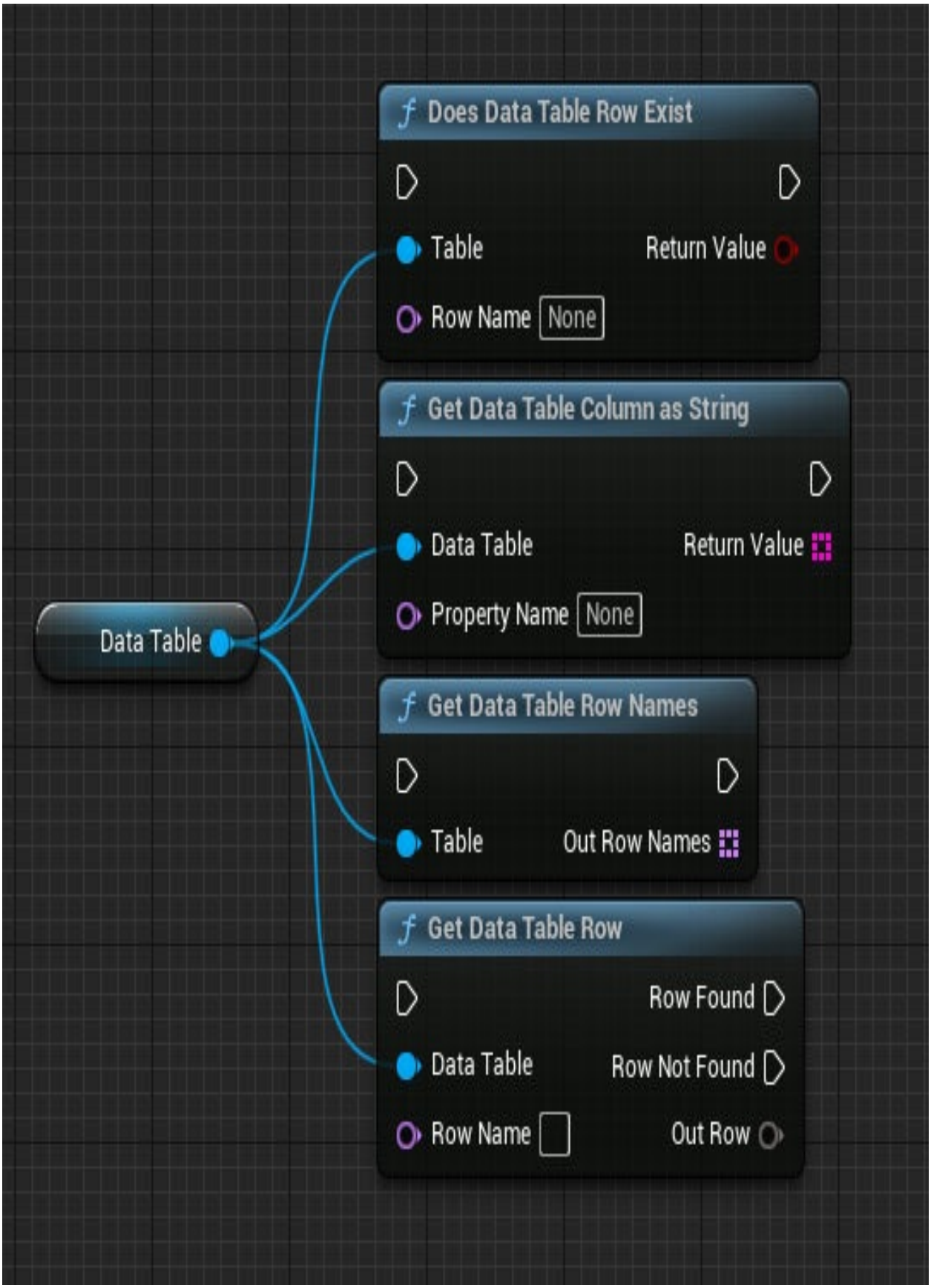

Does Data Table Row Exist
Table
Return Value
Row Name
None
Get Data Table Column as String
Data Table
Return Value
Property Name
None
Data Table
Get Data Table Row Names
Table
Out Row Names
Get Data Table Row
Row Found
Data Table
Row Not Found
Row Name
Out Row

Figure 9.29: Data Table nodes

These nodes each have specific uses that can be used well in conjunction with one another.

Does the data table row exist?

This node is used to check if there is a row in the input Data Table matching the input Row Name. This node serves as a IsValid node equivalent for data tables:

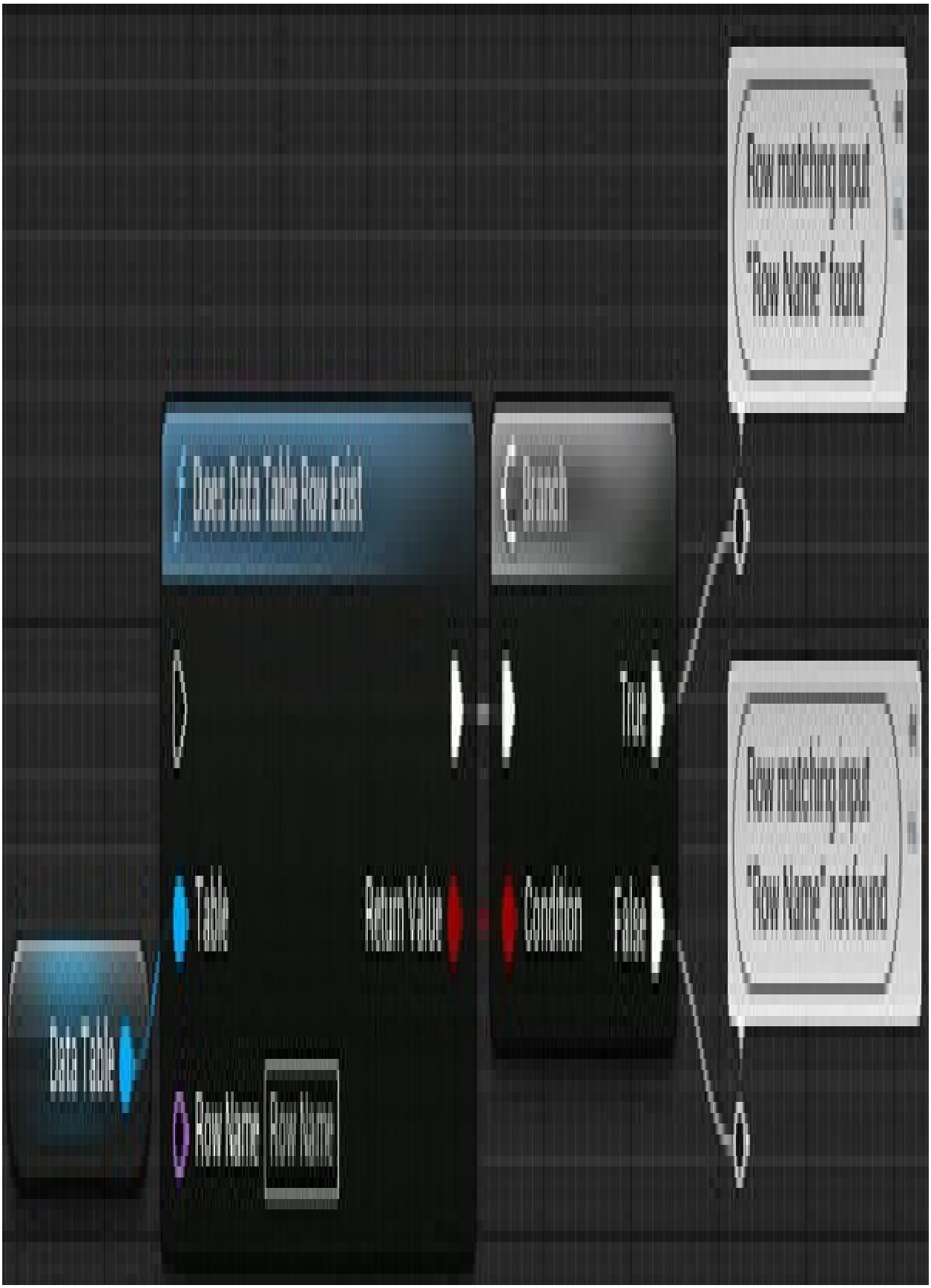

Data Table
Table
Row Name
Row Name
Does Data Table Row Exist
Return Value
Condition
Branch
True
False
Row matching input "Row Name" found
Row matching input "Row Name" not found

Figure 9.30: Does Data Table row exist

Get data table column as string

This node gets all the entries for a provided column/variable (the Property Name input) in a Data Table and returns them in an array of strings:

Get Data Table Column as String
For Each Loop
Exec
Loop Body
Data Table
Data Table
Return Value
Array
Array Element
Property Name
Array Index
Column Name
Completed

Figure 9.31: Get Data Table Column as String

Get data table row names

This node gets the row names for all the entries in a Data Table, which, when used in conjunction with Get Data Table Row, can allow searching or evaluating an entire Data Table.

Get data table row

This node gets the row under the provided Row Name (provided it exists) and returns the row as the struct the Data Table uses, with all the variable values that row contains in the data table:

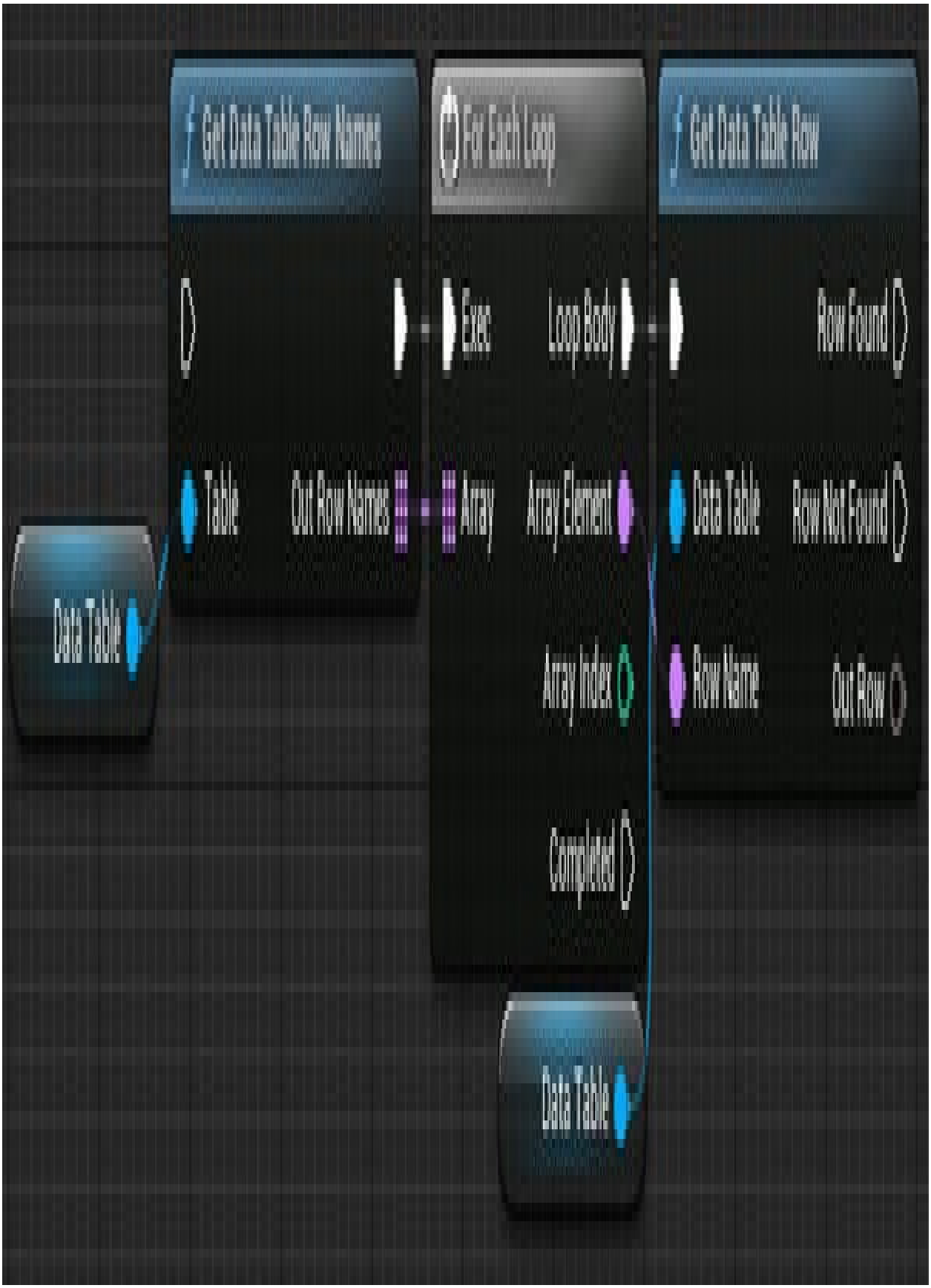

Get Data Table Row Names
For Each Loop
Get Data Table Row
Exec
Loop Body
Row Found
Table
Out Row Names
Array
Array Element
Data Table
Row Not Found
Data Table
Array Index
Row Name
Out Row
Completed
Data Table

Figure 9.32: Get Data Table Row Names & Get Data Table Row

Animation instances

An animation instance is the current instance of whatever object is driving the animation of a skeletal mesh, which is usually an Animation Blueprint, but it can also be a singular animation asset or a custom method created by an advanced user.

Animation instance nodes

There are a handful of Blueprint nodes related to animation instances, used for altering, referencing, or obtaining information about the animation playing on a skeletal mesh.

Get Anim Instance
Target is Skeletal Mesh Component
Mesh
Target
Return Value
Has Valid Animation Instance
Target is Skeletal Mesh Component
Mesh
Target
Return Value
Play Animation
Target is Skeletal Mesh Component
Mesh
Target
New Anim to Play
Select Asset
Looping
Set Animation
Target is Skeletal Mesh Component
Mesh
Target
New Anim to Play
Select Asset
Set Play Rate
Target is Skeletal Mesh Component
Mesh
Target
Rate
0.0
Set Position
Target is Skeletal Mesh Component
Mesh
Target
In Pos
0.0
Fire Notifies
Set Animation Mode
Target is Skeletal Mesh Component
Mesh
Target
In Animation Mode
Use Animation Blueprint

Figure 9.33: Some Animation Instance Nodes

Get Anim Instance

This node provides a reference to the animation instance for the provided mesh, which, in conjunction with a cast node, can be used to get a reference to a currently running animation blueprint (if the mesh is using one):

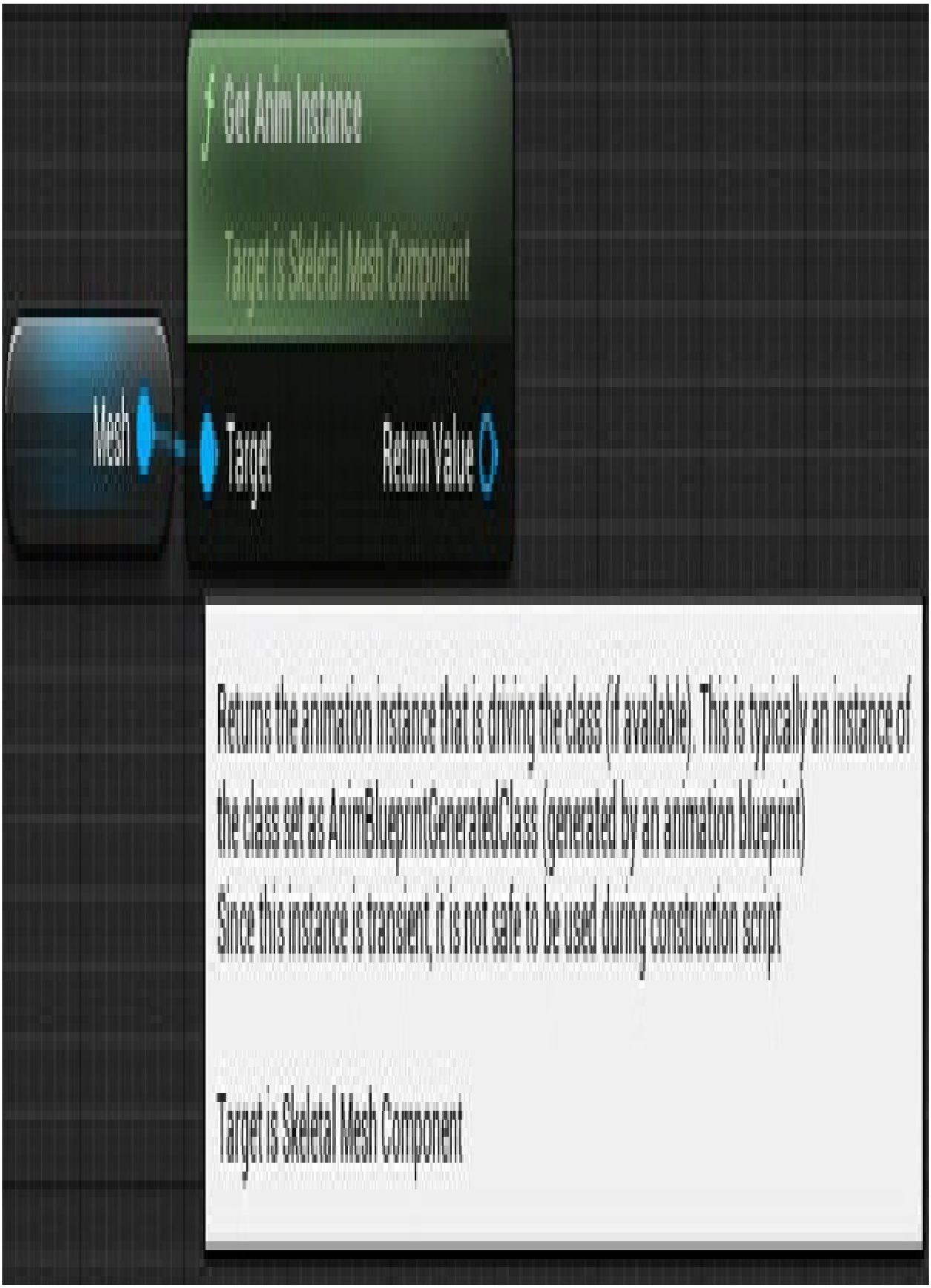

Get Anim Instance
Target is Skeletal Mesh Component
Mesh
Target
Return Value
Returns the animation instance that is driving the class (if available). This is typically an instance of the class set as AnimBlueprintGeneratedClass (generated by an animation blueprint)
Since this instance is transient, it is not safe to be used during construction script
Target is Skeletal Mesh Component

Figure 9.34: Get Animation Instance Node

Has valid animation instance

This node checks to see that the provided mesh has an animation instance, which can be used to avoid errors when trying to alter an Animation instance:

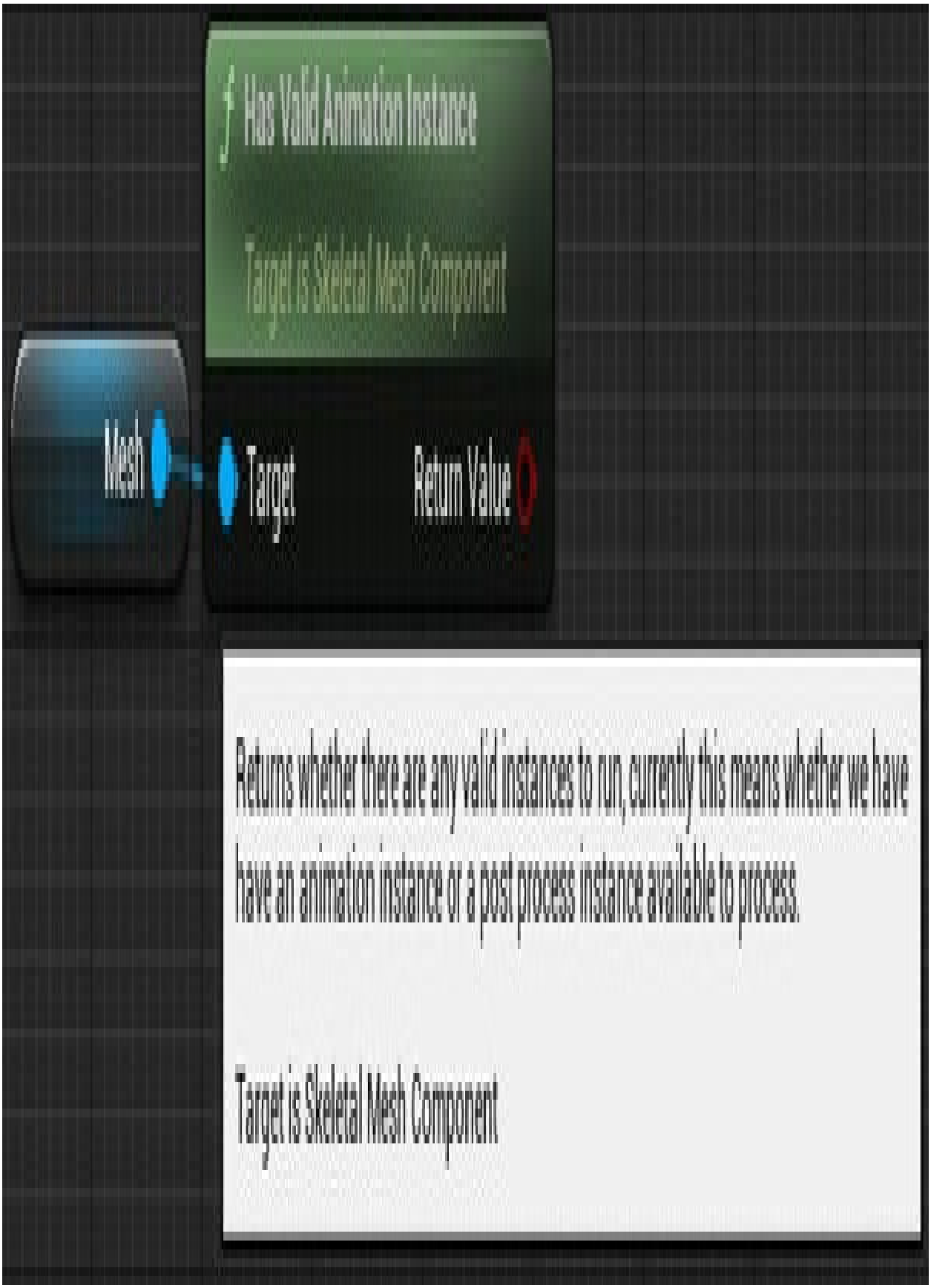

Has Valid Animation Instance
Target is Skeletal Mesh Component
Mesh
Target
Return Value
Returns whether there are any valid instances to run, currently this means whether we have have an animation instance or a post process instance available to process.
Target is Skeletal Mesh Component

Figure 9.35: Has Valid Animation Instance Node

Play

This node plays the animation currently set on the provided skeletal mesh:

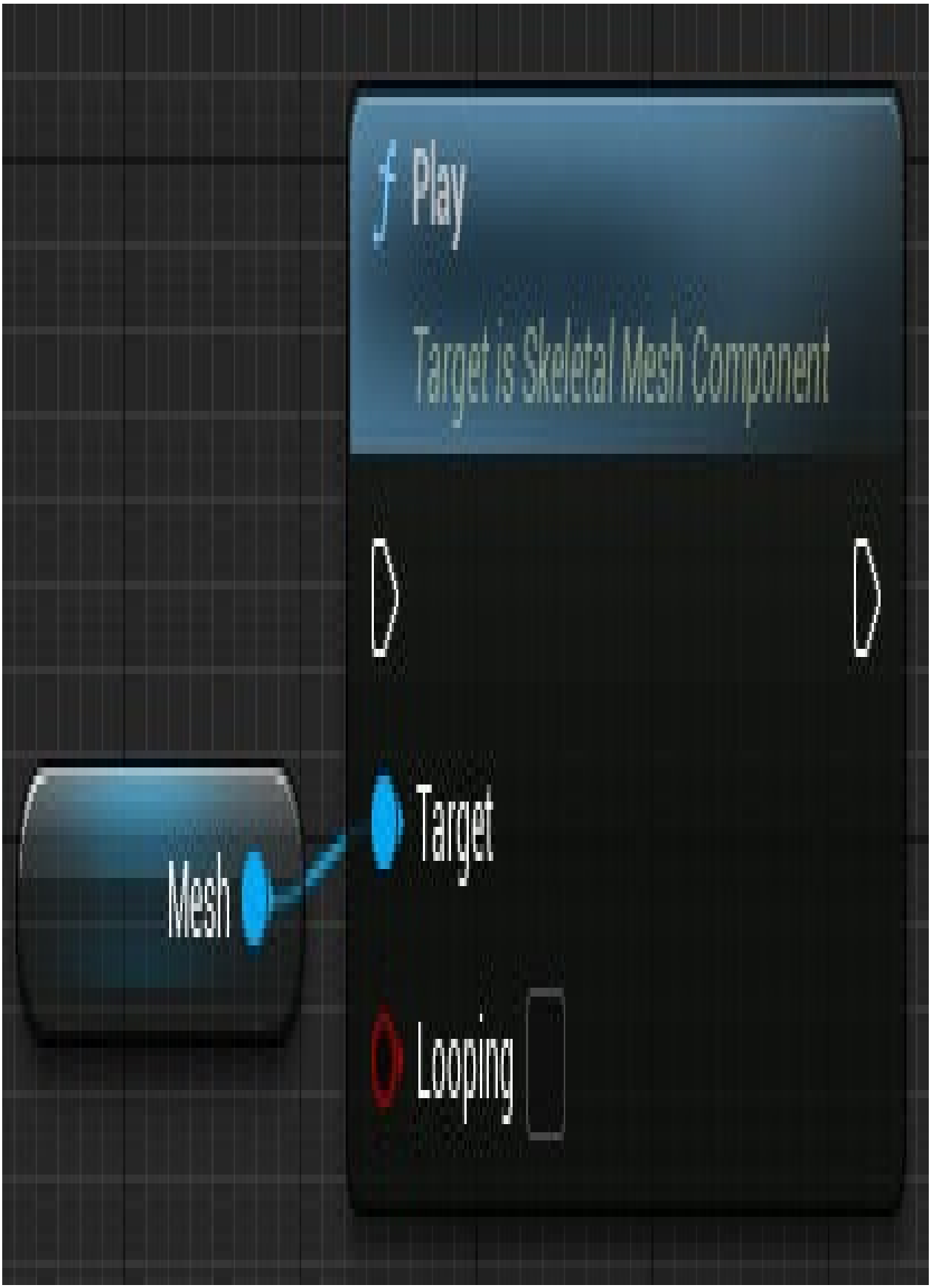

Play
Target is Skeletal Mesh Component
Mesh
Target
Looping

Figure 9.36: Play Node

Stop

This node stops the animation currently playing on the provided skeletal mesh:

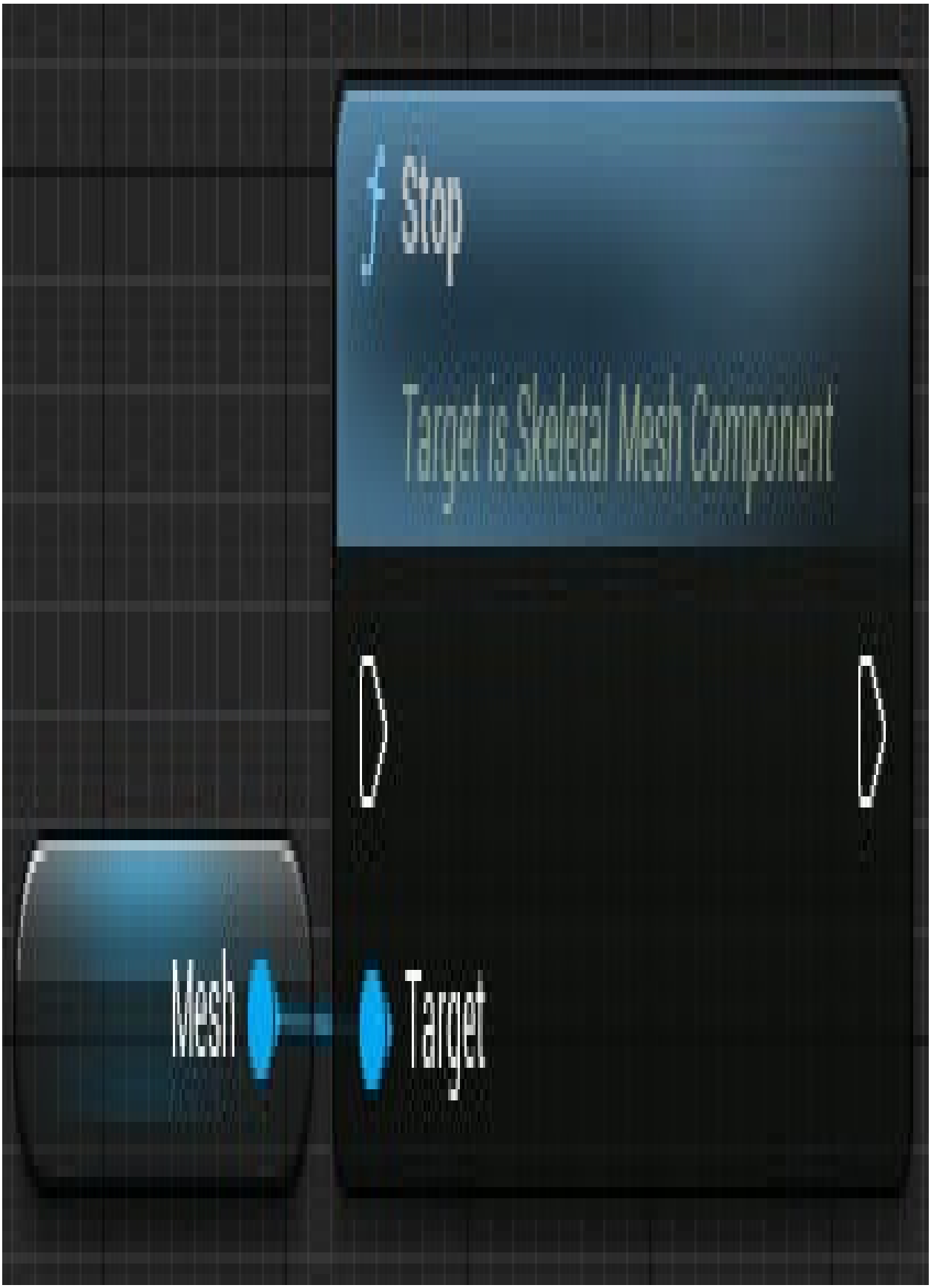

Stop
Target is Skeletal Mesh Component
Mesh
Target

Figure 9.37: Stop Node

Set animation

This node changes the current animation for the provided mesh but doesn’t automatically play the specified animation:

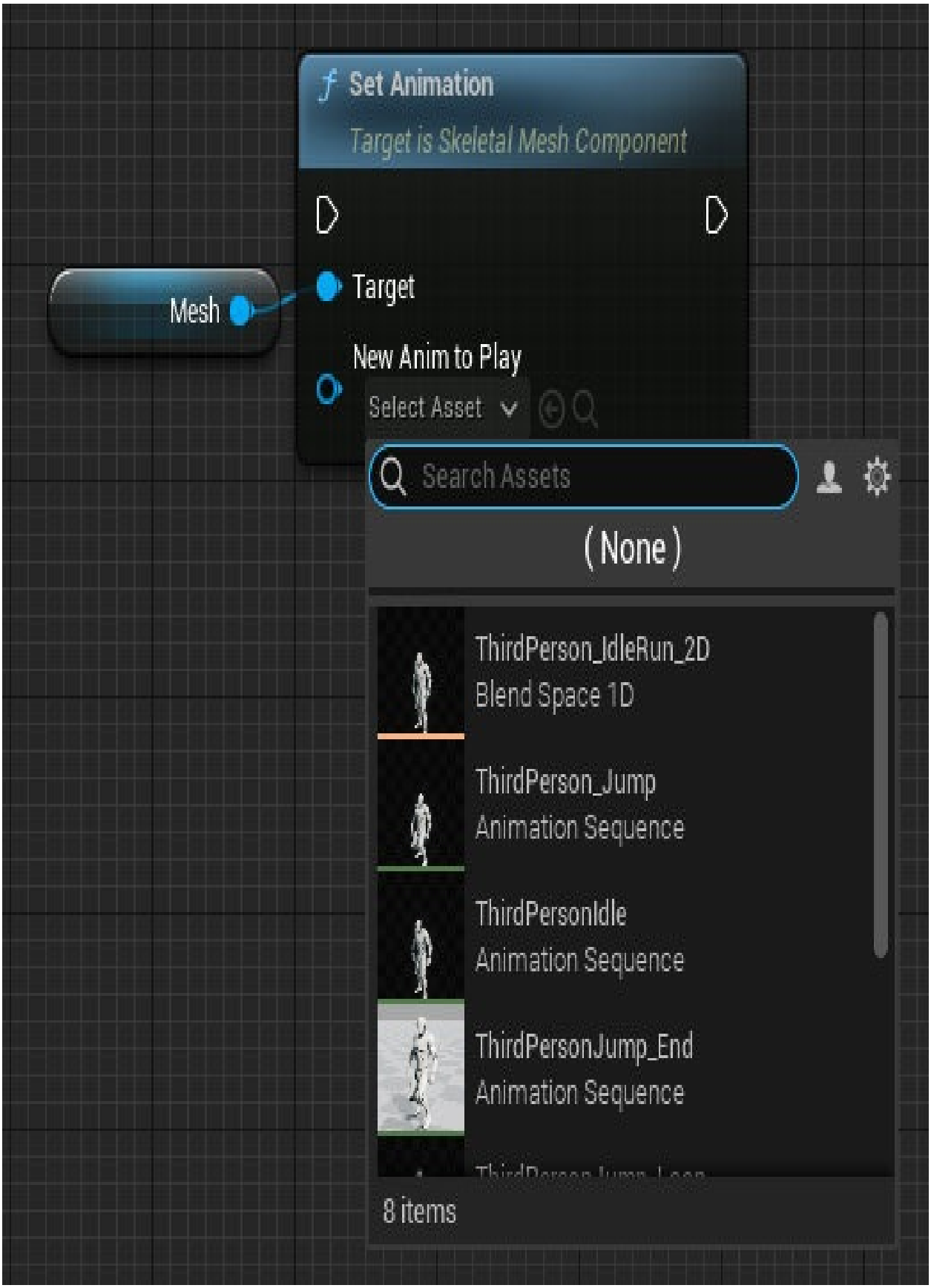

Set Animation
Target is Skeletal Mesh Component
Mesh
Target
New Anim to Play
Select Asset
Search Assets
(None)
ThirdPerson_IdleRun_2D
Blend Space 1D
ThirdPerson_Jump
Animation Sequence
ThirdPersonIdle
Animation Sequence
ThirdPersonJump_End
Animation Sequence
8 items

Figure 9.38: Set Animation Node

Set position

This node sets the current animation playing on the mesh to the provided time. The input In Pos defines (in seconds) the point in time to set the current animation to, and Fire Notifies sets whether any Animation Notifies between the position the animation is at before and after the node is executed are activated by this node:

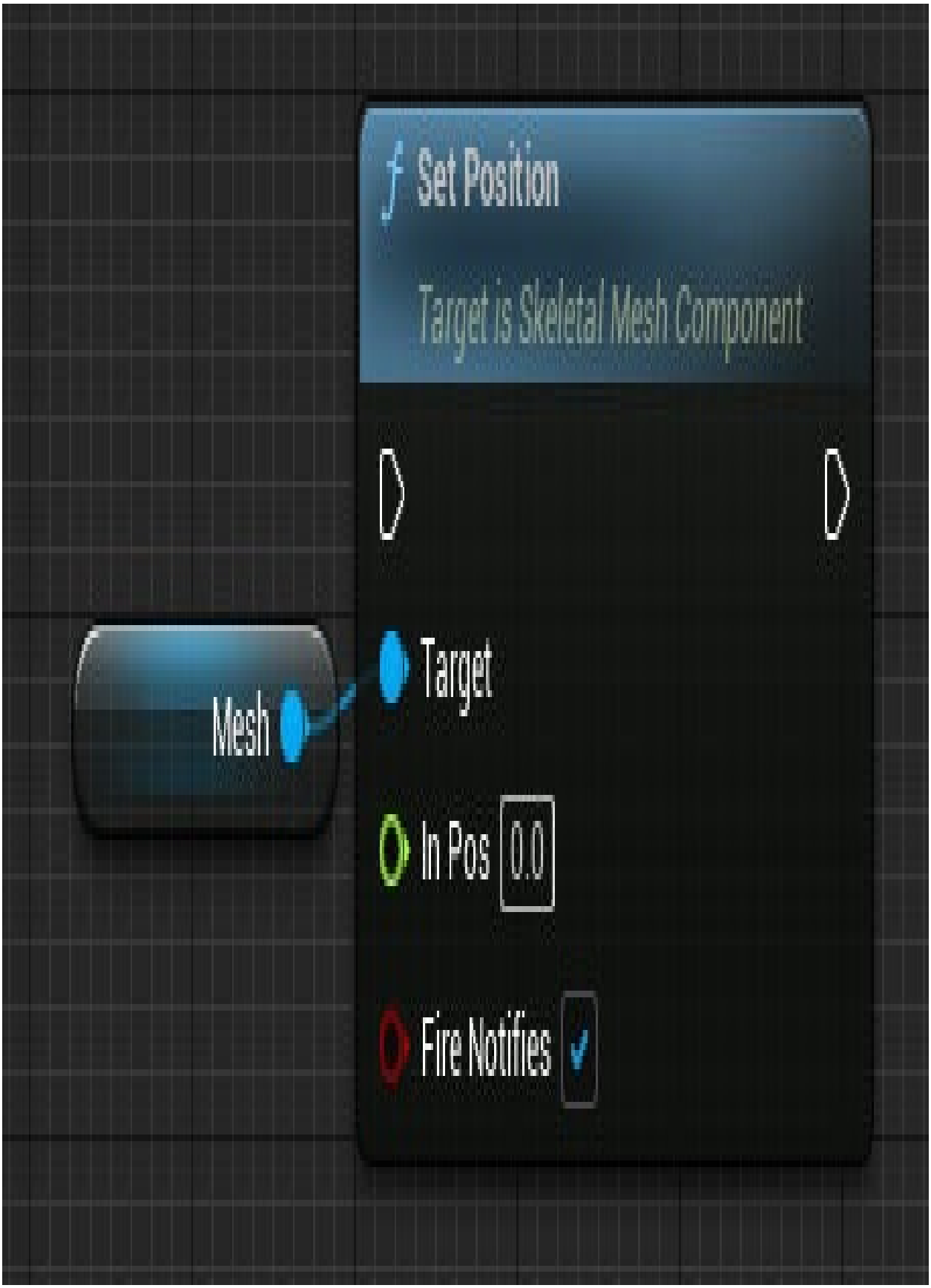

Set Position
Target is Skeletal Mesh Component
Mesh
Target
In Pos
0.0
Fire Notifies

Figure 9.39: Set Position Node

Get position

This node gets the current playback position of the animation of the provided mesh:

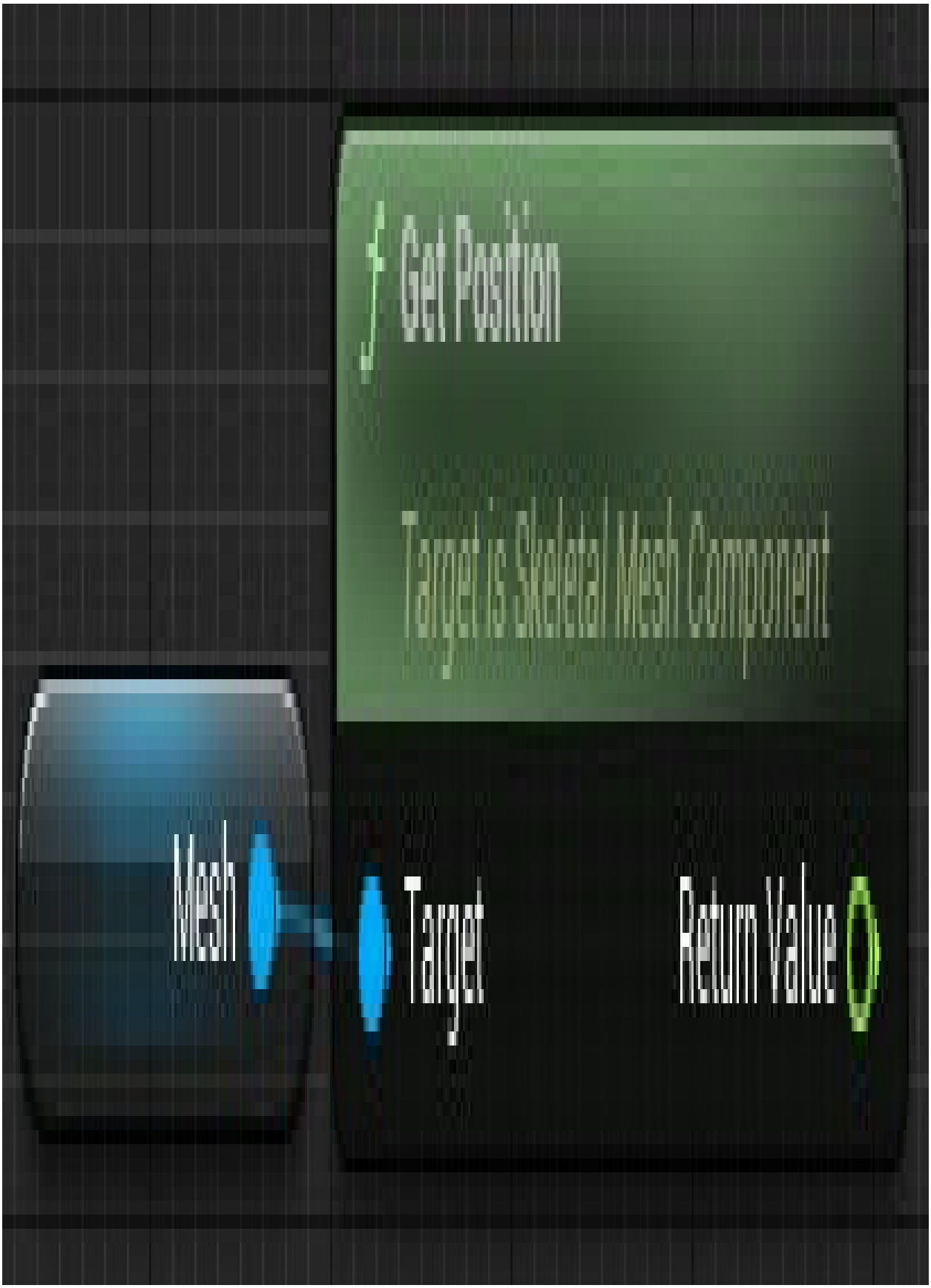

Get Position
Target is Skeletal Mesh Component
Mesh
Target
Return Value

Figure 9.40: Get Position Node

Is Playing

This node returns a Boolean stating whether the provided Skeletal Mesh is animating:

Is Playing
Target is Skeletal Mesh Component
Mesh
Target
Return Value

Figure 9.41: Is Playing Node

Play animation

This node changes the current animation for the provided mesh and plays it. The input Looping sets whether the provided animation will replay after it completes. This node is essentially a combination of the Set Animation and the Play Nodes:

Play Animation
Target is Skeletal Mesh Component
Target
Mesh
New Anim to Play
Select Asset
Looping

Figure 9.42: Play Animation Node

Set Play Rate

This node changes the speed that the current animation plays at. A value of one is standard speed, values lower than one are slower, and values higher than one are faster:

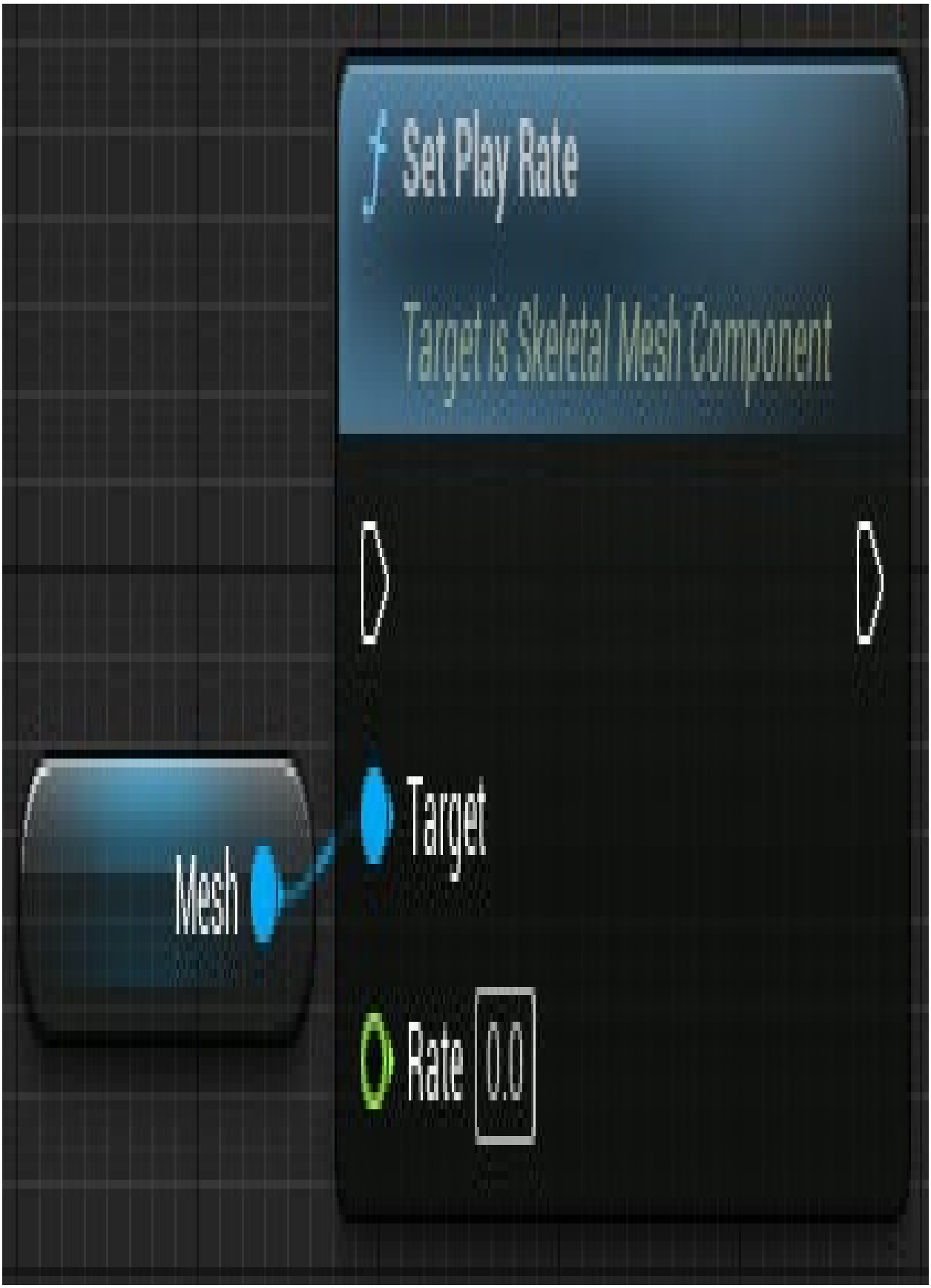

Set Play Rate
Target is Skeletal Mesh Component
Mesh
Target
Rate
0.0

Figure 9.43: Set Play Rate Node

Get Play Rate

This node returns the speed that the current animation is playing at:

Get Play Rate
Target is Skeletal Mesh Component
Mesh
Target
Return Value

Figure 9.44: Get Play Rate Node

Set animation mode

This node changes the current animation mode for the provided mesh, which is used for switching between using singular animation, animation blueprints, and other user defined animation modes:

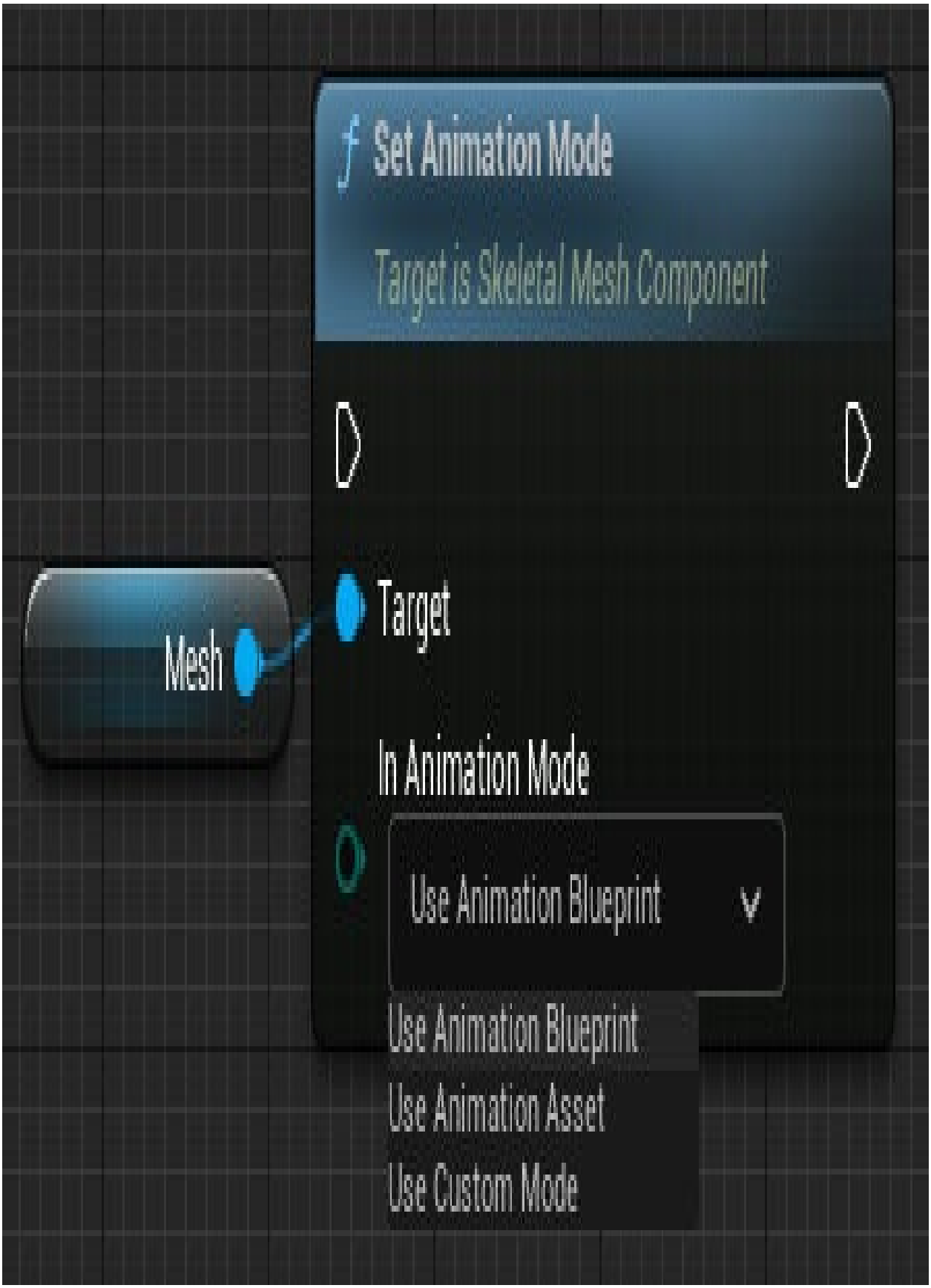

Set Animation Mode
Target is Skeletal Mesh Component
Mesh
Target
In Animation Mode
Use Animation Blueprint
Use Animation Blueprint
Use Animation Asset
Use Custom Mode

Figure 9.45: Set Animation Mode Node

Get animation mode

This node returns the current animation mode for the provided mesh:

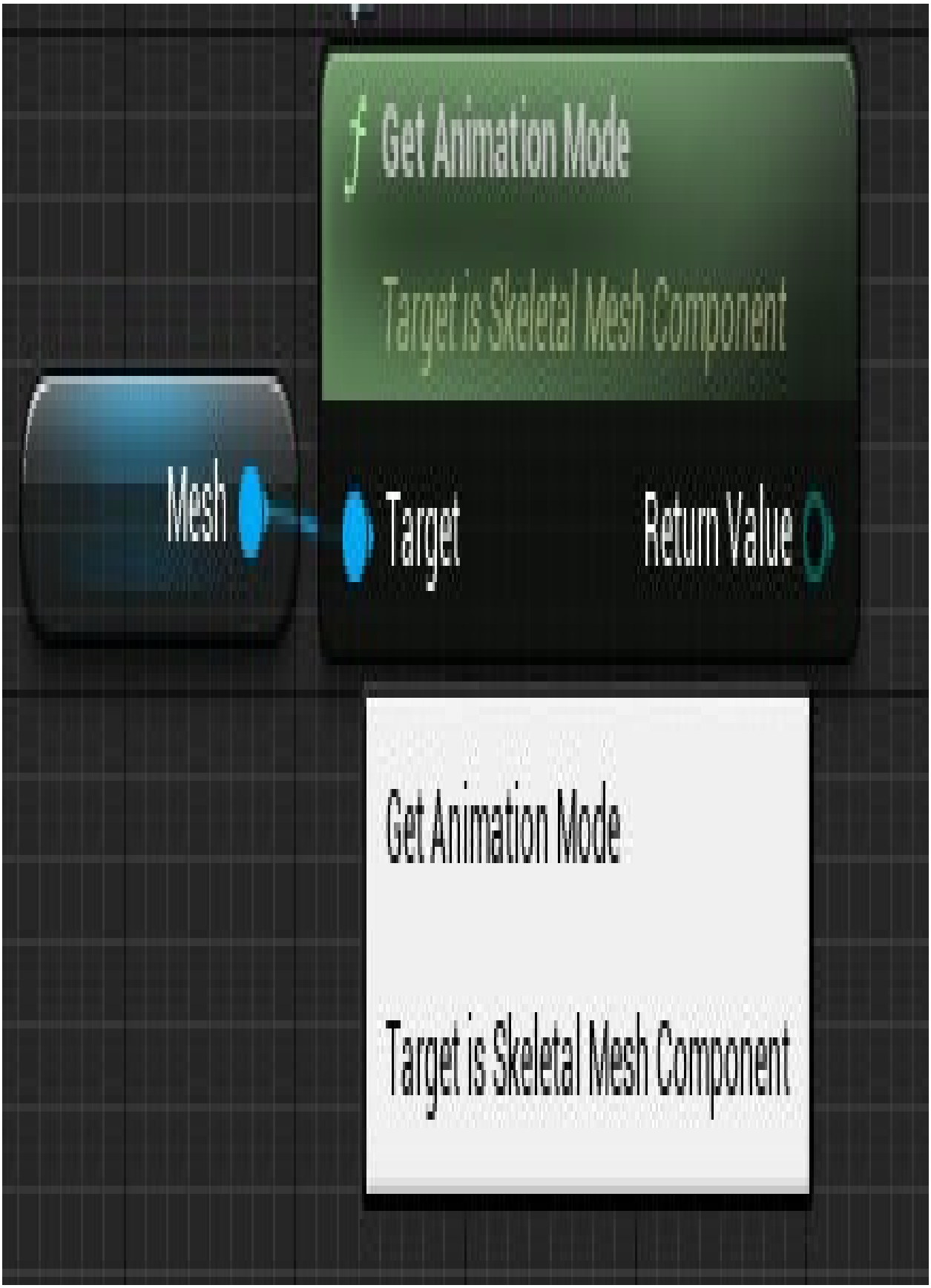

Get Animation Mode
Target is Skeletal Mesh Component
Mesh
Target
Return Value
Get Animation Mode
Target is Skeletal Mesh Component

Figure 9.46: Set Animation Mode Node

Override animation data

This node is a combination of most of the Animation Instance nodes previously covered. It is used for changing everything except the animation mode of a Mesh with a single node:

Override Animation Data
Target is Skeletal Mesh Component
Mesh
Target
In Anim to Play
Select Asset
Is Looping
Is Playing
Position
0.0
Play Rate
1.0

Figure 9.47: Override Animation Data Node

It is better to use the other, more specialized nodes for setting specific parameters regarding the animation of a mesh, but when it all needs to change at once for whatever reason, this node is better in terms of performance and readability of your blueprint.

Animation modes

Skeletal meshes can only be animated by a single source at a time. The different methods of doing so are referred to as Animation Modes, and they include Animation Blueprints, Animation Assets and Custom Modes:

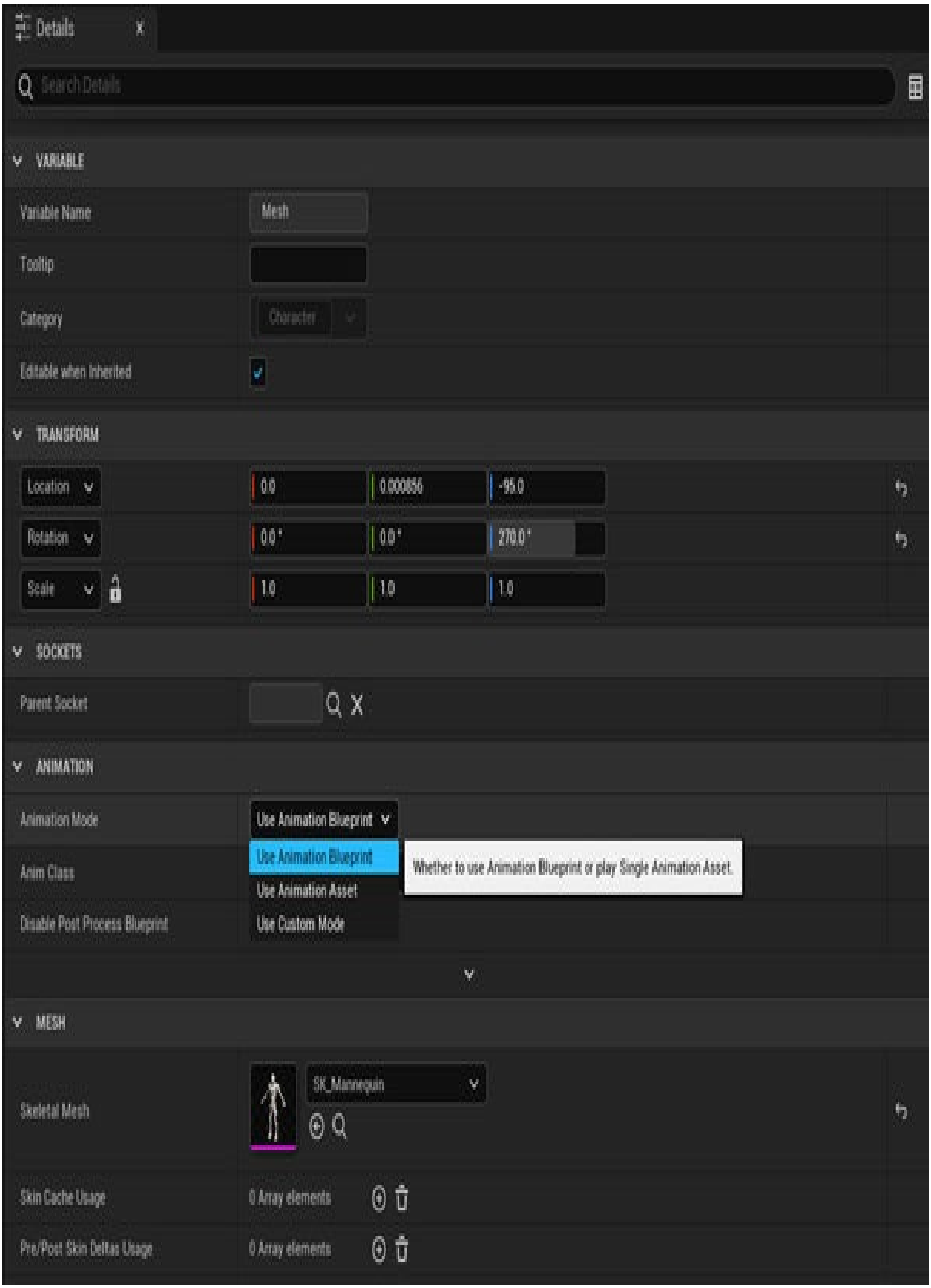

Details
Search Details
VARIABLE
Variable Name
Mesh
Tooltip
Category
Character
Editable when Inherited
TRANSFORM
Location
0.0
0.000856
-95.0
Rotation
0.0°
0.0°
270.0°
Scale
1.0
1.0
1.0
SOCKETS
Parent Socket
ANIMATION
Animation Mode
Use Animation Blueprint
Use Animation Blueprint
Use Animation Asset
Use Custom Mode
Whether to use Animation Blueprint or play Single Animation Asset.
Anim Class
Disable Post Process Blueprint
MESH
Skeletal Mesh
SK_Mannequin
Skin Cache Usage
0 Array elements
Pre/Post Skin Deltas Usage
0 Array elements

Figure 9.48: Animation Mode

Animation blueprints are specialized blueprints, specifically for providing skeletal meshes with the capacity for complex logic regarding animation, such as having two different animations play on different parts for a skeletal mesh, or having specific animations play under certain conditions. The custom animation mode is for advanced users who have created their own method for animating skeletal meshes.

Multi-variable type operators

A new feature in UE5 is that basic math operators can now natively handle variables of different types without the need for extra conversion or specific multi-variable math nodes. In order to make use of this, simply use a math operator and connect the different variables into the inputs:

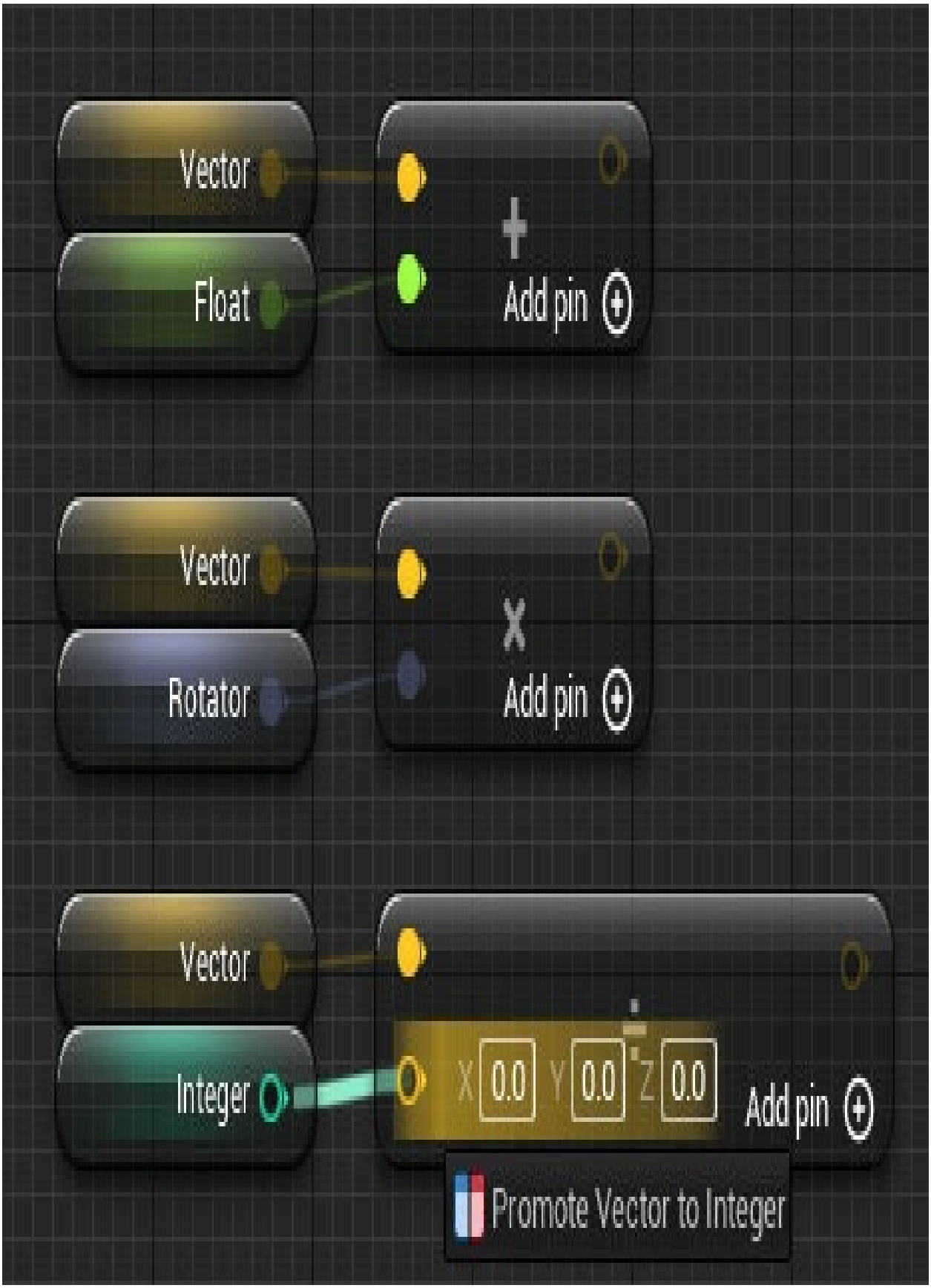

Vector
Float
+
Add pin
Vector
Rotator
X
Add pin
Vector
Integer
X 0.0 Y 0.0 Z 0.0
Add pin
Promote Vector to Integer

Figure 9.49: Multi-Variable Type Operators

Note that only compatible variables can do this, and that the output value will be of the same type as the variable in the first pin slot.

Conclusion

There are more complicated variables in UE5, which have specialized aspects to them, making them harder to understand and use, but they can be used to great effect due to their complex nature. Variables are also capable of becoming more complex through the use of arrays and maps.

The animation of skeletal meshes can be managed through blueprint through the use of specialized nodes but can also be managed through Animation Blueprints when more complicated animation logic is required.

UE5 has made some improvements over its predecessor around basic math, allowing for easier management of mathematics involving different variable types.

By Next chapter, we learn more about game objects by going through class properties, settings of tick function, replications setting, and serialization data related to game objects.

Points to remember

Properly used structures and data tables can make a project much easier to work on.

Enumerators convert natively to bytes.

Arrays and maps are similar and use some very similar nodes.

Data tables can be exported in and out of UE5.

Structures can contain structures, which are very useful for organization.

Skeletal meshes can only be animated by a single source at a time.

For loops and arrays are frequently used together.

Structures cannot contain a variable of the same struct, preventing infinite loops.

Multiple choice questions

What files can Data Tables be exported as?

JSON & CSV

.JSON & PNG

CSV & FBX

JPG & PSD

Can you add an entry to an array using theSet Array Elementnode?

Yes

No

What variable type does the output of a math operator use?

Integer

The variable type of the first pin

Vector

Answers

a

a

b

Questions

What is a break node?

What is an Animation Blueprint?

What is an operator?

Key terms

Array: A collection of values in a list

Struct: A collection of variables

Animation: Movement over time

Export: Outputting data from one program to use in another

Pin: The input/output instance of a variable on a node

CHAPTER 10

Game Objects (Advanced) and Serialization

This chapter will cover the more advanced aspects of game objects, including more specialized settings for objects and an easy method of interaction between objects. It will also cover saving data to the system the game is running on for future usage (serialization), which is important for keeping track of player progress and their graphical and input settings.

Structure

In this chapter, we will discuss the following topics:

Class defaults

Class settings

Changing inheritance

Interfaces (setup, returns, and usage)

Tick settings

Replication settings

Serialization

Save game objects

User settings (scalability and input)

Objectives

After studying this chapter, you should understand the core settings of game objects and how to alter them, in addition to being able to save data and alter the engine's settings from within the project.

Class defaults

At the top of the blueprint editor, there is a button to open up the default settings of the currently open blueprint; within this menu are options for changing the default values for variables within the blueprint, and for changing the values used by its components:

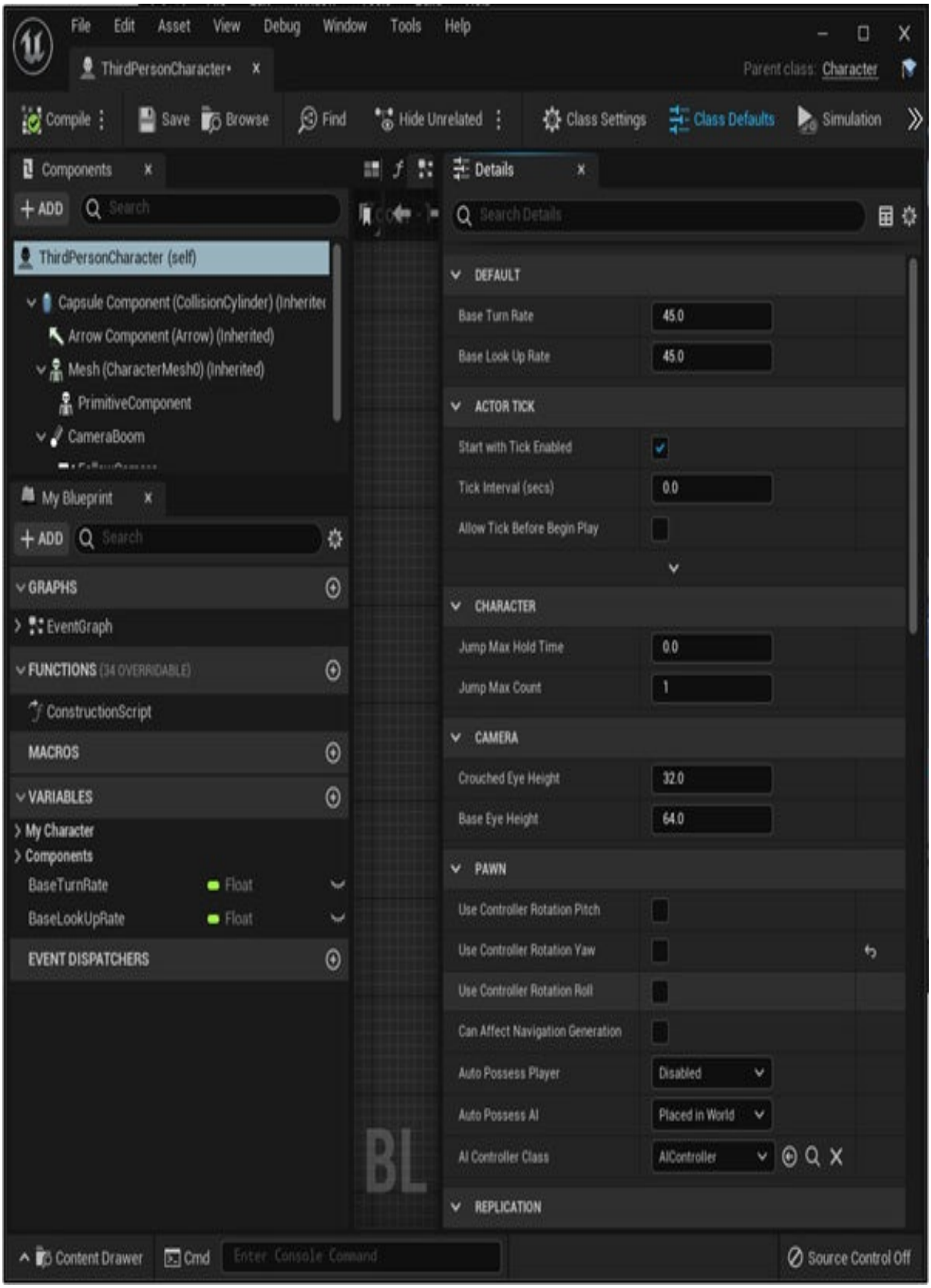

File Edit Asset View Debug Window Tools Help
ThirdPersonCharacter*
Parent class: Character
Compile
Save
Browse
Find
Hide Unrelated
Class Settings
Class Defaults
Simulation
Components
ADD
Search
ThirdPersonCharacter (self)
Capsule Component (CollisionCylinder) (Inherite
Arrow Component (Arrow) (Inherited)
Mesh (CharacterMesh0) (Inherited)
PrimitiveComponent
CameraBoom
My Blueprint
ADD
Search
GRAPHS
EventGraph
FUNCTIONS (34 OVERRIDABLE)
ConstructionScript
MACROS
VARIABLES
My Character
Components
BaseTurnRate
Float
BaseLookUpRate
Float
EVENT DISPATCHERS
Details
Search Details
DEFAULT
Base Turn Rate
45.0
Base Look Up Rate
45.0
ACTOR TICK
Start with Tick Enabled
Tick Interval (secs)
0.0
Allow Tick Before Begin Play
CHARACTER
Jump Max Hold Time
0.0
Jump Max Count
1
CAMERA
Crouched Eye Height
32.0
Base Eye Height
64.0
PAWN
Use Controller Rotation Pitch
Use Controller Rotation Yaw
Use Controller Rotation Roll
Can Affect Navigation Generation
Auto Possess Player
Disabled
Auto Possess AI
Placed in World
AI Controller Class
AIController
REPLICATION
BL
Content Drawer
Cmd
Enter Console Command
Source Control Off

Figure 10.1: Class Defaults Settings

Class settings

Next to the class defaults button, there is a button to open the class settings of the currently open blueprint; within this menu are options for changing the parent class, managing interfaces, modifying the thumbnail used for the blueprint in the content browser, changing the blueprint's metadata, and a couple of construction script settings:

File Edit Asset View Debug Window Tools Help

ThirdPersonCharacter*

Parent class: Character

Compile | Save | Browse | Find | Hide Unrelated | Class Settings | Class Defaults | Simulation

Components

+ ADD | Search

ThirdPersonCharacter (self)

- Capsule Component (CollisionCylinder) (Inherited)
  - Arrow Component (Arrow) (Inherited)
  - Mesh (CharacterMesh0) (Inherited)
    - PrimitiveComponent
  - CameraBoom

My Blueprint

+ ADD | Search

GRAPHS

EventGraph

FUNCTIONS (34 OVERRIDABLE)

ConstructionScript

MACROS

VARIABLES

My Character

Components

BaseTurnRate	Float
BaseLookUpRate	Float

EVENT DISPATCHERS

Details

Search Details

CLASS OPTIONS

Parent Class	Character

BLUEPRINT OPTIONS

Run Construction Script on Drag	✓
Run Construction Script in Sequencer	
Blueprint Display Name	
Blueprint Description	Character Blueprint that contains movement logic.
Blueprint Namespace	
Blueprint Category	
Hide Categories	0 Array elements

INTERFACES

Implemented Interfaces

No Interfaces

Add

Inherited Interfaces

Nav Agent Interface

THUMBNAIL

Orbit Pitch	-11.25
Orbit Yaw	-157.5
Orbit Zoom	0.0

BL

Content Drawer | Cmd | Enter Console Command | Source Control Off

Figure 10.2: Class settings

Changing inheritance

Inheritance can be changed from within the class settings of a blueprint; this allows you to change the parent of a blueprint, changing its inherited components, variables, functions, and so on to that of the new parent class:

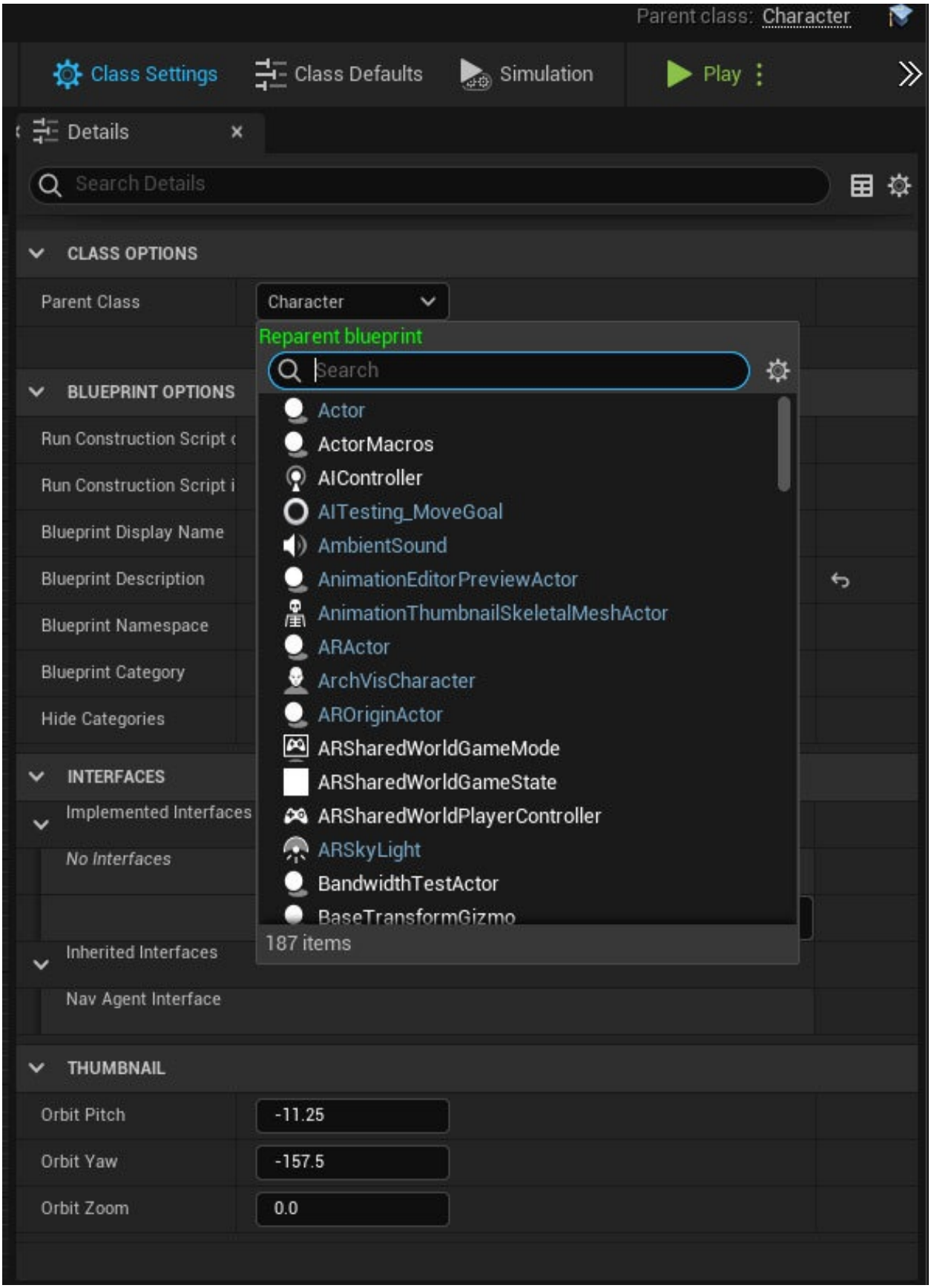

Parent class: Character
Class Settings
Class Defaults
Simulation
Play
Details
Search Details
CLASS OPTIONS
Parent Class
Character
Reparent blueprint
Search
Actor
ActorMacros
AIController
AITesting_MoveGoal
AmbientSound
AnimationEditorPreviewActor
AnimationThumbnailSkeletalMeshActor
ARActor
ArchVisCharacter
AROriginActor
ARSharedWorldGameMode
ARSharedWorldGameState
ARSharedWorldPlayerController
ARSkyLight
BandwidthTestActor
BaseTransformGizmo
187 items
BLUEPRINT OPTIONS
Run Construction Script
Run Construction Script i
Blueprint Display Name
Blueprint Description
Blueprint Namespace
Blueprint Category
Hide Categories
INTERFACES
Implemented Interfaces
No Interfaces
Inherited Interfaces
Nav Agent Interface
THUMBNAIL
Orbit Pitch
-11.25
Orbit Yaw
-157.5
Orbit Zoom
0.0

Figure 10.3: Changing inheritance

Interfaces

An interface is a way to get two objects to interact without requiring a reference to a specified class (casting), they are incredibly useful for having a single interaction from one object with numerous reactions from many different objects.

Setup

In order to use interfaces, they first need to be created; this can be done by right-clicking in the content browser and selecting the Blueprint Interface option under the Blueprints category:

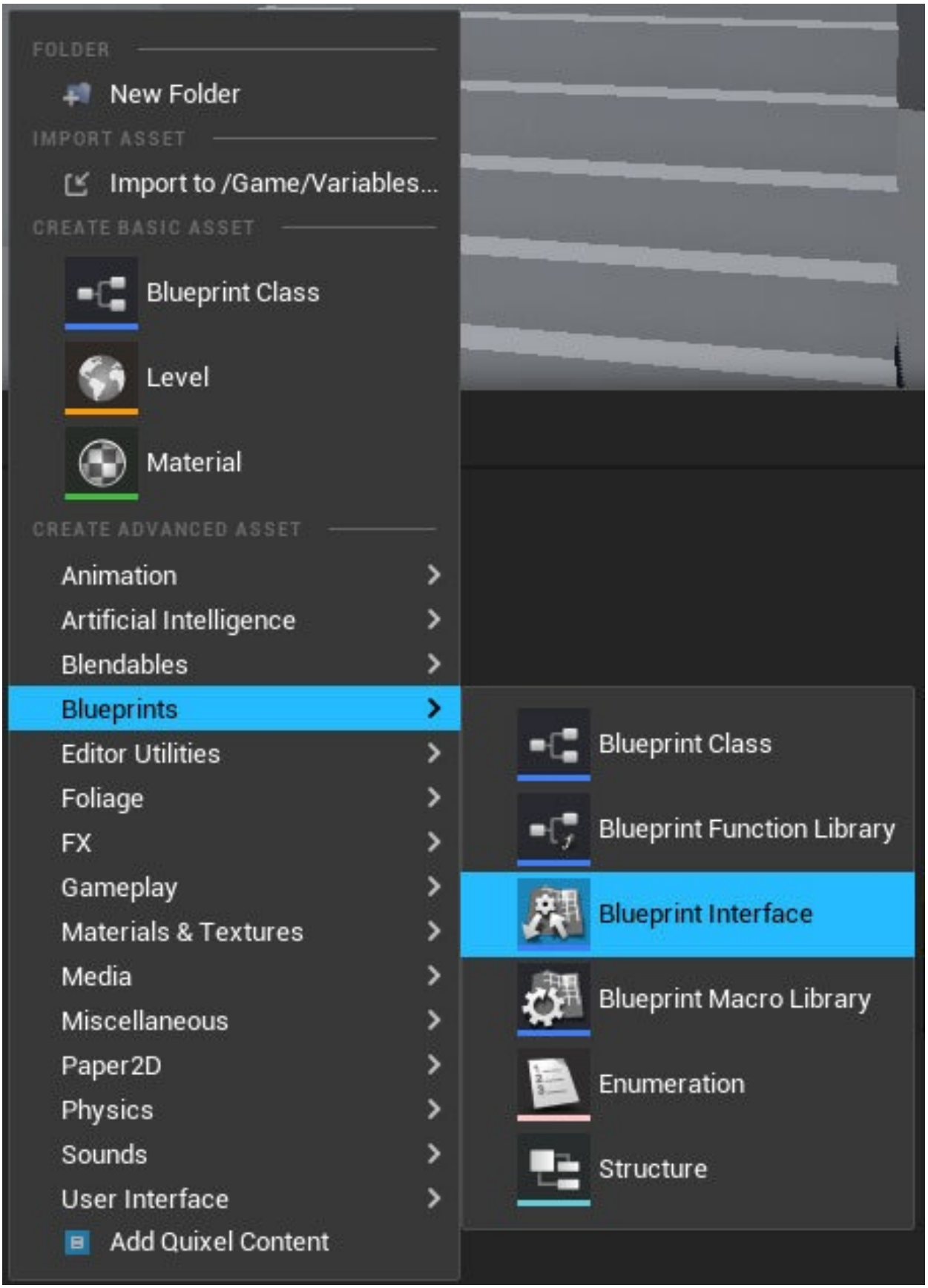

FOLDER
New Folder
IMPORT ASSET
Import to /Game/Variables...
CREATE BASIC ASSET
Blueprint Class
Level
Material
CREATE ADVANCED ASSET
Animation
Artificial Intelligence
Blendables
Blueprints
Editor Utilities
Foliage
FX
Gameplay
Materials & Textures
Media
Miscellaneous
Paper2D
Physics
Sounds
User Interface
Add Quixel Content
Blueprint Class
Blueprint Function Library
Blueprint Interface
Blueprint Macro Library
Enumeration
Structure

Figure 10.4: Creating interface

Once created, interfaces need to be set to be used by each blueprint that needs to use it. This is done within the interface section of the Class Settings menu.

Returns

Like data tables and enumerators, interfaces have their own editor. Within this editor, you can add functions to be called through this interface and manage inputs and outputs to be used by it. You can’t add code to interface’s function inside the interface editor, but this can be done in each blueprint that uses that interface.

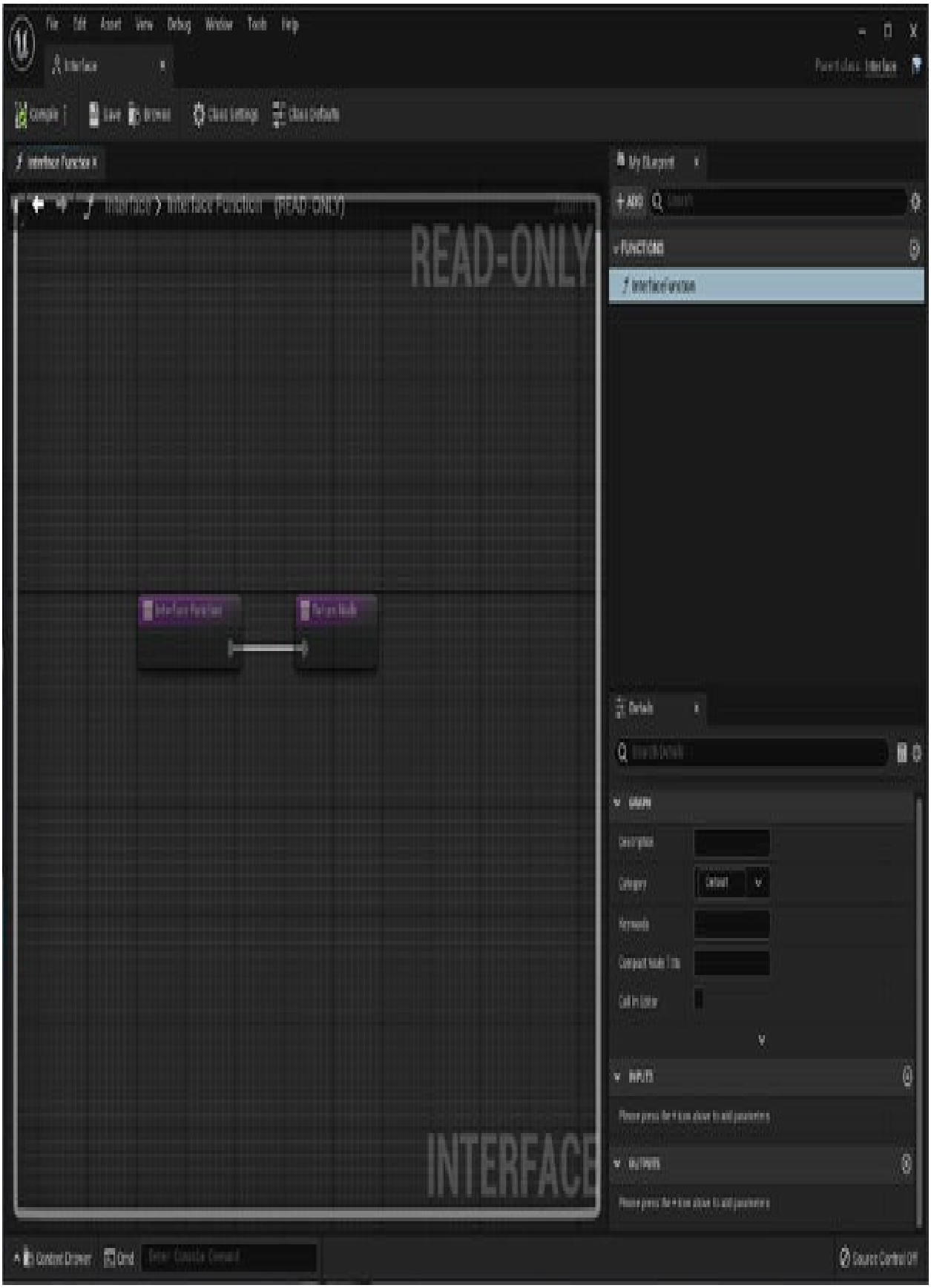

File Edit Asset View Debug Window Tools Help
Interface
Parent class: Interface
Compile
Save
Browse
Class Settings
Class Defaults
Interface Function
Interface > Interface Function (READ-ONLY)
READ-ONLY
My Blueprint
+ ADD
Search
Functions
Interface Function
Details
Search Details
GRAPH
Description
Category
Default
Keywords
Compact Node Title
Call In Editor
INPUTS
Please press the + icon above to add parameters
OUTPUTS
Please press the + icon above to add parameters
INTERFACE
Content Drawer
Cmd
Enter Console Command
Source Control Off

Figure 10.5: Interface Editor

Interfaces can contain multiple functions, which can be seen and managed in the Functions section of the My Blueprint panel within the interface editor, while the INPUTS and OUTPUTS of the currently selected function are located within the Details panel, which also contains metadata settings for the function (description, category, and so on).

INTERFACE
Interface Function
Return Node
Input
Output
INPUTS
Input
Number
Default Value
Pass-by-Reference
OUTPUTS
Output
Float

Figure 10.6: Interface function inputs and outputs

Usage

In order for interfaces to be utilized by a blueprint, they need to be added to the list of interfaces used by the blueprint from within the interface section of its Class Settings (as seen in Figure 10.7), and then the function(s) desired to be used need to be defined within the blueprint:

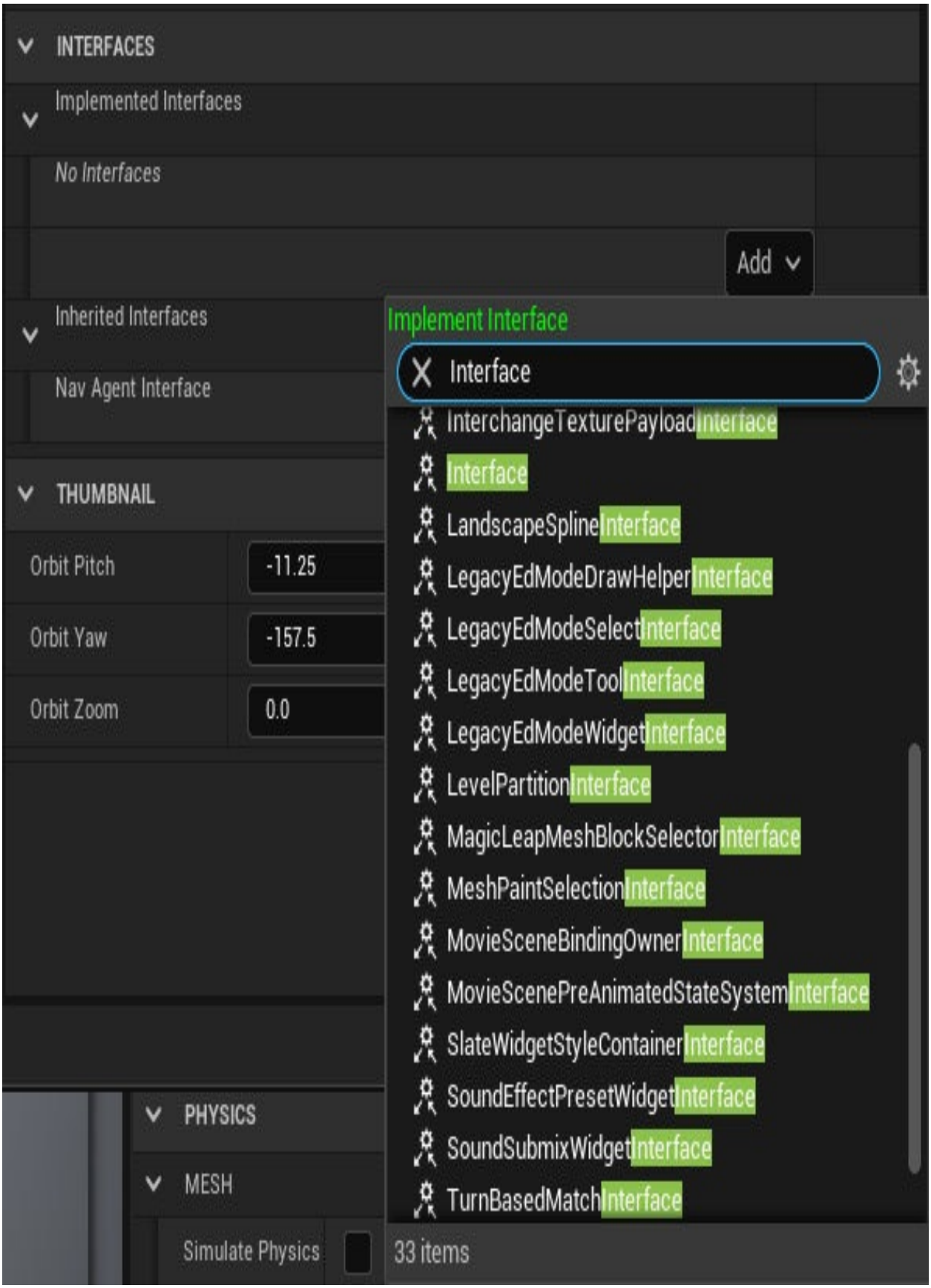

INTERFACES
Implemented Interfaces
No Interfaces
Add
Inherited Interfaces
Nav Agent Interface
Implement Interface
Interface
InterchangeTexturePayloadInterface
Interface
LandscapeSplineInterface
LegacyEdModeDrawHelperInterface
LegacyEdModeSelectInterface
LegacyEdModeToolInterface
LegacyEdModeWidgetInterface
LevelPartitionInterface
MagicLeapMeshBlockSelectorInterface
MeshPaintSelectionInterface
MovieSceneBindingOwnerInterface
MovieScenePreAnimatedStateSystemInterface
SlateWidgetStyleContainerInterface
SoundEffectPresetWidgetInterface
SoundSubmixWidgetInterface
TurnBasedMatchInterface
33 items
THUMBNAIL
Orbit Pitch
-11.25
Orbit Yaw
-157.5
Orbit Zoom
0.0
PHYSICS
MESH
Simulate Physics

Figure 10.7: Adding an interface to an Actor

After an interface is used by an actor, the functions inside the interface can be defined within the blueprint. This is done by first implementing the function under the INTERFACES section of the My Blueprint panel within the blueprint editor, as shown in Figure 10.8:

My Blueprint
ADD
Search
GRAPHS
FUNCTIONS (35 OVERRIDABLE)
ConstructionScript
INTERFACES
Interface Function
MACROS
VARIABLES
EVENT DISPATCHERS
Rename F2
Implement event
Find References ALT+SHIFT+F
Cut CTRL+X
Copy CTRL+C
Delete DELETE
Implements this overridable function as a new event.

Figure 10.8: Implementing interface function

Once the function has been implemented, it can be defined, as shown in Figure 10.9. If an interface function has outputs, it will be handled as a function within the blueprint; if it does not, it will be treated as an event:

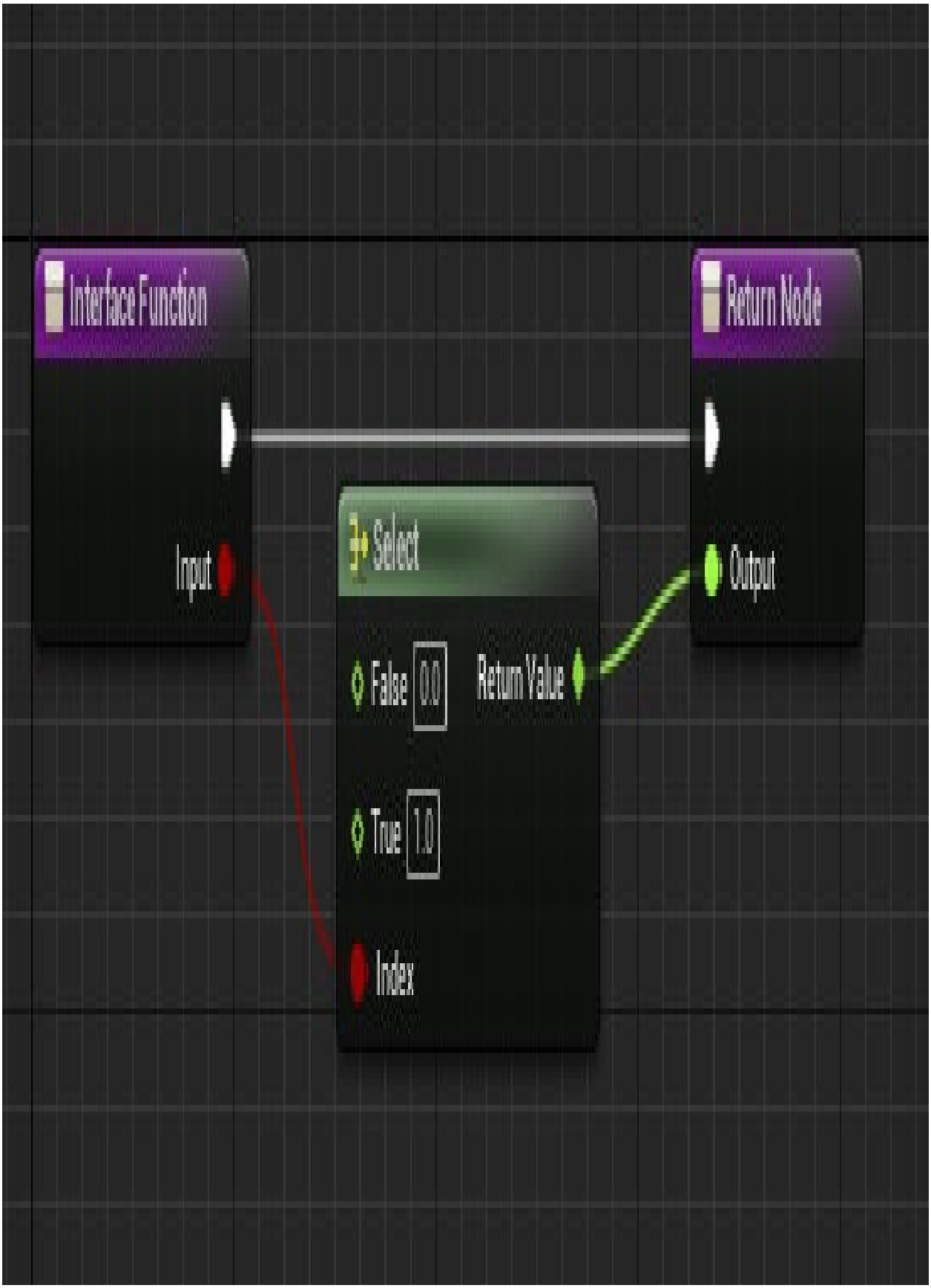

Interface Function
Input
Select
False
0.0
Return Value
True
1.0
Index
Return Node
Output

Figure 10.9: Defined interface function

After implementing an Interface function, it can be called. This is done by getting a reference to the object to execute the function and then executing it using a message node. It is also suggested to make use of a Does Implement Interface node to avoid errors, which can be seen in Figure 10.10 alongside the message node:

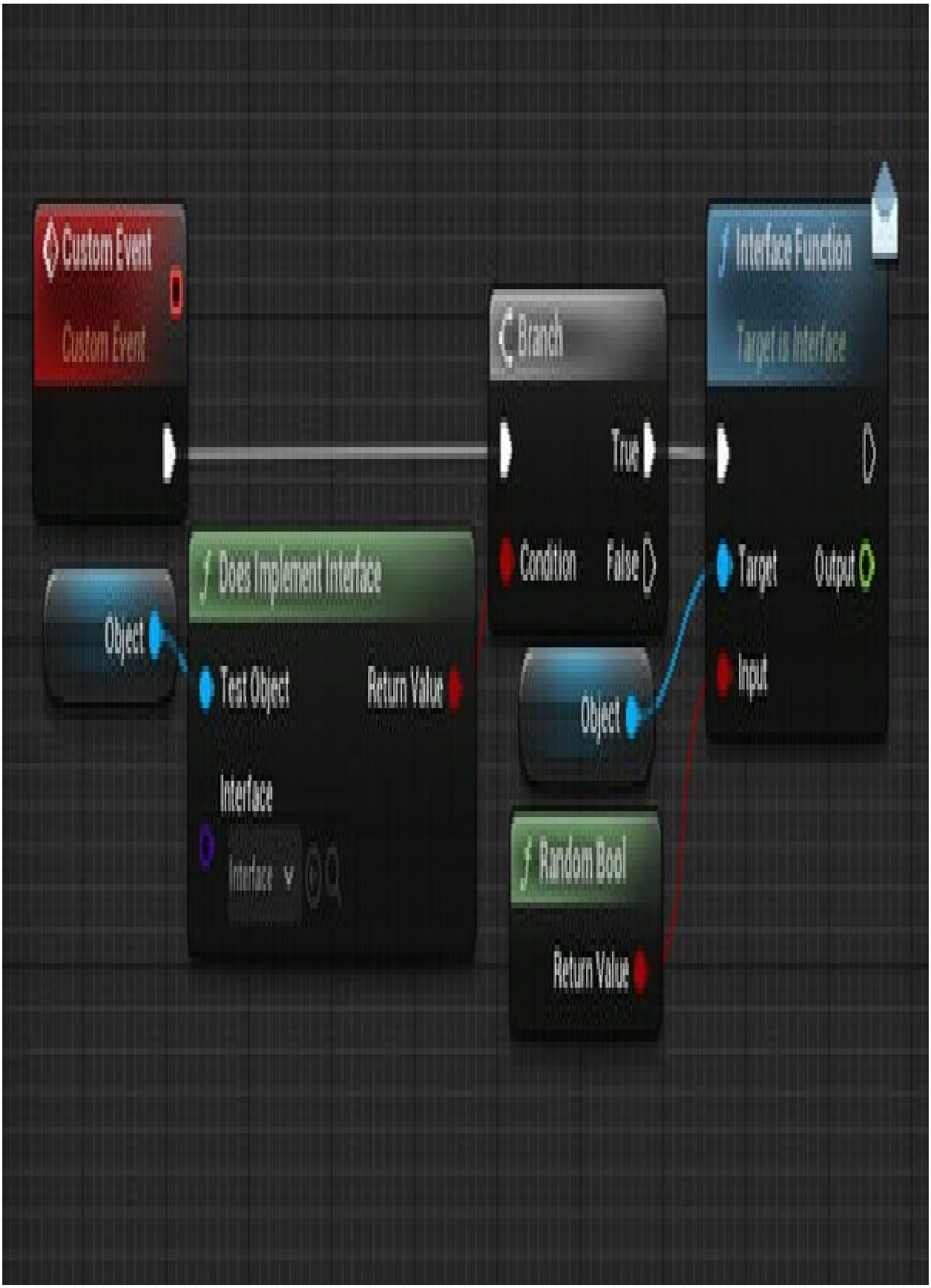

Custom Event
Custom Event
Branch
True
Condition
False
Interface Function
Target is Interface
Target
Output
Input
Does Implement Interface
Object
Test Object
Return Value
Interface
Interface
Object
Random Bool
Return Value

Figure 10.10: Calling interface function

Tick settings

Tick settings can be found under the ACTOR TICK section of a blueprint's CLASS DEFAULT settings. These settings directly influence the Tick event covered in Chapter 6, Game Objects and Materials, and when the Actor's physics are calculated:

Class Defaults
Simulation
Play
ThirdPersonCharacter
Details
Search Details
ACTOR TICK
Start with Tick Enabled
Tick Interval (secs)
0.0
Allow Tick Before Begin Play
Tick Even when Paused
Allow Tick on Dedicated Server
Tick Group
Pre Physics

Figure 10.11: Tick Settings

The tick settings are as follows:

Start with Tick Enabled: Sets whether the Actor will be ticking by default when it is initialized. An Actor's Tick can be enabled or disabled during runtime if necessary.

Tick Interval (secs): Sets how long in seconds the actor is to wait between Ticks. This setting is very useful for optimization, as the Tick Event can be very performance intensive depending on what the event is used for, so delaying a tick will ease the load placed on the system, although the functionality dependent on the tick will not always be completely updated.

Allow Tick Before Begin Play: Allows the actor to tick before it is initialized and the BeginPlay event is executed.

Tick Even when Paused: Sets whether the Actor will be allowed to continue ticking when the project is paused, although the tick likely won't function properly if it does so, depending on what logic the event is executing.

Allow Tick on Dedicated Server: Sets whether the Actor is allowed to tick on a server that is not also functioning as a client. This is a multiplayer setting that should be disabled for actors that are intended to be handled locally.

Tick Group: This setting determines the point during the engine updating that this object's tick should execute. This is useful for making sure that the functionality of the Tick Event on multiple objects interacts properly. For example, if you have an actor that has Tick functionality depending on values set in another actor's Tick, you will want the Tick of the dependent object to execute after that of the actor setting the value, so the value is always up to date and valid.

Replication settings

Replication is a multiplayer term that refers to the transmission of data between a server and clients. A blueprint class's replication setting (as seen in Figure 10.12) can be found within its CLASS DEFAULTS:

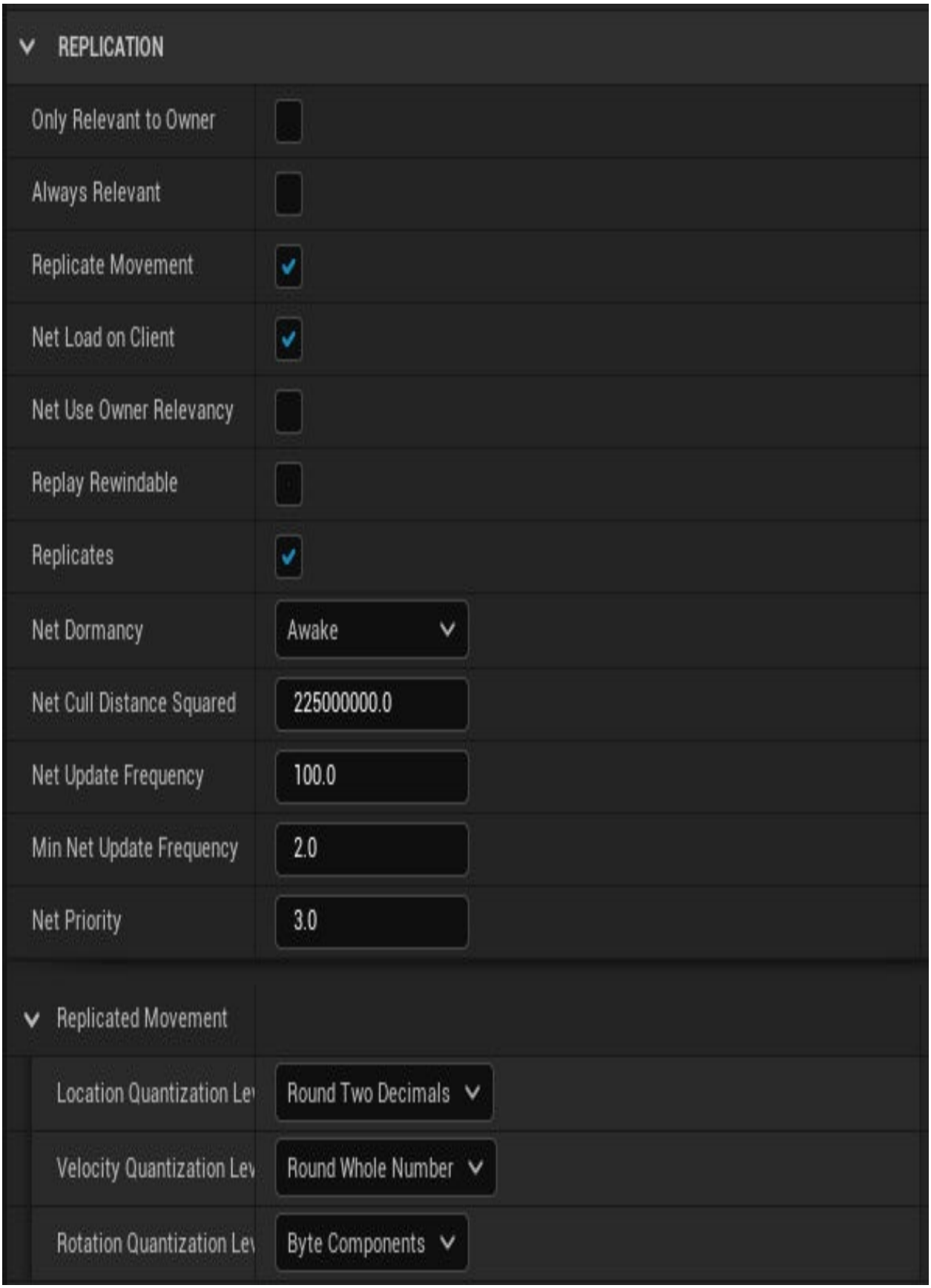

REPLICATION
Only Relevant to Owner
Always Relevant
Replicate Movement
Net Load on Client
Net Use Owner Relevancy
Replay Rewindable
Replicates
Net Dormancy
Awake
Net Cull Distance Squared
225000000.0
Net Update Frequency
100.0
Min Net Update Frequency
2.0
Net Priority
3.0
Replicated Movement
Location Quantization Lev
Round Two Decimals
Velocity Quantization Lev
Round Whole Number
Rotation Quantization Lev
Byte Components

Figure 10.12: Replication settings

The replication settings are as follows:

Only Relevant to Owner: Relevancy is whether an object is deemed capable of influencing or being visible to a client. This setting specifically sets the object to only be relevant to the owning object, which for a pawn, would be its controller.

Always Relevant: This sets the object to always be relevant.

Replicate Movement: This sets the object's positioning and rotation to be replicated between the server and clients.

Net Load on client: This forced actor to be loaded by clients loading the level.

Net Use Owner Relevancy: This sets the actor to share relevancy with its owner.

Replay Rewindable: This sets whether the object will be handled when using UE5's replay system.

Replicates: This sets the object to be replicated to clients.

Net Dormancy: A dormant object is one that is capable of being replicated but is temporarily set not to. This setting allows the user to disable dormancy entirely, to allow it but disable it by default, make the object always dormant, and make it partially or initially dormant.

Net Cull Distance Squared: This is the squared value of the distance away from a client's viewpoint at which the object will stop being relevant and replicated.

Net Update Frequency: This sets how many times per second the object's replicated data will be updated.

Min Net Update Frequency: This sets how many times per second the object's replicated data will be updated if the object's replicated data is changed infrequently.

Net Priority: This is the importance of replicating the actor; a higher value means the object is more likely to be replicated under a stressed network connection.

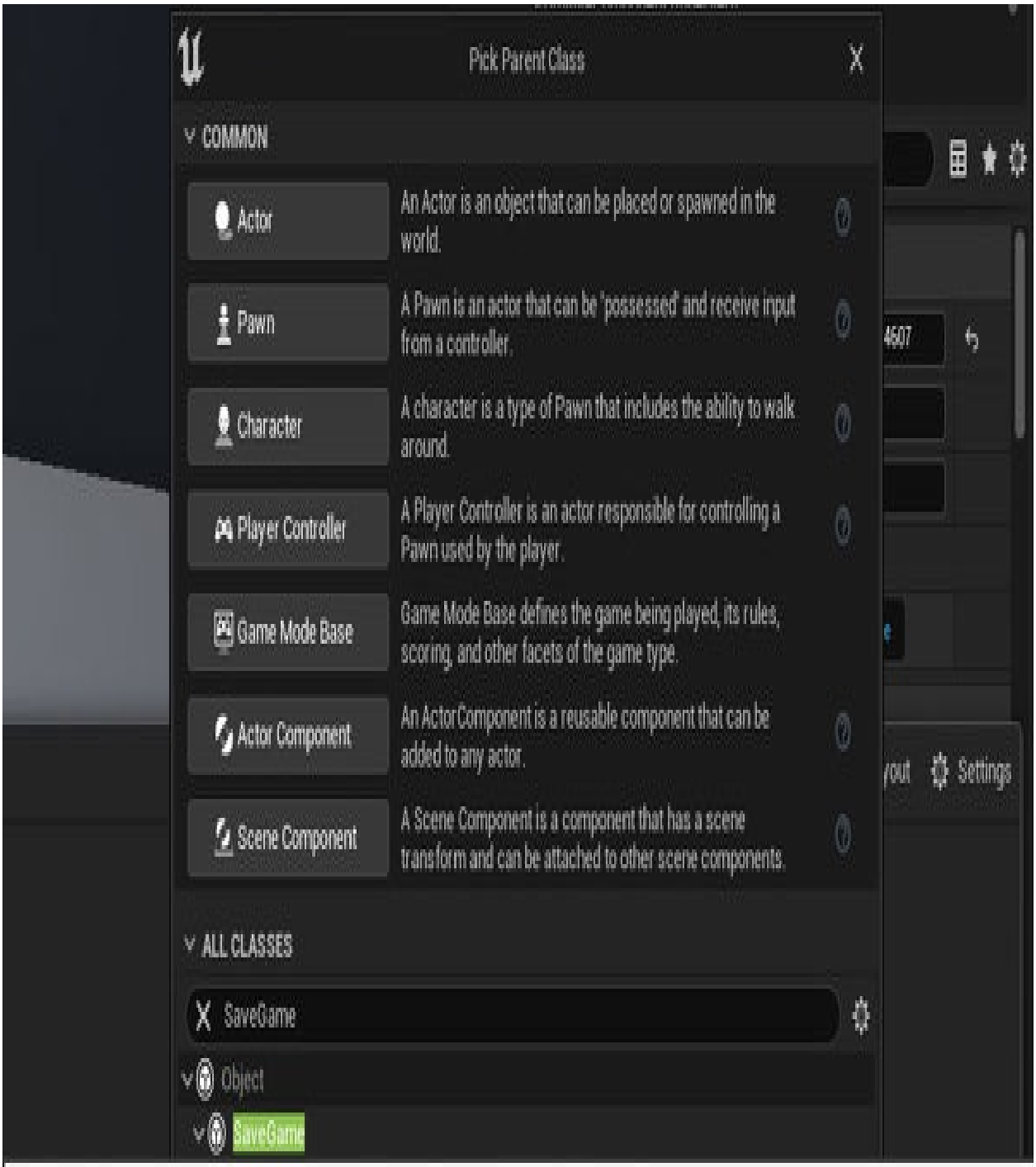
Replicated Movement: This is used for fine-tuning the accuracy of the object's replicated positioning, rotation, and velocity.

Serialization

Serialization is storing data on the user's device for later usage. In the case of save game objects, this can be used for storing gameplay data, such as where the player character is located, what's in their inventory, their name, and so on. User settings, such as graphical and input settings, are handled separately by the engine.

Save game objects

In order to make use of save game objects, a Save Game class first needs to be created and defined. This can be done by selecting Blueprint Class within the context menu of Content Browser, and then, under All Classes in the menu that is created, selecting SaveGame as the parent class, as shown in Figure 10.13. The save game class is used as the template for the save game objects that will be created to store player data:



This class acts as a base class for a save game object that can be used to save state about the game.
When you create your own save game subclass, you would add member variables for the information that you want to save.
Then when you want to save a game, create an instance of this object using CreateSaveGameObject, fill in the data, and use SaveGameToSlot, providing a slot name.
To load the game you then just use LoadGameFromSlot, and read the data from the resulting object.

@see https://docs.unrealengine.com/latest/INT/Gameplay/SaveGame

Figure 10.13: Creating Save Game Class

Save game classes have their own editor very similar to the structure editor (as shown in Figure 10.14), in which the data that the save game object will store can be defined in the form of VARIABLES:

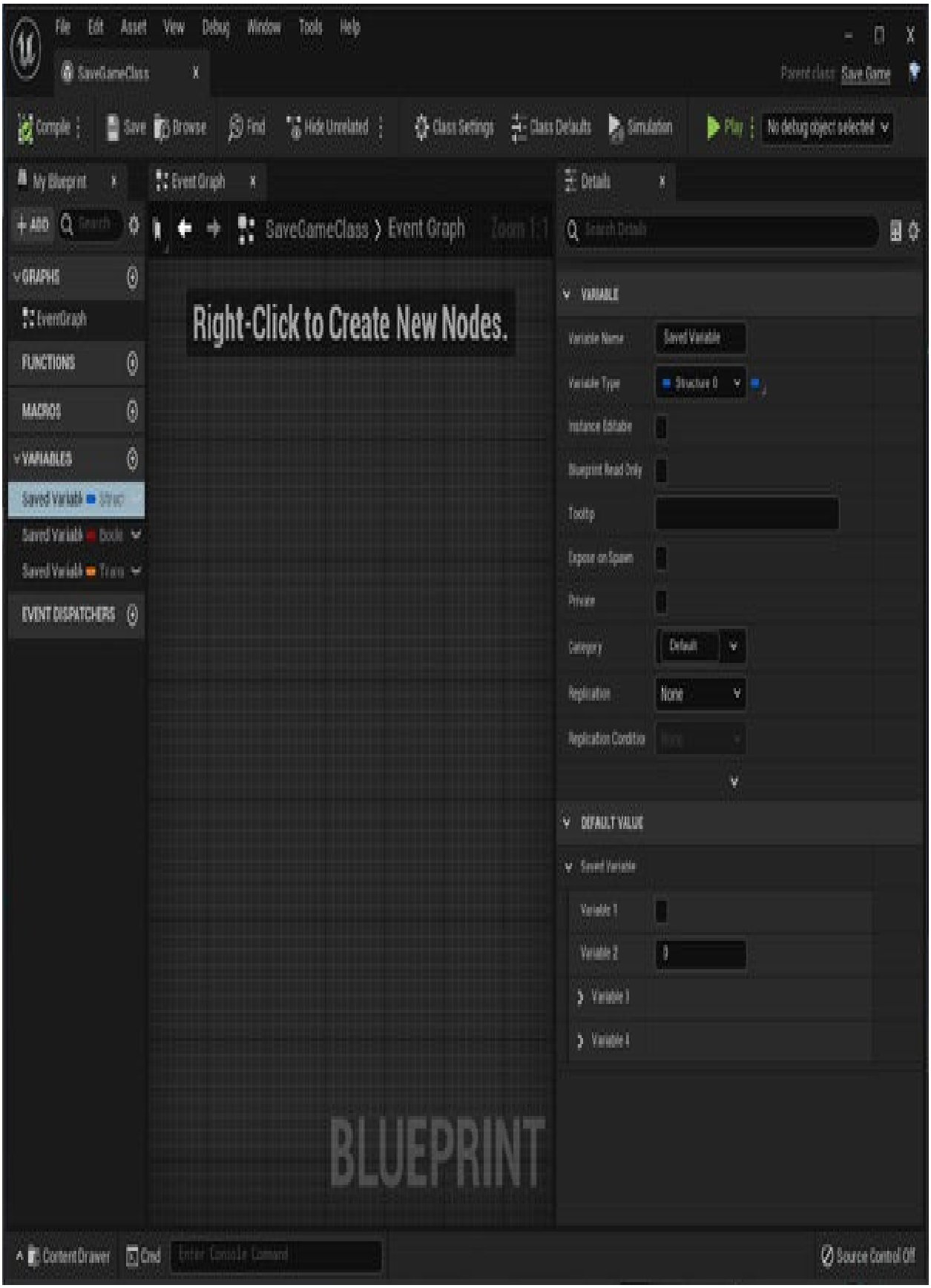

File Edit Asset View Debug Window Tools Help
SaveGameClass
Parent class: Save Game
Compile
Save
Browse
Find
Hide Unrelated
Class Settings
Class Defaults
Simulation
Play
No debug object selected
My Blueprint
Event Graph
Details
SaveGameClass > Event Graph
Zoom 1:1
Right-Click to Create New Nodes.
GRAPHS
EventGraph
FUNCTIONS
MACROS
VARIABLES
Saved Variable
EVENT DISPATCHERS
VARIABLE
Variable Name
Saved Variable
Variable Type
Instance Editable
Blueprint Read Only
Tooltip
Expose on Spawn
Private
Category
Default
Replication
None
Replication Condition
DEFAULT VALUE
Saved Variable
Variable 1
Variable 2
Variable 3
Variable 4
BLUEPRINT
Content Drawer
Cmd
Enter Console Command
Source Control Off

Figure 10.14: Save Game Class Editor

Once a Save Game class has been created and defined, it is ready to be used. This is done through blueprint, by creating A Save Game Object, setting the variables within it, and then saving it to the user device with a specific name and user index. This can be seen in Figure 10.15:

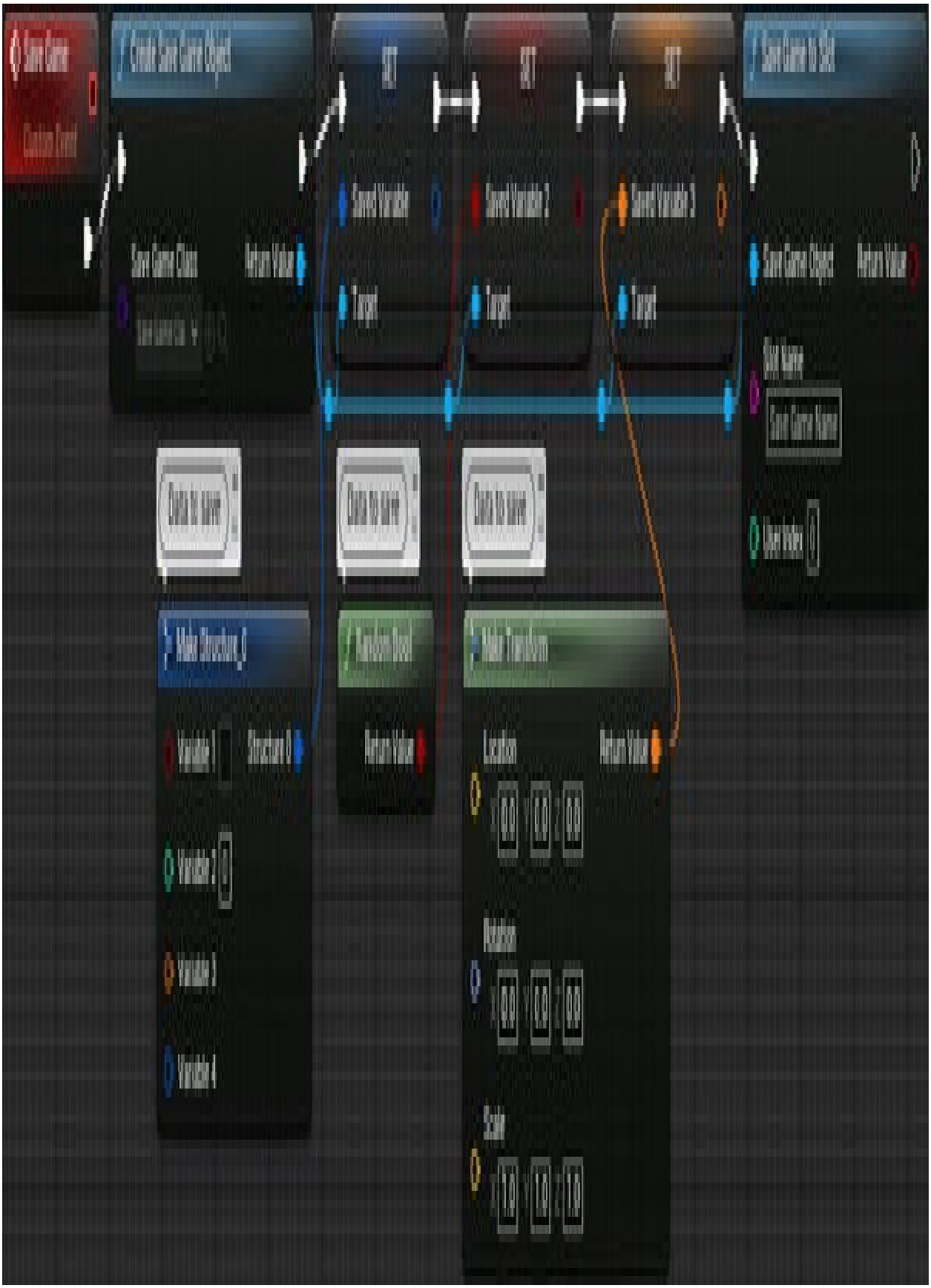


Figure 10.15: Saving

In order to load a previously created Saved Game Object, a variant of the Load Game from Slot node needs to be used, with an input slot name that matches that of a previously created Save Game Object. Once this is done, the data from the Save Game Object can be obtained using a cast node, and then the variables can be used as needed. This entire process can be seen in Figure 10.16:

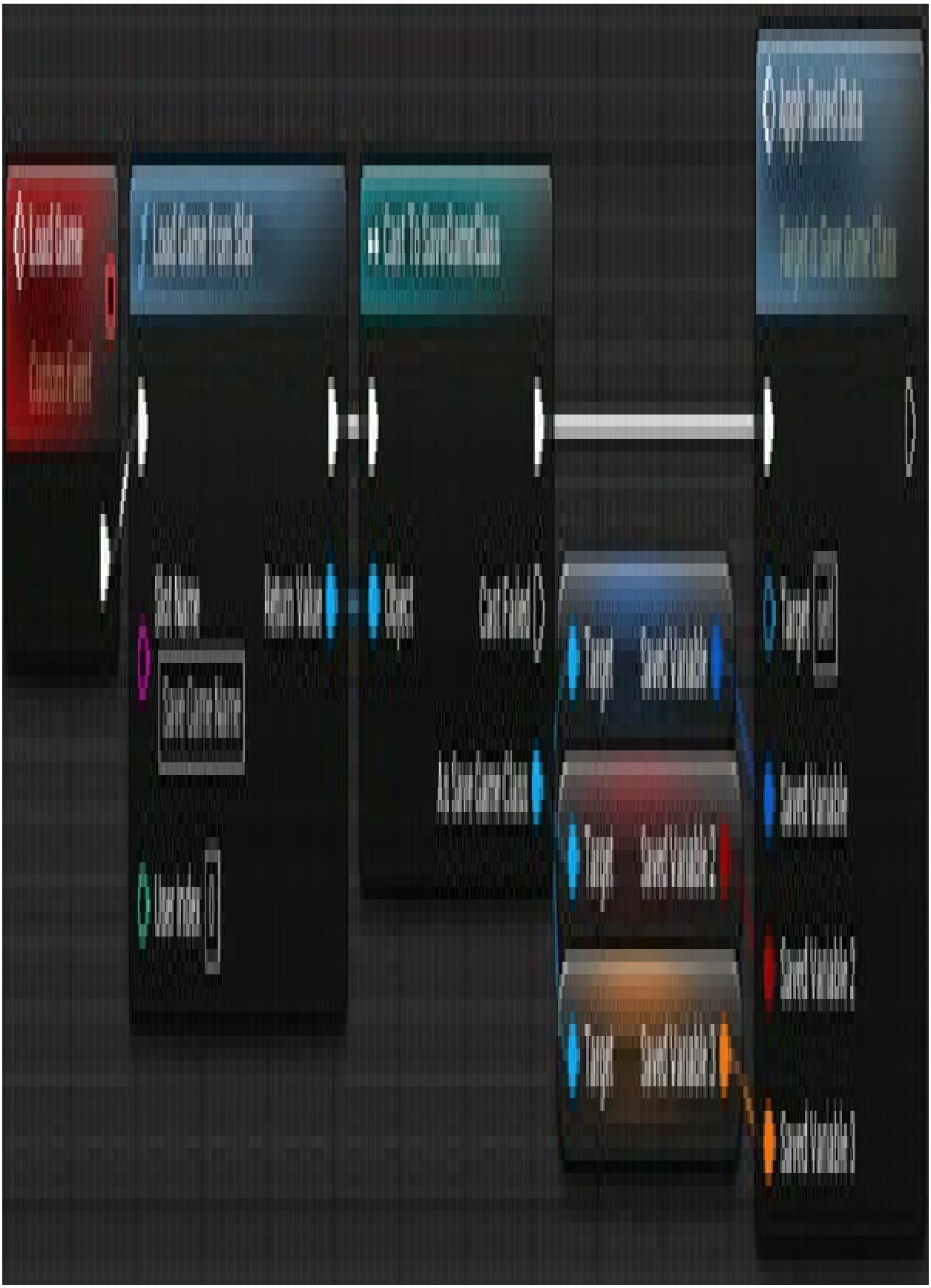


Figure 10.16: Loading

User settings

User settings are the user's graphical and input settings that are stored and used by the engine. They are handled separately to Save Game Objects. These settings are accessed using the Get Game User Settings and Get Input Settings nodes shown in Figure 10.17:

Get Game User Settings
Return Value
Get Input Settings
Return Value

Figure 10.17: User Settings nodes

Scalability

Scalability refers to the visual quality the engine is rendering the project at. This can be modified in the editor and at runtime through blueprint, with the functionality usually accessed by the player through UI elements, such as a settings menu. An example of the texture quality being changed can be seen in Figure 10.18:

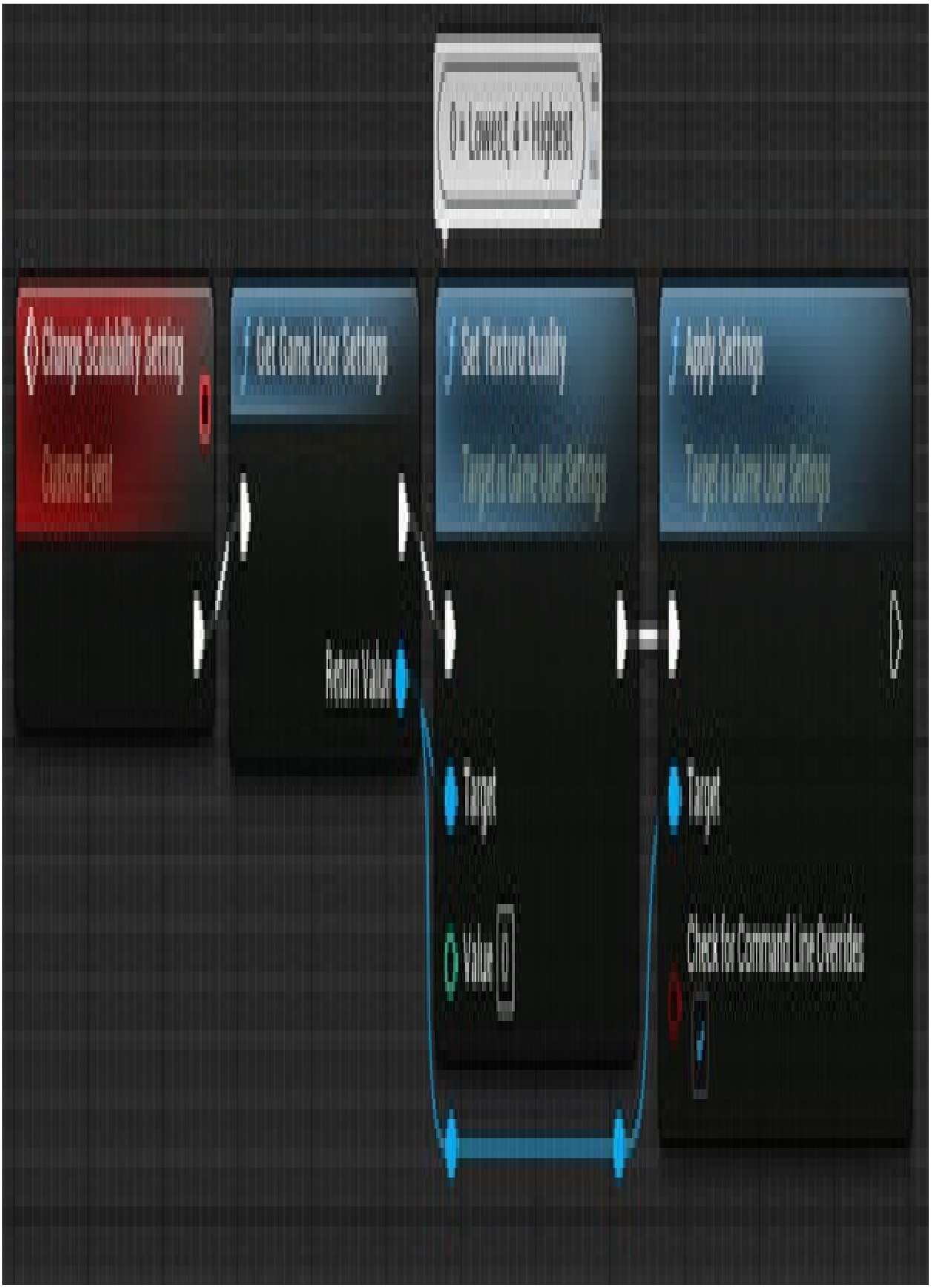

Change Scalability Settings
Custom Event
Get Game User Settings
Return Value
Target
Value
Set Texture Quality
Target is Game User Settings
Apply Settings
Target is Game User Settings
Target
Check for Command Line Overrides

Figure 10.18: Changing Scalability

The value of Scalability settings can also be obtained using the Get Game User Settings node, as shown in Figure 10.19. This is very useful for altering level elements based on the current settings the project is operating under, which is, in turn, incredibly useful for optimizing the project:

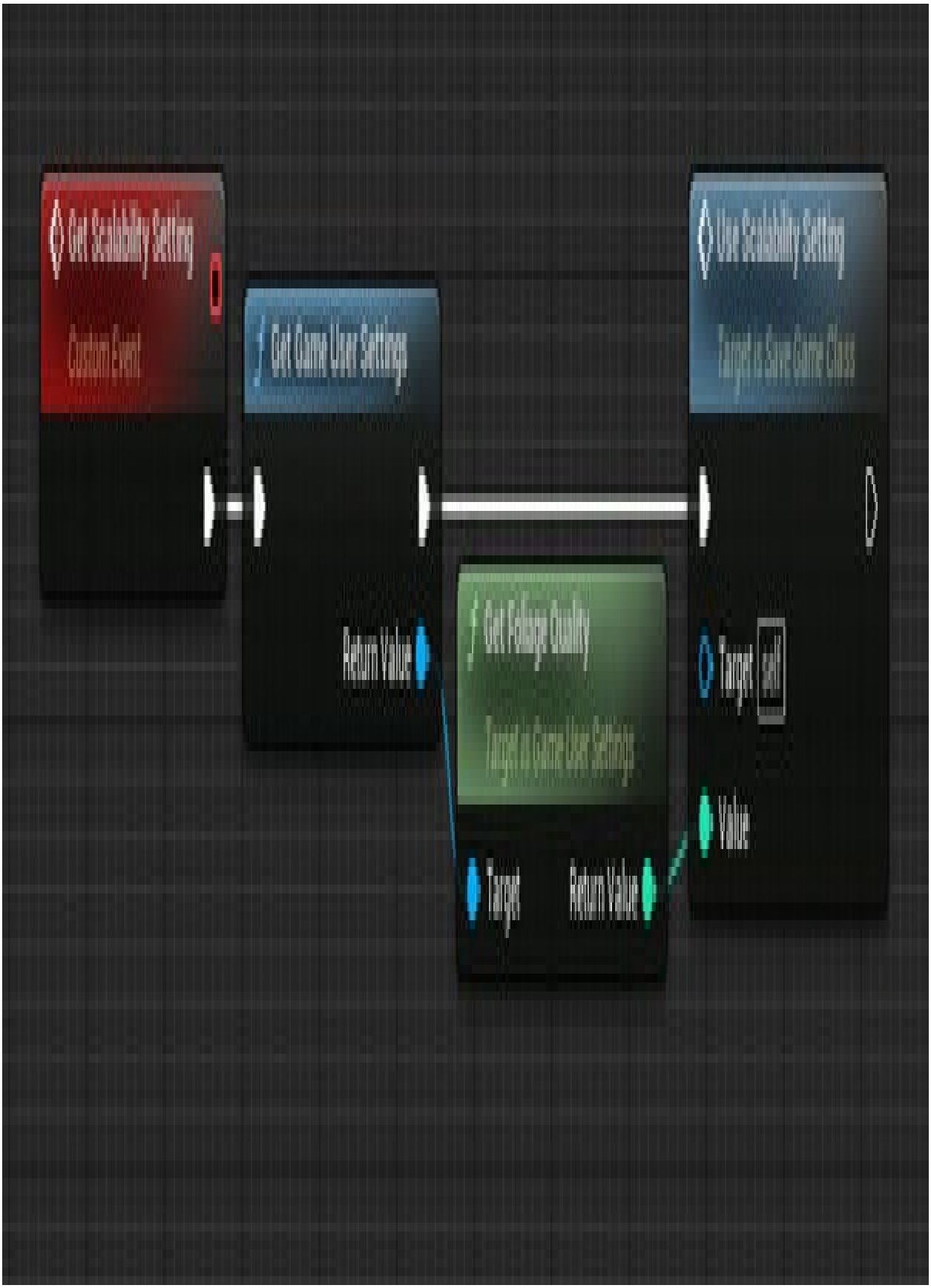

Get Scalability Settings
Custom Event
Get Game User Settings
Return Value
Get Foliage Quality
Target is Game User Settings
Target
Return Value
Use Scalability Settings
Target is Game Class
Target self
Value

Figure 10.19: Getting Scalability

In addition to specific graphics settings, the overall graphical settings of the engine can be altered via the Set Overall Scalability Level Node, as shown in Figure 10.20:

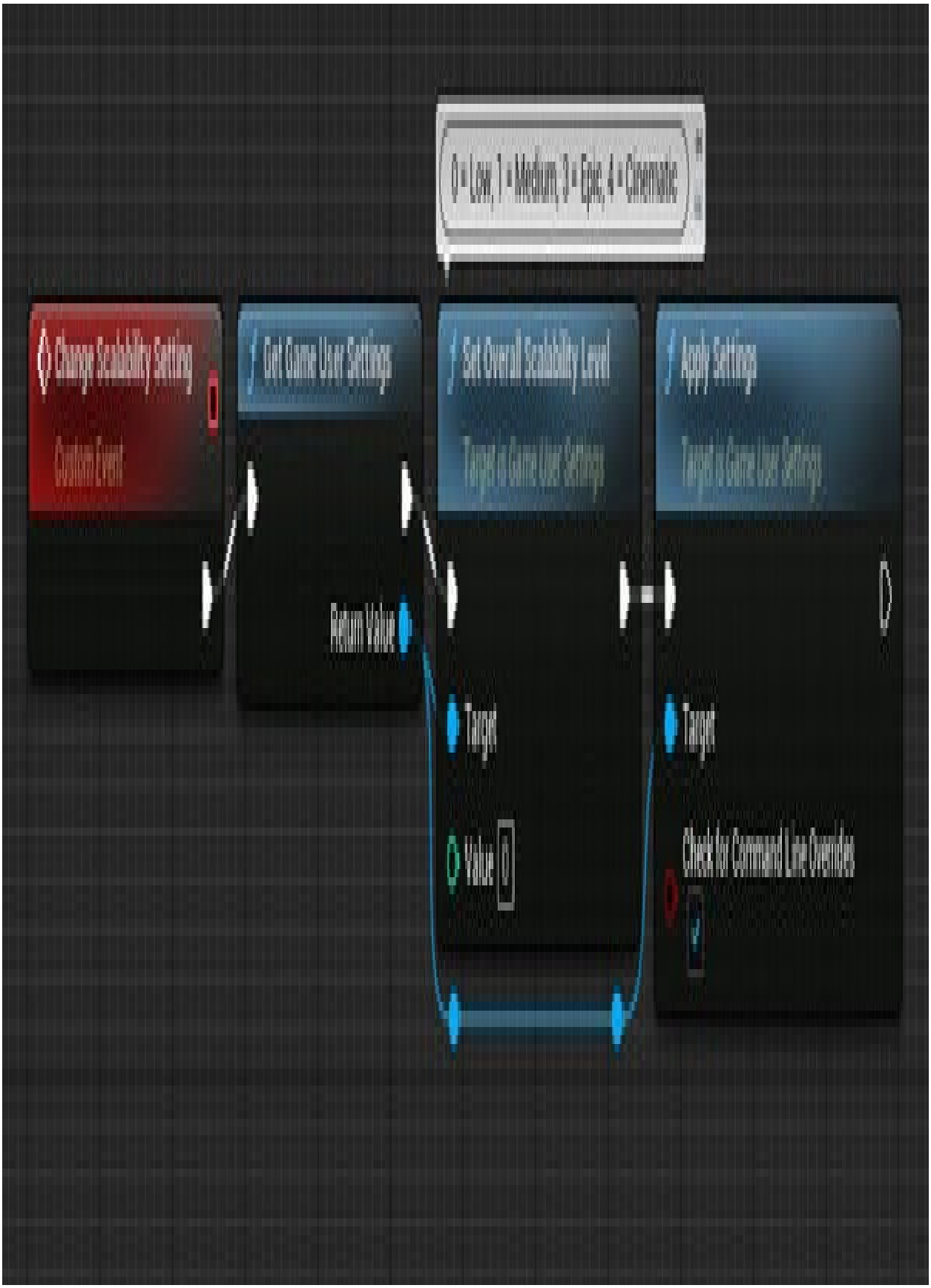

0 = Low, 1 = Medium, 2 = Epic, 4 = Cinematic
Change Scalability Setting
Custom Event
Get Game User Settings
Return Value
Set Overall Scalability Level
Target is Game User Settings
Target
Value
Apply Settings
Target is Game User Settings
Target
Check for Command Line Overrides

Figure 10.20: Setting Overall Scalability

Input

Input is how the user interacts with the project; they use an input on their device, be it a keyboard, mouse or some form of controller, and the engine takes that input and executes necessary events tied to those inputs, as covered in Chapter 5, Templates and User Interaction. Inputs can have mappings added using the “Add Action Mapping” Node, as shown in Figure 10.21:

Change Input Setting
Custom Event
Add Action Mapping
Target is Input Settings
Target
Key Mapping
Force Rebuild Keymaps
Get Input Settings
Return Value
Make InputActionKeyMapping
Action Name
Input
Input Action Key Mapping
Shift
Ctrl
Alt
Cmd
Key
0

Figure 10.21: Adding Input Mapping

Inputs can also have mappings removed using the Remove Action Mapping node, as shown in Figure 10.22:

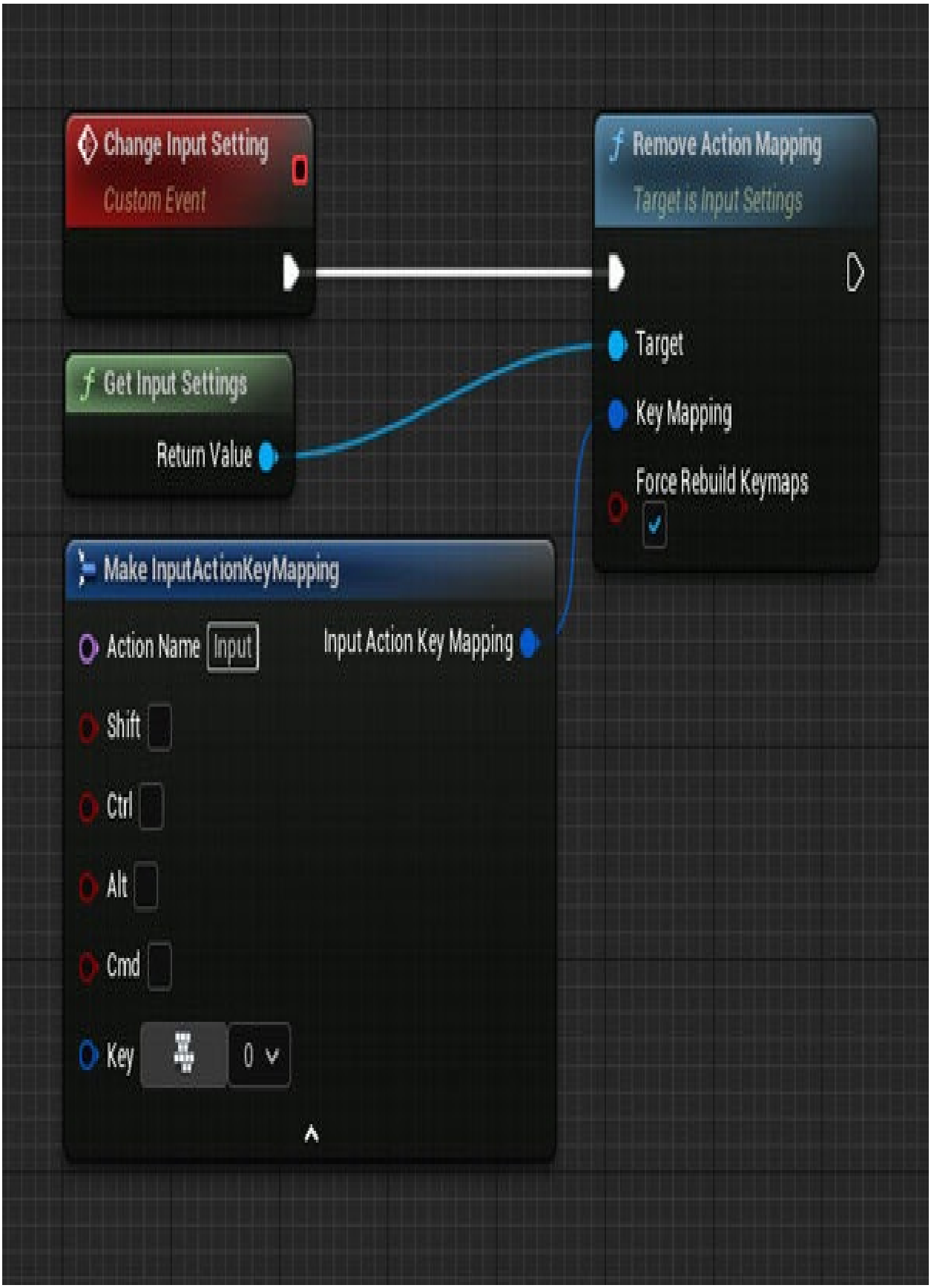

Change Input Setting
Custom Event
Remove Action Mapping
Target is Input Settings
Target
Key Mapping
Force Rebuild Keymaps
Get Input Settings
Return Value
Make InputActionKeyMapping
Action Name
Input
Input Action Key Mapping
Shift
Ctrl
Alt
Cmd
Key
0

Figure 10.22: Removing Input Mapping

Conclusion

Developers have a great deal of control over game objects, how they interact, and how the user interacts with and views the project. You can greatly modify how objects act by default and over the internet via multiplayer by changing their default and class settings and can even change the inheritance of an object easily. Most of these settings are rather advanced and will generally see minimal usage, but in the niche situations they apply to, it is incredibly useful to be aware of them and their purpose.

Interfaces are a great way to standardize interaction between objects neatly; they can be applied to almost any situation. Serialization is important not just for keeping track of player progress throughout a game but also for input and the visuals of the project.

By next chapter we learn how to add sound to game, by using a new feature known as Metasound in Unreal Engine 5. Indeed, we will learn using Niagara to add particle system to the scene and control it by blueprint code.

Points to remember

Inputs can have multiple mappings.

You can change the overall scalability as well as specific settings.

Interfaces with outputs are treated as functions, and those without are treated as events.

Objects inherit the functions, variables, events, and components of their parents.

Ticks can be delayed to improve performance.

Only relevant objects will be replicated.

Multiple choice questions

Where are the Tick Settings located?

Class Defaults

Content Browser

Class Settings

Interface Editor

What node is used to get/set scalability settings?

Get User Game Settings

Get Game User Settings

Get Input Settings

Is Tick limited when the game is paused?

Yes

No

Answers

a

b

a

Questions

How many mappings can an input have?

What is the replay system?

What is the User Index of a saved game object?

What is culling?

Key terms

UI: User interface

Mapping: A hardware input matched to an input in the project settings

Replication: The transferal of data over multiplayer

CHAPTER 11

Audio and Particles

Unreal Engine 5 uses a flexible VFX system to generate visual effects at runtime known, as Niagara, which we will go through in this chapter. Niagara has some default templates that provide a range of basic to complicated visual effects and are ideal for using as base-effect to make more complicated ones, and prototyping. A technical artist or VFX developer can use Niagara's functions and procedure to generate a flexible particle system and then programmers can use it and render /trigger it by using game parameters. Like shaders, Niagara system is running on each frame and can use both CPU and GPU for running the visual effect on screen.

At the same time, the engine has an audio system that provides complete control over a Digital Signal Processing (DSP) graph for the generation of sound sources. Audio programmers can customize the audio, reuse sound graph as feedback, import external audio files, and use a separate editor for sound design and programming. This sound system is known as MetaSound, and we will cover how to use and program this system in this chapter.

Structure

In this chapter, we will discuss the following topics:

Using Niagara

Using audio

Using MetaSound in blueprint

Objectives

By the end of this chapter, you will have an understanding of how to use Niagara to create particle systems. We will go through simulating a rain effect and then connect it to an actor blueprint in the scene. We will also learn how to assign and use parameters to control a particle system from other objects. Additionally, we will mix two Niagara particle systems at the end to show how you can simplify them as one.

The next part of the chapter is dedicated to learning MetaSound, which is an Unreal Engine 5 feature to program and create audio effects in game. MetaSound provides advanced support compared to older versions of Unreal Engine, to use Wave audio files and dynamically change them based on user parameters. MetaSound has its own editor and uses blueprint to generate code like other actors, but the way audio code works is a bit different. We will go through a simple play and loop sound functionality and explain different approaches to make it. At the end, you will learn essential basic skills on how to invoke triggers in MetaSound and make internal feedback to control the audio.

Keep in mind that both VFX and Audio are huge and expensive topics in game design and programming with Unreal Engine; you may require more research and practice in this area. Making sample project of each learning curve is recommended when you deal with Niagara and MetaSound.

Using Niagara

The Niagara is a particle system generator used by Unreal Engine to create/render and run VFX effects in game. Each particle system is a program that runs an infinite loop. Inside this loop, there are a number of tasks/modules that hire CPU and GPU (graphic card) to calculate and render the particle system's effect in the game world. This process is expensive for the engine in cases of memory usage and processing tasks. Imagine that you have 10 particle systems in the scene; this means you have 10 infinite loops that are running each frame to make all the particle systems up and running on each frame. This may work fine on a gaming PC machine, but your application will experience lag and even freeze in mobile phones with weaker graphic processing units and limited memory for system. There are a number of solutions to avoid this. User can deactivate particle systems that are not in player's view which leads to having less process and memory usage in the background. The engine also has a mechanism known as Culling which works similar, and it deactivates any process (like particle system) that are not in player field of view.

Another method is to combine a couple of effect as one particle system and changing it by passing its parameters. Also, dynamically deleting or disabling particle system components that are not in use will help increase performance.

Making Niagara emitter

The first step to establishing a particle system by using Niagara in Unreal Engine 5 is to simply make a Niagara emitter. Follow these steps to do so:

Navigate to the blueprint folder in content browser, right-click and click on Niagara Emitter from the VFX list, as shown in Figure 11.1:

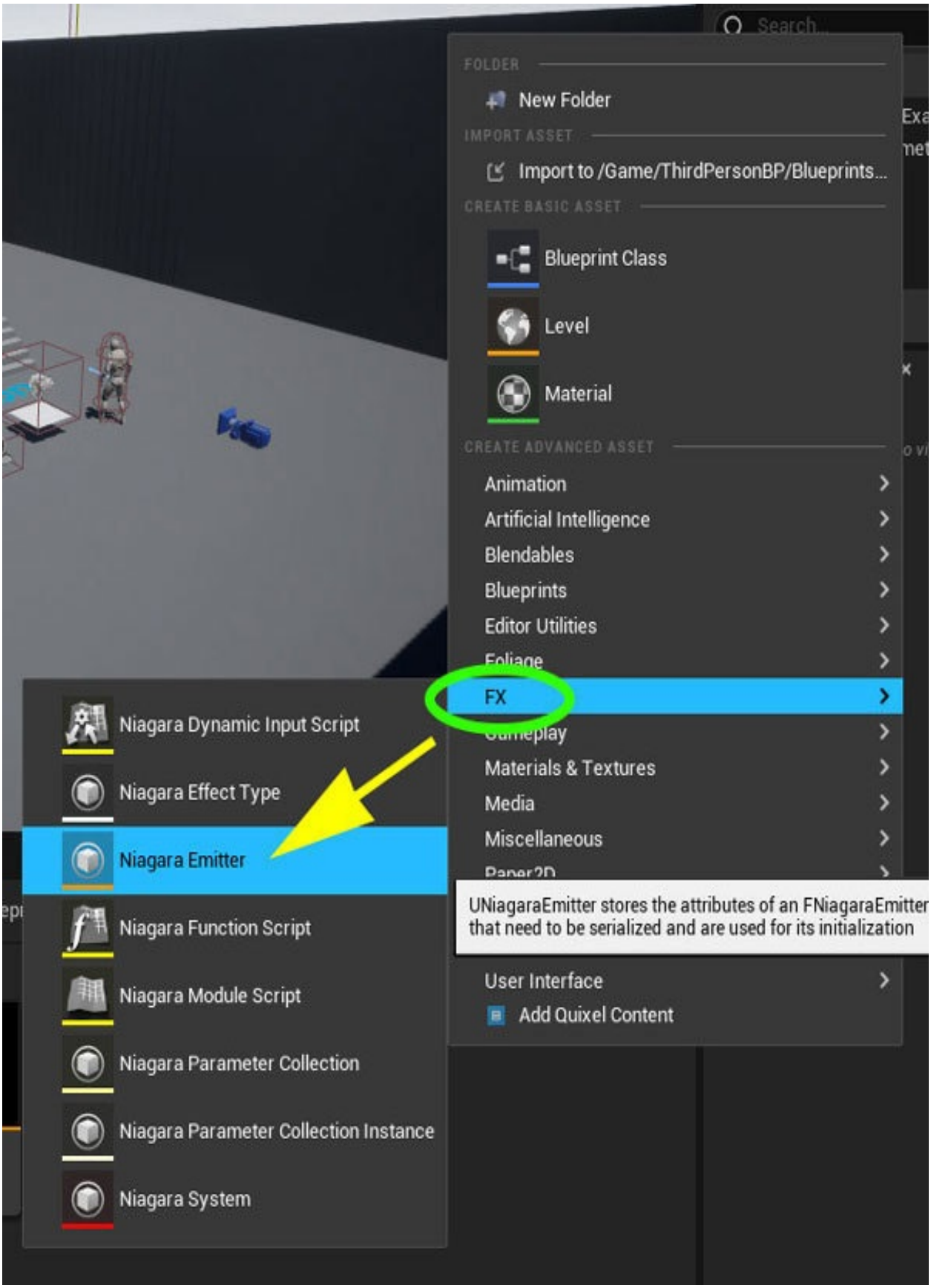

Search...
FOLDER
New Folder
IMPORT ASSET
Import to /Game/ThirdPersonBP/Blueprints...
CREATE BASIC ASSET
Blueprint Class
Level
Material
CREATE ADVANCED ASSET
Animation
Artificial Intelligence
Blendables
Blueprints
Editor Utilities
Foliage
FX
Gameplay
Materials & Textures
Media
Miscellaneous
Paper2D
UNiagaraEmitter stores the attributes of an FNiagaraEmitter that need to be serialized and are used for its initialization
User Interface
Add Quixel Content
Niagara Dynamic Input Script
Niagara Effect Type
Niagara Emitter
Niagara Function Script
Niagara Module Script
Niagara Parameter Collection
Niagara Parameter Collection Instance
Niagara System

Figure 11.1: Make new Niagara Emitter particle system object in content browser

The engine will ask the starting point of the emitter, as shown in Figure 11.2, select New emitter, and click on the Next button. The starting point of each emitter is designed to use other emitters when the user likes to combine them or customize previous ones as a new emitter:

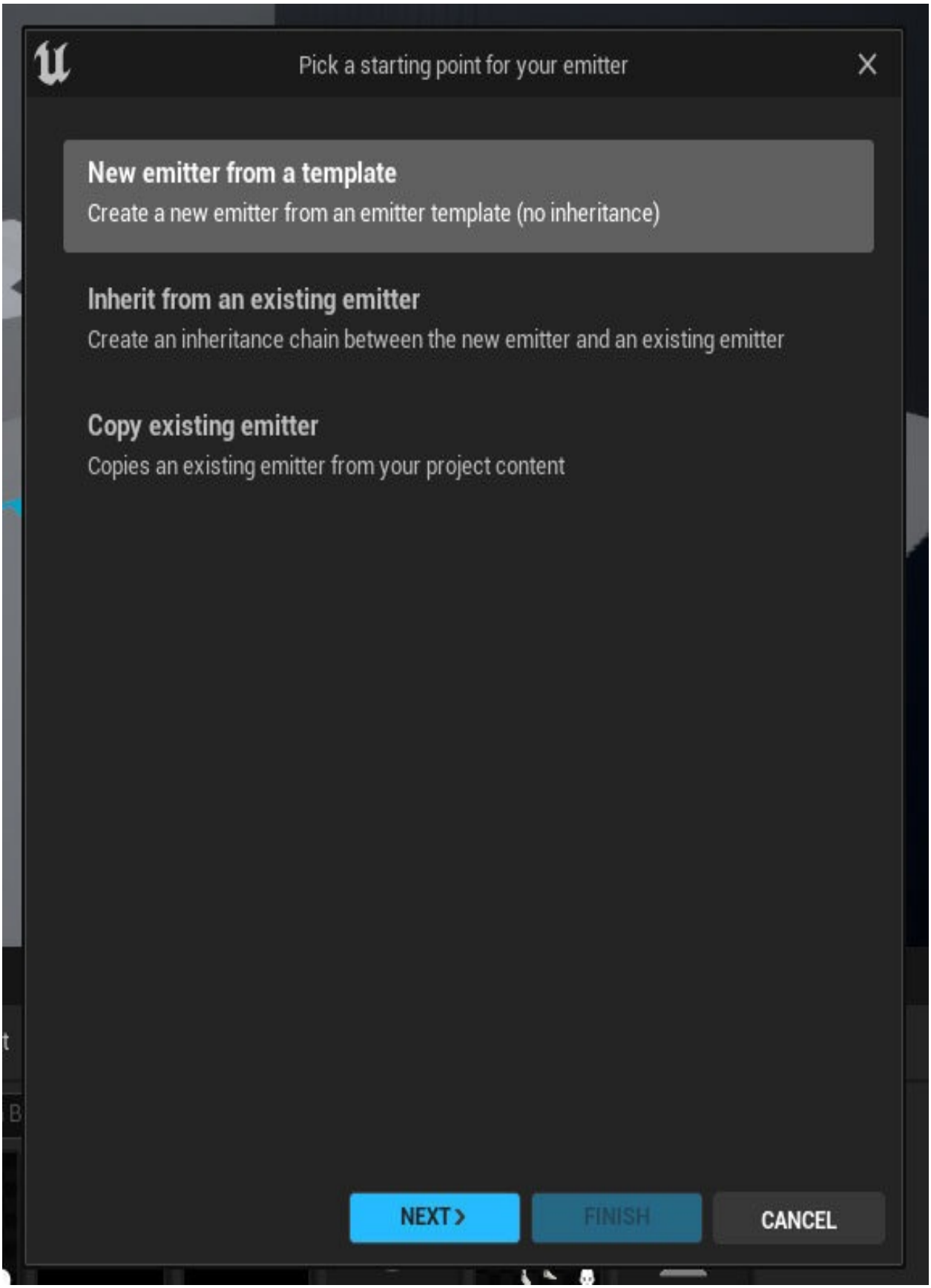

Pick a starting point for your emitter
New emitter from a template
Create a new emitter from an emitter template (no inheritance)
Inherit from an existing emitter
Create an inheritance chain between the new emitter and an existing emitter
Copy existing emitter
Copies an existing emitter from your project content
NEXT >
FINISH
CANCEL

Figure 11.2: Pick starting point windows

Now, we need to choose a template for the emitter. From the Templates tab, select the Empty template, as shown in Figure 11.3. The Empty template contains basic preferences for making a Niagara particle system. The other tabs are advanced topics, and we will not dig into them in this chapter. Click on the Finish button and then rename it to NE_01:

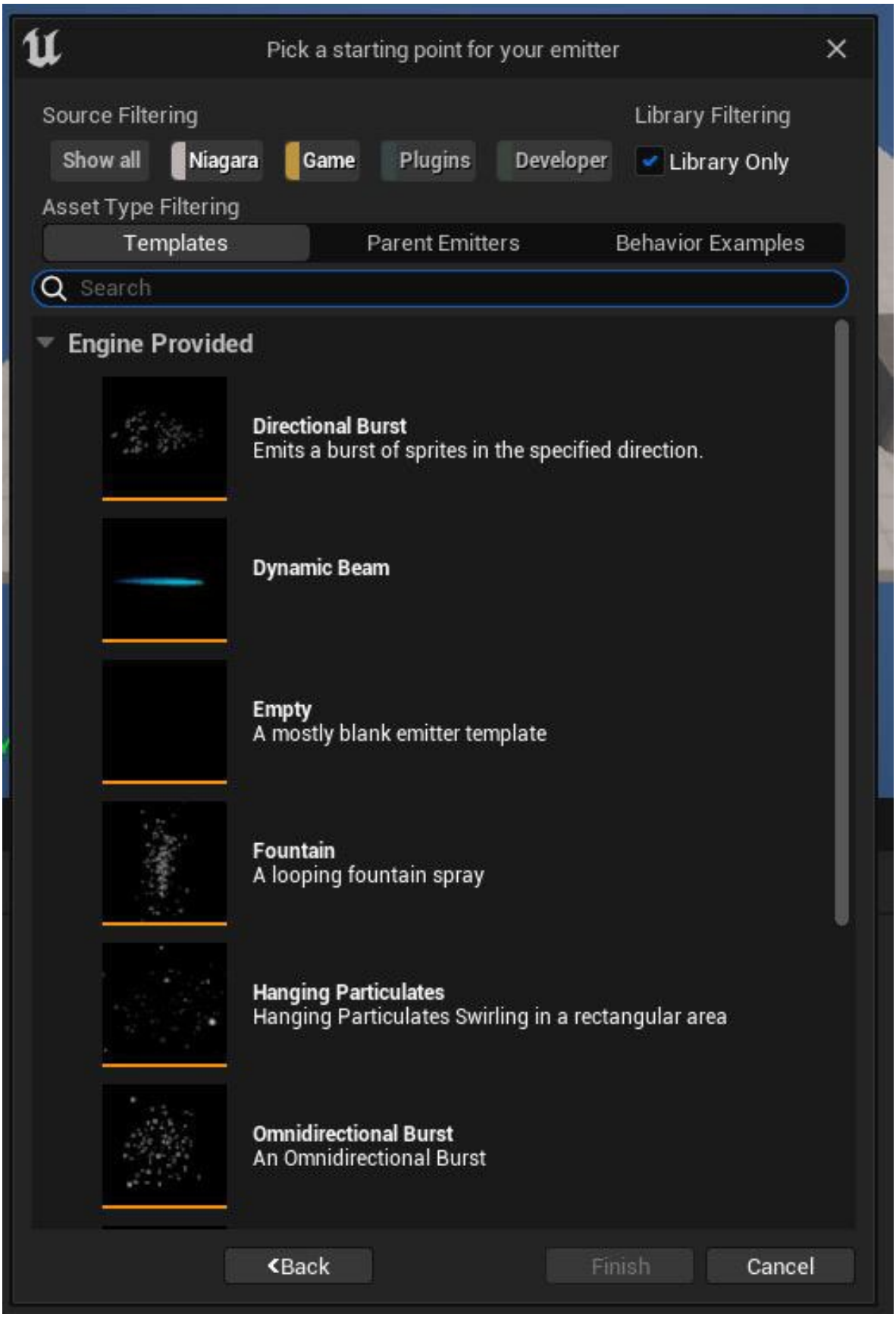

Pick a starting point for your emitter
Source Filtering
Library Filtering
Show all
Niagara
Game
Plugins
Developer
Library Only
Asset Type Filtering
Templates
Parent Emitters
Behavior Examples
Search
Engine Provided
Directional Burst
Emits a burst of sprites in the specified direction.
Dynamic Beam
Empty
A mostly blank emitter template
Fountain
A looping fountain spray
Hanging Particulates
Hanging Particulates Swirling in a rectangular area
Omnidirectional Burst
An Omnidirectional Burst
Back
Finish
Cancel

Figure 11.3: List of default templates of Niagara emitter

The next step is to customize the Niagara emitter. Double-click on NE_01 Niagara emitter, and the engine will navigate to Niagara editor, as shown in Figure 11.4. Locate the System Overview tab on top, and you will find an orange block named NE_01. This block, which is known as Niagara Overview Node, is responsible to run and render your particle system code (which is an infinite loop). We will go through a simple setup to simulate Rain effect by using it. The editor has a Preview tab that renders Niagara Overview Node in real time and is the output of the block. The Selection tab shows the properties of selected items in Niagara Overview Node:

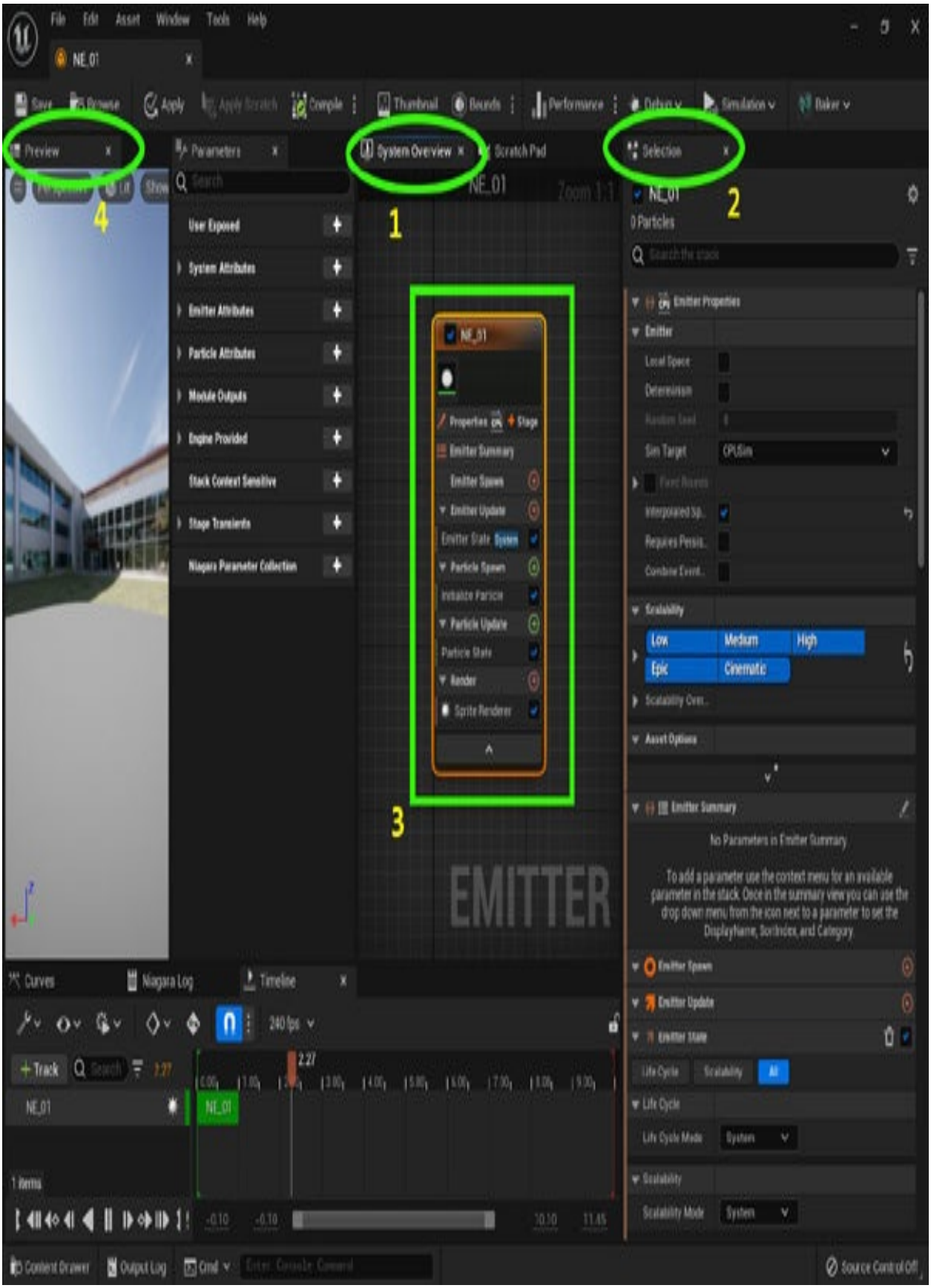

File Edit Asset Window Tools Help
NE_01
Save Browse Apply Apply Scratch Compile Thumbnail Bounds Performance Debug Simulation Baker
Preview
Parameters
System Overview
Scratch Pad
Selection
1
2
3
4
User Exposed
System Attributes
Emitter Attributes
Particle Attributes
Module Outputs
Engine Provided
Stack Context Sensitive
Stage Transients
Niagara Parameter Collection
NE_01
Properties
Stage
Emitter Summary
Emitter Spawn
Emitter Update
Emitter State
Particle Spawn
Particle Update
Particle State
Render
Sprite Renderer
EMITTER
0 Particles
Emitter Properties
Emitter
Local Space
Deterministic
Sim Target
CPUSim
Scalability
Low
Medium
High
Epic
Cinematic
Asset Options
Emitter Summary
No Parameters in Emitter Summary
To add a parameter use the context menu for an available parameter in the stack. Once in the summary view you can use the drop down menu from the icon next to a parameter to set the DisplayName, SortIndex, and Category.
Emitter Spawn
Emitter Update
Emitter State
Life Cycle
Life Cycle Mode
System
Scalability
Scalability Mode
System
Curves
Niagara Log
Timeline
240 fps
Track
NE_01
1 items
Content Drawer
Output Log
Cmd
Source Control Off

Figure 11.4: The Niagara editor 1- System Overview tab shows the "Niagara Overview Node" and its modules and renderers. 2- Selection tab is designed to show properties of each selected item in "Niagara Overview Node". 3- The actual "Niagara Overview Node" of "Empty" emitter template in Unreal Engine 5. 4- Preview tan renders the output of "Niagara Overview Node" in real-time.

The NE_01 node has a number of main procedures that are executed from top to down on each frame. Each procedure can run a number of functions known as Module, Renderer, and Event, which are codes and functions, designed to provide services, effects, and communications with other game objects. Let's begin with Emitter Update procedure, as shown in Figure 11.5. Click on the small circular icon, type spawn, and select the Spawn Rate module from the list:

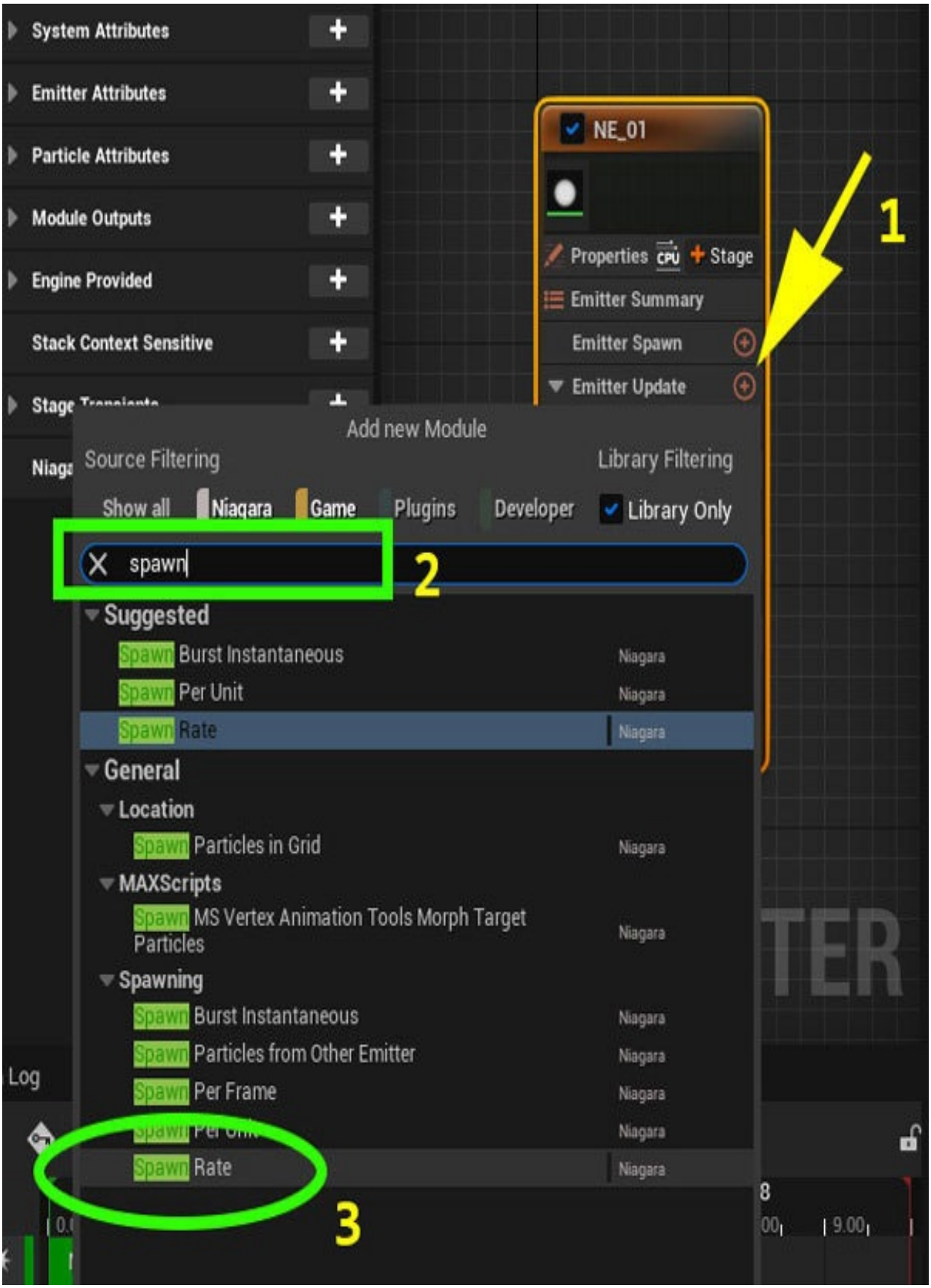

System Attributes
Emitter Attributes
Particle Attributes
Module Outputs
Engine Provided
Stack Context Sensitive
NE_01
Properties
Stage
Emitter Summary
Emitter Spawn
Emitter Update
1
Add new Module
Source Filtering
Library Filtering
Show all
Niagara
Game
Plugins
Developer
Library Only
spawn
2
Suggested
Spawn Burst Instantaneous
Spawn Per Unit
Spawn Rate
General
Location
Spawn Particles in Grid
MAXScripts
Spawn MS Vertex Animation Tools Morph Target Particles
Spawning
Spawn Burst Instantaneous
Spawn Particles from Other Emitter
Spawn Per Frame
Spawn Rate
Niagara
3
Log

Figure 11.5: First click on "Emitter Update" then: 1- Click on little circular icon. 2- Then immediately type "spawn", the engine automatically open and search for the keyword in a drop-down list of Niagara modules in the engine. 3- Select "Spawn Rate" module

The module will be added as the last module on this Emitter Update. Click on it and then change Spawn Rate to 64, as shown in Figure 11.6. The Previewtab immediately updates with the latest change in Niagara Overview Node. We customize the total number of a sprite image to 64 by using Spawn Rate:

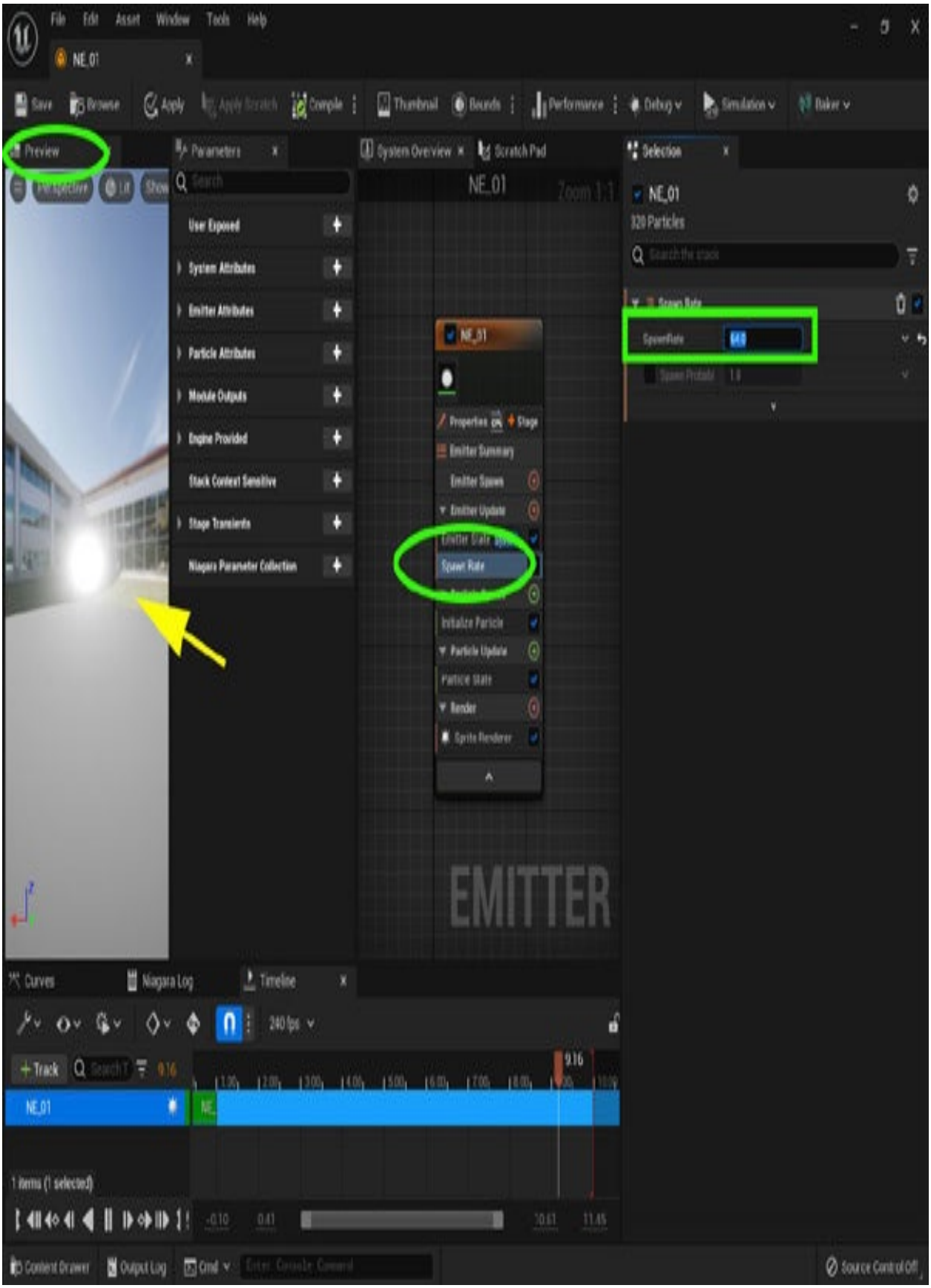

File Edit Asset Window Tools Help
NE_01
Save Browse Apply Apply Scratch Compile Thumbnail Bounds Performance Debug Simulation Baker
Preview
Parameters
System Overview
Scratch Pad
Selection
NE_01
320 Particles
User Exposed
System Attributes
Emitter Attributes
Particle Attributes
Module Outputs
Engine Provided
Stack Context Sensitive
Stage Transients
Niagara Parameter Collection
Properties
Stage
Emitter Summary
Emitter Spawn
Emitter Update
Spawn Rate
Initialize Particle
Particle Update
Particle State
Render
Sprite Renderer
EMITTER
Curves
Niagara Log
Timeline
Track
1 items (1 selected)
Content Drawer
Output Log
Cmd
Source Control Off

Figure 11.6: The "Spawn Rate" module will customize number of spawned instances in a Niagara emitter. In this image, 64 instances of a sprite object are spawned at the same location, so the preview tab shows a shiny spot.

Now, select Particle Spawn and then click on the small circular icon on it; then, type location and select Shape Location, as shown in Figure 11.7:

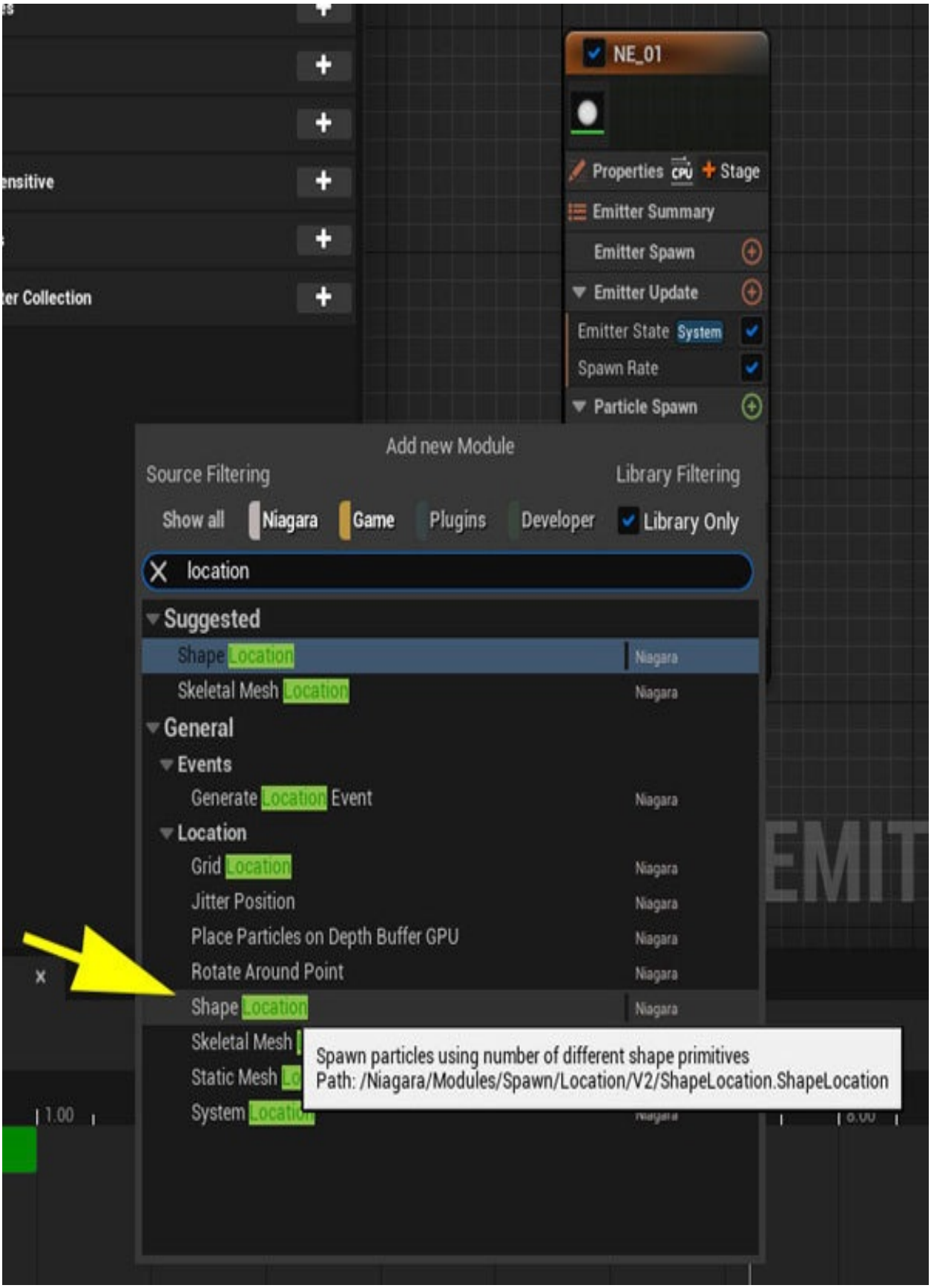

NE_01
Properties
CPU
Stage
Emitter Summary
Emitter Spawn
Emitter Update
Emitter State
System
Spawn Rate
Particle Spawn
Add new Module
Source Filtering
Library Filtering
Show all
Niagara
Game
Plugins
Developer
Library Only
location
Suggested
Shape Location
Niagara
Skeletal Mesh Location
Niagara
General
Events
Generate Location Event
Niagara
Location
Grid Location
Niagara
Jitter Position
Niagara
Place Particles on Depth Buffer GPU
Niagara
Rotate Around Point
Niagara
Shape Location
Niagara
Skeletal Mesh
Static Mesh
System
Spawn particles using number of different shape primitives
Path: /Niagara/Modules/Spawn/Location/V2/ShapeLocation.ShapeLocation
ensitive
er Collection
1.00

Figure 11.7: Remember the "Niagara Overview Node" executes each module form "Top" to "Down". The "Particle Spawn" has numbers of modules to set the location of spawned particle which are spawned by "Spawn Rate" module on top of them. Click on the little circular icon and immediately type "location" and select "Sphere location" from the list.

Then, the engine will immediately render 64 instances of a sprite image in a spherical 3D space in Preview tab, as shown in Figure 11.8. The Niagara particle system first runs Spawn Rate from Emitter Update, which spawn 64 instances of sprite to the scene; then, in the next step, relocate them by running Shape Location module from Particle Spawn, which results in rendering all sprite images in a spherical 3D coordination that you can see in the preview tab. Keep in mind that the execution order of modules is from top to down:

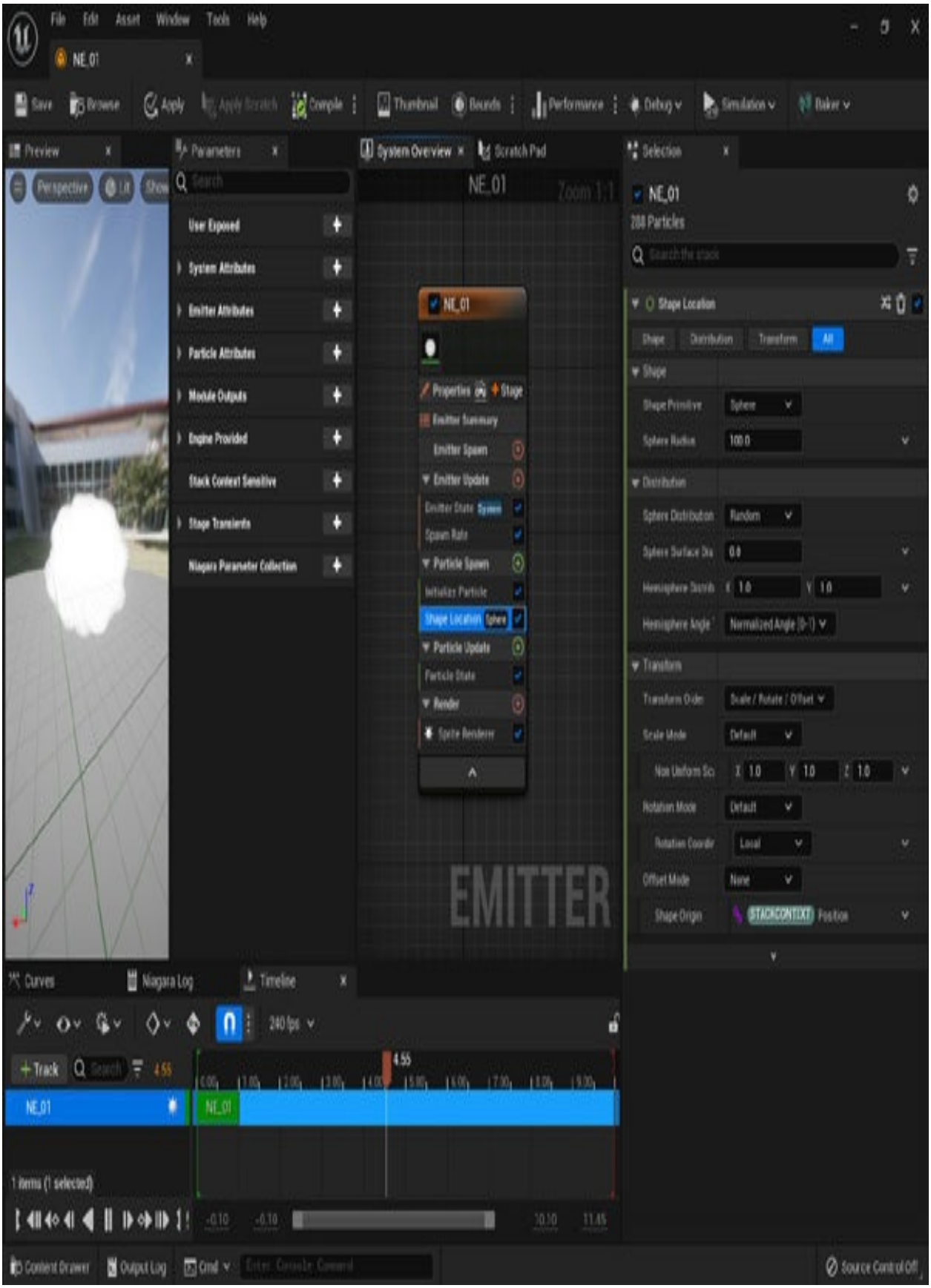

File Edit Asset Window Tools Help
NE_01
Save Browse Apply Apply Scratch Compile Thumbnail Bounds Performance Debug Simulation Baker
Preview
Parameters
System Overview
Scratch Pad
Selection
Perspective Lit Show
User Exposed
System Attributes
Emitter Attributes
Particle Attributes
Module Outputs
Engine Provided
Stack Context Sensitive
Stage Transients
Niagara Parameter Collection
NE_01
Zoom 1:1
Properties Stage
Emitter Summary
Emitter Spawn
Emitter Update
Emitter State Spawn
Spawn Rate
Particle Spawn
Initialize Particle
Shape Location Sphere
Particle Update
Particle State
Render
Sprite Renderer
EMITTER
NE_01
288 Particles
Shape Location
Shape Distribution Transform All
Shape
Shape Primitive Sphere
Sphere Radius 100.0
Distribution
Sphere Distribution Random
Sphere Surface Dis 0.0
Hemisphere Distrib X 1.0 Y 1.0
Hemisphere Angle Normalized Angle [0-1]
Transform
Transform Order Scale / Rotate / Offset
Scale Mode Default
Non Uniform Sc X 1.0 Y 1.0 Z 1.0
Rotation Mode Default
Rotation Coordin Local
Offset Mode None
Shape Origin STACKCONTEXT Position
Curves
Niagara Log
Timeline
240 fps
Track
4.55
NE_01
NE_01
1 items (1 selected)
Content Drawer
Output Log
Cmd
Enter Console Command
Source Control Off

Figure 11.8: A simple Niagara emitter with spherical location in preview tab

Now, let’s make it move like rain. There are a number of methods here to move these sprites. Let’s try gravity force, by following these steps:

Click on Particle Update, which has a small circular icon.

Type gravity and select the Gravity Force module from the list.

Niagara may pop-up an error message, as shown in Figure 11.9.

Press Fix issue and the engine will fix the conflict. (This option works for a majority of the issues on making simple emitters in Niagara.):

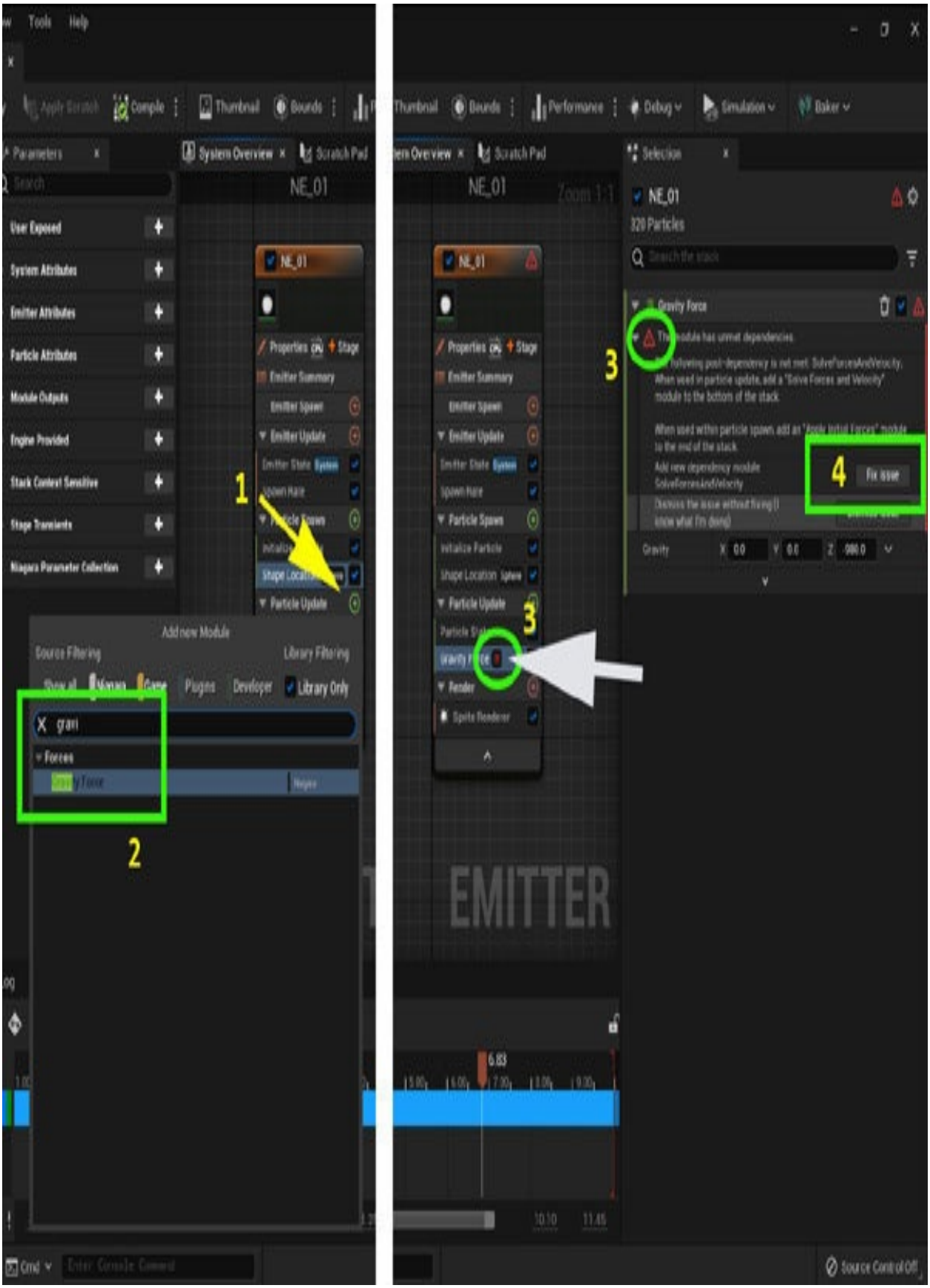

Tools
Help
Compile
Thumbnail
Bounds
Performance
Debug
Simulation
Baker
Parameters
System Overview
Scratch Pad
Selection
NE_01
User Exposed
System Attributes
Emitter Attributes
Particle Attributes
Module Outputs
Engine Provided
Stack Context Sensitive
Stage Transients
Niagara Parameter Collection
Properties
Stage
Emitter Summary
Emitter Spawn
Emitter Update
Particle Spawn
Particle Update
Render
Sprite Renderer
Add new Module
Source Filtering
Library Filtering
Plugins
Developer
Library Only
grav
Forces
Gravity Force
320 Particles
Fix issue
Gravity
EMITTER
1
2
3
4

Figure 11.9: Sometimes when you add a module in Niagara, an error message comes up. In this example, we like to add Gravity Force module to the NS_01 emitter.

After fixing the issue, select the Gravity Force module and check the Selection tab. The engine automatically assigns -980 on Z-axis as gravity value, which matches with earth gravity in the real world, and the result is falling sprites (like snow) in the Preview tab, as shown in Figure 11.10:

Preview
Perspective
Lit
Show
Particle Counts
204 Current, 323 Max (est.) - [NE_01] [A
Z
X
Y

Figure 11.10: Falling effect on sprites by using Gravity Force module

The final step is making this particle system visually similar to actual rain in nature. Click on and select Initialize Particle from Particle Spawn and change the SpriteSize property to Non-Uniform and change the value of X and Y to 4 and 54, as shown in Figure 11.11:

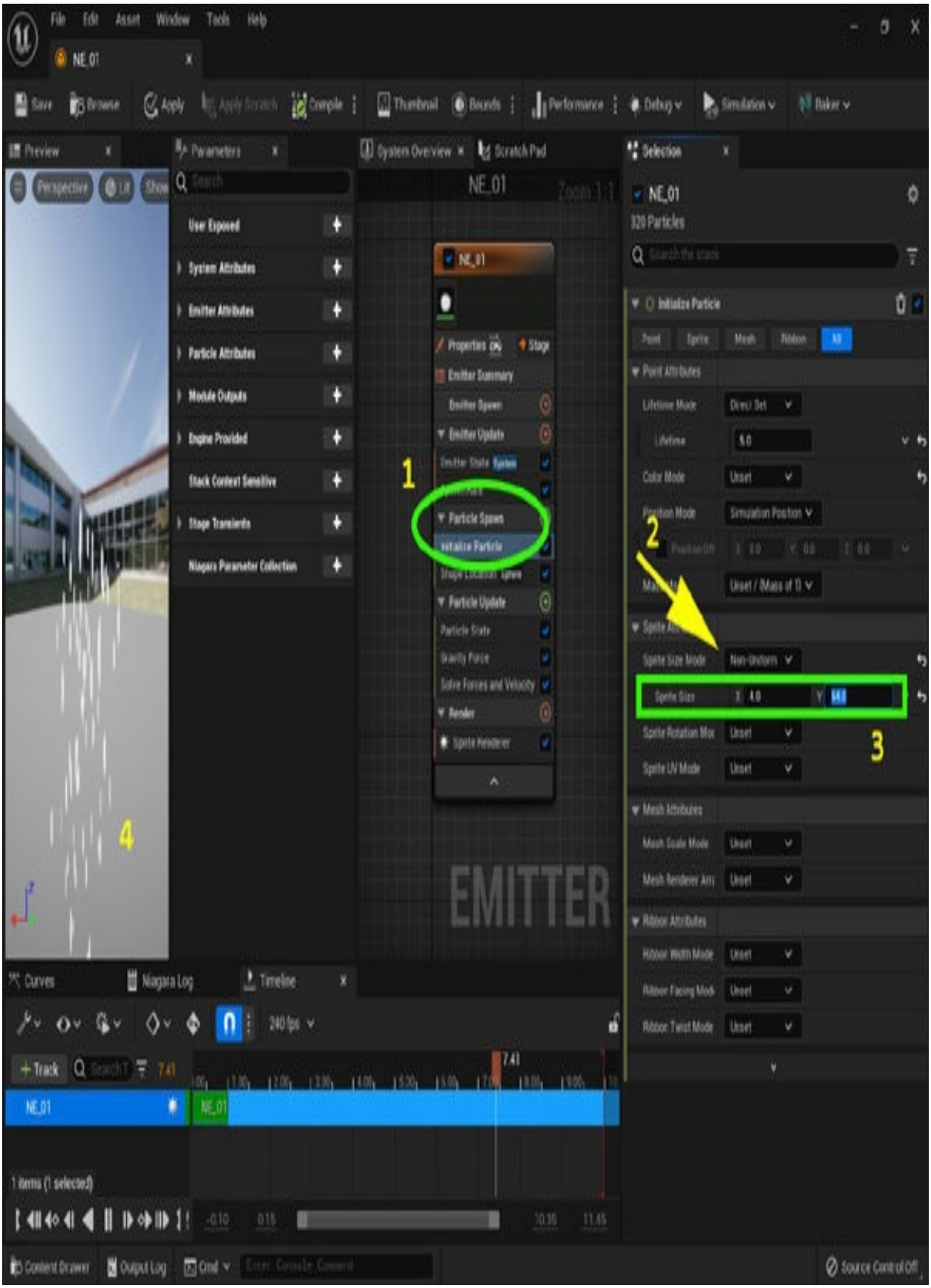
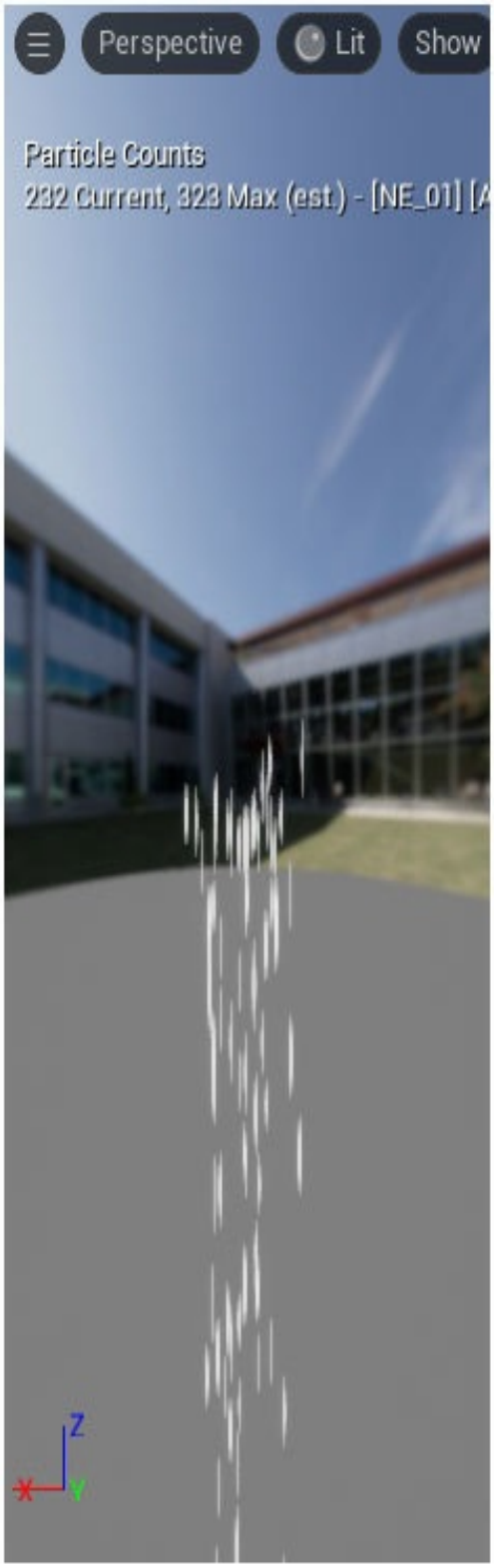
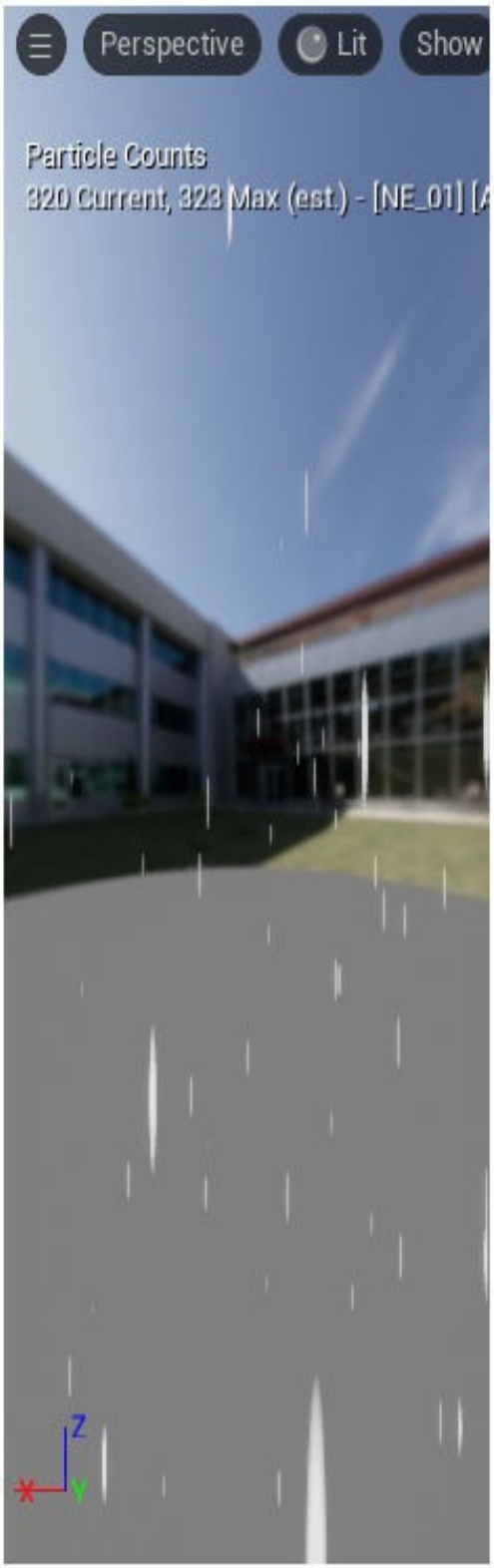

File Edit Asset Window Tools Help
NE_01
Save Browse Apply Apply Scratch Compile Thumbnail Bounds Performance Debug Simulation Baker
Preview
Parameters
System Overview
Scratch Pad
Selection
Perspective Lit Show
User Exposed
System Attributes
Emitter Attributes
Particle Attributes
Module Outputs
Engine Provided
Stack Context Sensitive
Stage Transients
Niagara Parameter Collection
NE_01
Zoom 1:1
Properties
Stage
Emitter Summary
Emitter Spawn
Emitter Update
Particle Spawn
Initialize Particle
Particle Update
Particle State
Gravity Force
Solve Forces and Velocity
Render
Sprite Renderer
1
2
3
4
EMITTER
NE_01
320 Particles
Initialize Particle
Point Sprite Mesh Ribbon All
Point Attributes
Lifetime Mode
Lifetime
Color Mode
Position Mode
Simulation Position
Sprite Size Mode
Non-Uniform
Sprite Size
Sprite Rotation Mode
Sprite UV Mode
Mesh Attributes
Mesh Scale Mode
Mesh Renderer Arrs
Ribbon Attributes
Ribbon Width Mode
Ribbon Facing Mode
Ribbon Twist Mode
Curves
Niagara Log
Timeline
240 fps
Track
NE_01
1 items (1 selected)
Content Drawer
Output Log
Cmd
Source Control Off

Figure 11.11: Change particle shape to rain's drop. 1- Select Initialize Particle. 2-Locate Sprite Size Mode property in Selection tab and change it from "Unset" to "Non-Uniform". In general, "Non-Uniform "option allows users to customize values in the selected property. 3- Change dimensions of sprite by using Sprite Size property. 4- The engine automatically updates the result with your change in Preview tab.

Now, select Sphere Location from Particle Spawn and change Sphere Radius to 512. This way, you can increase the size of the sphere that the particles are spawned in. The result will look like light rain. Now, change it to 64 and the result looks different, which we like to use further in a blueprint actor. Figure 11.12 shows the visual differences of using these values:



Sphere Radius 64.0



Sphere Radius 512.0

Figure 11.12: Different values on Sphere Radios property which is part of Sphere Location in Particle Spawn

Don’t forget to compile and save your emitter after any change (otherwise, you may experience unusual behavior in particle, especially when there are large number of modules involved in making particle).

Making Niagara system

At this level, we just made a simple Niagara emitter to simulate rain effect. To use this emitter inside game, we will make a Niagara System and add our Niagara Emitter to it, as shown in Figure 11.13:

Right-click in the Content browser and select Niagara System from FX:

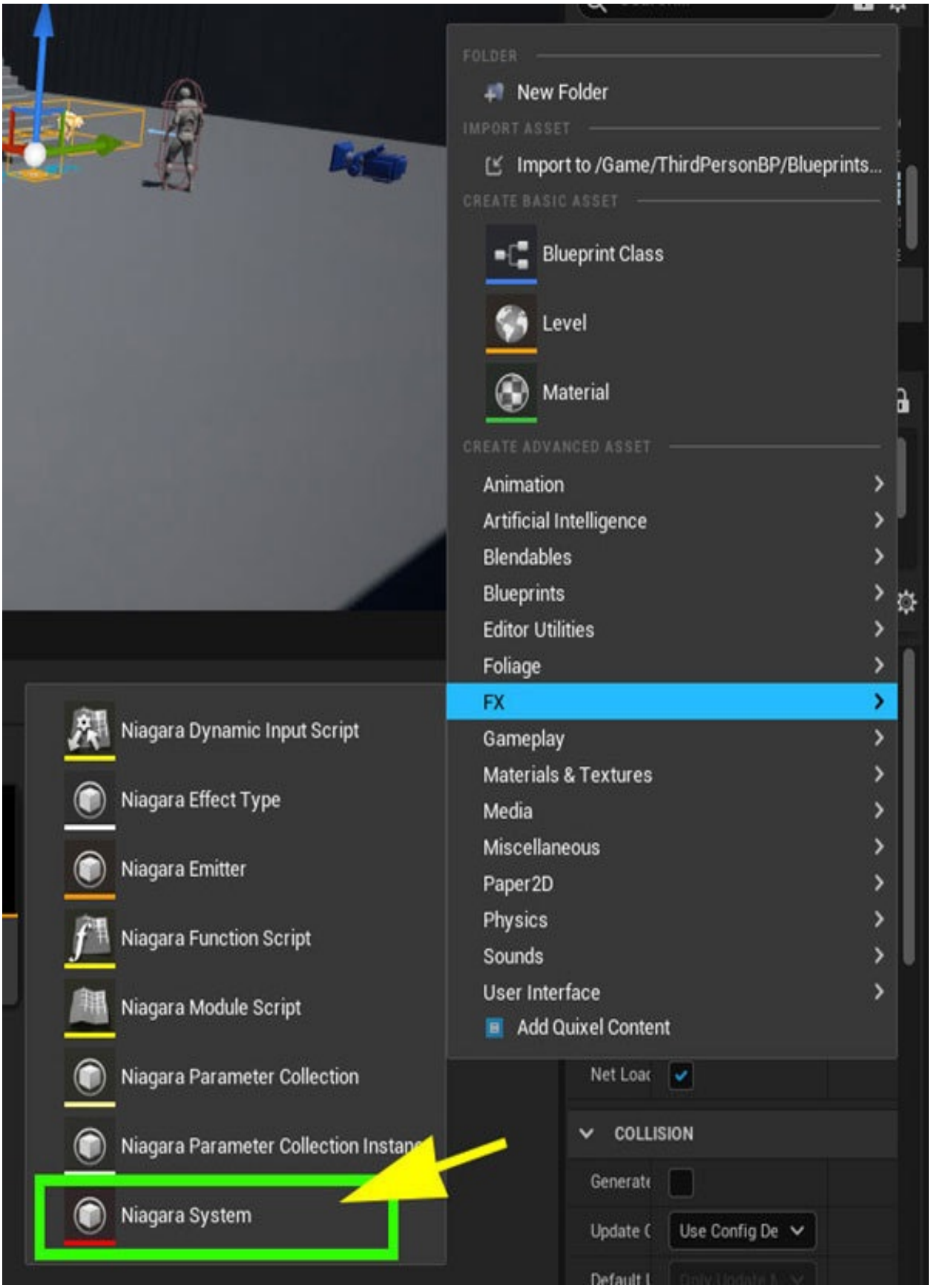

FOLDER
New Folder
IMPORT ASSET
Import to /Game/ThirdPersonBP/Blueprints...
CREATE BASIC ASSET
Blueprint Class
Level
Material
CREATE ADVANCED ASSET
Animation
Artificial Intelligence
Blendables
Blueprints
Editor Utilities
Foliage
FX
Gameplay
Materials & Textures
Media
Miscellaneous
Paper2D
Physics
Sounds
User Interface
Add Quixel Content
Niagara Dynamic Input Script
Niagara Effect Type
Niagara Emitter
Niagara Function Script
Niagara Module Script
Niagara Parameter Collection
Niagara System
COLLISION
Use Config De

Figure 11.13: Create Niagara System from FX menu

The engine automatically opens a dialog box, as shown in Figure 11.14; select New systemfrom selected emitter(s) and press Next:

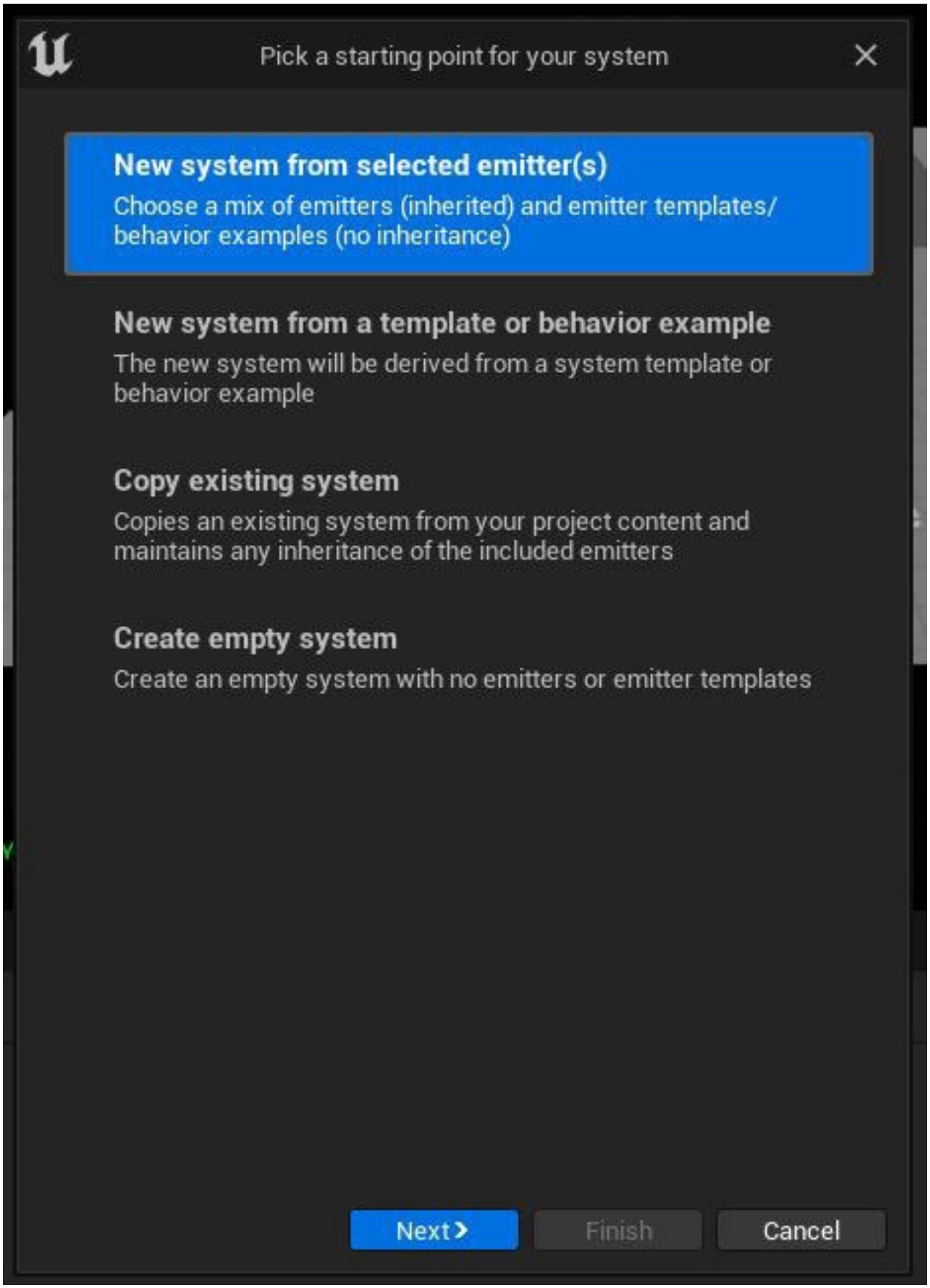
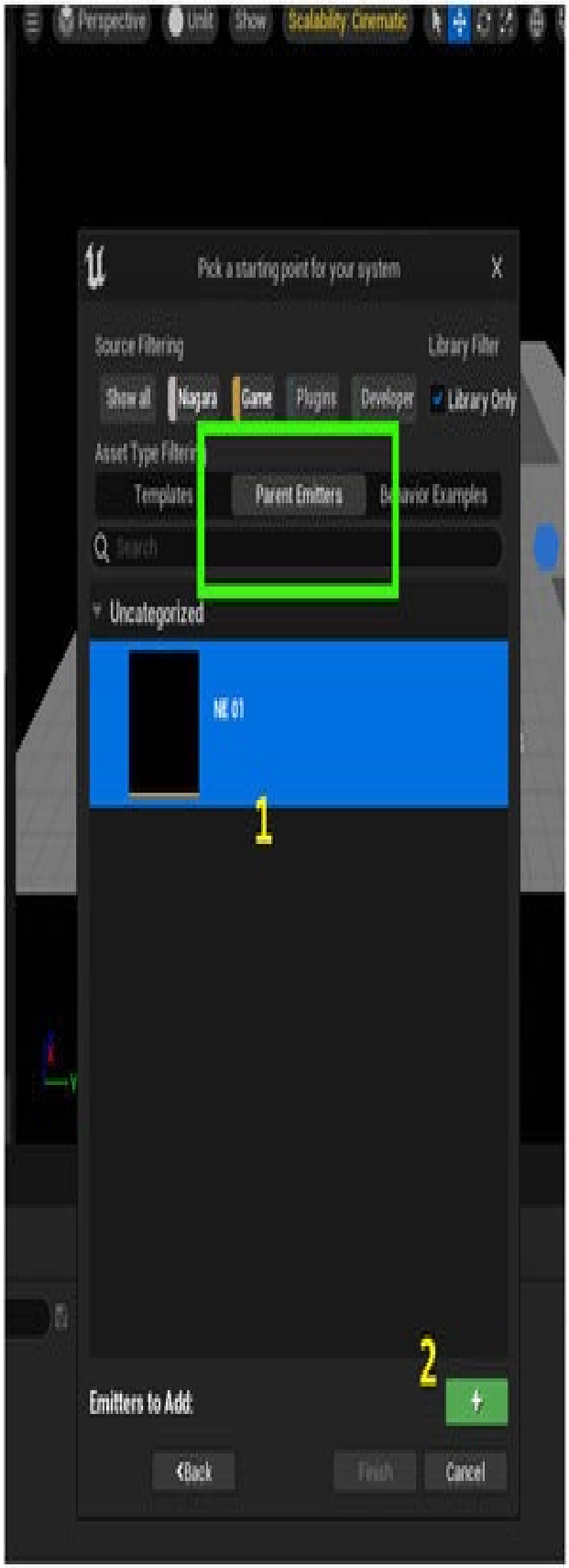

Pick a starting point for your system
New system from selected emitter(s)
Choose a mix of emitters (inherited) and emitter templates/ behavior examples (no inheritance)
New system from a template or behavior example
The new system will be derived from a system template or behavior example
Copy existing system
Copies an existing system from your project content and maintains any inheritance of the included emitters
Create empty system
Create an empty system with no emitters or emitter templates
Next
Finish
Cancel

Figure 11.14: Select starting point windows for Niagara System. Like Niagara Emitter, users are allowed to use previous systems to make custom systems or create new one.

On the next page, first locate and select NE_01 from the Parent Emitters panel, and then click on the + button, as shown in Figure 11.15. This way, the engine will add the NE_01 emitter to our Niagara System and will update it on each frame. Next, click on the Finish button and rename the new Niagara System as NS_01.


Perspective
Unlit
Show
Scalability Cinematic
Pick a starting point for your system
X
Source Filtering
Library Filter
Show all
Niagara
Game
Plugins
Developer
Library Only
Asset Type Filtering
Templates
Parent Emitters
Behavior Examples
Search
Uncategorized
NE 01
1
2
Emitters to Add:
+
<Back
Finish
Cancel

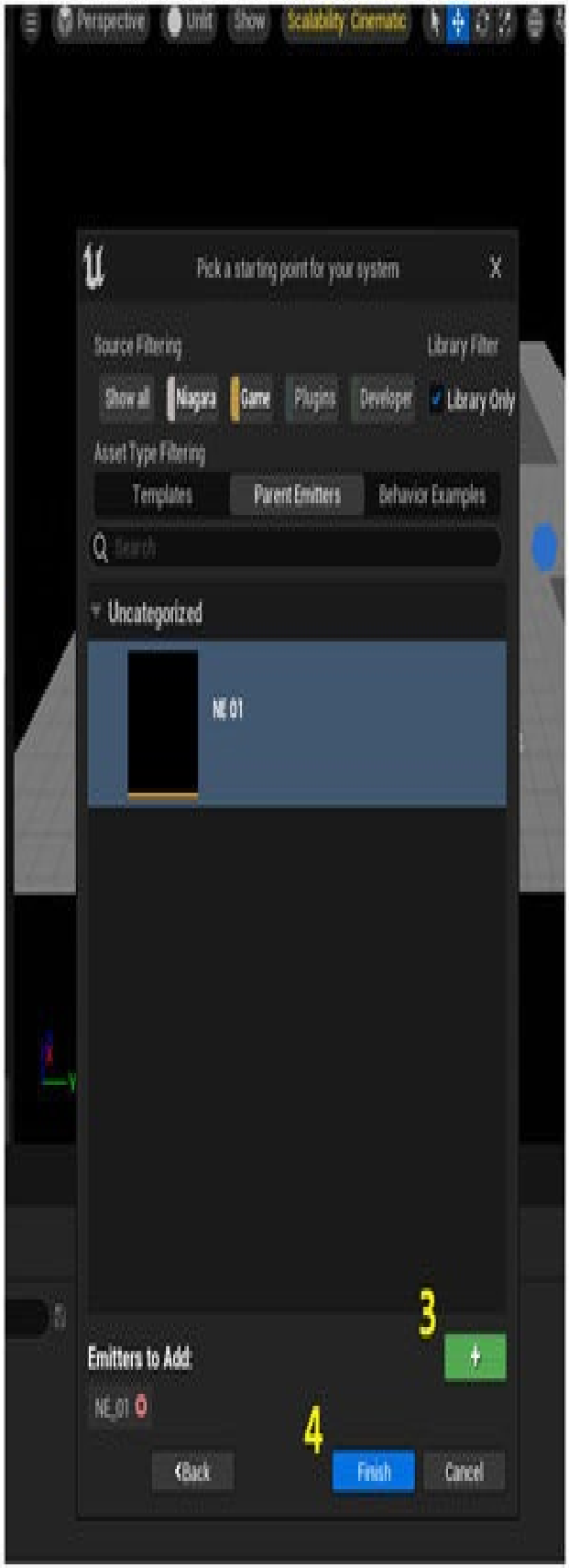

Perspective
Unlit
Show
Scalability Cinematic
Pick a starting point for your system
X
Source Filtering
Library Filter
Show all
Niagara
Game
Plugins
Developer
Library Only
Asset Type Filtering
Templates
Parent Emitters
Behavior Examples
Search
Uncategorized
NE 01
3
Emitters to Add:
+
NE_01
4
<Back
Finish
Cancel

Figure 11.15: To add Niagara Emitter template to Niagara System. 1- Select a Niagara Emitter template from the list in Parent Emitters panel. 2-Press + button. 3- The name of template should appear under "Emitters to Add:" title, then press Finish button

Double-click on the NS_01 Niagara system and the engine will automatically open its editor, as shown in Figure 11.16. In the editor, there is the NE_01Niagara Overview node, which can get activated or deactivated by using the top-left tick box. Indeed, here we have a new box, which is responsible for managing dynamic features of this particle system. This box is always active, and you can't switch it off like the Niagara Overview node. We will discuss this box, but let's add this particle system to the stage first:

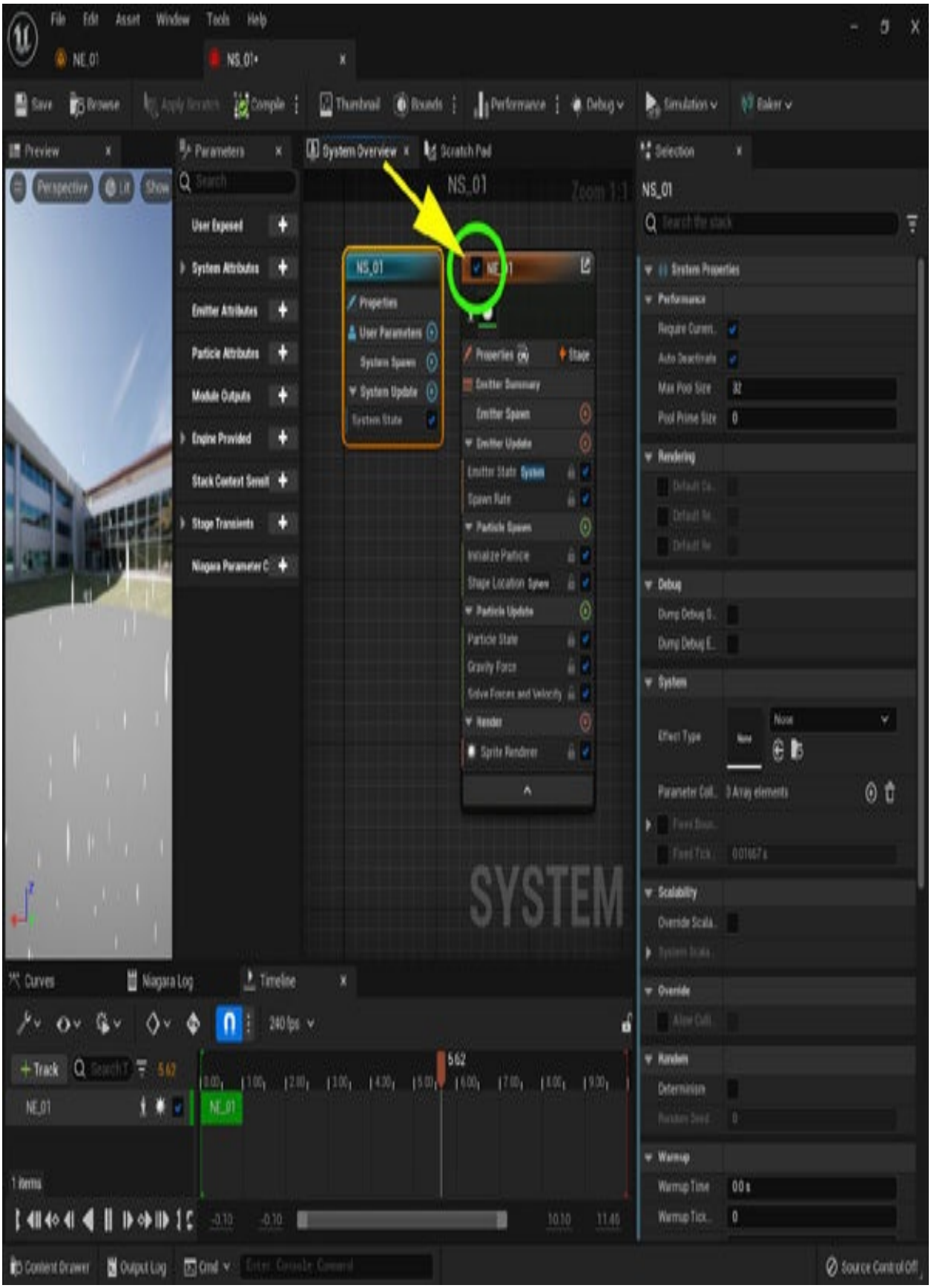

File Edit Asset Window Tools Help
NE_01
NS_01*
Save
Browse
Compile
Thumbnail
Bounds
Performance
Debug
Simulation
Baker
Preview
Perspective
Lit
Parameters
User Exposed
System Attributes
Emitter Attributes
Particle Attributes
Module Outputs
Engine Provided
Stack Context Scratch
Stage Transients
System Overview
Scratch Pad
NS_01
Properties
User Parameters
System Spawn
System Update
System State
Emitter Summary
Emitter Spawn
Emitter Update
Spawn Rate
Particle Spawn
Initialize Particle
Particle Update
Particle State
Gravity Force
Solve Forces and Velocity
Render
Sprite Renderer
SYSTEM
Selection
System Properties
Performance
Max Pool Size
Pool Prime Size
Rendering
Debug
System
Effect Type
Scalability
Override
Random
Determinism
Warmup
Warmup Time
Warmup Tick
Curves
Niagara Log
Timeline
240 fps
Track
NE_01
1 items
Content Drawer
Output Log
Cmd
Source Control Off

Figure 11.16: The Niagara System editor; each emitter has a tick box for activation

Referring to the previous chapters, make an actor blueprint called BP_01 that has two collision boxes. Each collision box is parent of a Plane static mesh component and a billboard component and is assigned to an overlapped event, as shown in Figure 11.17:

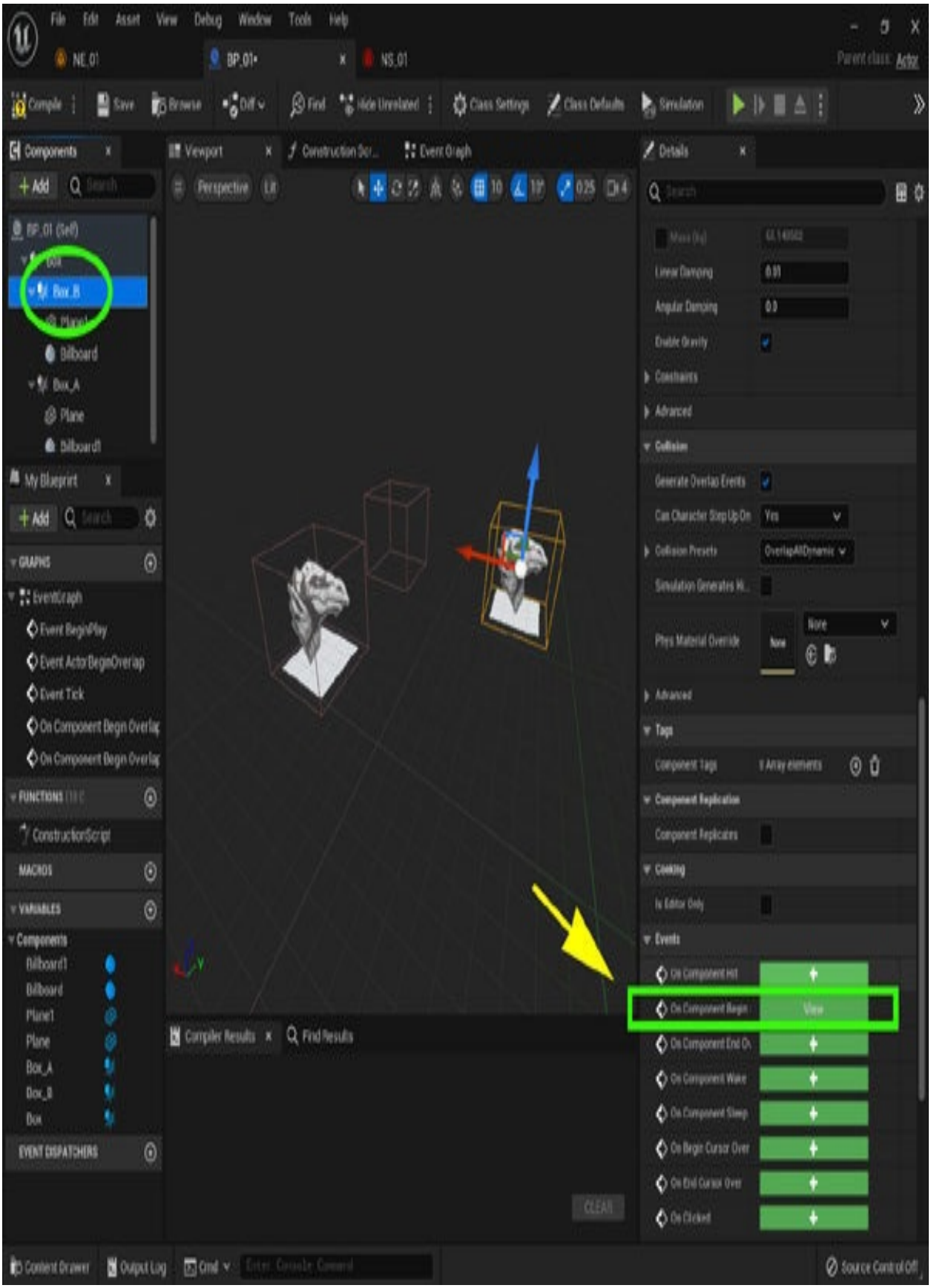

File
Edit
Asset
View
Debug
Window
Tools
Help
NE_01
BP_01*
NS_01
Parent class: Actor
Compile
Save
Browse
Diff
Find
Hide Unrelated
Class Settings
Class Defaults
Simulation
Components
Add
BP_01 (Self)
Box
Box_B
Plane1
Billboard
Box_A
Plane
Billboard1
My Blueprint
GRAPHS
EventGraph
Event BeginPlay
Event ActorBeginOverlap
Event Tick
FUNCTIONS
ConstructionScript
MACROS
VARIABLES
Components
Billboard1
Billboard
Plane1
Plane
Box_A
Box_B
Box
EVENT DISPATCHERS
Viewport
Perspective
Lit
Construction Scr...
Event Graph
Compiler Results
Find Results
CLEAR
Details
Mass (kg)
Linear Damping
Angular Damping
Enable Gravity
Constraints
Advanced
Collision
Generate Overlap Events
Can Character Step Up On
Yes
Collision Presets
OverlapAllDynamic
Simulation Generates Hi...
Phys Material Override
None
Advanced
Tags
Component Tags
1 Array elements
Component Replication
Component Replicates
Cooking
Is Editor Only
Events
On Component Hit
On Component Begin
View
On Component End Ov
On Component Wake
On Component Sleep
On Begin Cursor Over
On End Cursor Over
On Clicked
Content Drawer
Output Log
Cmd
Enter Console Command
Source Control Off

Figure 11.17: An actor blueprint with 2 collision boxes; each event has assigned for overlapping

Now, add a Niagara Particle System blueprint component to the root of your actor, as shown in Figure 11.18, and then assign NS_01 to it. The component begins to play the particle system in the editor's Viewport tab:

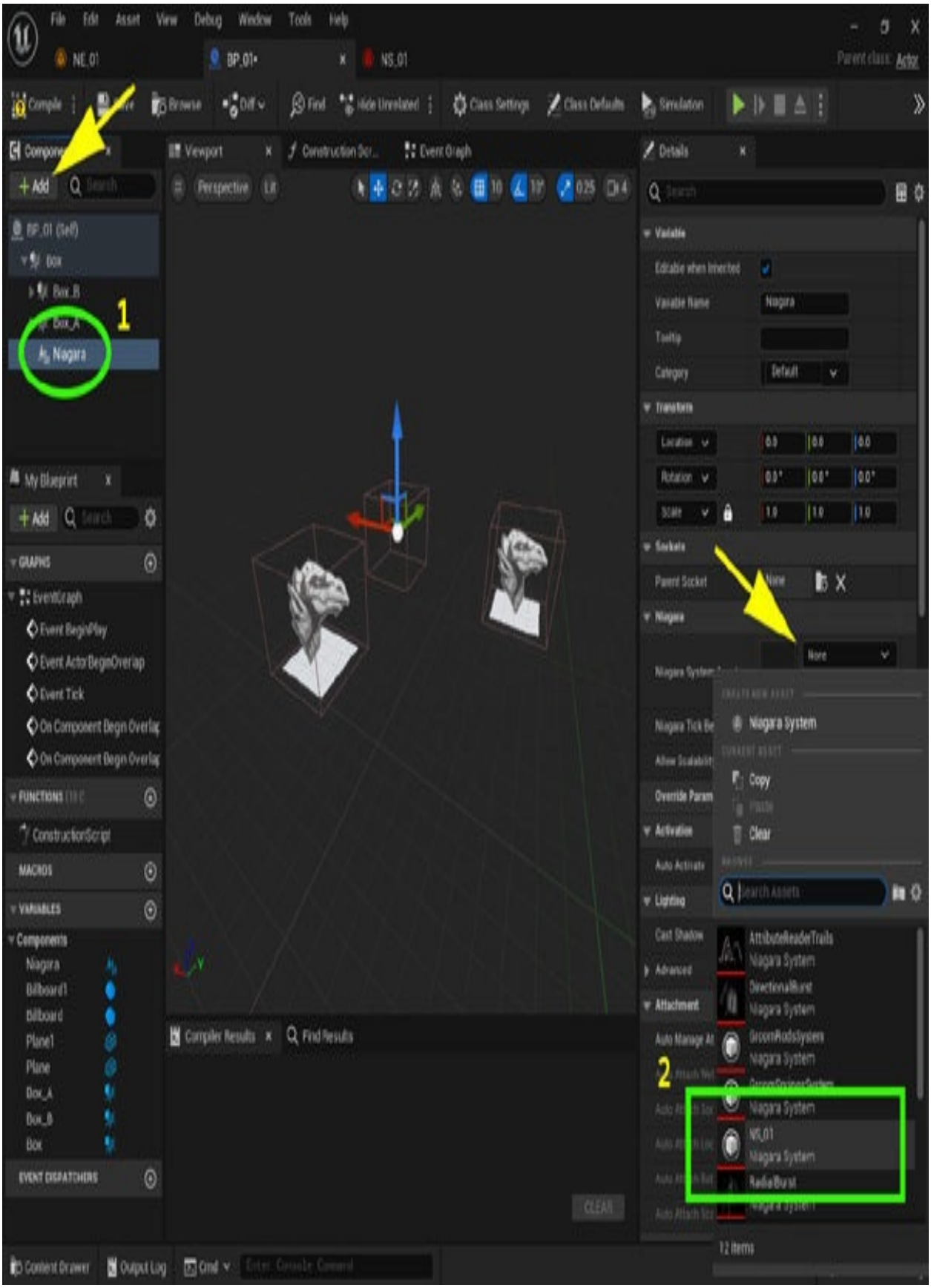

File Edit Asset View Debug Window Tools Help
NE_01
BP_01*
NS_01
Parent class: Actor
Compile
Save
Browse
Diff
Find
Hide Unrelated
Class Settings
Class Defaults
Simulation
Components
Add
Search
BP_01 (Self)
Box
Box_B
Box_A
Niagara
1
Viewport
Construction Scr...
Event Graph
Perspective
Lit
Details
Variable
Editable when Inherited
Variable Name
Niagara
Tooltip
Category
Default
Transform
Location
Rotation
Scale
Sockets
Parent Socket
None
Niagara
None
Niagara System
Copy
Paste
Clear
Search Assets
My Blueprint
GRAPHS
EventGraph
Event BeginPlay
Event ActorBeginOverlap
Event Tick
FUNCTIONS
ConstructionScript
MACROS
VARIABLES
Components
Niagara
Billboard1
Billboard
Plane1
Plane
Box_A
Box_B
Box
EVENT DISPATCHERS
Compiler Results
Find Results
CLEAR
Lighting
Cast Shadow
Advanced
Attachment
Auto Manage Attachment
2
AttributeReaderTrails
Niagara System
DirectionalBurst
Niagara System
GroomRodsSystem
Niagara System
Niagara System
NS_01
Niagara System
RadialBurst
12 items
Content Drawer
Output Log
Cmd
Enter Console Command

Figure 11.18: Click on the ADD button and select Niagara Particle System blueprint component from the drop-down list

Select the component you add, then locate Niagara System Asset property in Details panel, click on drop down menu and select “NS_01”

Now, imagine that we want to switch the location of this particle to collision boxes (in the BP_01 actor) when we collide with them. For doing this, we must make a Parameter inside the Niagara System and use it as a location of our particle system. It sounds complicated, but Unreal Engine makes this very simple. First, open the NS_01 editor by double-clicking on it and select Sphere Location in the NE_01 box. As you see in selection tab, this module has a property known as Sphere Origin, as shown in Figure 11.19. This is a vector type property and will determine the location in which the Sphere Location module spawned the emitters:

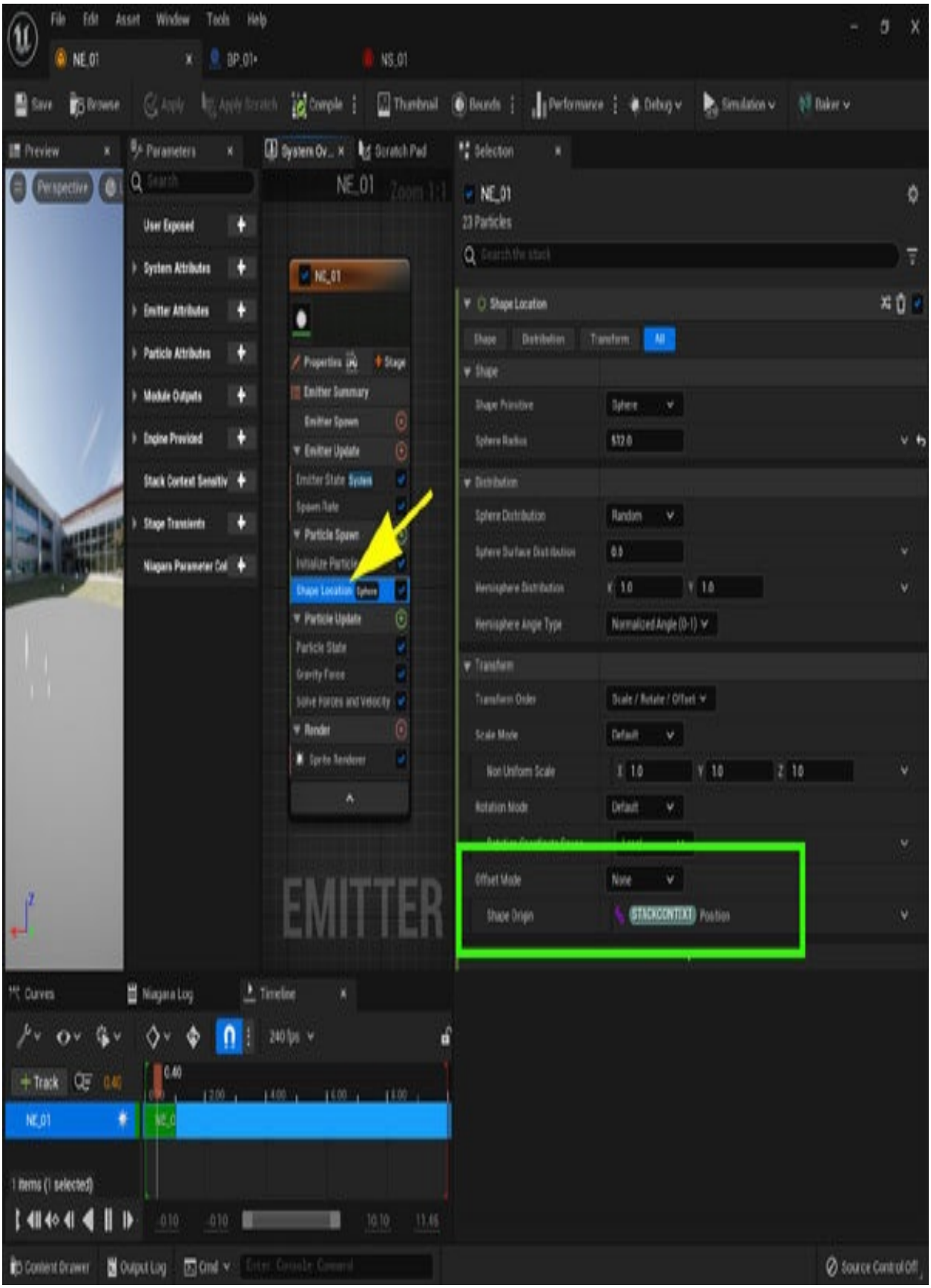

File Edit Asset Window Tools Help
NE_01
DP_01*
NS_01
Save
Browse
Apply
Apply Scratch
Compile
Thumbnail
Bounds
Performance
Debug
Simulation
Baker
Preview
Perspective
Parameters
Search
User Exposed
System Attributes
Emitter Attributes
Particle Attributes
Module Outputs
Engine Provided
Stack Context Sensitiv
Stage Transients
Niagara Parameter Col
System Ov...
Scratch Pad
NE_01
Zoom 1:1
Properties
Stage
Emitter Summary
Emitter Spawn
Emitter Update
Emitter State
System
Spawn Rate
Particle Spawn
Initialize Particle
Shape Location
Sphere
Particle Update
Particle State
Gravity Force
Solve Forces and Velocity
Render
Sprite Renderer
EMITTER
Selection
NE_01
23 Particles
Search the stack
Shape Location
Shape
Distribution
Transform
All
Shape
Shape Primitive
Sphere
Sphere Radius
512.0
Distribution
Sphere Distribution
Random
Sphere Surface Distribution
0.0
Hemisphere Distribution
X 1.0
Y 1.0
Hemisphere Angle Type
Normalized Angle (0-1)
Transform
Transform Order
Scale / Rotate / Offset
Scale Mode
Default
Non Uniform Scale
X 1.0
Y 1.0
Z 1.0
Rotation Mode
Default
Offset Mode
None
Shape Origin
STACKCONTEXT
Position
Curves
Niagara Log
Timeline
240 fps
Track
0.40
NE_01
1 items (1 selected)
Content Drawer
Output Log
Cmd
Enter Console Command
Source Control Off

Figure 11.19: Click on Sphere Location module in Particle Spawn, and locate Sphere Origin in the Selection tab

We want to access this property from the blueprint BP_01 in game and change it to control the location of emitter. For making this functionality, we must make and assign a parameter to this Niagara system and then control it from the BP_01 actor blueprint. Click on the + button from the User Exposed dropdown box. Here, we need to make our parameter, so choose a Vector parameter from the Common category and name it SPLocation. Then, select Shape Location particle spawn procedure, click on the arrow icon in Shape Origin, and type convert. Now, select Convert Vector to Position from the Dynamic Inputs category. This function will add two parameters to your Shape Origin property. The Input Position property defines the received vector value to this function, so we need to connect it to our SPLocation parameterm which is also a vector. To do this, click on the little arrow and type user; as you see in Figure 11.20, your parameter name will appear in the list, and by selecting it, this user defined parameter will be directly connected to the Niagara emitter:

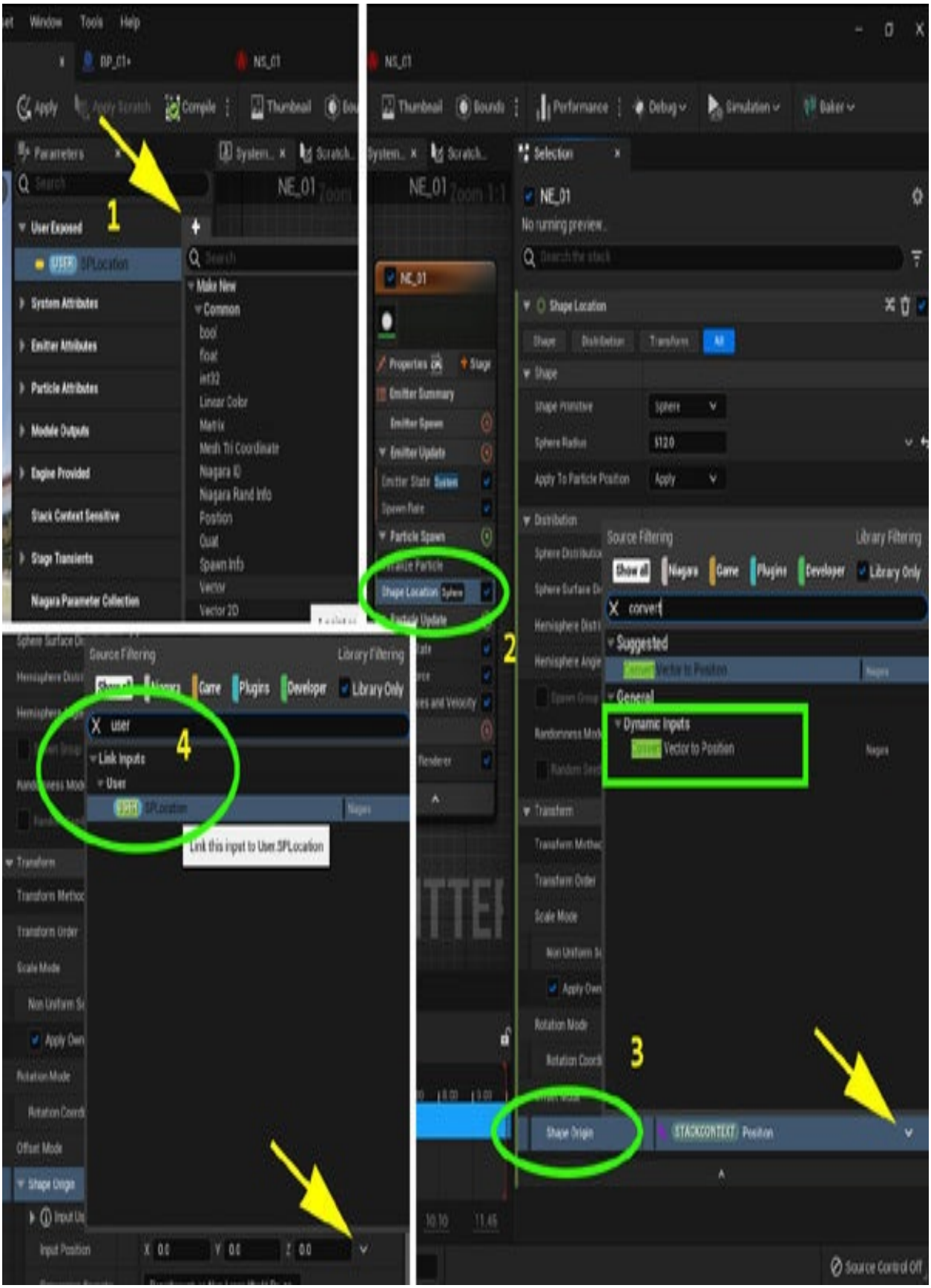

1
2
3
4
User Exposed
SPLocation
System Attributes
Emitter Attributes
Particle Attributes
Module Outputs
Engine Provided
Stack Context Sensitive
Stage Transients
Niagara Parameter Collection
Make New
Common
bool
float
int32
Linear Color
Matrix
Mesh Tri Coordinate
Niagara ID
Niagara Rand Info
Position
Quat
Spawn Info
Vector
Vector 2D
Shape Location
Source Filtering
Library Filtering
Show all
Niagara
Game
Plugins
Developer
Library Only
convert
Suggested
Vector to Position
General
Dynamic Inputs
Shape Origin
STACKCONTEXT Position
user
Link Inputs
User
SPLocation
Link this input to User.SPLocation
Input Position
Source Control Off

Figure 11.20: First step is assigning a parameter to the Niagara emitter. 1-Click on little + icon in User Exposed dropdown list and add a Vector parameter rwith name SPLocation. 2-Select Shape Location in NS_01 Emitte. 3-Then Locate Shape Origin property and assign Convert Vector to Position function to it. 4-Finaly, assign SPLocationas USER pinput to Input Position property.

Now, open NS_01, which is a Niagara System component, and click on User Parameters in the NS_01 node. As Figure 11.21 shows, you will have your custom parameter, SPLocation, listed here. If you do not have your parameter listed, you must compile and save your emitter (NE_01), then compile and save your Niagara System component (NS_01) and then open them again. If you have a very complex system and emitters, you may need to restart the editor to find your custom parameters listed in this property:

File Edit Asset Window Tools Help
NS_01
Save
Browse
Compile
Thumbnail
Bounds
Performance
Debug
Simulation
Editor
Preview
Parameters
System Overview
Scratch Pad
Selection
Perspective
Show
User Tagged
System Attributes
Emitter Attributes
Particle Attributes
Module Outputs
Engine Provided
Stack Output Event
Properties
User Parameters
System Update
System State
Emitter Summary
Emitter Spawn
Emitter Update
Emitter State
Spawn Rate
Stage
Search the Stack
User Parameters
Vector
X 0.0
Y 0.0
Z 0.0

Figure 11.21: List of user-defined parameter in NS_01 node

The last step is to use the SPLocation parameter inside BP_01 actor blueprint. Open BP_01 to drag and drop an instance of Niagara particle system component into event graph. Then, assign the Set Vector Parameter blueprint function to the Niagara component, and in the Parameter Name field, add SPLocation, which is the name of the new parameter we just made. Keep in mind that the parameter name is case sensitive data and must be the same as what you edit in System Setting in the Niagara system. Now, assign world location of each collision box to Param field, as shown in Figure 11.22:

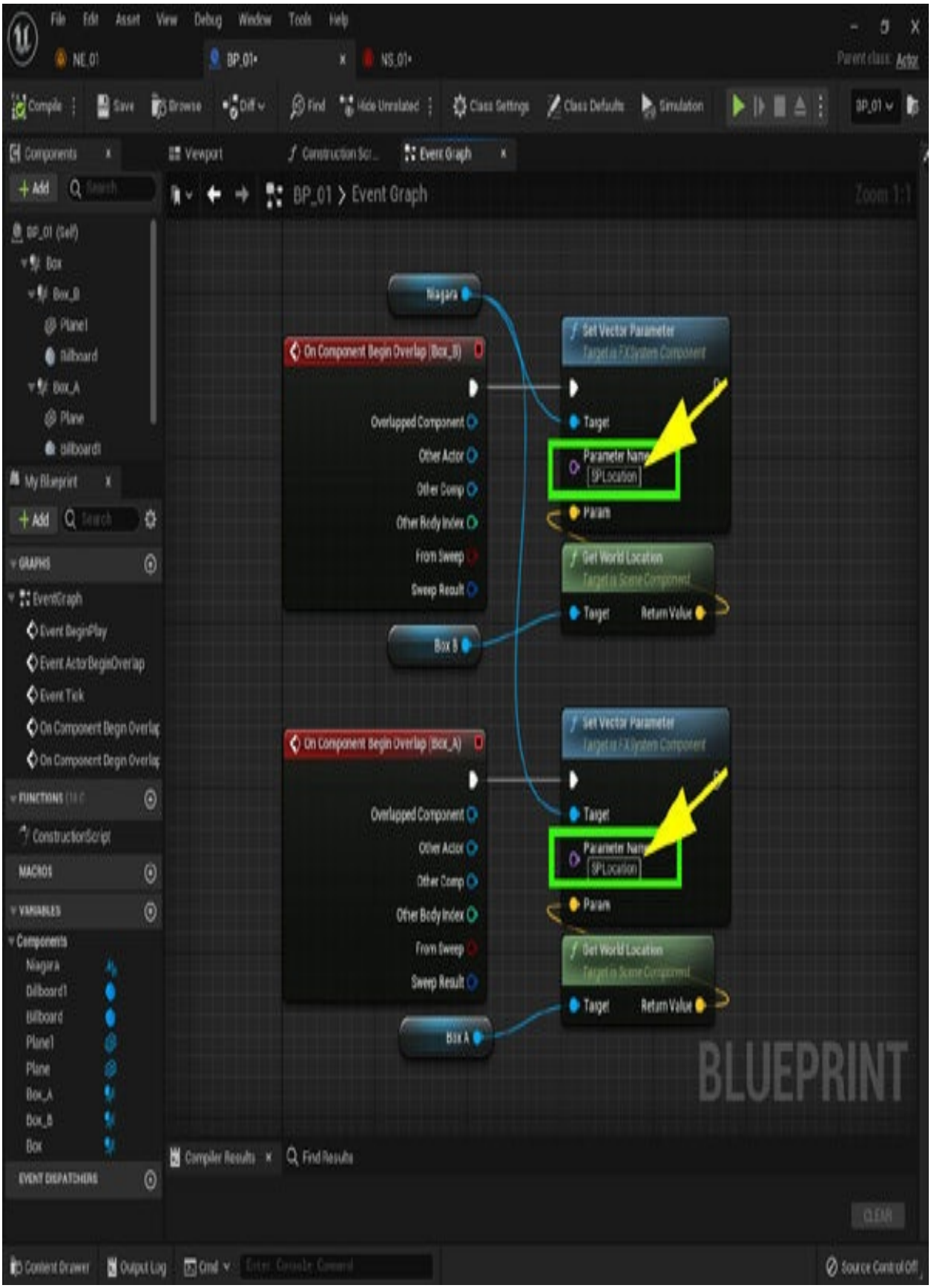

File Edit Asset View Debug Window Tools Help
NE_01
BP_01*
NS_01*
Parent class: Actor
Compile
Save
Browse
Diff
Find
Hide Unrelated
Class Settings
Class Defaults
Simulation
BP_01
Components
Viewport
Construction Scr...
Event Graph
Add
BP_01 > Event Graph
Zoom 1:1
BP_01 (Self)
Box
Box_B
Plane1
Billboard
Box_A
Plane
Billboard1
My Blueprint
GRAPHS
EventGraph
Event BeginPlay
Event ActorBeginOverlap
Event Tick
On Component Begin Overlap
On Component Begin Overlap
FUNCTIONS
ConstructionScript
MACROS
VARIABLES
Components
Niagara
Billboard1
Billboard
Plane1
Plane
Box_A
Box_B
Box
EVENT DISPATCHERS
Niagara
On Component Begin Overlap (Box_B)
Overlapped Component
Other Actor
Other Comp
Other Body Index
From Sweep
Sweep Result
Box B
Set Vector Parameter
Target is FXSystem Component
Target
Parameter Name
SPLocation
Param
Get World Location
Target is Scene Component
Target
Return Value
On Component Begin Overlap (Box_A)
Overlapped Component
Other Actor
Other Comp
Other Body Index
From Sweep
Sweep Result
Box A
Set Vector Parameter
Target is FXSystem Component
Target
Parameter Name
SPLocation
Param
Get World Location
Target is Scene Component
Target
Return Value
BLUEPRINT
Compiler Results
Find Results
CLEAR
Content Drawer
Output Log
Cmd
Enter Console Command
Source Control Off

Figure 11.22: Using overlap event for collision box to relocate Niagara particle system. The particle system uses "SPLocation" parameter to communicate with this actor blueprint. Keep in mind the parameter's name is critical data and MUST be the same.

Place some BP_01 actors on the scene, run the game, and walk into the collision boxes. As you see, on each collision, the particle system will relocate to that location. Now, make another Niagara Emitter called NE_02 from an Empty template, as we did for NE_01, and follow these steps to customize it:

Open NE_02 it and click on Renderer; add Mesh Renderer to it by using the little circular icon, as shown in Figure 11.23. You can activate and deactivate each module inside the Niagara Emitter by clicking on its check box, so deactivate Sprite Renderer:

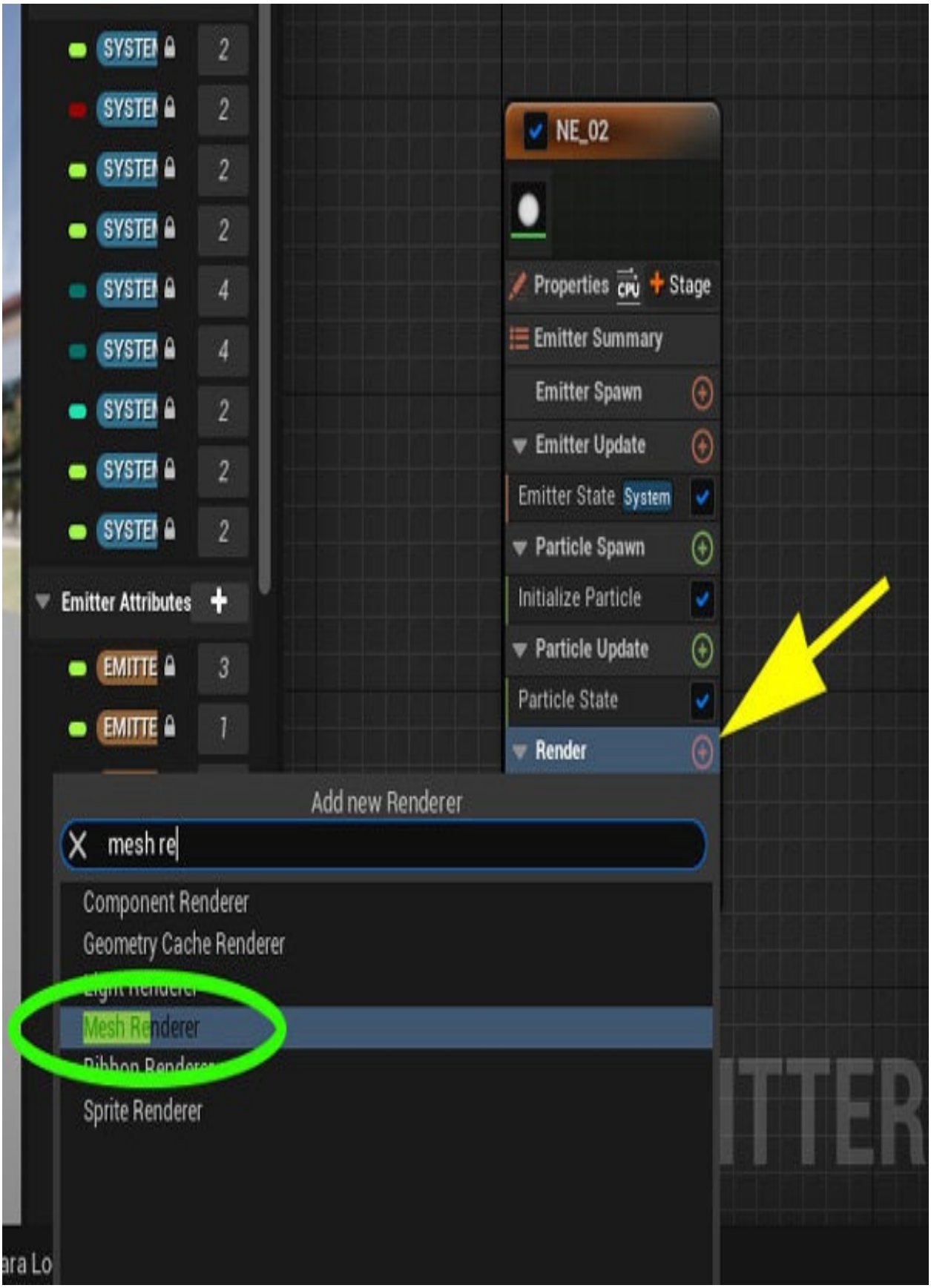

SYSTEM 2
SYSTEM 2
SYSTEM 2
SYSTEM 2
SYSTEM 4
SYSTEM 4
SYSTEM 2
SYSTEM 2
SYSTEM 2
Emitter Attributes
EMITTE 3
EMITTE 1
NE_02
Properties CPU Stage
Emitter Summary
Emitter Spawn
Emitter Update
Emitter State System
Particle Spawn
Initialize Particle
Particle Update
Particle State
Render
Add new Renderer
mesh re
Component Renderer
Geometry Cache Renderer
Mesh Renderer
Sprite Renderer

Figure 11.23: Select Renderer, click on the small circular icon and then select Mesh renderer from the list.

The Mesh Renderer renders mesh objects instead of sprite objects for the emitter, which is more expensive in case of processing, but has its own visual features. First, we need to assign a mesh to this renderer. Click on Mesh Renderer, then locate Meshes in the selection tab, press on the little circular icon there and then add 1M_Cube static mesh to this module. Then, in the Scale field, change X and Y to .2 and Z to 4, as shown in Figure 11.24. You can also customize mesh materials in this module. Indeed, turn off the Sprite Renderer module because we don’t like to render any sprite as we did for the NS_01 emitter:

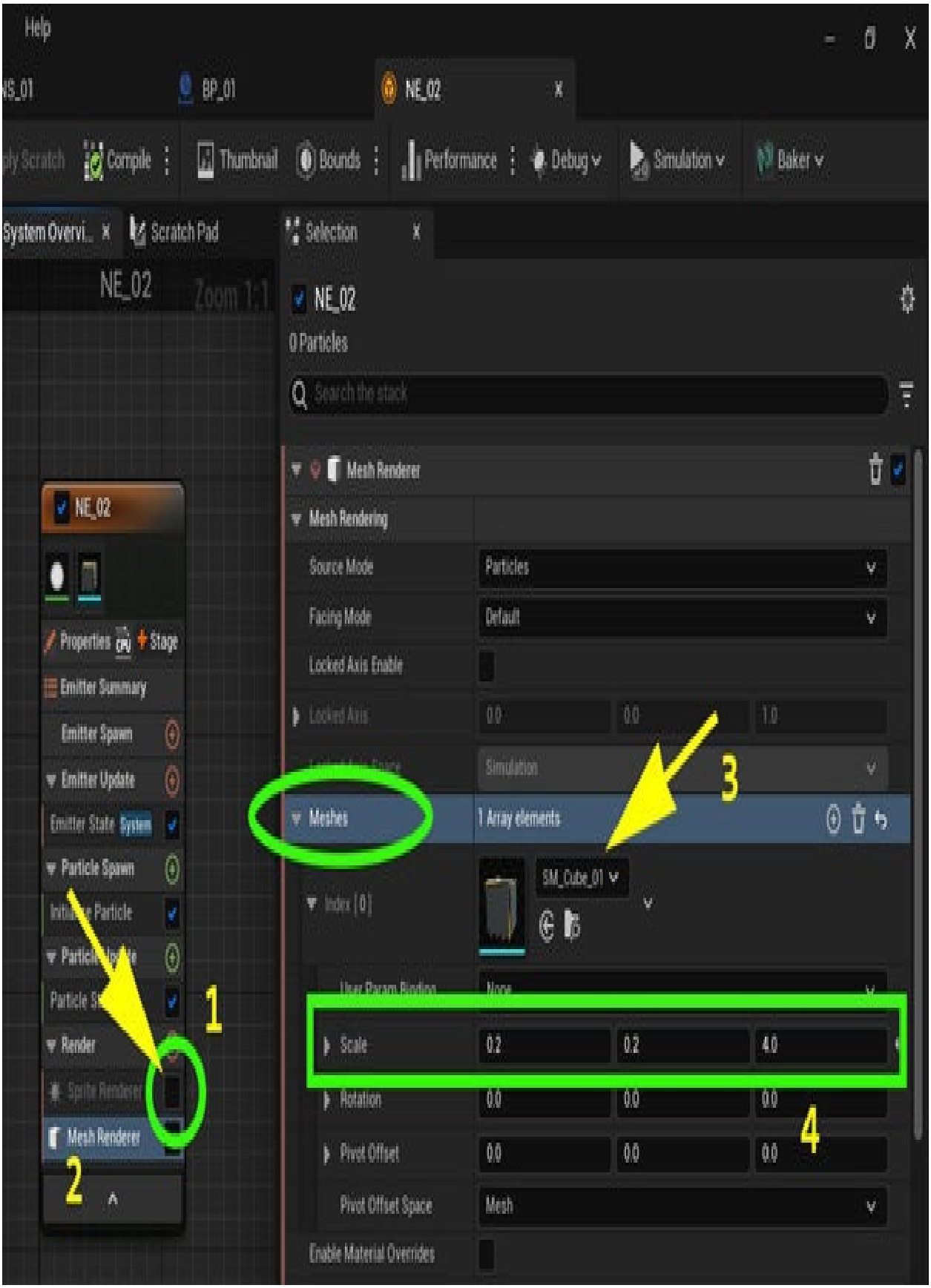

Help
BP_01
NE_02
Compile
Thumbnail
Bounds
Performance
Debug
Simulation
Baker
System Overvi..
Scratch Pad
Selection
NE_02
Zoom 1:1
NE_02
0 Particles
Search the stack
Mesh Renderer
Mesh Rendering
Source Mode
Particles
Facing Mode
Default
Locked Axis Enable
Locked Axis
0.0
0.0
1.0
Simulation
Meshes
1 Array elements
SM_Cube_01
Index [0]
None
Scale
0.2
0.2
4.0
Rotation
0.0
0.0
0.0
Pivot Offset
0.0
0.0
0.0
Pivot Offset Space
Mesh
Enable Material Overrides
NE_02
Properties
Stage
Emitter Summary
Emitter Spawn
Emitter Update
Emitter State
System
Particle Spawn
Render
Sprite Renderer
Mesh Renderer
1
2
3
4

Figure 11.24: First, switch off the Sprite renderer (1) by unticking its module. Then, select the Mesh Renderer module (2) and from the list of its properties, locate Meshes. From here, choose "1M_Cube" (3) or any other static mesh there. Now, locate Scale property and change the scale values of x, y and z. (4).

Now, like the previous particle, add the Spawn Rate module to Emitter Update, and set spawn rate property to 64. Then, add the Shape Location module and set Shape to use Torus, as shown in Figure 11.25, and set its properties Large Radius to 720 and Handle Radius to 64. This module spawns the emitter in different shapes:

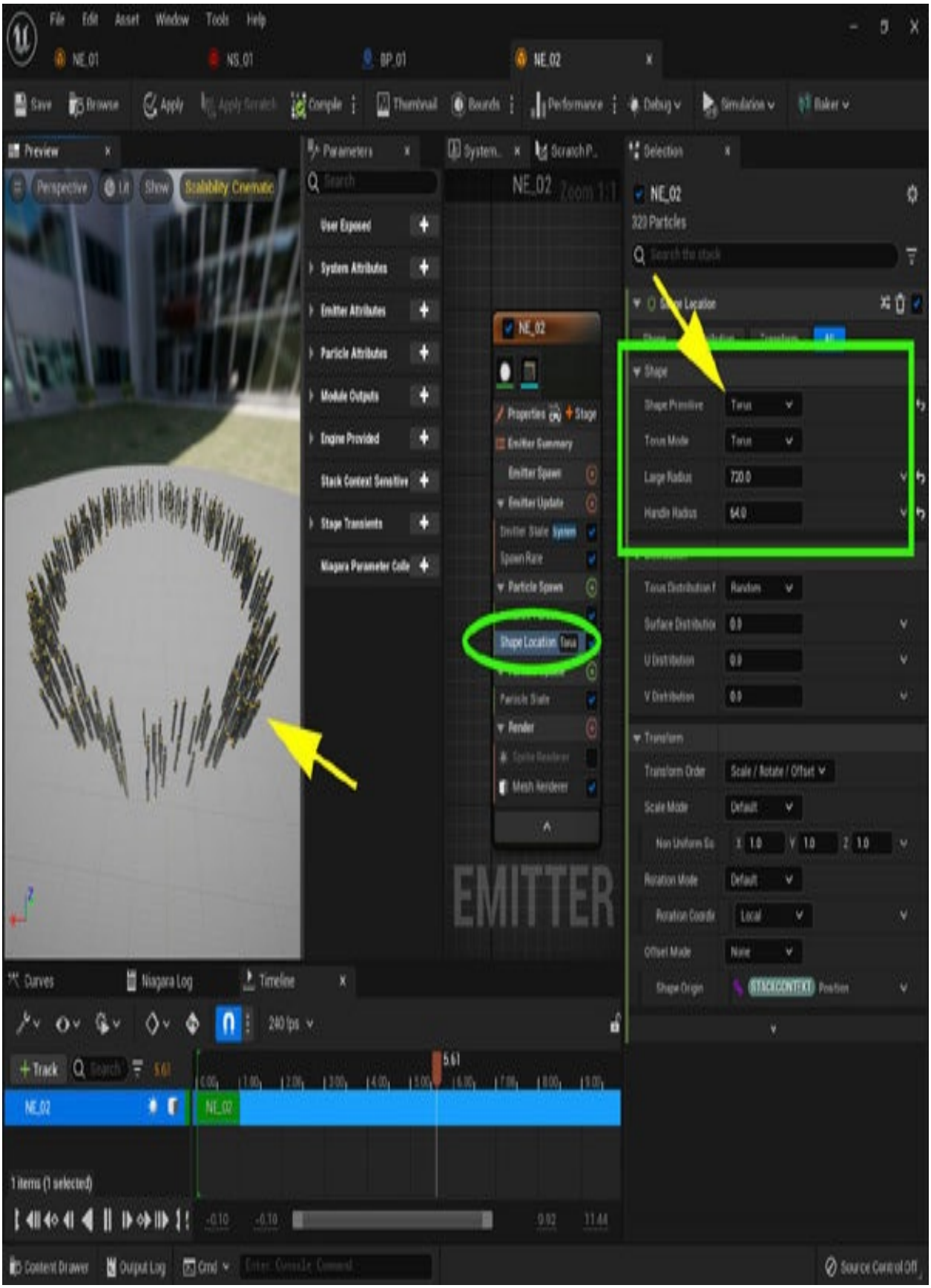

File Edit Asset Window Tools Help
NE_01
NS_01
BP_01
NE_02
Save
Browse
Apply
Compile
Thumbnail
Bounds
Performance
Debug
Simulation
Baker
Preview
Perspective
Lit
Show
Scalability Cinematic
Parameters
System...
Scratch P...
Selection
NE_02
Zoom 1:1
User Exposed
System Attributes
Emitter Attributes
Particle Attributes
Module Outputs
Engine Provided
Stack Context Sensitive
Stage Transients
Niagara Parameter Calls
NE_02
Properties
Stage
Emitter Summary
Emitter Spawn
Emitter Update
Spawn Rate
Particle Spawn
Shape Location
Particle State
Render
Mesh Renderer
EMITTER
NE_02
320 Particles
Shape
Shape Primitive
Torus
Torus Mode
Large Radius
720.0
Handle Radius
64.0
Surface Distribution
U Distribution
V Distribution
Transform
Transform Order
Scale / Rotate / Offset
Scale Mode
Default
Rotation Mode
Rotation Coordinate
Local
Offset Mode
None
Shape Origin
Curves
Niagara Log
Timeline
240 fps
Track
NE_02
1 items (1 selected)
Content Drawer
Output Log
Cmd
Source Control Off

Figure 11.25: Using Torus on Shape Location module in Particle Spawn will shape a ring of spawned particle

Now, select the NS_01 Niagara system and open its editor by double-clicking on it. Right-click inside the System Overview tab, click on Add Emitter and choose NE_02 from the list, as shown in Figure 11.26:

Add Emitter
Clear Isolated
Zoom to Fit
Zoom to Fit All
Paste
1

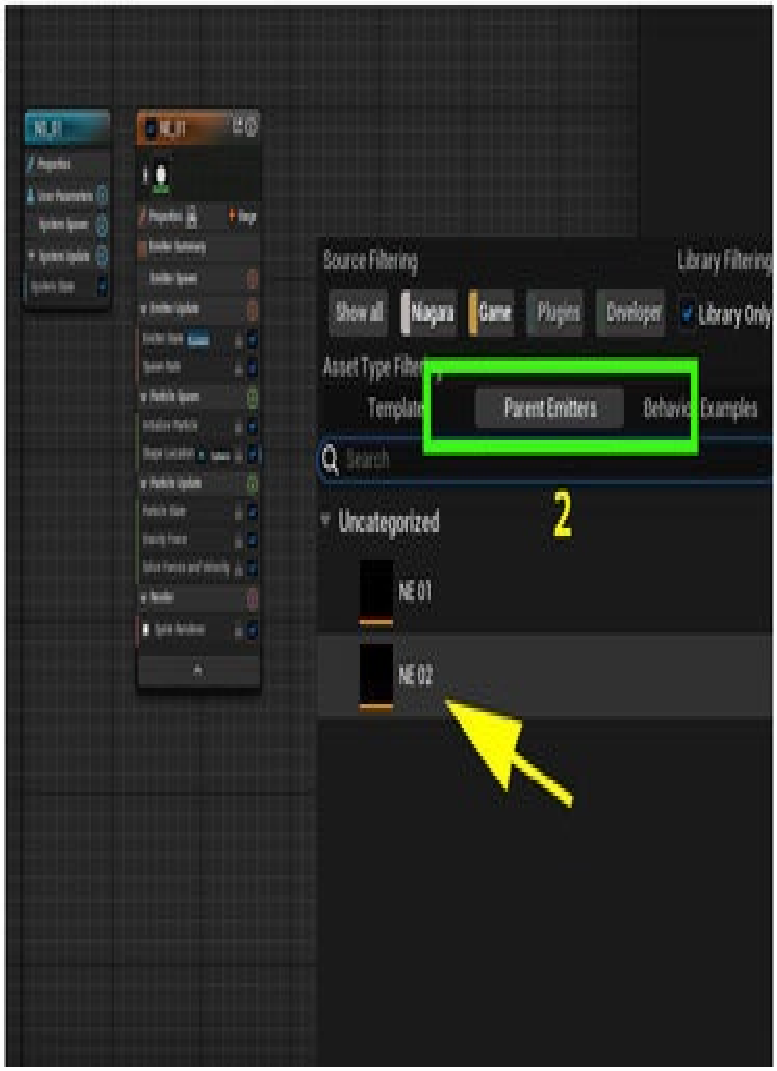

Source Filtering
Library Filtering
Show all
Niagara
Game
Plugins
Developer
Library Only
Parent Emitters
Search
Uncategorized
2
NE 01
NE 02

Figure 11.26: Add new Niagara emitter to Niagara system

The engine automatically adds the new emitter to the Niagara system and will show it on actor, as shown in Figure 11.27. This is how you combine a number of Niagara emitters with each other as one Niagara System particle system. Keep in mind to press the Compile and Save buttons after each update in your particle system objects when you edit them:

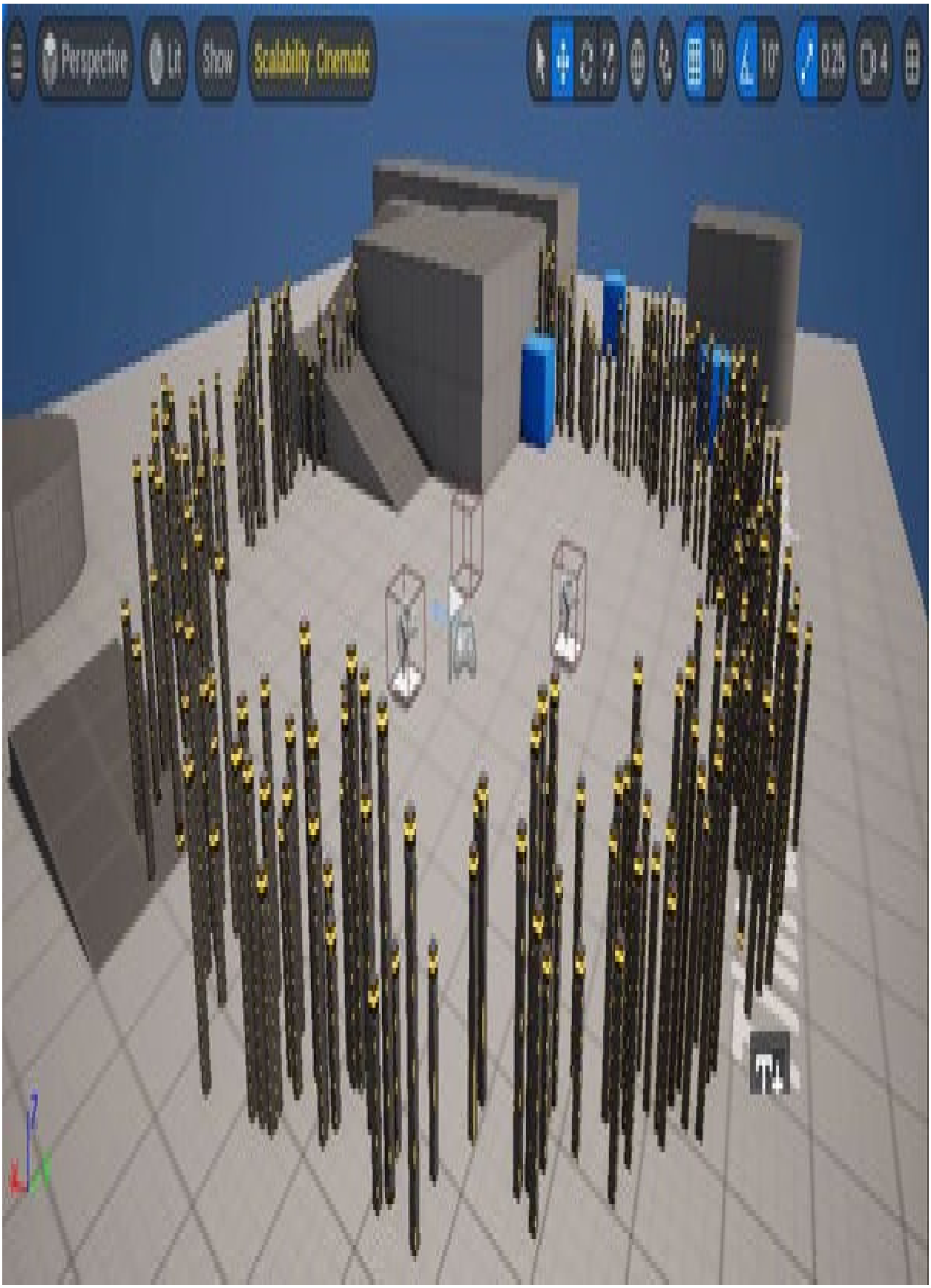

Perspective
Lit
Show
Scalability: Cinematic
10
10°
0.25
4

Figure 11.27: Each Niagara System can combine and mix Niagara emitter as one particle system and presents the effect in the scene. In the example actor blueprint, NS_01 Niagara system, used NE_01 and NE_02 Niagara emitters to perform this VFX effect.

Using audio

Having audio in any interactive application increases the quality of service that the application is developed for and satisfies the users when interacting with the application. Computer games are interactive applications and for some games, having a detailed and accurate audio in the game is essential. Games like VALORANT or Counter Strike are totally dependent on audio quality and accuracy when players experience game play.

The Unreal Engine 5 introduces an advanced method for audio programming, creates real time audio and processes audio data to develop applications like games. This audio system is known as MetaSound, and as compared to the previous versions of the engine, it revolutionized coding style for audio programming. The audio programmer has a complete list of audio functions and procedures to render and play audio in game. MetaSound provides audio designers with complete control over DSP graph generation for sound sources. They can use imported audio files or create sound in real-time by using internal signal generators of MetaSound to generate patterns and sequences of sound/music during game play.

There are a huge number of blueprints nodes to design and control DSP graph in real-time, which came with MetaSound. Audio designers and programmers can make a range of variable data types like integer, float, bool, and triggers as parameters inside the audio code. They can also make single or array of variables to save values or objects (like sounds) and monitor data inside MetaSound object during runtime. Here is a Print Log node that is extremely new and provides many useful features.

To import audio files into the engine, render your audio files in wave format .wav and then simply drag and drop them from your windows browser to content

browser in engine. The engine automatically addresses the new audio asset, and you can use it anywhere in the code.

Making MetaSound

The MetaSound is a plugin that sometimes is not activated by default, so you need to activate MetaSound in Plugins and after restarting the engine, the MetaSound will be available for development. Then, similar to Niagara, create an audio system and assign variables and events to control it. Here are the steps to learn the details of this process:

Click on Settings, located on top-right of main editor, and then click on Plugins in the drop-down menu, as shown in Figure 11.28. The engine will automatically open the Plugins window.

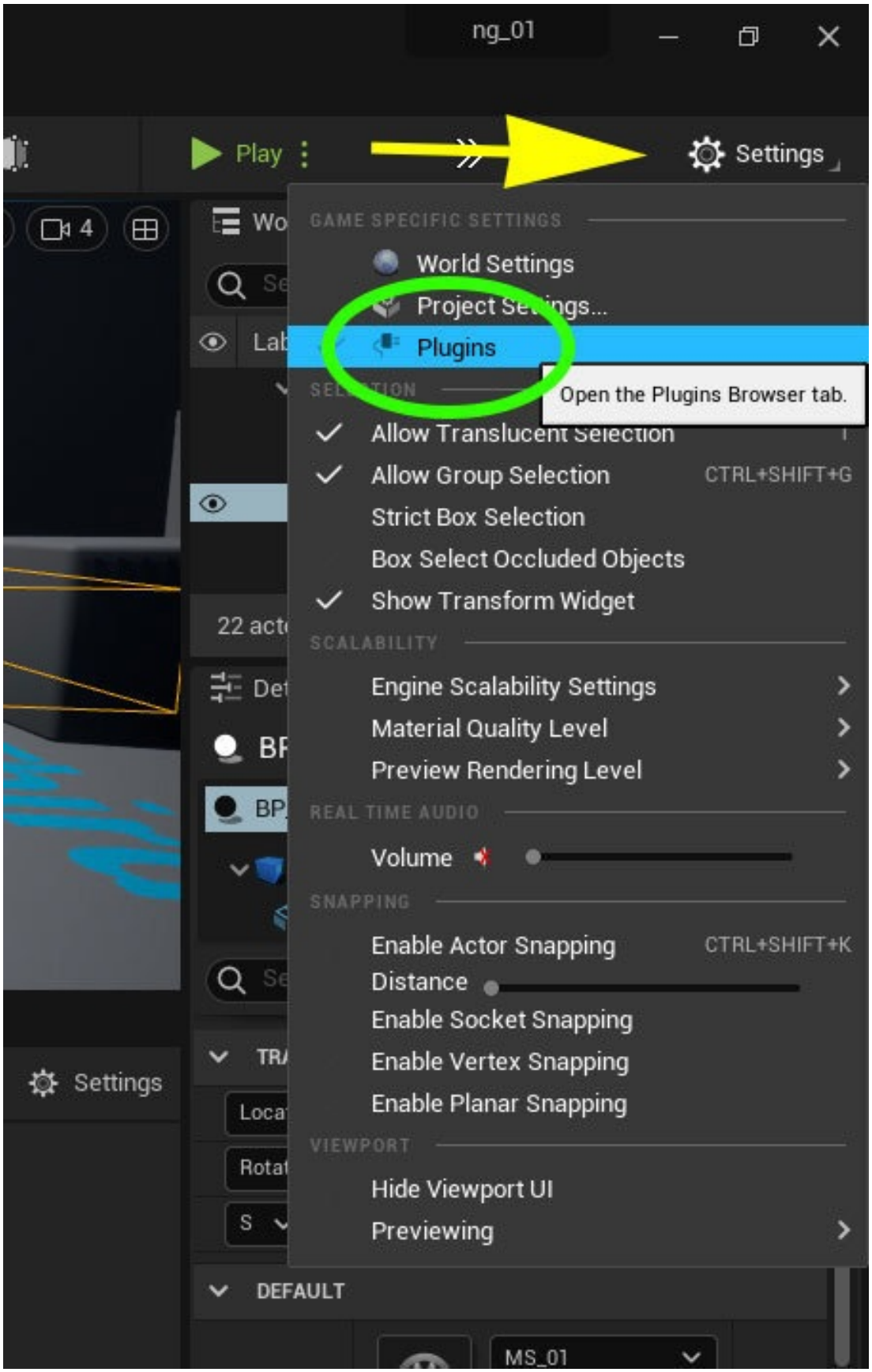

ng_01
Play
Settings
GAME SPECIFIC SETTINGS
World Settings
Project Settings...
Plugins
Open the Plugins Browser tab.
Allow Translucent Selection
Allow Group Selection
CTRL+SHIFT+G
Strict Box Selection
Box Select Occluded Objects
Show Transform Widget
SCALABILITY
Engine Scalability Settings
Material Quality Level
Preview Rendering Level
REAL TIME AUDIO
Volume
SNAPPING
Enable Actor Snapping
CTRL+SHIFT+K
Distance
Enable Socket Snapping
Enable Vertex Snapping
Enable Planar Snapping
VIEWPORT
Hide Viewport UI
Previewing
DEFAULT
MS_01

Figure 11.28: In the main editor, click on “Settings” and then select on Plugins

Locate Audio in the left bar of the plugin window and click on it; then, on the right, find the MetaSound plugin and click on Enable on its checkbox. The engine will open a message to confirm your selection, as shown in Figure 11.29. Click on Yes, and then restart your project:

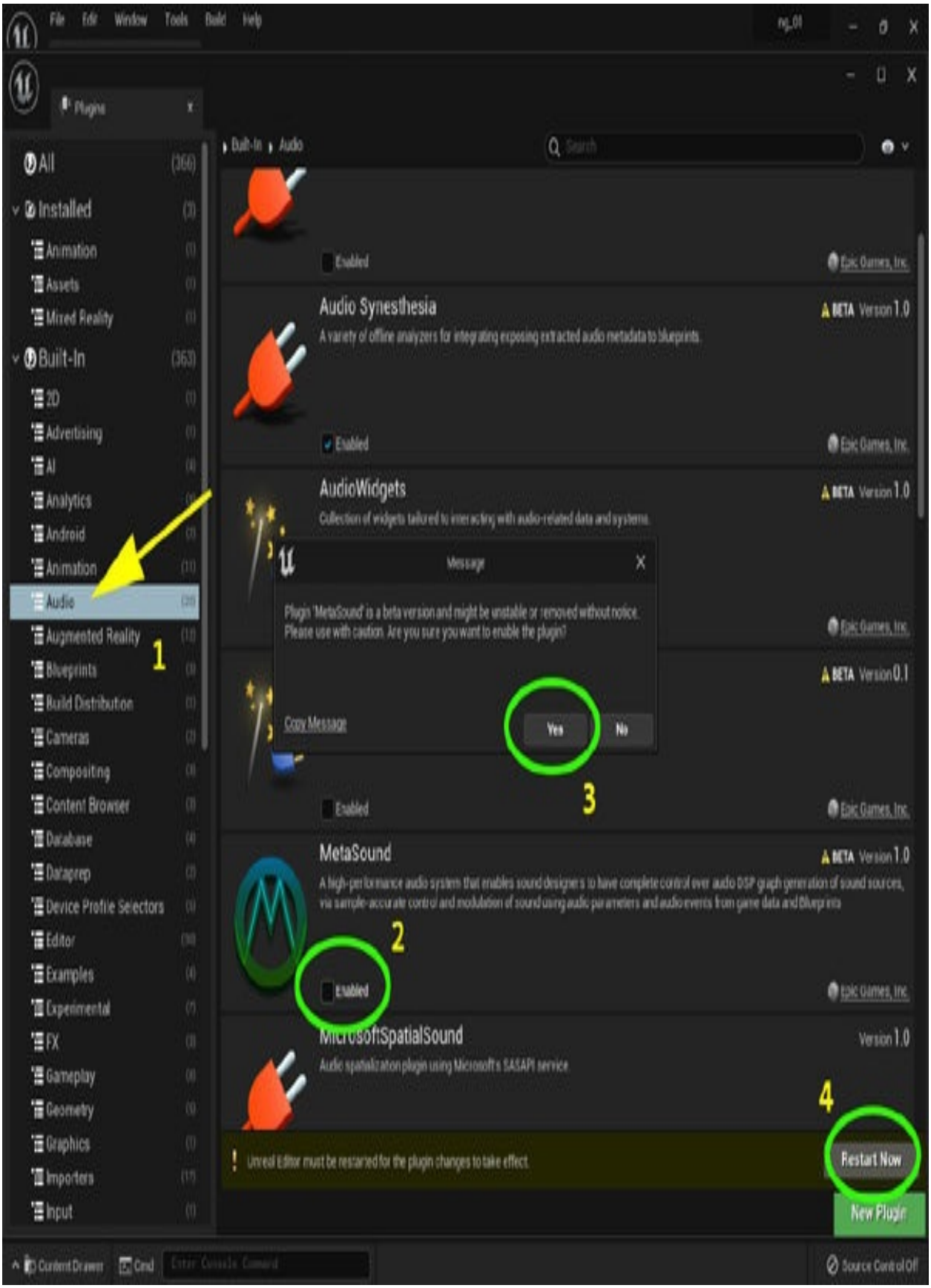

File
Edit
Window
Tools
Build
Help
Plugins
All (366)
Installed (3)
Animation
Assets
Mixed Reality
Built-In (363)
2D
Advertising
AI
Analytics
Android
Animation
Audio
Augmented Reality
Blueprints
Build Distribution
Cameras
Compositing
Content Browser
Database
Dataprep
Device Profile Selectors
Editor
Examples
Experimental
FX
Gameplay
Geometry
Graphics
Importers
Input
1
Built-In › Audio
Search
Enabled
Epic Games, Inc.
Audio Synesthesia
A variety of offline analyzers for integrating exposing extracted audio metadata to blueprints.
BETA Version 1.0
Enabled
Epic Games, Inc.
AudioWidgets
Collection of widgets tailored to interacting with audio-related data and systems.
BETA Version 1.0
Epic Games, Inc.
Message
Plugin 'MetaSound' is a beta version and might be unstable or removed without notice. Please use with caution. Are you sure you want to enable the plugin?
Copy Message
Yes
No
3
BETA Version 0.1
Enabled
Epic Games, Inc.
MetaSound
A high-performance audio system that enables sound designers to have complete control over audio DSP graph generation of sound sources, via sample-accurate control and modulation of sound using audio parameters and audio events from game data and Blueprints
BETA Version 1.0
2
Enabled
Epic Games, Inc.
MicrosoftSpatialSound
Audio spatialization plugin using Microsoft's SASAPI service.
Version 1.0
4
Unreal Editor must be restarted for the plugin changes to take effect.
Restart Now
New Plugin
Content Drawer
Cmd
Enter Console Command
Source Control Off

Figure 11.29: To activate the MetaSound plugin, click on Audio category from left panel (1) and then find MetaSound and click on Enable (2). The engine will ask your confirmation from a Message window, click" Yes" button (3) and then click on "Restart Now" button (4). You must restart your project to acticate MetaSound.

Now, inside content browser, right-click, and click on the Sounds category and select MetaSound Source from the blueprint list, as shown in Figure 11.30. The engine will make an instance of MetaSound and place it in content browser. Rename it to MS_01 and then double-click on it to open its editor:

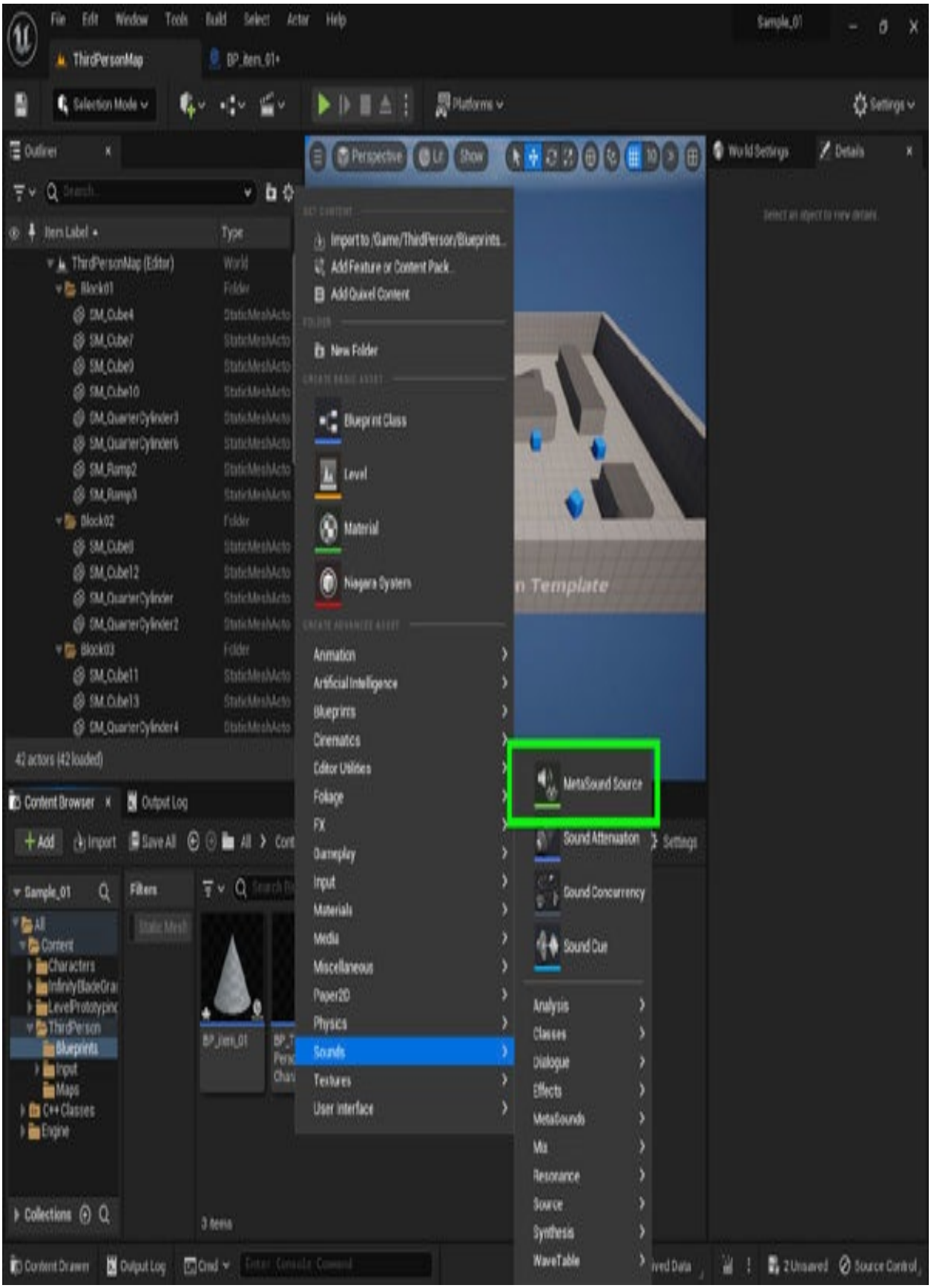

File Edit Window Tools Build Select Actor Help
ThirdPersonMap
BP_Item_01+
Sample_01
Selection Mode
Platforms
Settings
Outliner
Perspective
Show
World Settings
Details
Item Label
Type
ThirdPersonMap (Editor)
Block01
SM_Cube4
SM_Cube7
SM_Cube9
SM_Cube10
SM_QuarterCylinder3
SM_QuarterCylinder6
SM_Ramp2
SM_Ramp3
Block02
SM_Cube8
SM_Cube12
SM_QuarterCylinder
SM_QuarterCylinder2
Block03
SM_Cube11
SM_Cube13
SM_QuarterCylinder4
42 actors (42 loaded)
Import to /Game/ThirdPerson/Blueprints...
Add Feature or Content Pack...
Add Quixel Content
New Folder
Blueprint Class
Level
Material
Niagara System
Animation
Artificial Intelligence
Blueprints
Cinematics
Editor Utilities
Foliage
FX
Gameplay
Input
Materials
Media
Miscellaneous
Paper2D
Physics
Sounds
Textures
User Interface
MetaSound Source
Sound Attenuation
Sound Concurrency
Sound Cue
Analysis
Classes
Dialogue
Effects
MetaSounds
Mix
Resonance
Source
Synthesis
WaveTable
Content Browser
Output Log
Add
Import
Save All
Filters
Static Mesh
Sample_01
All
Content
Characters
InfinityBladeGra
LevelPrototypin
ThirdPerson
Blueprints
Input
Maps
C++ Classes
Engine
Collections
BP_Item_01
3 items
Content Drawer
Output Log
Cmd
Enter Console Command
2 Unsaved
Source Control

Figure 11.30: “MetaSound Source” blueprint object is located in Sounds category

The MetaSound editor is designed for audio programming in Unreal Engine 5. As you can see in Figure 11.31, there are three default nodes in the MetaSound editor known as Triggers. These nodes are listed in the left panels and are responsible to activate input and send output through MetaSound object to the game scene during runtime. To understand how these triggers operate, let’s add a sound and play it. Right-click and type wave and then select Wave Player (Mono) from the list, as shown in Figure 11.31:

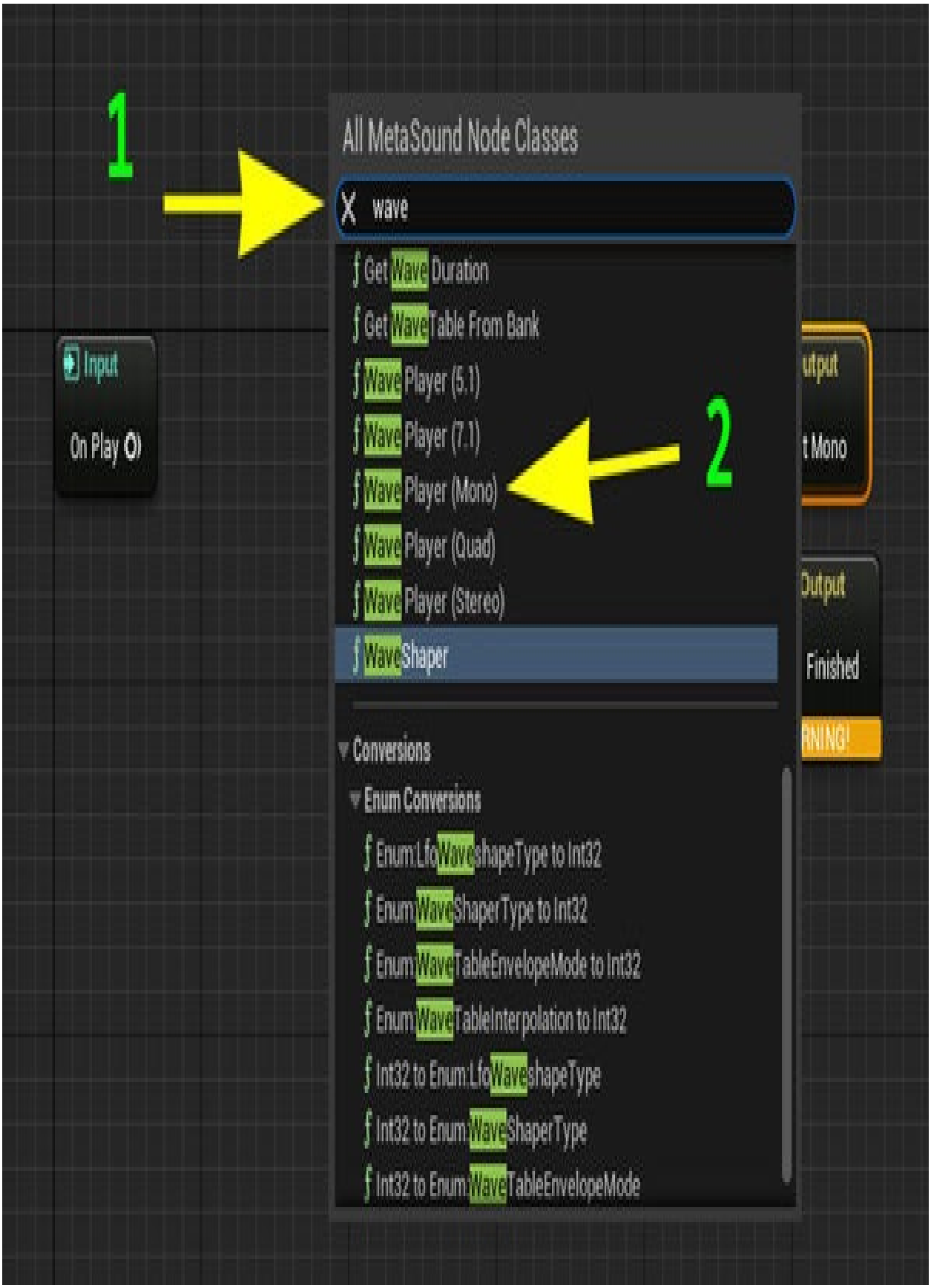

1
All MetaSound Node Classes
wave
Get Wave Duration
Get WaveTable From Bank
Wave Player (5.1)
Wave Player (7.1)
Wave Player (Mono)
Wave Player (Quad)
Wave Player (Stereo)
WaveShaper
2
Conversions
Enum Conversions
Enum:LfoWaveshapeType to Int32
Enum:WaveShaperType to Int32
Enum:WaveTableEnvelopeMode to Int32
Enum:WaveTableInterpolation to Int32
Int32 to Enum:LfoWaveshapeType
Int32 to Enum:WaveShaperType
Int32 to Enum:WaveTableEnvelopeMode
Input
On Play
utput
t Mono
Output
Finished
RNING!

Figure 11.31: The "MS_01" MetaSound object blueprint editor. For playing a wave sound, right click and type "wave" (1) and then slelect "WavePlayer(Mono)" from list (2).

The engine will add the Wave Player(Mono) blueprint block to the editor, which is responsible to play an audio file as mono. As you see there is a list of wave players, which provide different audio outputs, but for now we use mono output. Click on the Wave Asset option and choose an audio file (in this example, we use Click_On_Button sound wave asset, which is an engine default sound asset), as shown in Figure 11.32. Then, click on the OnPlay output pin in Input trigger and connect its execution line to Play pin in WavePlayer. Also, do the same for OutMono audio output in WavePlayer and connect it to the Out Mono pin in the Output trigger. The Output trigger will send the audio to the scene. Finally, press Play on top and the sound will play:

1
Wave Player (Mono)
Play
Stop
Wave Asset
X click
(None)
Sound Wave
5 items
2
Input
On Play
3
Play
Stop
Start Time
Pitch Shift
Loop
Loop Start
Loop Duration
On Play
On Finished
On Nearly Finished
On Looped
On Cue Point
Cue Point ID
Cue Point Label
Loop Ratio
Playback Location
Out Mono
Output
4
MetaSoun

Figure 11.32: First select an audio asset to play in Wave Player by setting "Wave Asset" property (1) (2), then click and drag execution line from OnPlay pin in Input node and connect it to Play pin in WavePlayer node. (4) Do the same for OutMonot and OnFinished pins.

Now, let's attach this MetaSound object to a blueprint actor and play the sound on box collisions. Make a new actor blueprint with a collision box and call it BP_item_01. First bind events for box collision components in blueprint editor and then add an Audio blueprint component to this actor. Now select it, and locate Sound property in the Details panel and assign the MS_01MetaSound object to it, as shown in Figure 11.33:

Components
Viewport
Construction Scr...
Event Graph
Details
Add
BP_item_01 > Event Graph
Zoom 1:1
BP_item_01 (self)
DefaultSceneRoot
Audio
Box
StaticMesh
1
2
2
On Component Begin Overlap (Box)
Overlapped Component
Other Actor
Other Comp
Other Body Index
From Sweep
Sweep Result
On Component End Overlap (Box)
Overlapped Component
Other Actor
Other Comp
Other Body Index
1
My Blueprint
Add
GRAPHS
EventGraph
FUNCTIONS
ConstructionScript
MACROS
Variable
Variable Name
Audio
Tooltip
Category
Default
Editable when Inst...
Transform
Location
Rotation
Scale
Sockets
Parent Socket
None
Sound
Sound
M_01
Pitch Multiplier
1.0
Low Pass Filter...
Priority
1.0
Play Multiple Inst...

Figure 11.33: Select Audio component and assign "MS_01" MetaSound object for its Sound property (1), also bind collision events for box component(2).

Next, drag and drop the Audio component to the event graph and assign Play blueprint node to it, as shown in Figure 11.34:

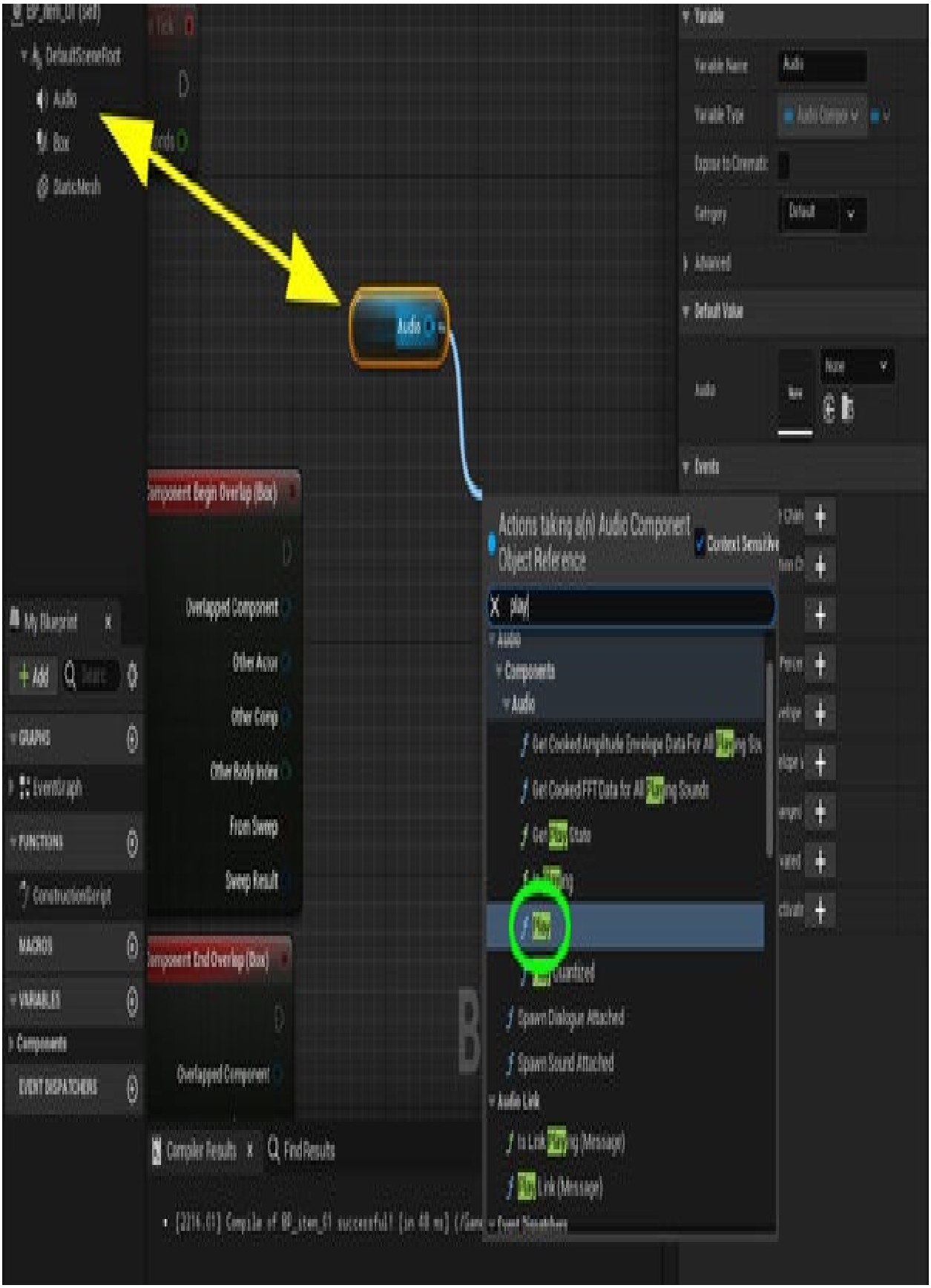

DefaultSceneRoot
Audio
Box
StaticMesh
Variable
Variable Name
Audio
Variable Type
Expose to Cinematic
Category
Default
Advanced
Default Value
None
Events
Actions taking a(n) Audio Component Object Reference
Context Sensitive
Play
Components
Audio
Spawn Dialogue Attached
Spawn Sound Attached
Audio Link
Overlapped Component
Other Actor
Other Comp
Other Body Index
From Sweep
Sweep Result
My Blueprint
Add
GRAPHS
Eventgraph
FUNCTIONS
ConstructionScript
MACROS
VARIABLES
Components
EVENT DISPATCHERS
Compiler Results
Find Results

Figure 11.34: Drag and drop Audio component to the event graph and assign Play node to it from blueprint function list

Assign Play from Audio to both collision event of collision box, as shown in Figure 11.35. Press Compile and test the game. You must hear the "Click_On_Button" sound on each collision with the box during runtime:

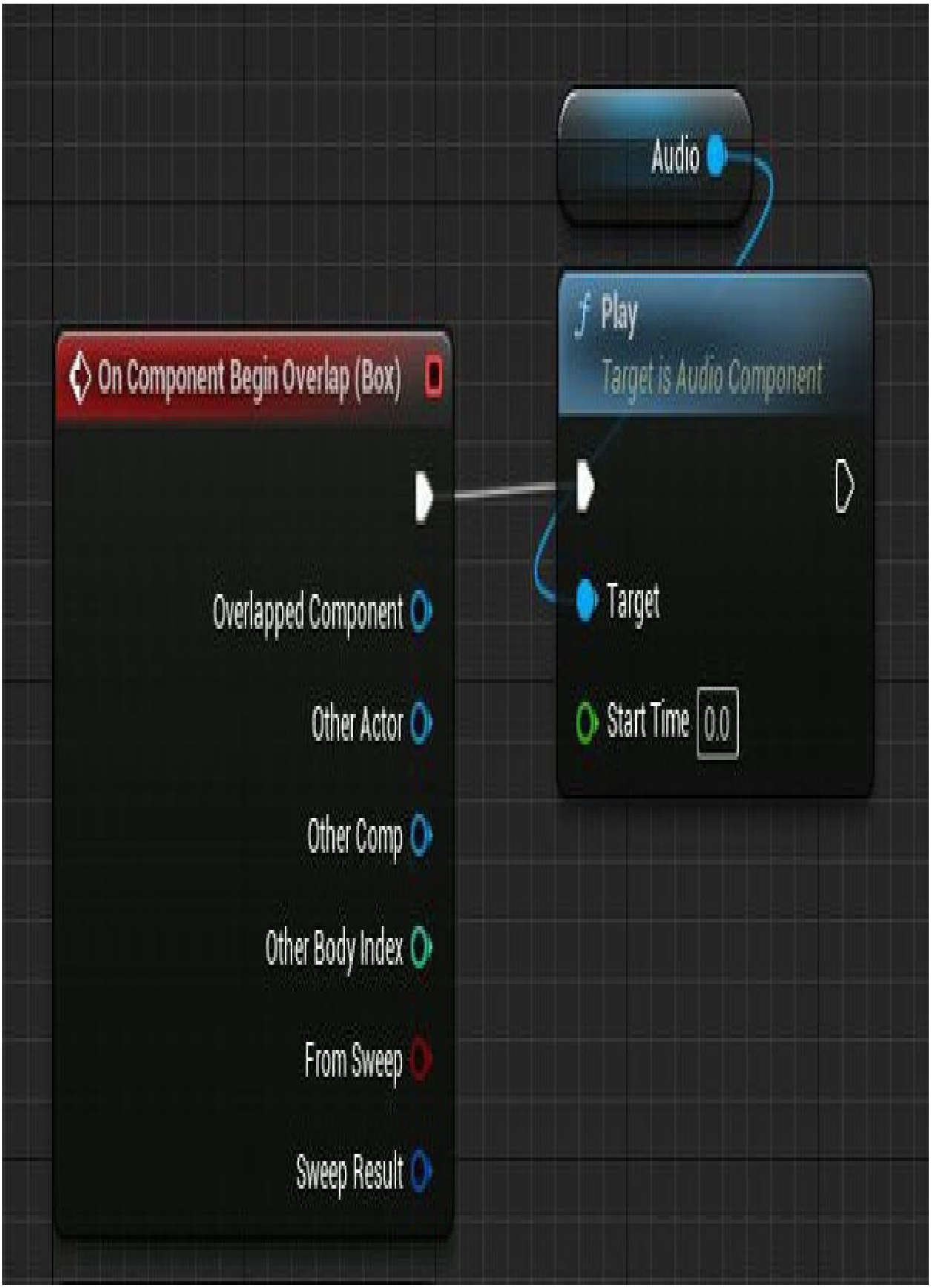

Audio
Play
Target is Audio Component
On Component Begin Overlap (Box)
Target
Overlapped Component
Start Time
0.0
Other Actor
Other Comp
Other Body Index
From Sweep
Sweep Result

Figure 11.35: Add play node to Audio component for box collision event.

So far, we learn how to play a sound asset by using audio component and events in an actor. What if we need to loop the sound or in other word, “repeat” the sound?

For this functionality, open MS_01 and check the Loop property in WavePlayer, as shown in Figure 11.36. When you run the game, the audio is repeated:

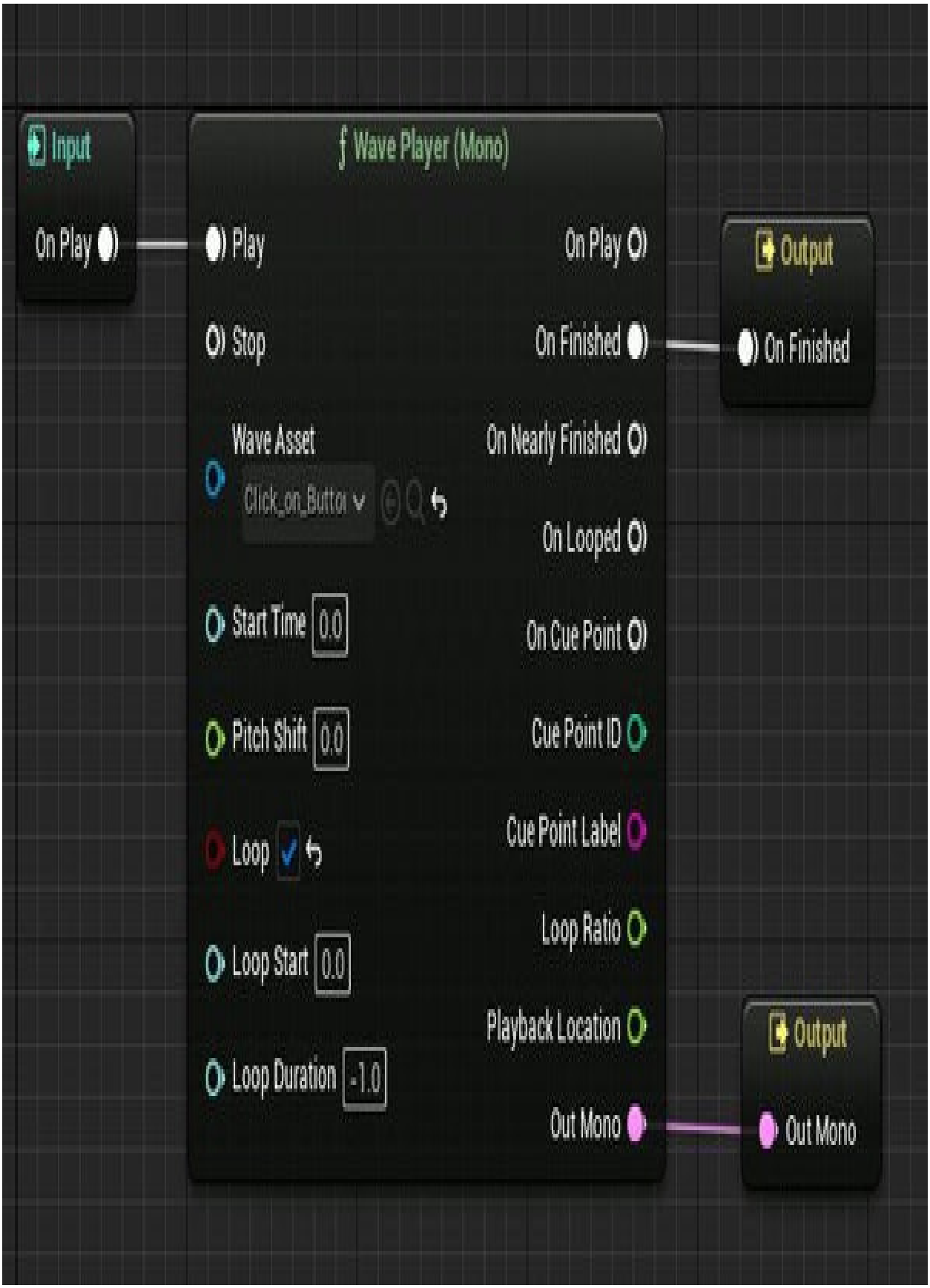

Input
On Play
Wave Player (Mono)
Play
Stop
Wave Asset
Click_on_Buttor
Start Time
0.0
Pitch Shift
0.0
Loop
Loop Start
0.0
Loop Duration
-1.0
On Play
On Finished
On Nearly Finished
On Looped
On Cue Point
Cue Point ID
Cue Point Label
Loop Ratio
Playback Location
Out Mono
Output
On Finished
Output
Out Mono

Figure 11.36: Check "Loop" check box in WavePlayer box to for looping the sound

Now, imagine that we like to play the audio on loop when a player collides with box collision and stop the audio when a player leaves the box collision. There are a couple of ways to do this, and one of them is to assign custom triggers in the MetaSound object and switch the sound by using them from actor blueprint. "custom triggers" behave like events in actor blueprint but they are designed for MetaSound control. Open MS_01, click on the circular icon (with a plus sign inside) in the Inputs section located in the MetaSound panel. The engine will make a new input variable and show its properties in Details panel. Change its name to PlayMySound and its Type to Trigger, as shown in Figure 11.37. Make another input trigger and rename it to StopMySound. Now we made 2 input triggers to play and stop our sound.:

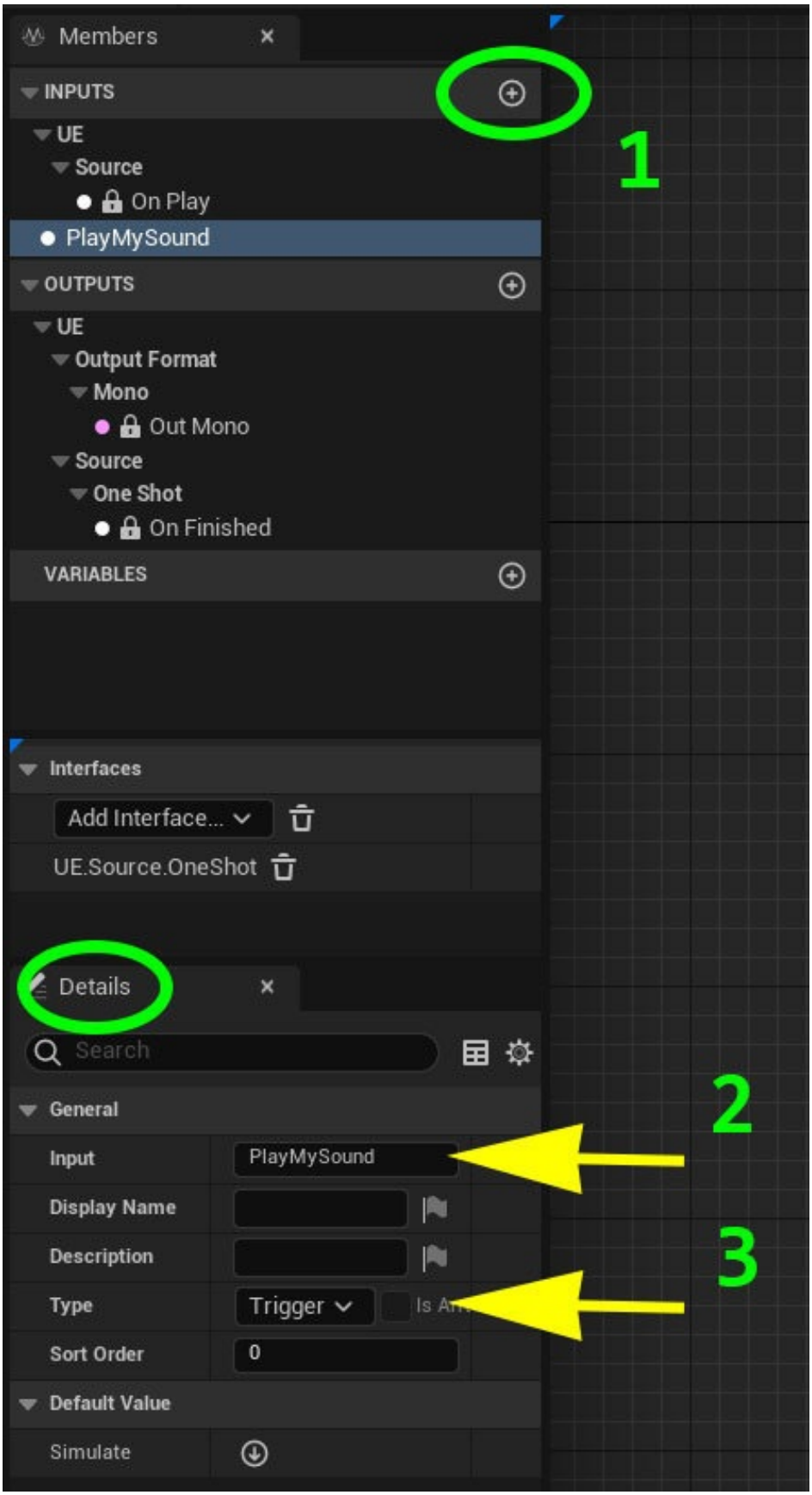

Members
INPUTS
UE
Source
On Play
PlayMySound
OUTPUTS
UE
Output Format
Mono
Out Mono
Source
One Shot
On Finished
VARIABLES
Interfaces
Add Interface...
UE.Source.OneShot
Details
Search
General
Input
PlayMySound
Display Name
Description
Type
Trigger
Sort Order
0
Default Value
Simulate
1
2
3

Figure 11.37: 1- Click on the circular icon (1) and add new input variable. Then change its name (2) and select "Trigger" for its "Type" property (3).

These input triggers will help us control the audio from blueprint. Drag and drop new triggers to the editor and connect them to Play and Stop pins of WavePlayer as you can see in Figure 11.38. Also disconnectOn Finishedpin fromWavePlayer:

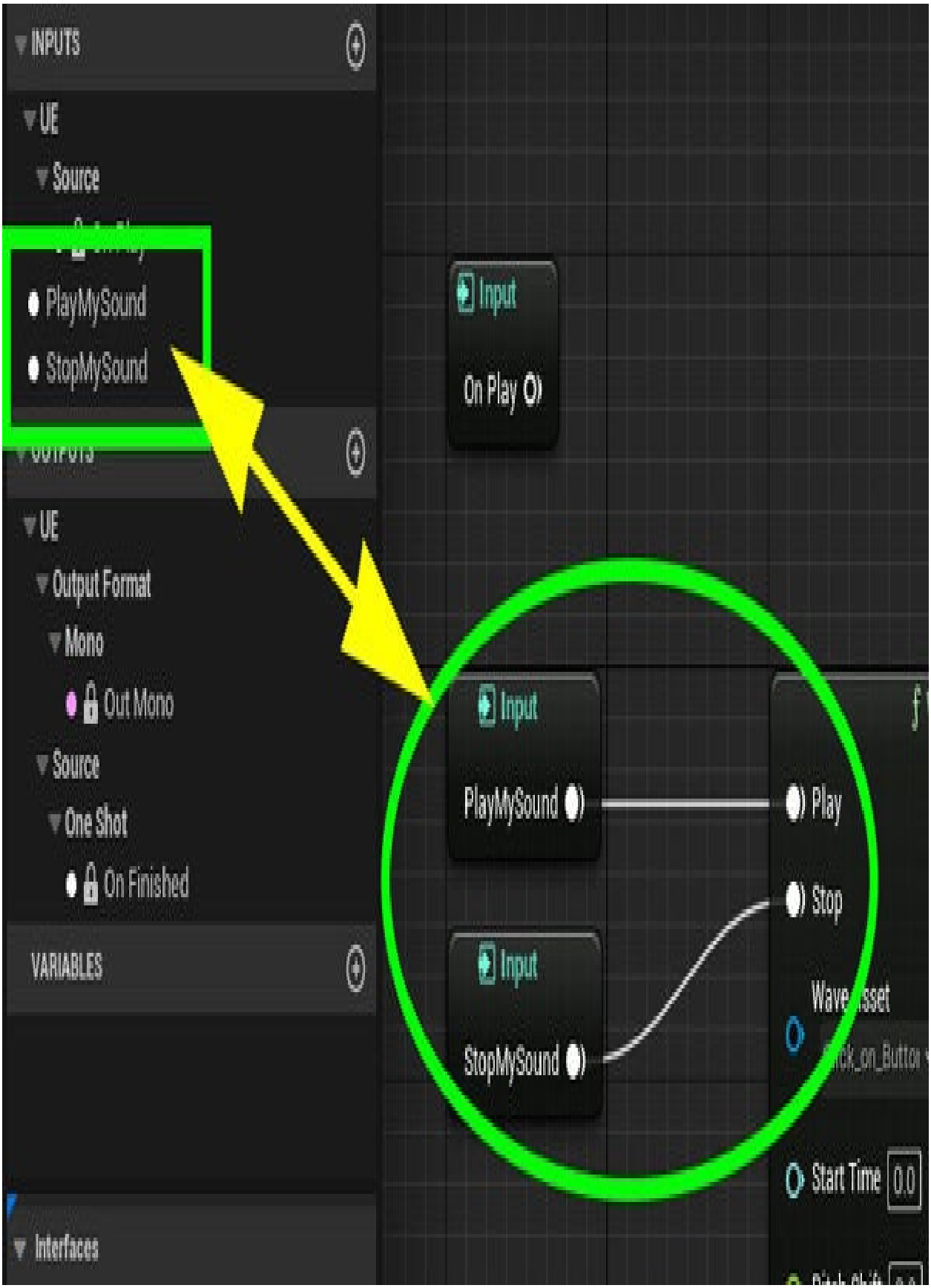

INPUTS
UE
Source
PlayMySound
StopMySound
UE
Output Format
Mono
Out Mono
Source
One Shot
On Finished
VARIABLES
Interfaces
Input
On Play
Input
PlayMySound
Input
StopMySound
Play
Stop
Start Time
0.0

Figure 11.38: Add Input triggers to the audio code

Now, we need to use these input triggers in BP_item_01 blueprint actor. Open it remove the play function for the Audio component. Now, assign the Execute Trigger Parameters blueprint node to each Audio component. This blueprint node works like as an interface between the MetaSound object and your actor objects. You can access to parameters inside the MetaSound object by using In Name property. Be very careful, the In Name property is case sensitive, so you must put “exact” parameter names there. In this example, we have PlayMySound and StopMySound as input names of our triggers. Put these names inside the In Name property, as shown in Figure 11.39. After you run game, the sound will be switched based on collision box events:

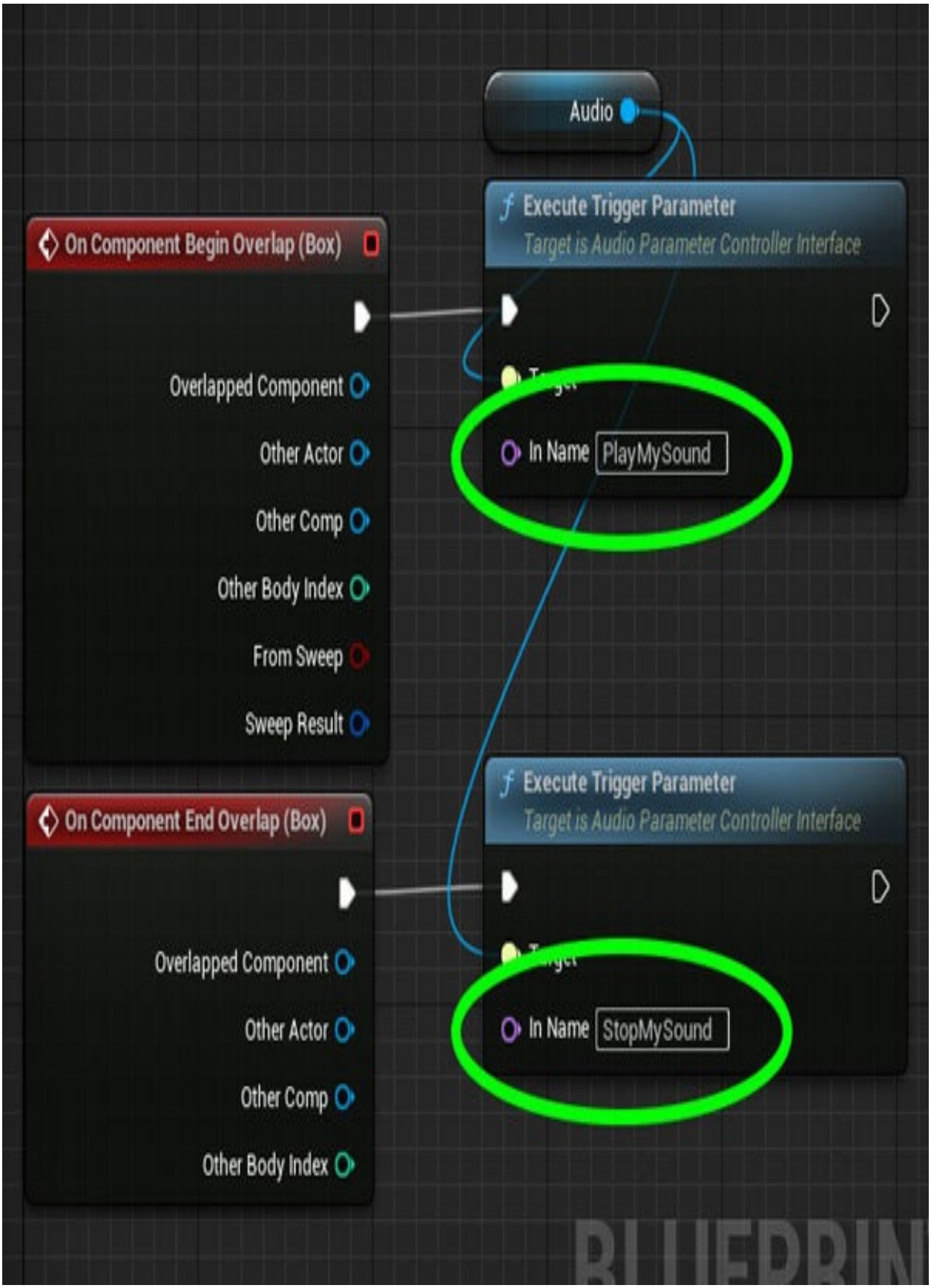

Audio
Execute Trigger Parameter
Target is Audio Parameter Controller Interface
On Component Begin Overlap (Box)
Overlapped Component
Other Actor
Other Comp
Other Body Index
From Sweep
Sweep Result
In Name
PlayMySound
Execute Trigger Parameter
Target is Audio Parameter Controller Interface
On Component End Overlap (Box)
Overlapped Component
Other Actor
Other Comp
Other Body Index
In Name
StopMySound

Figure 11.39: Sending parameter to MetaSound objects. Keep in mind the parameter name must be the same as MetaSound parameters

Now, let’s increase our knowledge by making this functionality with a different approach. Open MetaSound, make new trigger called SetMyLoop and set its Type as Bool. Then, add this trigger to the editor and connect it to the Loop pin in Wave Player, as shown in Figure 11.40. This way, we can directly change the loop functionality for wave player, so we don’t need StopMySound anymore and can unpin it from Stop pin on WavePlayer:

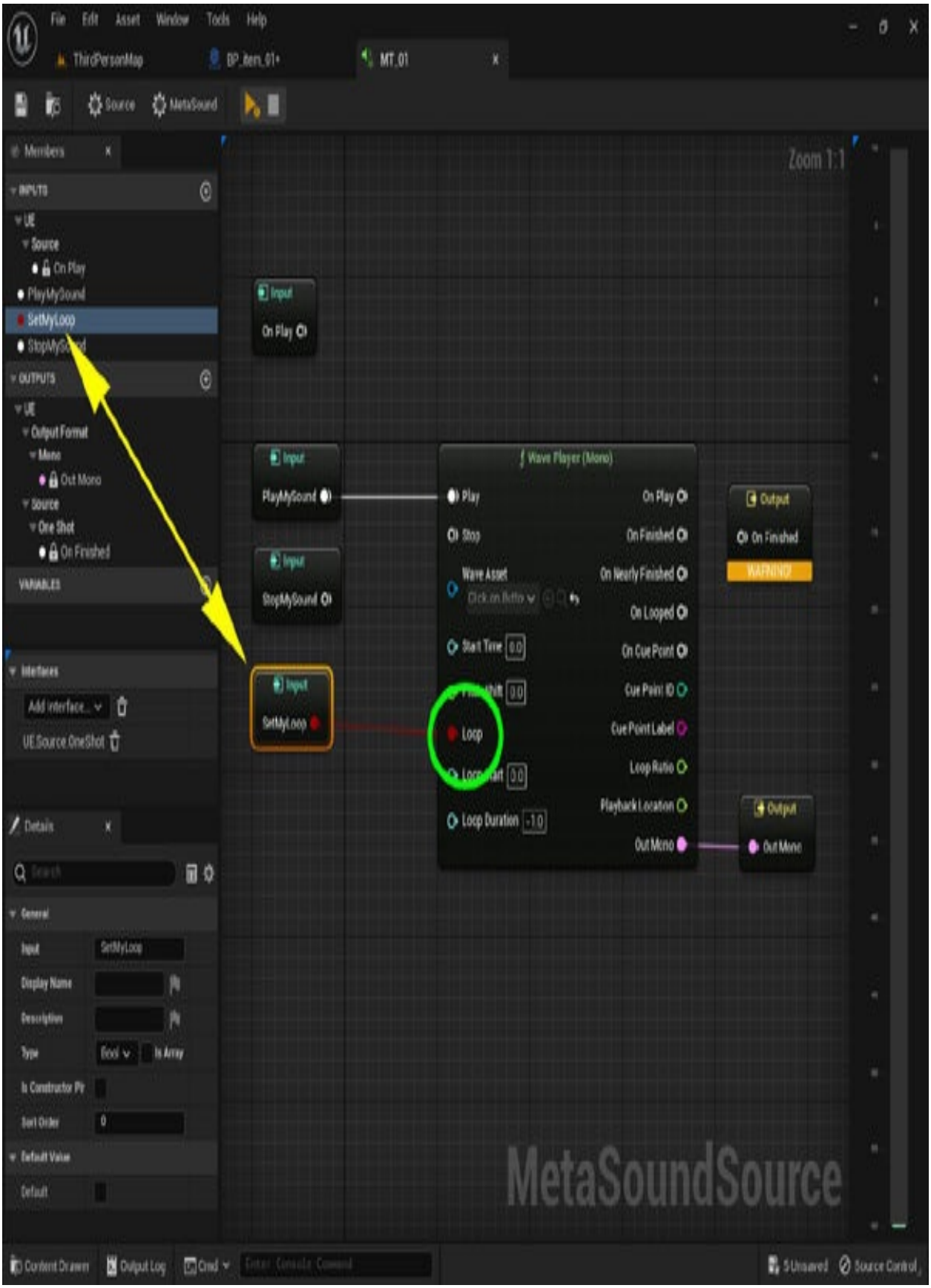

File Edit Asset Window Tools Help
ThirdPersonMap
BP_Item_01+
MT_01
Source
MetaSound
Members
INPUTS
UE
Source
On Play
PlayMySound
SetMyLoop
StopMySound
OUTPUTS
UE
Output Format
Mono
Out Mono
Source
One Shot
On Finished
VARIABLES
Interfaces
Add Interface...
UE.Source.OneShot
Details
General
Input
SetMyLoop
Display Name
Description
Type
Bool
Is Array
Is Constructor Pir
Sort Order
0
Default Value
Default
Zoom 1:1
Input
On Play
Input
PlayMySound
Input
StopMySound
Input
SetMyLoop
Wave Player (Mono)
Play
Stop
Wave Asset
Start Time
Loop
Loop Duration
On Play
On Finished
On Nearly Finished
On Looped
On Cue Point
Cue Point ID
Cue Point Label
Loop Ratio
Playback Location
Out Mono
Output
On Finished
WARNING!
Output
Out Mono
MetaSoundSource
Content Drawer
Output Log
Cmd
Enter Console Command
5 Unsaved
Source Control

Figure 11.40: Make new input trigger as “LoopCheck” and set its Type to bool. Drag and drop it to the editor and connect it to Loop pin on WavePlayer. Finaly, unpin the StopMySound trigger.

Open BP_item_01 again and assign Set Boolean Parameter blueprint node to the Audio component. This blueprint node will give you access to SetMyLoop bool parameter inside the MT_01 metasound object. Again, the In Name property is case sensitive, so you must put “exact” parameter names there. Also, call PlayMySound trigger after switch on the loop as shown in Figure 11.41.

Audio
Set Boolean Parameter
Target is Audio Parameter Controller Interface
Target
In Name
SetMyLoop
In Bool
Execute Trigger Parameter
Target is Audio Parameter Controller Interface
Target
In Name
PlayMySound
Overlapped Component
Other Actor
Other Comp
Other Body Index
From Sweep
Sweep Result
Set Boolean Parameter
Target is Audio Parameter Controller Interface
Target
In Name
SetMyLoop
In Bool
Overlapped Component
Other Actor
Other Comp
Other Body Index
BLUEPRINT

Figure 11.41: To access SetMyLoop bool parameter, click and add "Set Boolean Parameter" node and use exact name of bool parameter in the "InName" field.

Now, let's add a delay to this looping sound. Open MS_01 and unpin Loop and set it to false in WavePlayer, then and add the Trigger Delay node to the On Play pin in WavePlayer, as shown in Figure 11.42. This trigger gets activated (triggered) when the WavePlayer playing sound and generate delay in second based on an integer value in Delay Time field. But there is one problem here; how play the sound "again" to make this delayed loop working?

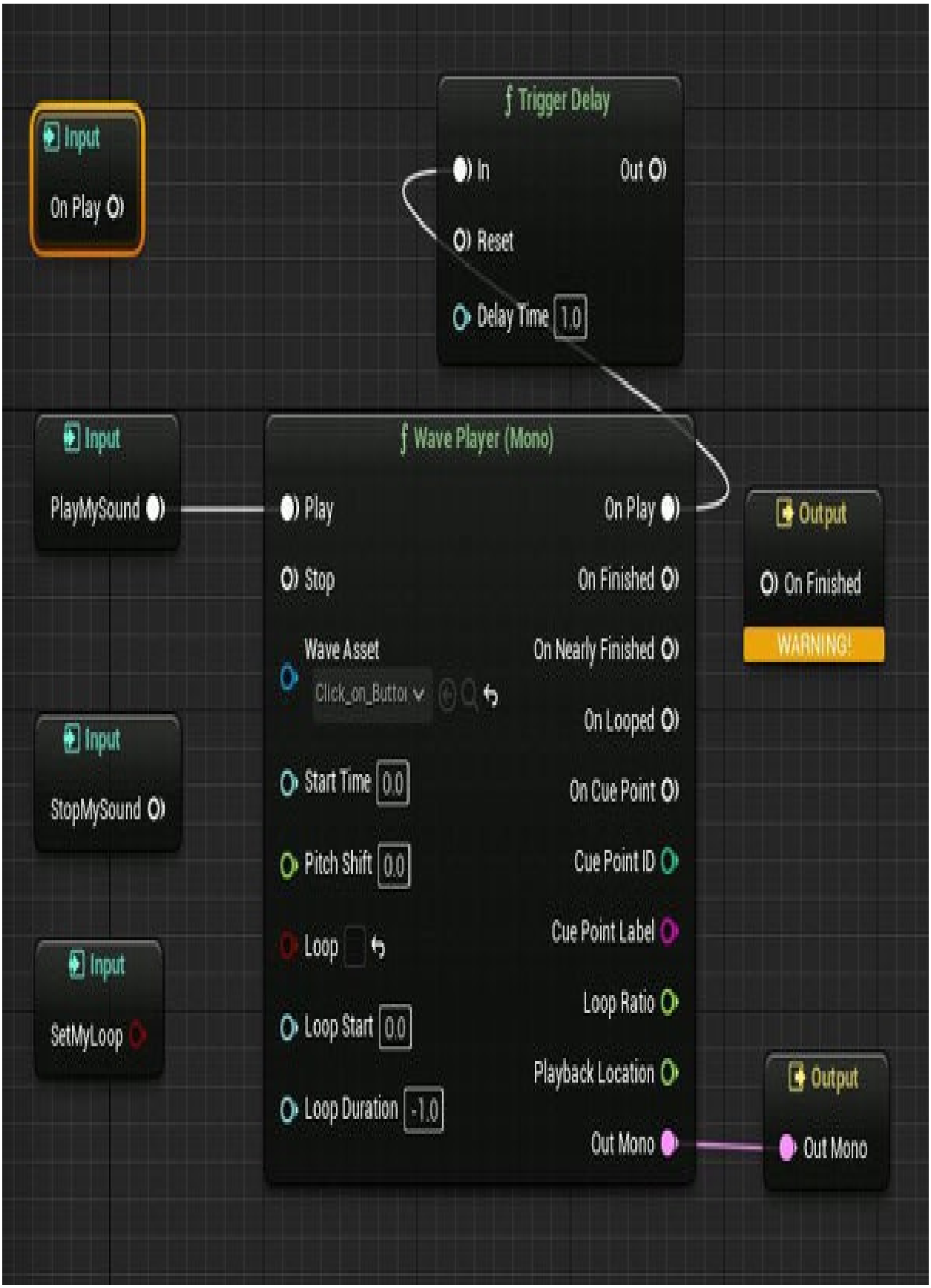

Input
On Play
Trigger Delay
In
Out
Reset
Delay Time
1.0
Input
PlayMySound
Wave Player (Mono)
Play
On Play
Stop
On Finished
Wave Asset
Click_on_Buttoı
On Nearly Finished
On Looped
Start Time
0.0
On Cue Point
Pitch Shift
0.0
Cue Point ID
Loop
Cue Point Label
Loop Start
0.0
Loop Ratio
Loop Duration
-1.0
Playback Location
Out Mono
Output
On Finished
WARNING!
Input
StopMySound
Input
SetMyLoop
Output
Out Mono

Figure 11.42: Add the Trigger Delay node to the On Play trigger pin and set Loop pin to false.

MetaSound has patterns for coding audio loops. One of these patterns is implement “feedback” inside the audio code. You can create a variable and use it like a trigger anywhere in the code (similar to events in actor blueprint). For solving our problem here, we need to activate the Play pin in WavePlayer again. Click and drag a line from Out pin of Trigger Delay node and select Promote To Graph Variable option from the list, as shown in Figure 11.43:

Classes with input of type 'Trigger'
Search
Add Reroute Node...
Promote To Graph Variable
Functions
Trigger Delay
In
Out
Reset
Delay Time
1.0
1
2
Wave Player (Mono)
On Play
On Finished
On Nearly Finished
On Looped
On Cue Point
Cue Point ID
Cue Point Label
0.0
0.0

Figure 11.43: Click and drag from “Out” pin in “Trigger Delay” node (1) and select “Promote to Graph Variable” from the list (2).

The metasound will automatically create a variable and add it to VARIABLES panel. Click on it and rename it to Out_01 as shown in Figure 11.44:

OUTPUTS
UE
Output Format
Mono
Out Mono
Source
One Shot
On Finished
Output
VARIABLES
Out_01
Interfaces
Add Interface...
UE.Source.OneShot
Details
Search
Variable
Out_01
Type
Trigger
Trigger Delay
In
Out
Reset
1.0
Out_01
Wave Player (Mono)
Play
On Play
Stop
On Finished
Wave Asset
On Nearly Finished
On Looped
Start Time
0.0
On Cue Point
Pitch Shift
0.0
Cue Point ID
Loop
Cue Point Label
Loop Start
0.0
Loop Ratio
Loop Duration
-1.0
Playback Location
Out Mono
Output
On Finished
WARNING!
Output
Out Mono

Figure 11.44: Click on new variable and rename it to “Out_01”.

Now, we need to use Out_01 as a trigger on Play pin in WavePlayer, in order to repeat the sound. By using Trigger Any node, you can grab multiple triggers as input and activate an output trigger if any of them get triggered. As image Fig 11:45 shows, we add Trigger Any (2) node and connect our PlayMySound trigger to it as first input. Now anytime PlayMySound get triggered, the sound will be played.

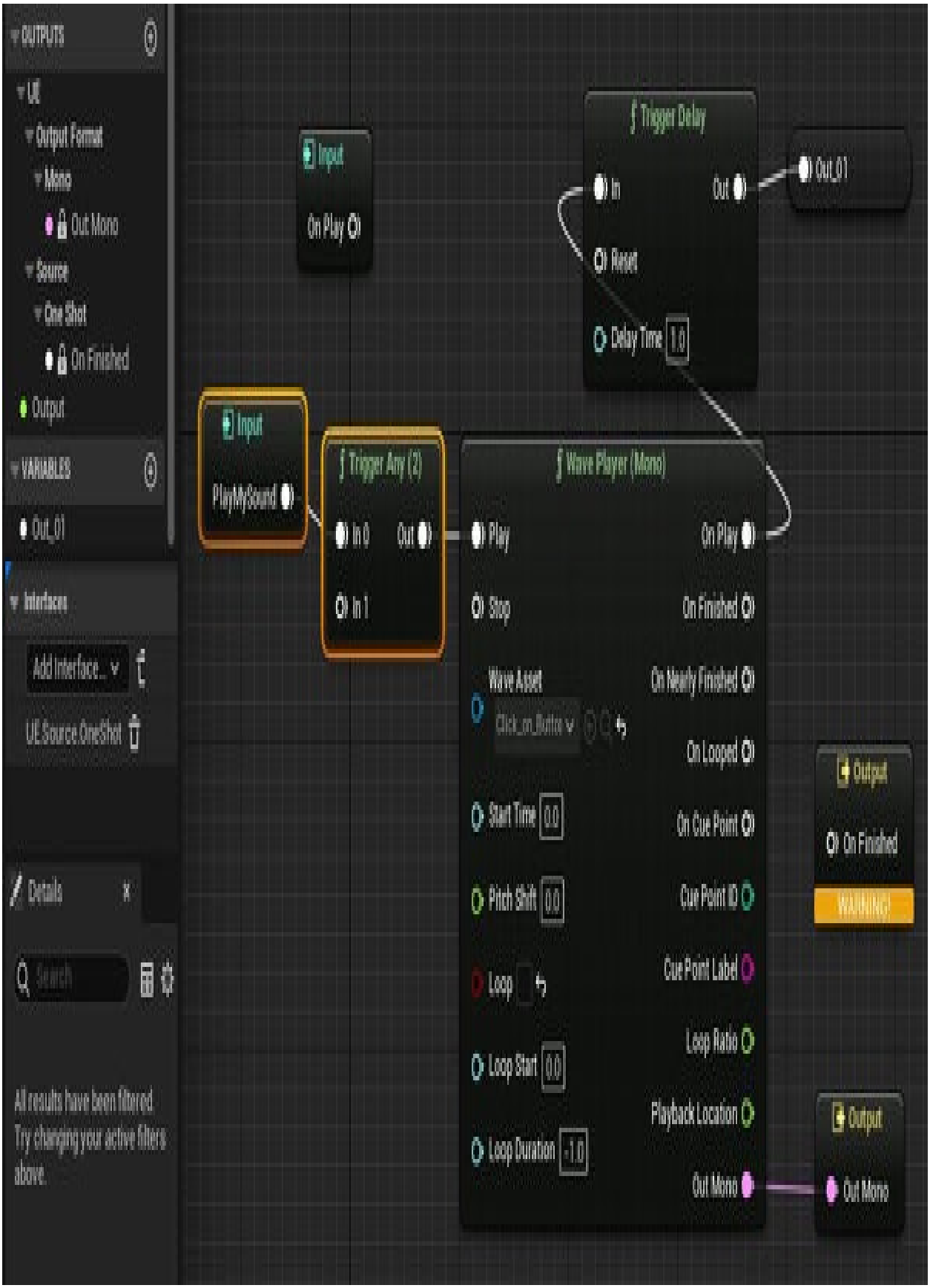

OUTPUTS
UE
Output Format
Mono
Out Mono
Source
One Shot
On Finished
Output
VARIABLES
Out_01
Interfaces
Add Interface...
UE.Source.OneShot
Details
Search
All results have been filtered.
Try changing your active filters above.
Input
On Play
Trigger Delay
In
Out
Reset
Delay Time
1.0
Out_01
Input
PlayMySound
Trigger Any (2)
In 0
Out
In 1
Wave Player (Mono)
Play
Stop
Wave Asset
Click_on_Button
Start Time
0.0
Pitch Shift
0.0
Loop
Loop Start
0.0
Loop Duration
-1.0
On Play
On Finished
On Nearly Finished
On Looped
On Cue Point
Cue Point ID
Cue Point Label
Loop Ratio
Playback Location
Out Mono
Output
On Finished
WARNING!
Output
Out Mono

Figure 11.45: Click on new variable and rename it to “Out_01”.

At this stage we already address PlayMySound trigger, and we need to add another trigger to Trigger Any (2) node in order to make the feedback working, and play the loop. We can use Out_01 variable as a trigger. As you see in Fig 11:46, drag and drop Out_01 variable in to the editor has numbers of extra options. Normal drag and drop makes a default reference to variable. Using Alt on keyboard will create a reference to delayed version of variable (which we will use). By holding Shift on keyboard and drag, we can “set” the trigger and is available only once per variable. By holding Ctrl on keyboard and drag, the editor will highlight all instances of that variable in the editor which is handy to find them in complex graph of code. We need to use delayed version of variable because this version will automatically be triggered by engine “after” very small delay. As you see, there is a clock like icon over delayed variable to make them separate from default ones.

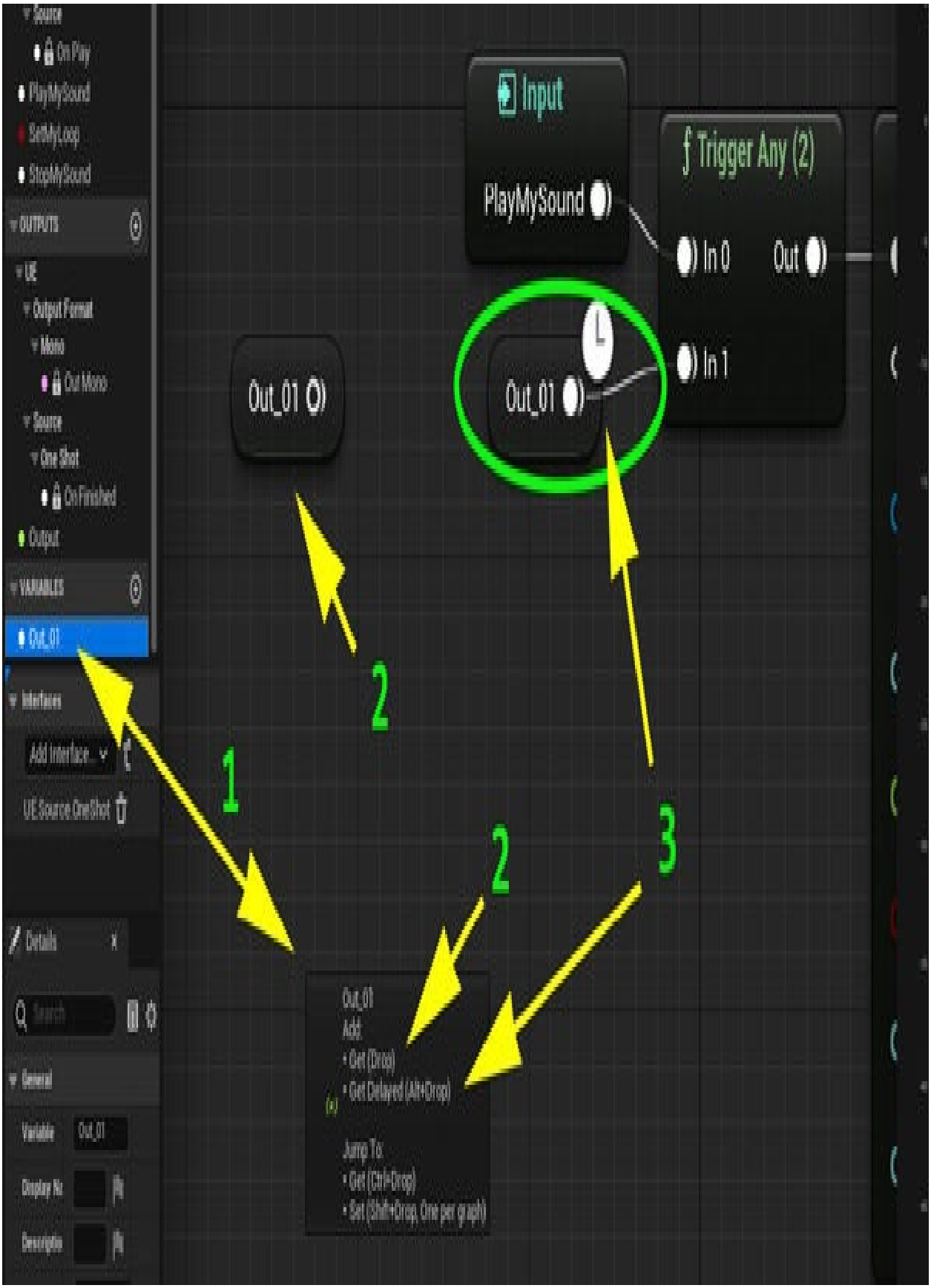

Source
On Play
PlayMySound
SetMyLoop
StopMySound
OUTPUTS
UE
Output Format
Mono
Out Mono
Source
One Shot
On Finished
Output
VARIABLES
Out_01
Interfaces
Add Interface...
UE.Source.OneShot
Details
General
Variable
Out_01
Display Na
Description
Input
PlayMySound
Trigger Any (2)
In 0
Out
In 1
Out_01
Out_01
1
2
2
3
Out_01
Add:
• Get (Drop)
• Get Delayed (Alt+Drop)
Jump To:
• Get (Ctrl+Drop)
• Set (Shift+Drop, One per graph)

Figure 11.46: Drag and drop the variable in the editor(1) by default creates a referenced to variable (2), but, if hold Alt key on keyboard and drag and drop to editor (3), then we have a reference to delayed variable.

Now run the game and the sound should be heard as loop with 1 second delay. To stop the sound after player, leave collision box, we can use SetMyLoop bool value with a compare node.

Right click in the editor and type “trigger compare”. The editor will give you 3 types of compare node for bool, float and int32 variables. We can use bool node for checking SetMyLoop trigger, so select Trigger Compare (Bool) node. This node has two input pin as A and B, and this node compare these two and trigger True and False output triggers as result. So as Fig 11.47 shows, we set pin A to true, and compare it with trigger SetMyLoop which is connected to pin B.

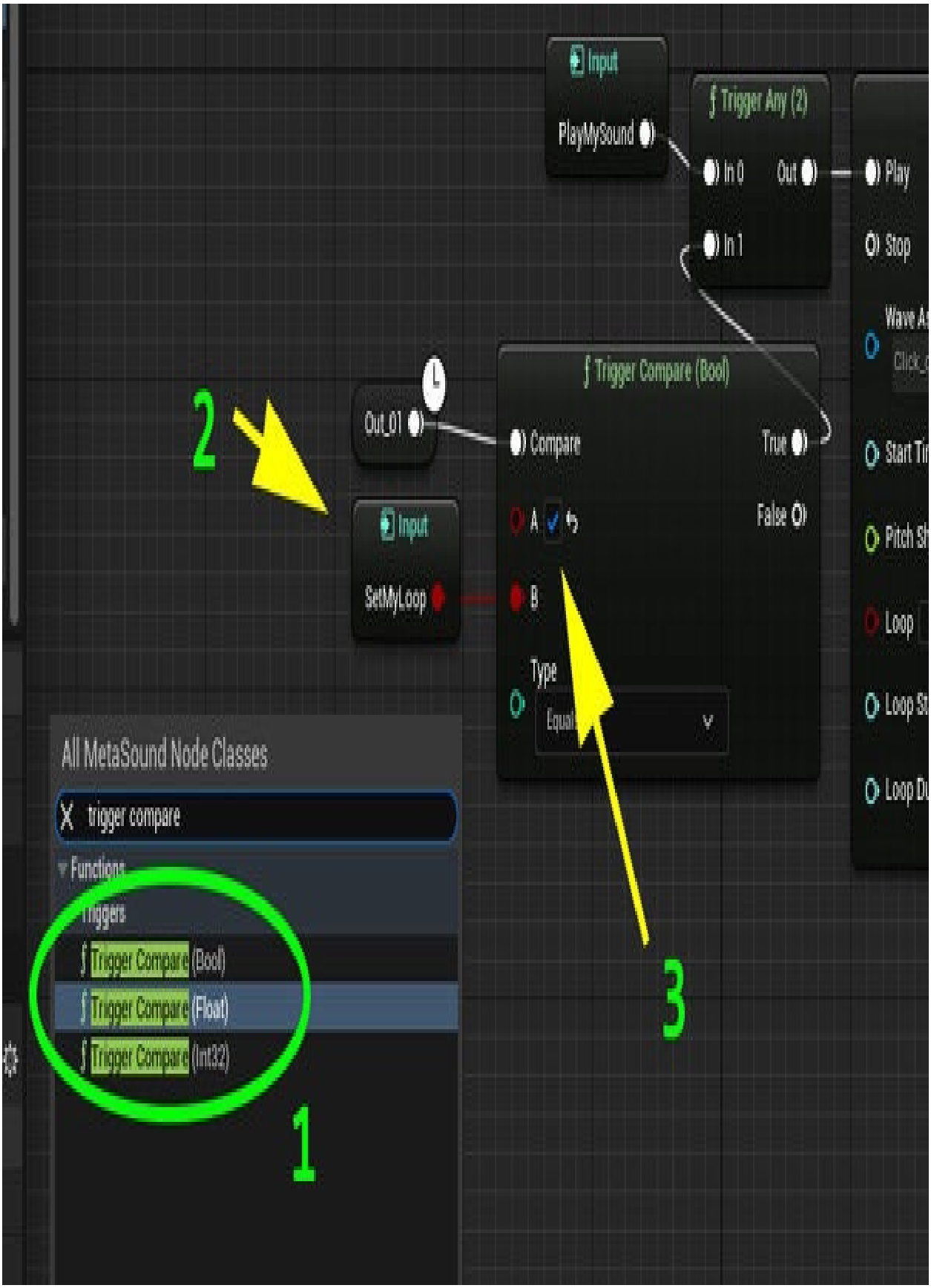

Input
PlayMySound
Trigger Any (2)
In 0
Out
In 1
Play
Stop
Trigger Compare (Bool)
Out_01
Compare
True
A
False
Input
SetMyLoop
B
Type
Loop
All MetaSound Node Classes
trigger compare
Functions
Triggers
Trigger Compare (Bool)
Trigger Compare (Float)
Trigger Compare (Int32)
1
2
3

Figure 11.47: Right click in the editor and type “trigger compare”(1). Then add “Trigger Compare(Bool)” and connect “SetMyLoop” bool trigger to pin “B” on it (2) and set “A” pin to true (3).

After running the game, when SetMyLoop is equal to true, the True output pin will be triggered and we have a looped sound. But in case if it is false, the compare node will activate the False trigger output and as previous image shows, it is not connected to any other node, so in result the looping sound will stop playing.

Like actor blueprint, we have a node in metasound editor to print debug message in output log panel in main editor. Actor blueprints use Print String node, and metasound use Print Log node to print debug messages. This node has an input trigger to activate it, an input string text field known as Label to add extra note, and another input pin known as Value To Log which depends on type can be bool, float, int32 or string. Fig 11.48 demonstrates using Print Log(Bool) to print value of SetMyLoop on each loop.

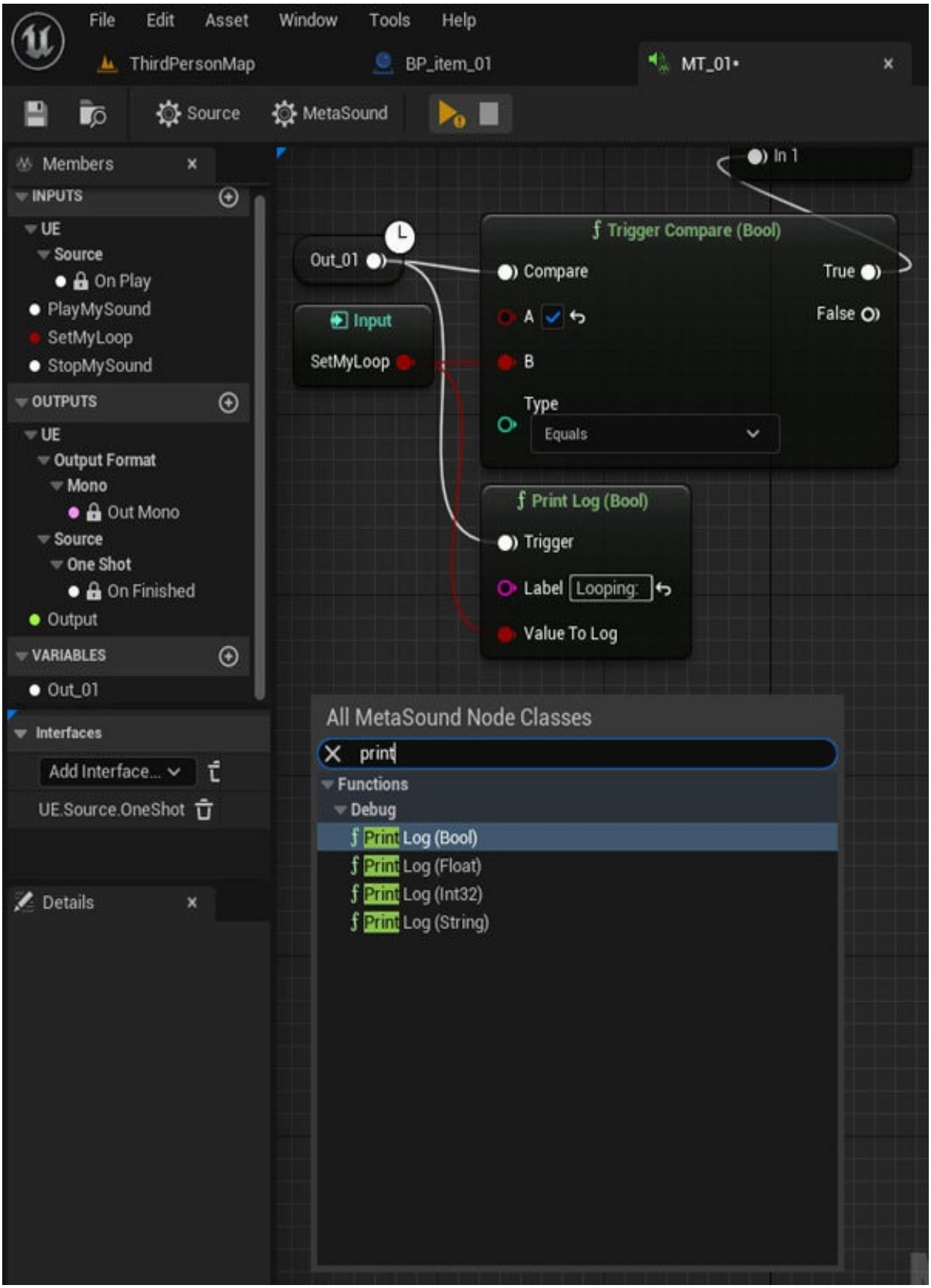

File
Edit
Asset
Window
Tools
Help
ThirdPersonMap
BP_item_01
MT_01*
Source
MetaSound
Members
INPUTS
UE
Source
On Play
PlayMySound
SetMyLoop
StopMySound
OUTPUTS
UE
Output Format
Mono
Out Mono
Source
One Shot
On Finished
Output
VARIABLES
Out_01
Interfaces
Add Interface...
UE.Source.OneShot
Details
In 1
Out_01
Input
SetMyLoop
Trigger Compare (Bool)
Compare
True
A
False
B
Type
Equals
Print Log (Bool)
Trigger
Label
Looping:
Value To Log
All MetaSound Node Classes
print
Functions
Debug
Print Log (Bool)
Print Log (Float)
Print Log (Int32)
Print Log (String)

Figure 11.48: Right click in editor and type print and then choose "PringLog(Bool)"and connect it to "Out_01" trigger and "SetMyLoop" bool trigger.

You can check the output of Print Log(Bool) in the editor in output log panel as shown in Fig 11.49 by running the game and interact with BP_item_01 collision box.

Content Browser | Output Log | X

Search Log | Filters

```
LogMetaSound: Display: [MT_01]: Looping:   true
LogMetaSound: Display: [MT_01]: Looping:   true
LogMetaSound: Display: [MT_01]: Looping:   true
LogMetaSound: Display: [MT_01]: Looping:   false
LogMetaSound: Display: [MT_01]: Looping:   true
LogMetaSound: Display: [MT_01]: Looping:   true
LogMetaSound: Display: [MT_01]: Looping:   true
LogMetaSound: Display: [MT_01]: Looping:   false
```

Figure 11.49: Printing log notes in "Output Log" panel in main editor with values from metasound object at runtime.

There are more details about setting and coding patterns in MetaSound, which meet much dedicated book to this topic. At this stage, we have learned how to create MetaSound object, play an audio asset by using it, make triggers and parameters inside it, and use them to communicate with blueprint actors. Also, we have learned how to invoke triggers inside the MetaSound object by using delayed variable and derive logical procedures based on bool triggers. These are basic skills that will help you to research and practice more about MetaSound coding patterns in Unreal Engine 5.

Conclusion

The harmony between visual effects and sound is always a memorable feature of any game. It doesn’t matter if the game is simple or belongs to a franchise. We went through the basics of Niagara, which provides powerful tools to generate and address a complex particle system inside game scene. We learned how to make parameters to control Niagara System and mix emitters to make complex visual effects. At the end, we went through MetaSound, which a unique feature of Unreal Engine 5. We learned how to generate and control sound effects inside the game scene at runtime by learning the basics of audio programming and practice different approaches.

Both Niagara and MetaSounds looks complex environment, but since we know the basics, the rest is research and development by making sample projects.

In the next chapter, we will learn about packaging and learn how to make the final product for target platforms like PC and Android. There, you can test and compare the quality of your sample projects on PC and phone device and make it more professional.

Points to remember

Use the .wav format for audio files before import to engine as audio asset.

Having complex static mesh or expensive material for static mesh when using Niagara Render is risky. You may need to research on how to optimize your mesh render cost or in case of material, simplify your shader code as much as you can.

MetaSound sometimes works unusually. The best way to fix this issue is by closing its editor, pressing Save All in content browser and then open it again.

MetaSound comes with numbers of audio-rate generators: Saw, Sine, Square, and Triangle, as shown in Figure 11.50 are classic examples. Each of these nodes supports controlling their frequency and modulating that frequency at audio rate (for FM synthesis). You can check other generators in “Function>Generators” from drop down blueprint node list in editor.

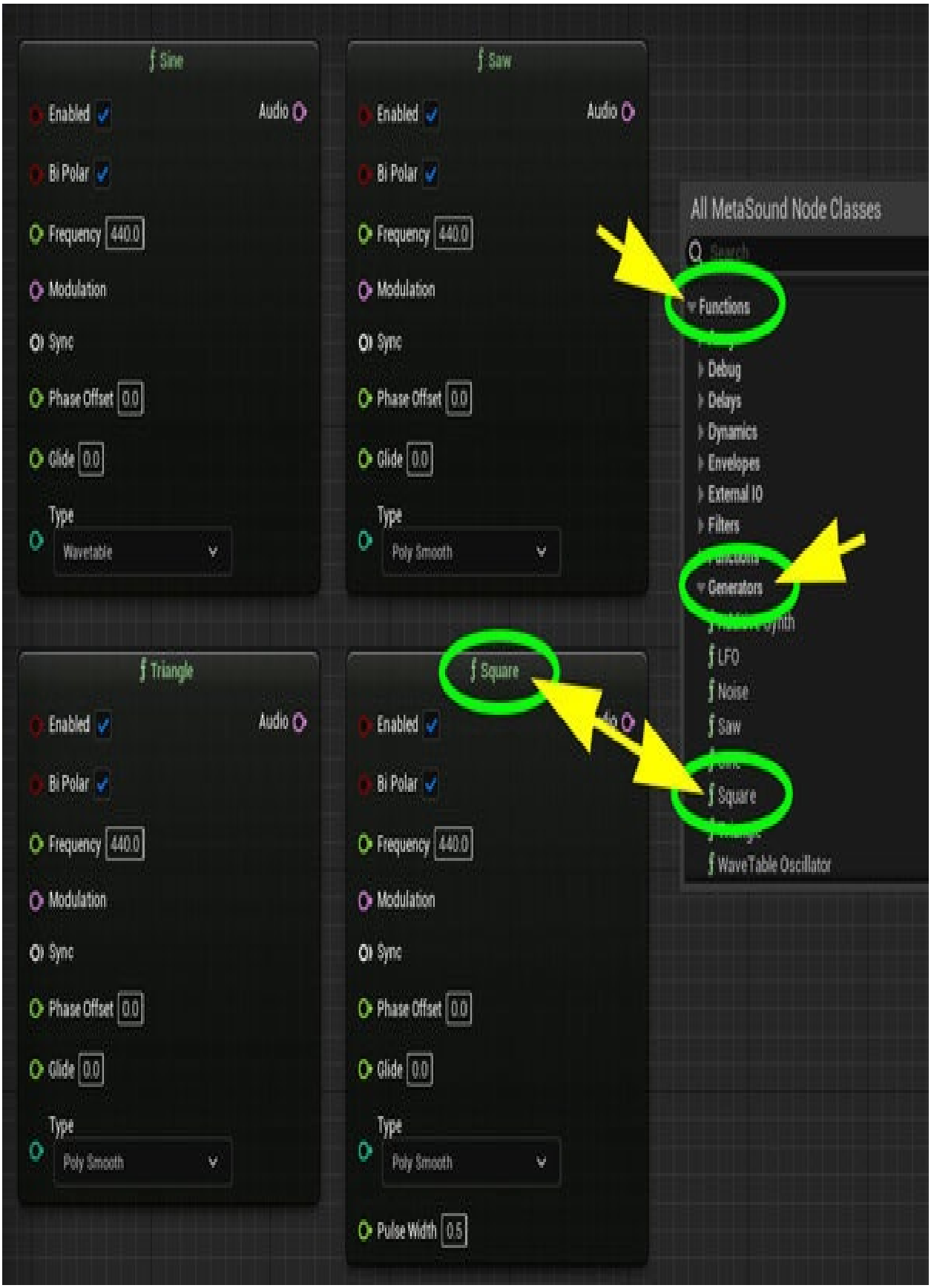

Sine
Enabled
Audio
Bi Polar
Frequency 440.0
Modulation
Sync
Phase Offset 0.0
Glide 0.0
Type
Wavetable
Saw
Enabled
Audio
Bi Polar
Frequency 440.0
Modulation
Sync
Phase Offset 0.0
Glide 0.0
Type
Poly Smooth
Triangle
Enabled
Audio
Bi Polar
Frequency 440.0
Modulation
Sync
Phase Offset 0.0
Glide 0.0
Type
Poly Smooth
Square
Enabled
Bi Polar
Frequency 440.0
Modulation
Sync
Phase Offset 0.0
Glide 0.0
Type
Poly Smooth
Pulse Width 0.5
All MetaSound Node Classes
Search
Functions
Debug
Delays
Dynamics
Envelopes
External IO
Filters
Generators
LFO
Noise
Saw
Square
WaveTable Oscillator

Figure 11.50: Classic audio-rate generators in MetaSound: Saw, Sine, Square, and Triangle. You can find more generators in "Function>Generators" after right click in editor.

Multiple choice questions

Why do we use Niagara System in Unreal Engine?

To add Niagara Emitters and control them by parameters

To make a particle system

Implement real-time visual effects in game scene

Options a, b and c are correct

Which of the following sentences aboutTriggerin MetaSound is correct?

It works like event in actor blueprints.

It handles receiving parameters of various data type from other objects.

It has series of special nodes to select, combine, compare, etc. in case of using numbers of triggers together.

Options a, b, c are correct.

Answers

d

d

Questions

What are your own system limitations (home or office) when you work with Niagara?

Why does Niagara Emitter’s Render sometime not show any visual output in the Preview panel?

Some external audio cards provide a wider range of audio tools for creating and processing real-time sound. How can this help MetaSound to provide complex real-time audio experience with Unreal Engine 5 when you make sound by using pure audio-rate generators?

What is the difference between Send and Receiver when we use Triggers in MetaSound object?

Key terms

Niagara - Niagara is Unreal Engine's VFX system to design and develop particle systems in application.

Renderer – Rendering any visual effect from Niagara is the function of Renderer.

Emitter - Niagara emitters are basically like a containers for other Niagara modules.

Modules - Niagara modules are the base level of Niagara VFX which present unique behavior and visualizations.

User parameter - An abstraction of data in a Niagara simulation which is defined by user.

MetaSound – Unique feature in Unreal Engine 5 to design and develop high-performance audio system that provides audio designers with complete control over a Digital Signal Processing (DSP) graph for the generation of sound sources.

Trigger – Trigger is a pin or series of pins on MetaSound`s blueprint blocks

to receive and send data or execution lines.

Set Boolean Parameter: Set a Boolean value in MetaSound by using its name.

Execute Trigger Parameter: Activate a trigger in MetaSound by using its name.

Delayed Variable: In MetaSound, developers can use a variable as a trigger. When they get triggered, the engine automatically trigger them as default and as a delayed version. The delayed version will triggered after a small value of time.

CHAPTER 12

Packaging

Each game engine has its own procedures and options to release a Built version of the project. The Built version of a project is an executable standalone application that users can run on their platform and observe its functionalities and interact with it during runtime. In Unreal Engine, the process of making and releasing the built version is known as Packaging . The engine will go through several processes that are customizable by the user to compile the source code, involve game assets, and make the executable version of the project at the end.

Structure

In this chapter, we will discuss the following topics:

Platforms and licensing

Plugins (Engine and Project Level)

Objectives

In this chapter, we will learn how to build and release a playable standalone game. We will learn the packaging method, review options and windows related to this process, and point out Android built and plugins options in project setting related to this topic.

Platforms and licensing

Platform in computer science is a digital environment that provides resources to run a software/app compatible with that platform. Each platform has its own features: some can provide cloud processing tools for the applications, some use virtual machine technologies to execute applications independently from local machines and some totally depend on it. For example, Microsoft Windows operating system family provide a platform for PC computers in which developers can create application and software and execute them by using Windows tools and resources on PC machines. Example of these applications are games, word processing, network management applications, graphic software, and so on.

Unreal Engine 5 supports a number of platforms to develop and run applications. As Figure 12.1 shows, by clicking on the vertical three-dots icon to the right of the Play button in the main editor, you will have access to a drop-down list of available platforms that you can run a preview of your game on.

By default, the engine has these options to preview game, which is listed in MODES of drop-down list:

Selected Viewport: The engine runs game inside the editor. By default, the mouse cursor will disappear, and the keyboard/controller is active in the game. You can hold shift and press F1 to release control of mouse and keyboard while the game is running.

Mobile preview (version & type): Mobile devices have less processing power

and graphic qualities than a normal PC. When you have heavy shaders or complex assets and want to check the quality for example in a mobile phone, the engine allows to run a mobile rendered playable preview of game in separate windows when you click on this option.

New Editor Windows: Instead of running the game inside the main editor, you can run it in a separate window by choosing this option.

VR Preview: In case of having a VR headset connected to your machine, the engine will preview the game inside the VR headset. Keep in mind this is just a preview, and in order to have a real VR game, you have to make your project from a VR template (refer to chapter # engines template) or develop a new one from scratch.

Standalone Game: The engine run one standard preview of game, based on your local machine features in separate window.

Simulate: When the engine previews the game in Simulate mode, the game is running and all game objects receive tick event at runtime, but the user interaction with game mouse and keyboard will not be taken into account. So, the user can click on each object and check its blueprint and monitor the execution line, variables, events, and so on inside the selected blueprint. At the same time, user is not allowed to edit any blueprint code because all event graphs are disabled. This is extremely important for debugging projects at runtime, and it’s highly recommended to be skillful on using Simulate mode when you develop a serious project with Unreal Engine.

Now, let’s see these Play options in the editor, as shown in Figure 12.1:

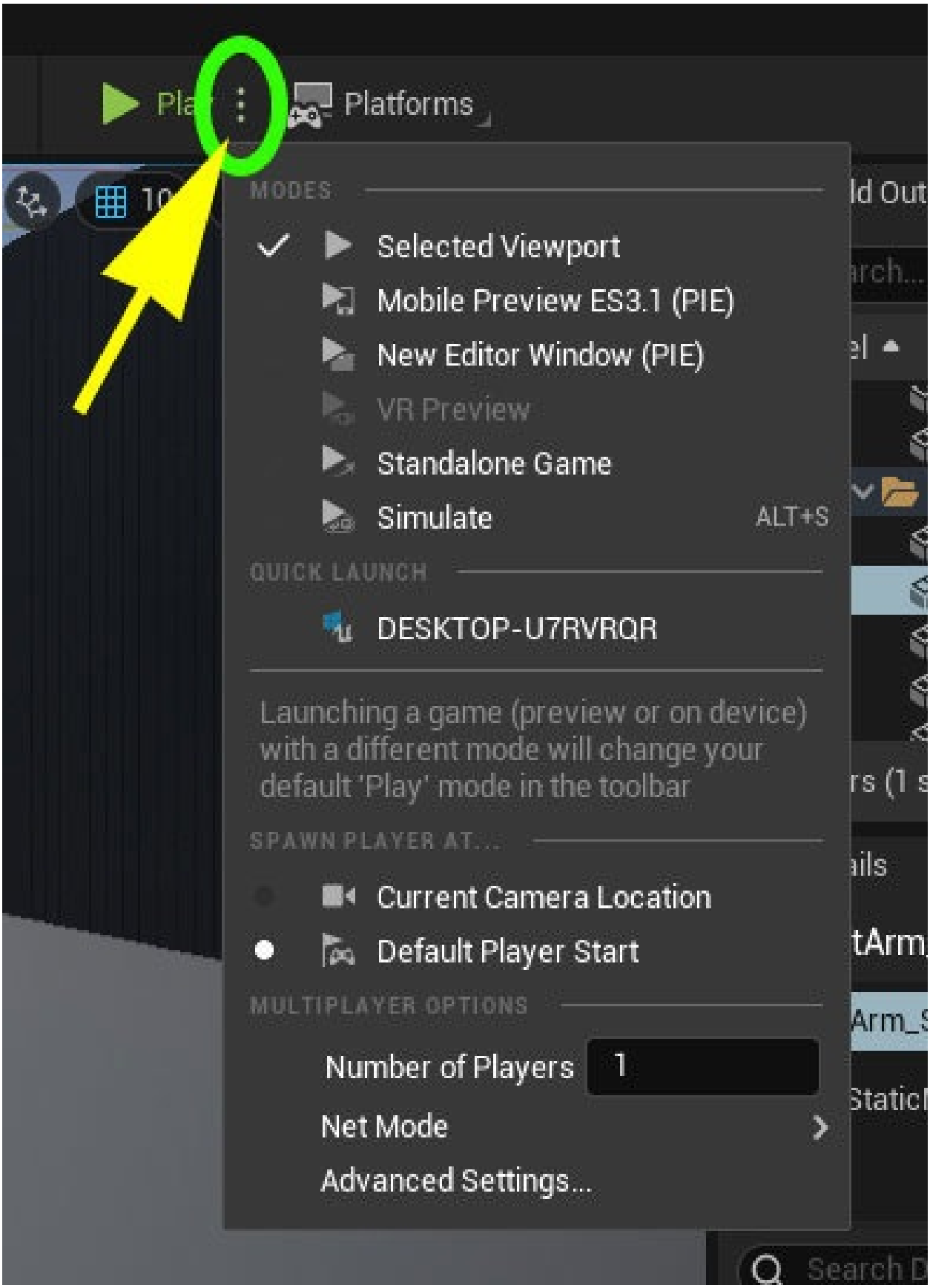

Platforms
MODES
Selected Viewport
Mobile Preview ES3.1 (PIE)
New Editor Window (PIE)
VR Preview
Standalone Game
Simulate
ALT+S
QUICK LAUNCH
DESKTOP-U7RVRQR
Launching a game (preview or on device) with a different mode will change your default 'Play' mode in the toolbar
SPAWN PLAYER AT...
Current Camera Location
Default Player Start
MULTIPLAYER OPTIONS
Number of Players
1
Net Mode
Advanced Settings...

Figure 12.1: Click on the vertical three-dots icon to the right of the Play button to expand play options

Let's get back to the Platform topic at the beginning. As you see, by using different Play options, the engine can preview and run the game/application in different platforms, but how can a PC machine run other platform previews? The answer is hidden in a toolkit known as Software Development Kit (SDK). The SDK is a set of digital tools mostly designed and published by platform manufacturers. For example, this SDK can provide services and support for making applications with Android, which is a public platform, for a number of mobile phones, VR headsets, and tablets. In order to develop/create a new application that can run with an Android platform, developers need to use Android SDK on their machine. The Android SDK adds a series of codes and libraries to support development and debug on local machine. This sounds pretty complex, but we don't need to be worried, since the engine has methods to grab SDKs and use them for target platform. Follow these steps to do that:

Click on Platform Icon in main editor, as shown in Figure 12.2. The drop-down list shows a number of platforms and by default, your machine is listed and is available to launch and run the game:

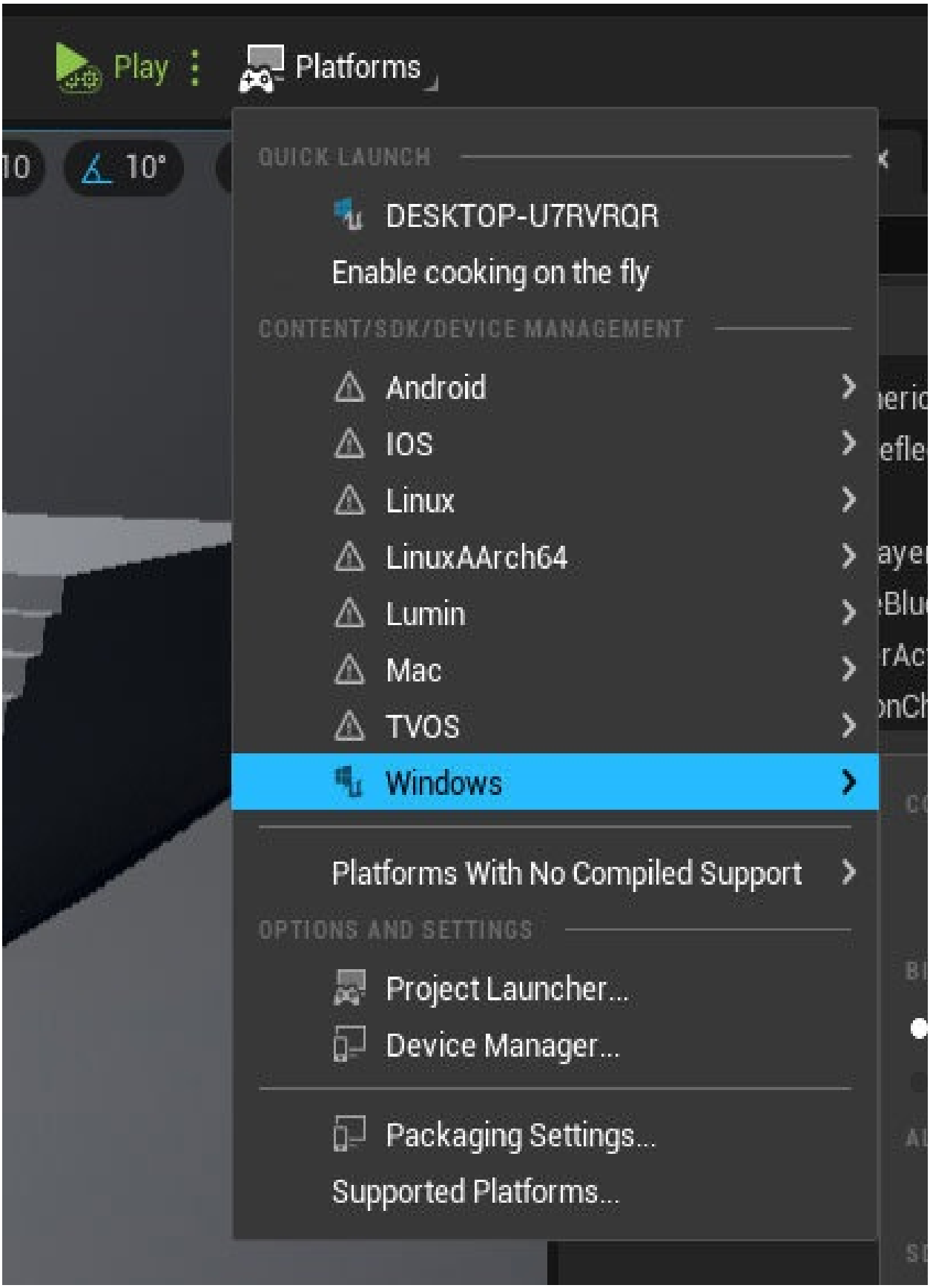

Play
Platforms
10°
QUICK LAUNCH
DESKTOP-U7RVRQR
Enable cooking on the fly
CONTENT/SDK/DEVICE MANAGEMENT
Android
IOS
Linux
LinuxAArch64
Lumin
Mac
TVOS
Windows
Platforms With No Compiled Support
OPTIONS AND SETTINGS
Project Launcher...
Device Manager...
Packaging Settings...
Supported Platforms...

Figure 12.2: Platforms drop-down menu

By clicking on the Project Launcher in the Platforms drop-down menu, the engine will automatically open project launcher windows. Here, users can assign projects to different platforms for testing, cook, debugging, and releasing shipping version.

As Figure 12.3 shows, the project launcher has two main panels. The top one shows the available platforms, and by pressing Advanced, you can see the details of the device where you want to deploy project builds. The bottom panel with title Custom Launch Profiles is designed to customize project built. Users can select default engine profiles by clicking on the small arrow or add new profile and customize it by clicking on the + icon:

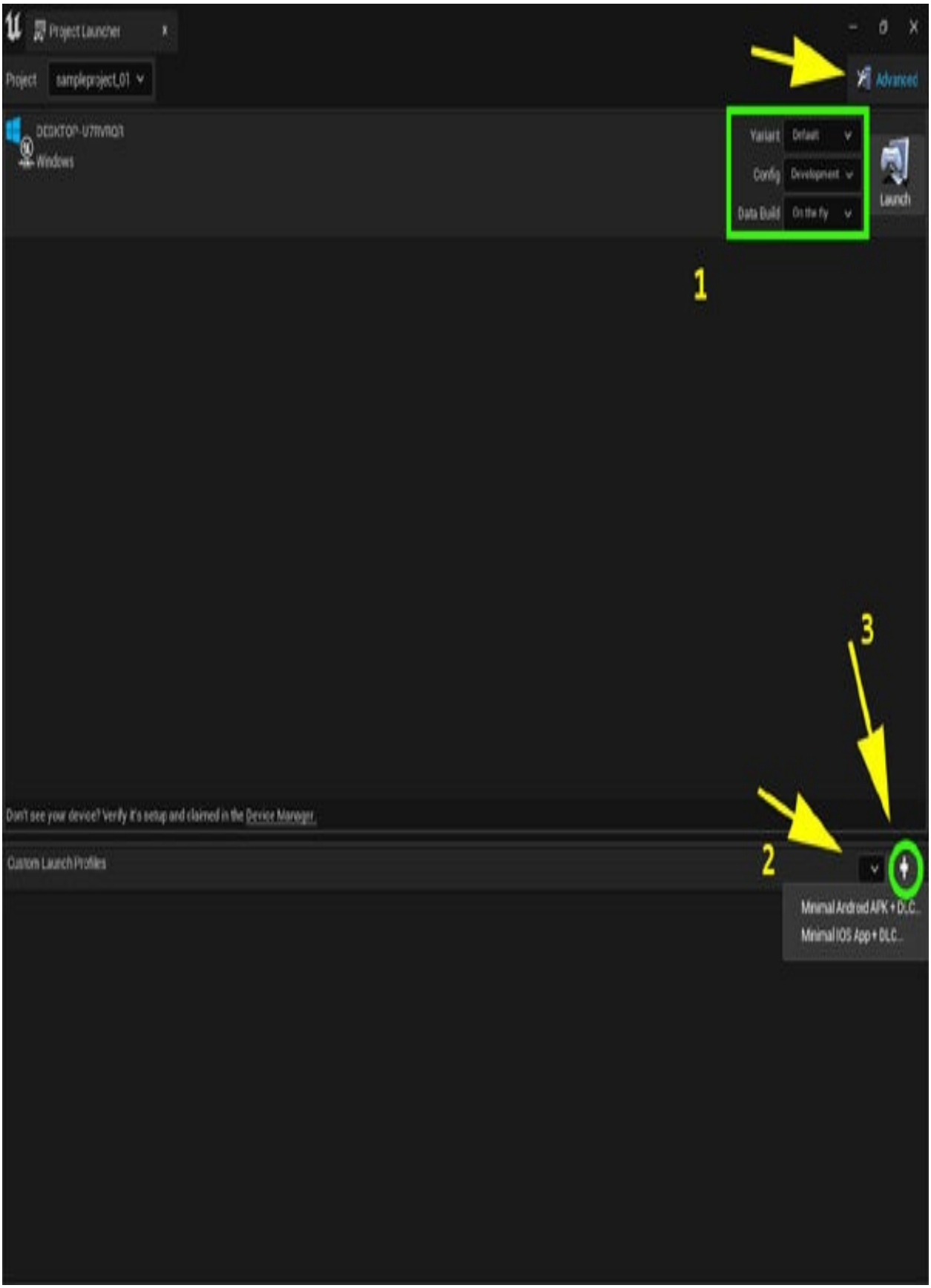

Project Launcher
Project
sampleproject_01
Advanced
DESKTOP-U7RVRQ3
Windows
Variant
Default
Config
Development
Data Build
On the fly
Launch
1
3
Don't see your device? Verify it's setup and claimed in the Device Manager.
Custom Launch Profiles
2
Minimal Android APK + DLC...
Minimal IOS App + DLC...

Figure 12.3: Click on Advanced button (1), then to assign engine's default launch profile click on the little arrow (2). Also, by pressing "+" icon (3), you can make a custom launch profile.

When the user clicks on the + icon, the engine opens a new profile page, and we can customize the Build, Package, Archive, Deploy and Launch properties of the project, as shown in Figure 12.4:

Project Launcher

New Profile 0

Enter a description here

Back

Project Which project would you like to use?

Project: sampleproject_01

Build Do you wish to build? Detect Automatically

Build Configuration: Development

Advanced Settings

Cook How would you like to cook the content? On the fly

Advanced Settings

Package How would you like to package the build? Do not package

Archive Do you wish to archive?

Deploy How would you like to deploy the build? Copy to device

This mode requires 'By The Book' cooking

Launch How would you like to launch? Using default role

Default Role

Launch As:

Standalone Client

Initial Culture:

en

Initial Map:

«default»

Additional Command Line Parameters:

Synchronize Screen Refresh Rate (vSync)

Figure 12.4: Custom launch profile screen

Click on Device Manager in the Platform drop-down menu, and the engine will open device manager window. By default, users have at least one device listed there (the machine who runs the engine). Click on the default device in Device Manager, as shown in Figure 12.5, and the engine automatically show details of that device plus a list of running processes that can be terminated by the user:

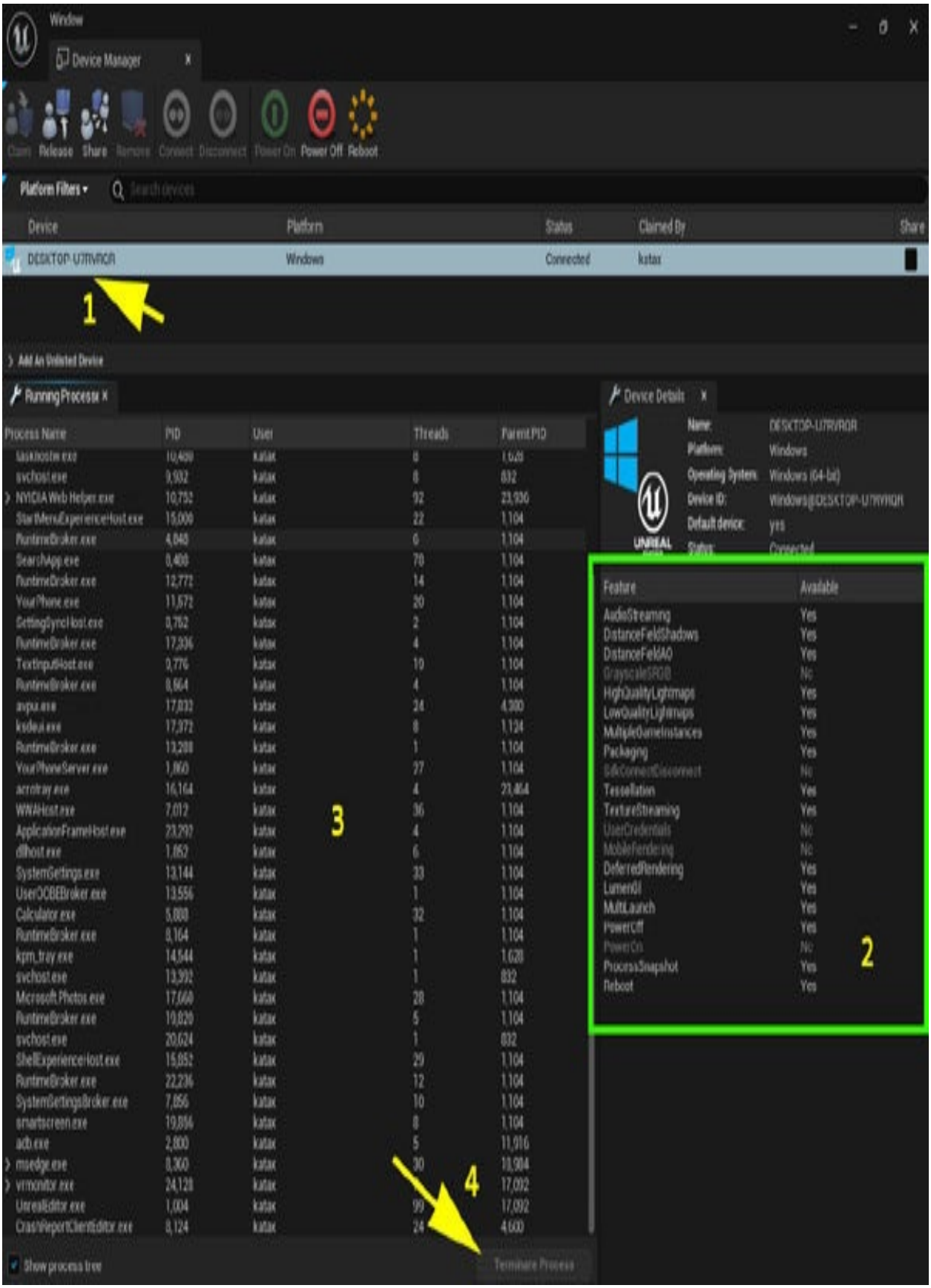

Window
Device Manager
Claim
Release
Share
Remove
Connect
Disconnect
Power On
Power Off
Reboot
Platform Filters
Search devices
Device
Platform
Status
Claimed By
Share
DESKTOP-U7RVRQR
Windows
Connected
katax
1
Add An Unlisted Device
Running Processes
Process Name
PID
User
Threads
Parent PID
svchost.exe
NVIDIA Web Helper.exe
StartMenuExperienceHost.exe
RuntimeBroker.exe
SearchApp.exe
YourPhone.exe
TextInputHost.exe
ksdeui.exe
YourPhoneServer.exe
acrotray.exe
WWAHost.exe
ApplicationFrameHost.exe
dllhost.exe
SystemSettings.exe
Calculator.exe
kpm_tray.exe
Microsoft.Photos.exe
ShellExperienceHost.exe
SystemSettingsBroker.exe
smartscreen.exe
adb.exe
msedge.exe
vmmonitor.exe
UnrealEditor.exe
CrashReportClientEditor.exe
3
4
Show process tree
Terminate Process
Device Details
Name:
DESKTOP-U7RVRQR
Platform:
Windows
Operating System:
Windows (64-bit)
Device ID:
Windows@DESKTOP-U7RVRQR
Default device:
yes
Status:
Connected
UNREAL
Feature
Available
AudioStreaming
Yes
DistanceFieldShadows
Yes
DistanceFieldAO
Yes
GrayscaleSRGB
No
HighQualityLightmaps
Yes
LowQualityLightmaps
Yes
MultipleGameInstances
Yes
Packaging
Yes
SdkConnectDisconnect
No
Tessellation
Yes
TextureStreaming
Yes
UserCredentials
No
MobileRendering
No
DeferredRendering
Yes
LumenGI
Yes
MultiLaunch
Yes
PowerOff
Yes
PowerOn
No
ProcessSnapshot
Yes
Reboot
Yes
2

Figure 12.5: Device Manager windows with list of devices (1), properties related selected platform (2), running processes related to it (3), and "Terminate Process" button (4) for terminating a process

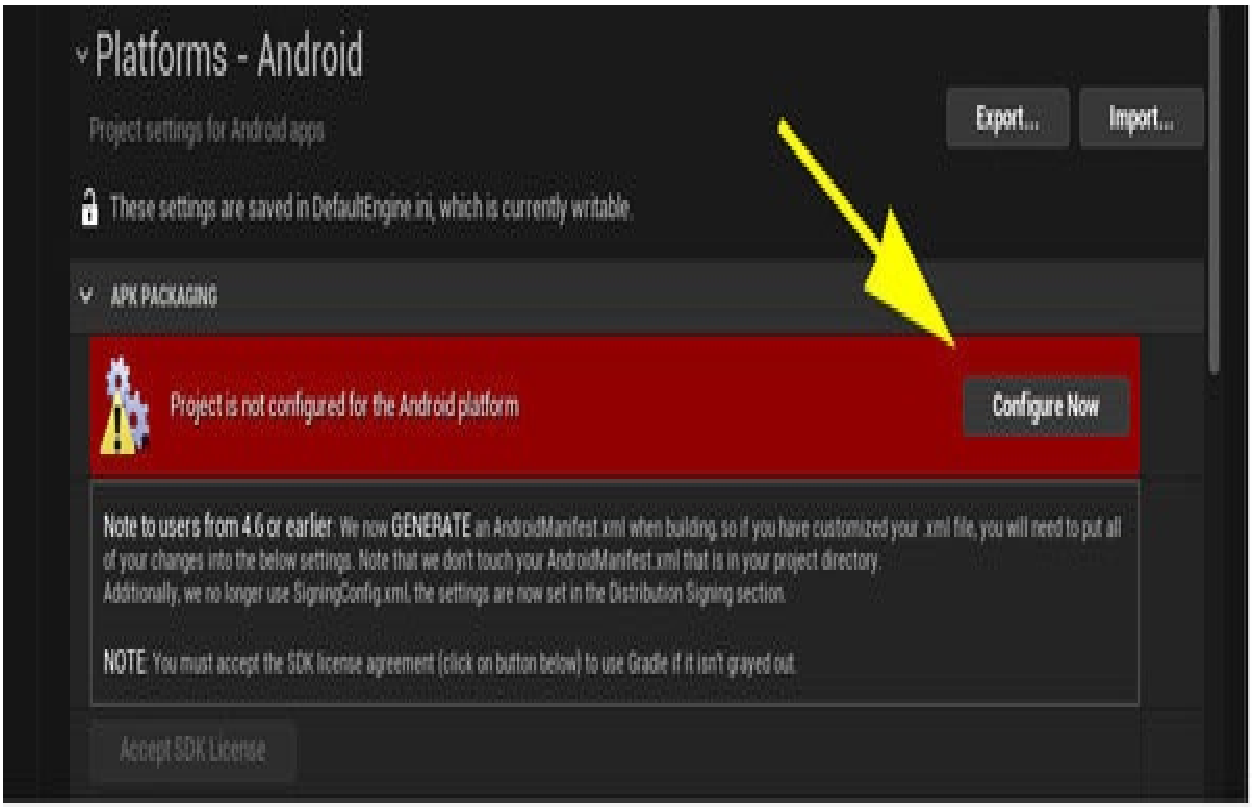
Click on Supported Platform, and the engine will open Project Setting (which is also available from Edit menu in main editor) and shows a list of available platforms for the project, as shown in Figure 12.6.

For example, if your game/application is made for only PC users, it is recommended to untick other platforms here and leave Windows ticked to simplify the packaging process. Now, refer to the topic Platform at the beginning of this section; you can see that there are a number of platforms that Unreal Engine 5 is able to support to make an interactive application. Android is one of most important platforms in this list, which, as we mentioned before, is used in a number of digital smart devices. Locate the Platforms title on the left side of the Project Setting window, as shown in Figure 12.6:

File
Edit
Window
Tools
Build
Help
sampleproject_01
Project Settings
Mesh Simplification
Paper2D - Import
Skeletal Mesh Simplification
Struct Viewer
Texture Import
Widget Designer (Team)
Platforms
Android
Android Material Quality - ES31
Android Material Quality - Vulkan
Android SDK
Android SM5 Material Quality - Vulkan
iOS
iOS Material Quality
Linux
Lumin Material Quality - Vulkan
Mac
Magic Leap
Magic Leap SDK
Windows
Plugins
AVF Media
GoogleVAD
IMG Media
Level Sequencer
Magic Leap Plugin
MagicLeapARPin Plugin
Niagara
Niagara Editor
OculusVR
Paper 2D
Search Details
All Platforms
Android
iOS
Linux
LinuxAArch64
Lumin
Mac
TVOS
Windows
1
2
Select the supported platforms for your project. Attempting to package, run, or cook your project on an unsupported platform will result in a warning.
Content Drawer
Cmd
Enter Console Command
Source Control Off

Figure 12.6: 1- Supported Platform list in Project Settings windows 2- Android SDK properties in Platforms

Now, click on Android and, as shown in Figure 12.7, there is a list of properties to customize the Android release of application. The first buttons you must click on are the Configure Now buttons, after which the engine will set the project for releasing in Android at background. The next one is Accept SDK License, which is grayed out by default:


Platforms - Android
Project settings for Android apps
Export...
Import...
These settings are saved in DefaultEngine.ini, which is currently writable.
APK PACKAGING
Project is not configured for the Android platform
Configure Now
Note to users from 4.6 or earlier: We now GENERATE an AndroidManifest.xml when building, so if you have customized your .xml file, you will need to put all of your changes into the below settings. Note that we don't touch your AndroidManifest.xml that is in your project directory.
Additionally, we no longer use SigningConfig.xml, the settings are now set in the Distribution Signing section.
NOTE: You must accept the SDK license agreement (click on button below) to use Gradle if it isn't grayed out.
Accept SDK License

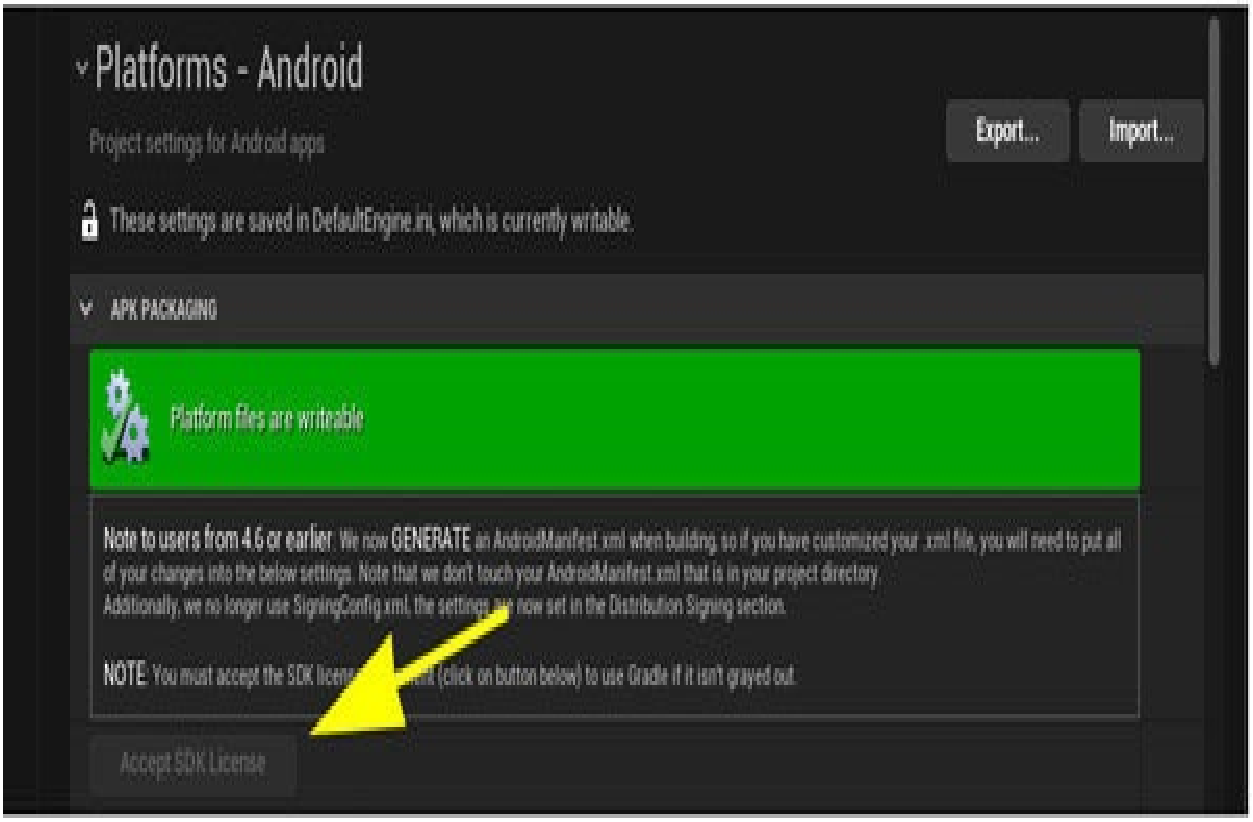

Platforms - Android
Project settings for Android apps
Export...
Import...
These settings are saved in DefaultEngine.ini, which is currently writable.
APK PACKAGING
Platform files are writable
Note to users from 4.6 or earlier: We now GENERATE an AndroidManifest.xml when building, so if you have customized your .xml file, you will need to put all of your changes into the below settings. Note that we don't touch your AndroidManifest.xml that is in your project directory.
Additionally, we no longer use SigningConfig.xml, the settings are now set in the Distribution Signing section.
NOTE: You must accept the SDK license agreement (click on button below) to use Gradle if it isn't grayed out.
Accept SDK License

Figure 12.7: Click on the "Configure Now" button to apply Android configuration to your project

To activate this button, we need to do licensing first. Licensing is an agreement between SDK provider and users who like to use the SDK and develop applications with it. or like to download and use the application developed with that SDK.

For example, when an application checks the licensing status with Google, their servers use a key that is uniquely associated with the application to support user and developers.

To use Android SDK, you must click on Android SDK, as shown in Figure 12.8, and then address the necessary resources from local drive. Then, switch back to the Android section, as shown in Figure 12.8, and click on Accept SDK License:

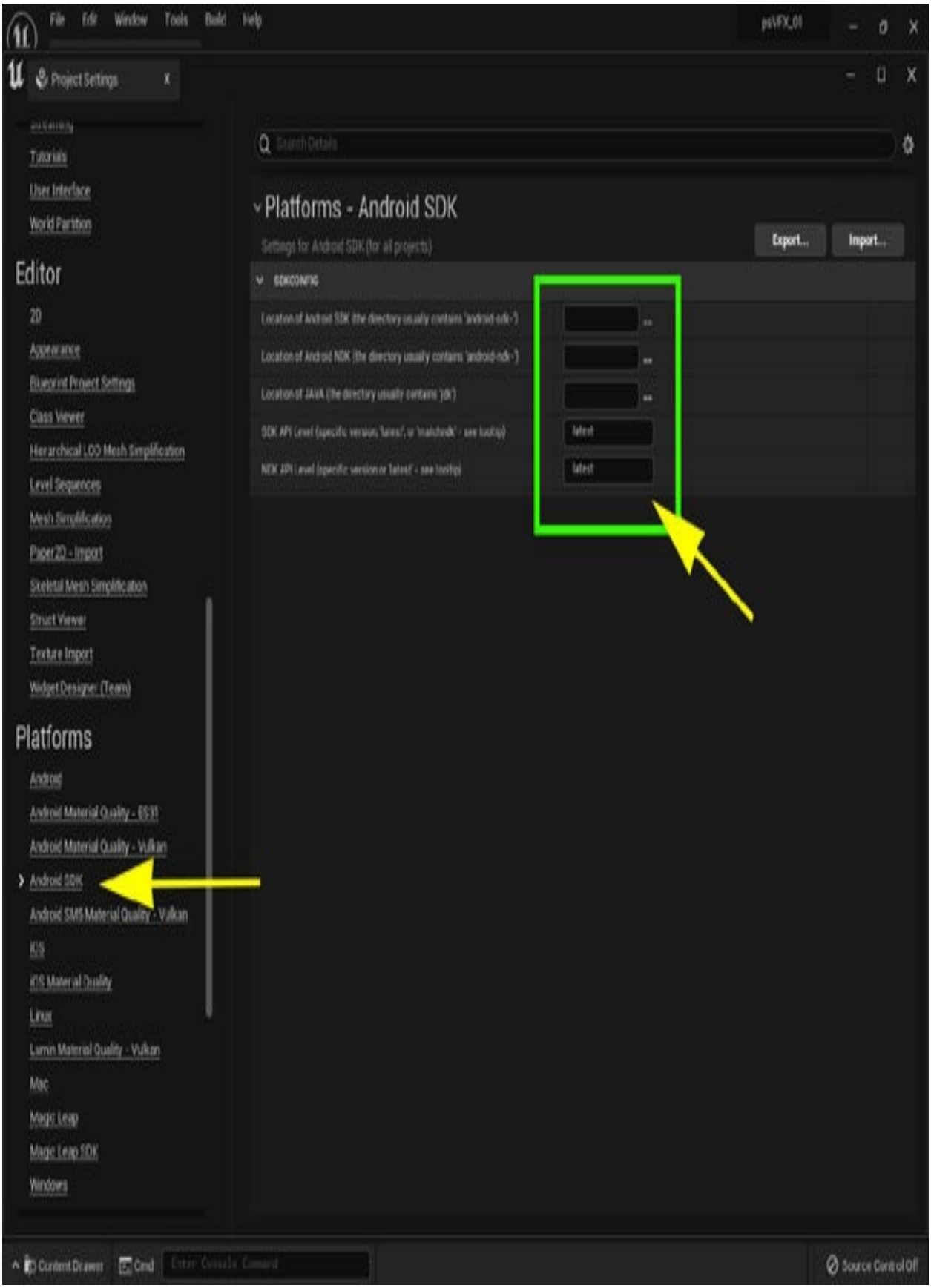

File
Edit
Window
Tools
Build
Help
Project Settings
Tutorials
User Interface
World Partition
Editor
2D
Appearance
Blueprint Project Settings
Class Viewer
Hierarchical LOD Mesh Simplification
Level Sequences
Mesh Simplification
Paper2D - Import
Skeletal Mesh Simplification
Struct Viewer
Texture Import
Widget Designer (Team)
Platforms
Android
Android Material Quality - GES
Android Material Quality - Vulkan
Android SDK
Android SM5 Material Quality - Vulkan
iOS
iOS Material Quality
Linux
Lumin Material Quality - Vulkan
Mac
Magic Leap
Magic Leap SDK
Windows
Platforms - Android SDK
Settings for Android SDK (for all projects)
Export...
Import...
SDKCONFIG
Location of Android SDK (the directory usually contains 'android-sdk-')
Location of Android NDK (the directory usually contains 'android-ndk-')
Location of JAVA (the directory usually contains 'jdk')
SDK API Level (specific version, 'latest', or 'matchndk' - see tooltip)
NDK API Level (specific version or 'latest' - see tooltip)
latest
latest
Content Drawer
Cmd
Enter Console Command
Source Control Off

Figure 12.8: Android SDK configuration

Plugins

Plugins are collections of data and code that users can easily enable or disable within the Editor on a per-project basis. They can modify built-in engine features (like MetaSound explained in Chapter 11, Audio and Particles), simplify and address complex instructions, create new file types, and add new menus or tool bar to editor to serve special order and more. You can get plugins from Marketplace or develop one by yourself. As Figure 12.9 shows, clicking on Settings and then on Plugins will make the engine open the Plugins window. Indeed, you can open this window from the Edit menu in editor:

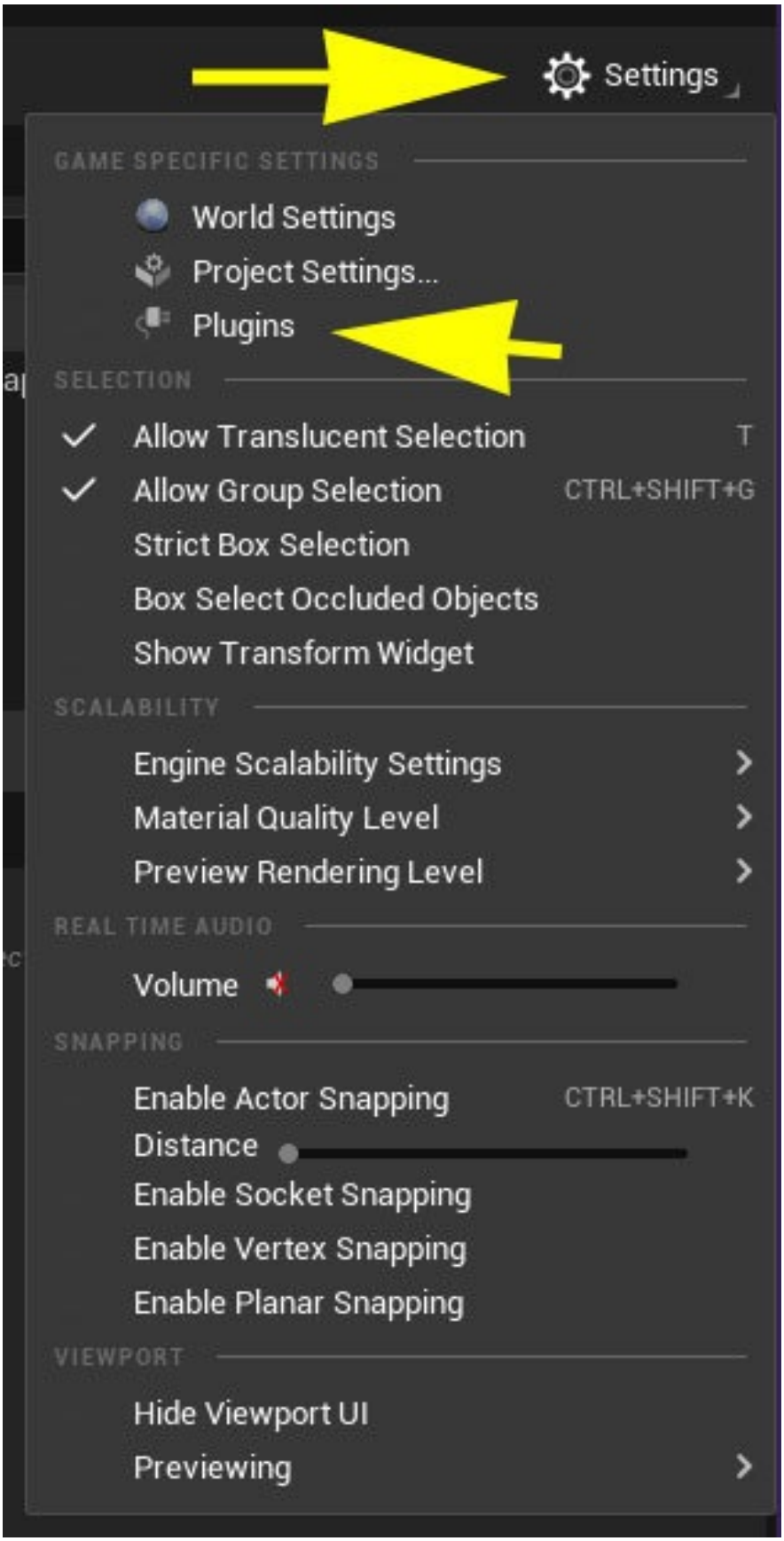

Settings
GAME SPECIFIC SETTINGS
World Settings
Project Settings...
Plugins
SELECTION
Allow Translucent Selection T
Allow Group Selection CTRL+SHIFT+G
Strict Box Selection
Box Select Occluded Objects
Show Transform Widget
SCALABILITY
Engine Scalability Settings
Material Quality Level
Preview Rendering Level
REAL TIME AUDIO
Volume
SNAPPING
Enable Actor Snapping CTRL+SHIFT+K
Distance
Enable Socket Snapping
Enable Vertex Snapping
Enable Planar Snapping
VIEWPORT
Hide Viewport UI
Previewing

Figure 12.9: Open Plugins from Setting icon

The Plugins window shows a list of Installed and Built-In plugins, as shown in Figure 12.10; a user can switch them by clicking on the Enabled tick box. After each switch, you must save and restart your project to activate or deactivate the plugin:

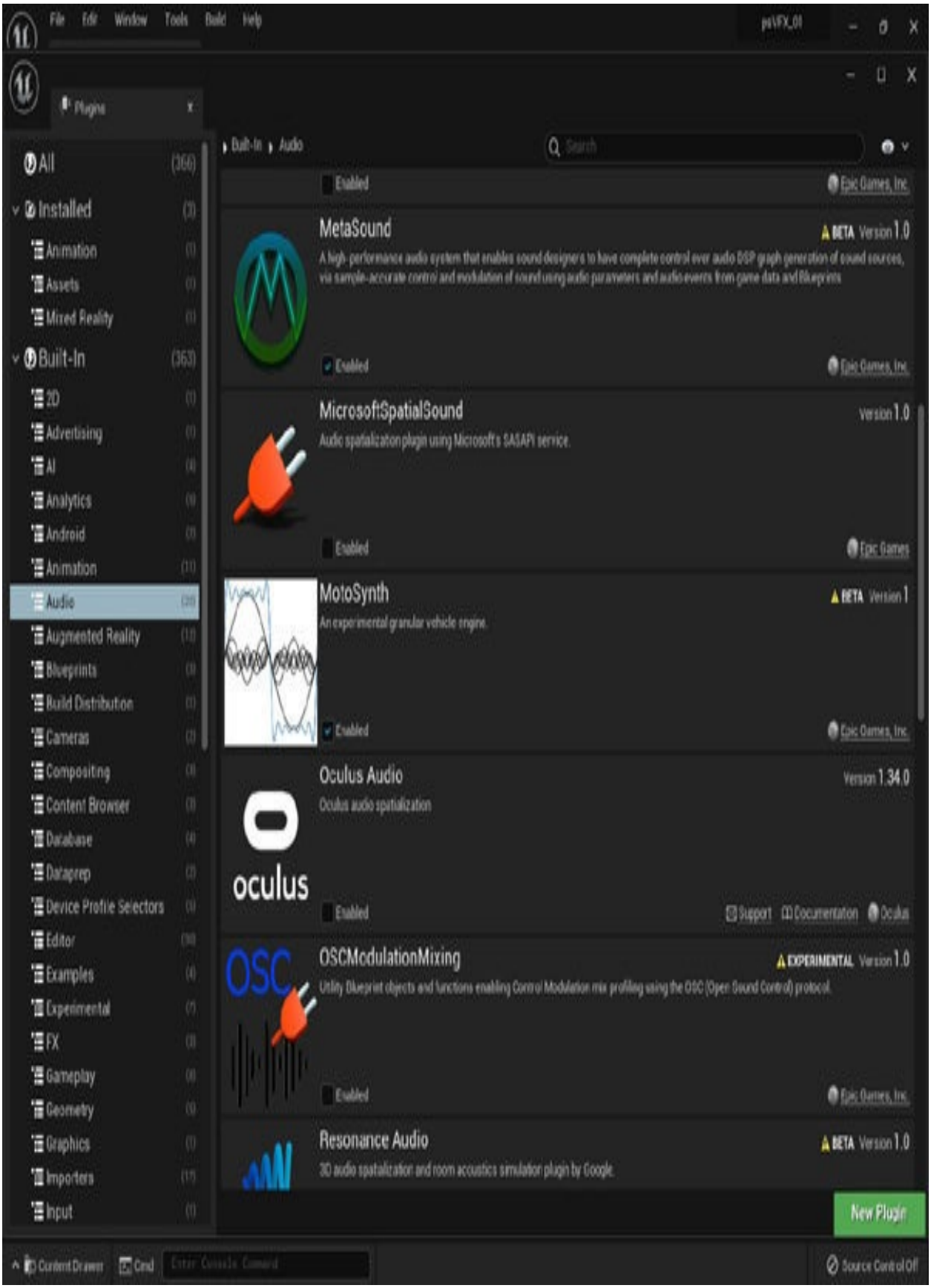

File Edit Window Tools Build Help
Plugins
All (366)
Installed (3)
Animation
Assets
Mixed Reality
Built-In (363)
2D
Advertising
AI
Analytics
Android
Animation
Audio
Augmented Reality
Blueprints
Build Distribution
Cameras
Compositing
Content Browser
Database
Dataprep
Device Profile Selectors
Editor
Examples
Experimental
FX
Gameplay
Geometry
Graphics
Importers
Input
Built-In › Audio
Enabled
Epic Games, Inc.
MetaSound
BETA Version 1.0
A high-performance audio system that enables sound designers to have complete control over audio DSP graph generation of sound sources, via sample-accurate control and modulation of sound using audio parameters and audio events from game data and Blueprints.
Enabled
Epic Games, Inc.
MicrosoftSpatialSound
Version 1.0
Audio spatialization plugin using Microsoft's SASAPI service.
Enabled
Epic Games
MotoSynth
BETA Version 1
An experimental granular vehicle engine.
Enabled
Epic Games, Inc.
Oculus Audio
Version 1.34.0
Oculus audio spatialization
oculus
Enabled
Support
Documentation
Oculus
OSC
OSCModulationMixing
EXPERIMENTAL Version 1.0
Utility Blueprint objects and functions enabling Control Modulation mix profiling using the OSC (Open Sound Control) protocol.
Enabled
Epic Games, Inc.
Resonance Audio
BETA Version 1.0
3D audio spatialization and room acoustics simulation plugin by Google.
New Plugin
Content Drawer
Cmd
Enter Console Command
Source Control Off

Figure 12.10: Plugins window

In Unreal Engine, there are two types of plugins:

The first one runs inside the engine and adds new functionality to it or improves existing ones, like the Steam VR plugin, which is designed to support Steam API communication with VR application.

The second type are used with game and are mostly designed to add new contents or simplify existing processes, depending on the scenario. For example, imagine you have to monitor the health bar for huge number of units inside a strategy game to use by tester team.

An example for first type is making a plugin to support new hardware like new VR headsets, new streaming data protocol, import and export data at runtime, using live cameras, etc. These plugins are designed to support communications between the engine and other data source which can be vital for the game or application developed by the Unreal Engine.

Example of second type can be creating a plugin to simplify the translucent materials using with static meshes in the scene. This plugin can increase the performance on devices like mobile phones which can’t handle transparent material by their graphic card. So, it`s obvious that this plugin will be active in game and also in final version because it adds new functionality and increased performance of game. Another example of second type is developed a plugin that is designed to automatically get the date from game objects and show them with a UI inside the game. This plugin will be useful for tester, and it will also

accelerate the testing process. This plugin is not necessary for game play and will be disabled in final version.

To make a new plugin, press New Plugin from the Plugins window; then, from the New Plugin window, as shown in Figure 12.11, you can customize your plugin. Plugin configuration files should be placed using the same convention as other configuration files:

Engine plugins: [PluginName]/Config/Base[PluginName].ini

Game plugins: [PluginName]/Config/Default[PluginName].ini

Each plugin needs an icon to display in the Editor's Plugin Browser. The image should be a 128x128 .png file called Icon128.png and should be kept in the Plugin's /Resources/ directory. You can share or sell your plugins inside Marketplace as well:

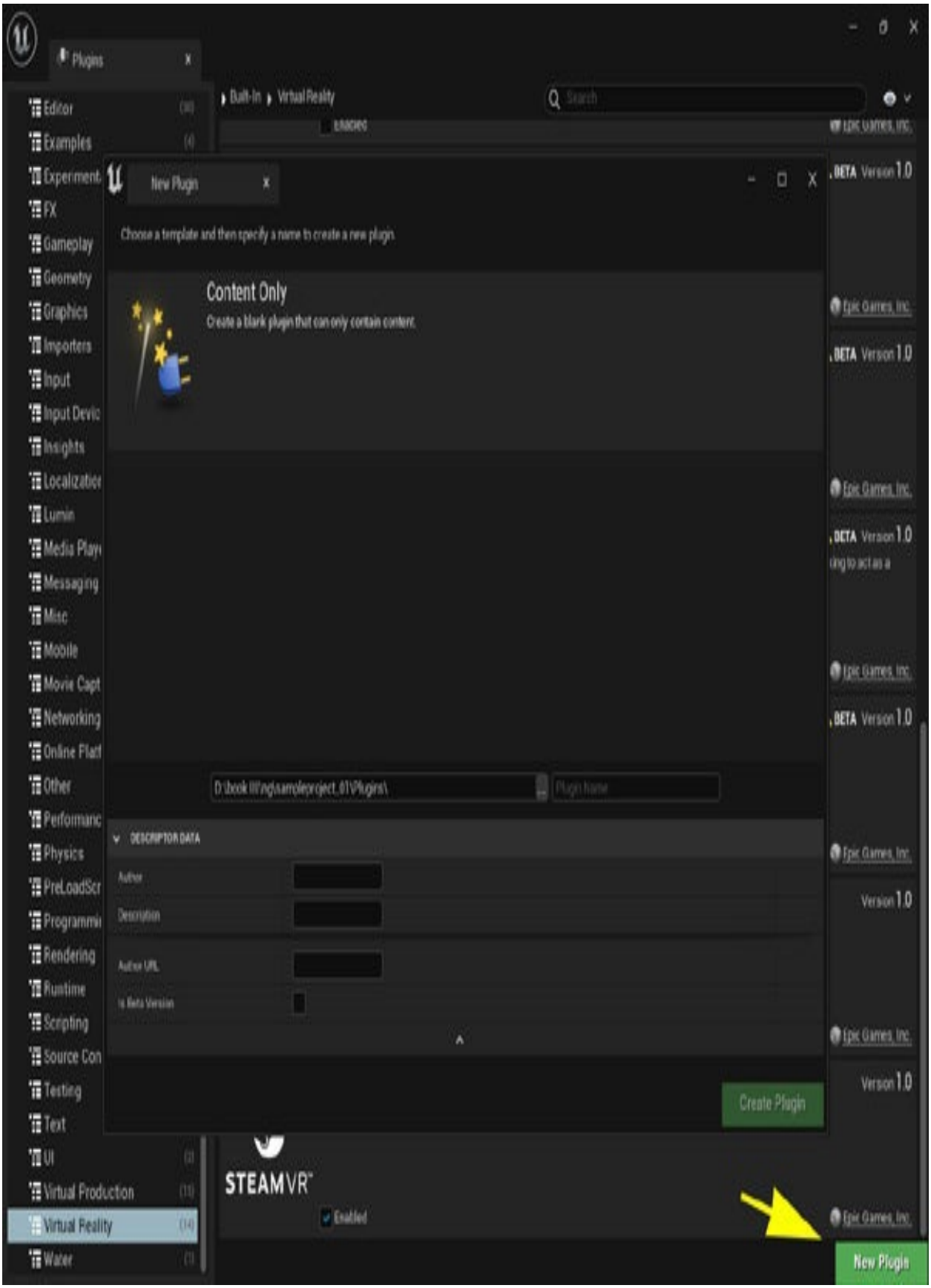

Plugins
Built-In
Virtual Reality
Search
Editor
Examples
Experiment
FX
Gameplay
Geometry
Graphics
Importers
Input
Input Devic
Insights
Localizatio
Lumin
Media Play
Messaging
Misc
Mobile
Movie Capt
Networking
Online Platf
Other
Performanc
Physics
PreLoadScr
Programmi
Rendering
Runtime
Scripting
Source Con
Testing
Text
UI
Virtual Production
Virtual Reality
Water
New Plugin
Choose a template and then specify a name to create a new plugin.
Content Only
Create a blank plugin that can only contain content.
DESCRIPTOR DATA
Author
Description
Author URL
Is Beta Version
Create Plugin
STEAMVR
Enabled
Epic Games, Inc.
BETA Version 1.0
Version 1.0
New Plugin

Figure 12.11: Making new plugin by clicking on the New Plugin button

Conclusion

In this chapter, we learned that Unreal Engine can support multiple platforms for developing game and applications. The engine will use platform SDKs as source and then adapt the packaging process based on the SDKs properties. The Device Manager and Project Launcher are useful tools to monitor and customize each platform's features. Also, users can customize SDK properties from Project Setting.

Now, it's time to sit and plan for a sample project or prototype for your portfolio. We know how to use the engine templates, customize them by creating new game objects, materials, and particle system, and then make them interactive and then establish a harmony of connected objects based on a Events, Interface and Enums. We also learned animation code and complex data processing with Unreal Engine.

It's time to make a plan and a schedule, and use Unreal Engine 5 to develop and build your own experience in the gaming industry.

Points to remember

Disable unnecessary platform from final built sometimes slightly decreases built file size.

Some plugins are not free or need special hardware on target machines. Sometimes, you may need to ask developers to program some code to support it. For example, automatically disable high-quality rendering by code because the platform graphic card is very low. At the end, you must make sure the final built can run for each target platform independently.

Double-check local addresses of save and load of your data and projects files. Sometimes, missing path is a source of catastrophic crash in the release version.

Multiple choice question

VR Preview in Play options is responsible for _____.

Converting an existing application to a virtual reality application

Changing Project Setting automatically

Previewing the game inside the headset by using current SDKs when the VR headset is connected to user`s local machine

Simulating a standalone mobile phone application

Answer

c

Questions

What is the right setting for Android SDK?

How can you use Android Studio to install the latest version of Android SDK?

Which types of plugins are expensive to get enabled, in case of using graphic and processing resources from system?

Key terms

Device manager - The Device Manager is an editor tool that allows monitoring connected devices to engine and running processes, with abilities to switch them on/off.

SDK – The SDK is stands for “software development kit” (also known as, devkit), and it is a set of software-building tools and libraries for a specific platform, including the built, framework, debuggers and libraries specific to an operating system.

Android - Android is an operating system (OS) which mostly used for handle inputs and running applications on mobile devices, tablets, and headsets.

Play modes - Unreal Editor allows users to instantly play preview and debug game from within the editor without waiting for files to save. Users can play preview in the actual editor as default output for play mode, or different outputs by switching play mode.

Project launcher - The Project Launcher is an editor tool, used to make and release builds of projects to specified platforms.

Plugins - Plugins are switchable collections of code and data, that can add runtime gameplay functionality, modify built-in Engine features (or add new ones), create new file types, and extend the capabilities of the Editor with new

menus, tool bar commands, and sub-modes.

A

Action 57

AND operator 16, 17

animation instance nodes 206

get animation mode 211

Get Anim Instance 206

get play rate 210

get position 209

Has valid animation instance 207

is playing 209

override animation data 212

play 207

play animation 209, 210

set animation 208

set animation mode 211

set play rate 210

set position 208

stop 208

animation instances 206

animation modes 212, 213

arrays 195

add 197

clear 198

get 196

length 198

remove 196

set array element 197

audio

using 259

B

Beginplay event 120

blueprint 53-59, 67

casting 163-167

code developing 93-100

collision detection 101-104

components panel 68-74

designing, with 59-67

Details 68

Event Graph 70

examples 55-57

game assets, creating from 105-109

interface implementation 168-172

Line Tracing 159-163

mesh, adding 74-78

My Blueprint 68

physics, adding 78-82

user interaction, adding 89-92

variables 134

Viewport 69-74

Blueprint Components 59

Blueprint Editor 59

Booleans (Bools) 136, 137

C

casting

in blueprint 163-167

class

default settings 218

class settings 219

inheritance, changing 220

interfaces 220

code

developing, in blueprint 93-100

collision 101

collision detection 101

Culling 236

D

data tables 201, 202

CSV/JSON export 203

editor 202

usage, in blueprint 204, 205

Dot Product 22

Doubles 136

Dynamic Material 128, 129

E

Editor layout, EGL

editing 41

menu 41, 42

standard layout 40

Edit tab 43

connect to soucre control 44

editor preferences 44

plugins 44

project settings 44

EGL layout

Editor layout 39

home page 34

library page 36

Project Browser 38, 39

store page 35

Unreal Engine Library 38

Unreal Engine Marketplace 37

Unreal Engine page 36, 37

enumerators (enums) 189, 190

bytes 190, 191

enumerator editor 191, 192

Epic Game Launcher (EGL) 34

installing 4-8

options 9-11

event dispatchers 155

using 155-158

events 119, 146-154

Beginplay 120

construction script 119, 120

custom events 121, 122

Endplay event 121

Tick event 121

execution line 97

F

File tab 43

first-person shooter (FPS) 3

float variable 135, 136

G

game assets

creating, from blueprint 105-109

game objects 114

classes 114, 115

components 117

inheritance 115, 116

transform 118

variables 116

H

hotkeys 42

I

Integers (Ints) 135

Doubles 136

float 135, 136

Integer 64 135

interface 220

implementation, in blueprint 168-172

returns 221, 222

setup 221

usage 222-224

using 159

L

licensing 280

Line Tracing

in blueprint 159-163

localization dashboard 47

M

maps 198

clear node 200

contains node 200

find node 200

get keys and values node 199

Is Empty and Is Not Empty node 201

length node 200

material editor 122, 123

Dynamic Material 128, 129

material data 125, 126

material instances 125

Material Parameter Collections (MPCs) 126-128

nodes 123, 124

mathematical functions 25

ABS 25

cell 26

clamp 26

cosine 26

distance 28

floor 25

normalized vectors 29

Pi 25

power 25

sine 26

mathematics 14-16

Boolean operator AND 16, 17

Boolean operator NOT 18

Boolean operator OR 17

Boolean operator XOR 18

using, in programming game 19

menu/window locations, UE5 editor 43

Build tab 47

Edit tab 43, 44

File tab 43

Help tab 47

Tools tab 47

Window tab 44

mesh component

adding, to blueprint 74-78

MetaSound 259

creating 260-275

multi-variable type operators 213, 214

N

Niagara 235

using 236

Niagara emitter

creating 237-247

Niagara system

creating 247-258

NOT operator 18

O

Object 57

object-based variables 188, 189

arrays 195

data tables 201

enumerators 189, 190

maps 198

structures (structs) 192, 193

order of execution 57

OR operator 17

P

physics

adding, to blueprint 78-82

physical behavior, making as material 180-184

physical force, adding with impulse 176-180

physical gravity, using 173-176

using 173

platforms 280

Play options 281-288

plugins 288-290

creating 290

Plugins menu 48, 49

Project Settings menu 48

project templates

ARCHITECTURE, ENGINEERING AND CONSTRUCTION 87, 88

FILM, TELEVISION/VIDEO, AND LIVE EVENTS 87

GAMES 87

R

replication settings 226, 227

right triangle rules 26-28

Rotator 139

S

serialization 228

save game objects, using 228-230

Software Development Kit (SDK) 281

Split Struct Pin 141

Static Mesh object

importing 77

string 138

name 138

text 138

structures (structs) 192, 193

nested structs 194, 195

structure editor 194

T

templates

using, in Unreal Engine 5 86-89

tick settings 224-226

trigonometry 26

U

Unreal Engine

history 2, 3

Unreal Engine 5 3, 6

event 146-154

events 119

game objects 114

material editor 122, 123

play options 280, 281

Plugins menu 48, 49

Project Settings menu 48

recommendations and minimum hardware requirement 6

templates, using 86, 87

user interaction

adding, to blueprint 89-92

user settings 230

input 231, 232

scalability 230, 231

V

variables, in blueprint 134

Booleans (Bools) 136, 137

conversions 141

Integers (Ints) 135

Rotator 139, 140

Split Struct Pin 141

string 138

Vector 139

Vector 19-22, 139

add operator 22

dividing, by scalar 23

Dot Product 23, 24

multiplying, by scalar 23

subtract operator 22

W

Window tab 44

Experimental tab 46

Layout tab 47

level editor 45, 46

logs 46

X

XOR operator 18