Making Huge Games in Unity with TOOLS!

Brian MacIntosh Programmer



Me

UCI Information and CS (2014) Video Game Development Club (4 yrs)



Me

- Camera Obscura (VGDC Spring 2011 Game Jam)
- Passed Steam Greenlight Jan 2014





Me

Obsidian Entertainment

- Pillars of Eternity (2013-2015)

- Pillars of Eternity II: Deadfire (2015+)

Programming (Tools, UI, Gameplay, Graphics)

Pillars of Eternity

- A huge game
- ~75 different developers over
- the course of the project
- 61 GB project
- 101000 assets
- 450 scenes

Mind Wave

Attacks Will Requires 10 Focus.

Target becomes the object of a concussive blast of psychic energy, suffering Raw damage from the trauma. Characters in a conical area behind the target failing a Fortitude check are knocked prone from the blast.

Right-click for detail

II

1st Lev

GAME PAUSED

Quest updated: 'Rogue Knight' Auto-Paused: Combat Start (Kat Kana (Ancient Memory): 7 Hit

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Pillars of Eternity II: Deadfire

- An even bigger game
- ~100 different developers over the course of the project
- 123 GB project
- 222000 assets
- 1000 scenes



F Serafen has enough experience to level up! Bestiary: Party gained 310 experience. Rich killed Xaurip Champion. Constant Recovery heals Edér for 1 Health.

Unity with a Large Project

Pros

- Fast start
 - Lots of functionality built in
- Popular lots of resources available

Cons

- Very slow loads
- Black box
- Pushing the limits

ReleaseAllScriptCaches did not release all script caches! (Filename: C

D o != NULL

Assembly-CSharp::Persistence Assembly-CSharp:Game:DeferredPointLight

Problems for Huge Games

- 1. Searching: Is this asset/prefab/script used? Where?
- 2. Maintaining Compatibility: Don't break old data.
- 3. Standalone Divergence: some bugs only happen in the standalone build.

- A program or part of a program that automates or streamlines a development task.
- Help you make your game better, make it faster, and have a better time.

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- A program or part of a program that automates or streamlines a development task.
- Help you make your game better, make it faster, and have a better time.
- As a programmer, they make people like you.

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- Help you make your game better, make it faster, and have a better time.
- As a programmer, they make people like you.
- Not the primary goal.

1. Have an idea

2. Evaluate development time versus savings

- Time savings
- Improved results
- Enjoy work more
- 3. Make it
- 4. Use it

HOW LONG CAN YOU WORK ON MAKING A ROUTINE TASK MORE EFFICIENT BEFORE YOU'RE SPENDING MORE TIME THAN YOU SAVE? (ACROSS FIVE YEARS)

	50/DAY	5/DAY	DAILY	WEEKLY	MONTHLY	YEARLY
1 SECON	D 1 DAY	2 HOURS	30 MINUTES	4 MINUTES	1 MINUTE	5 SECONDS
5 SECOND	5 DAYS	12 HOURS	2 HOURS	21 MINUTES	5 MINUTES	25 SECONDS
30 SECOND	S 4 WEEKS	3 DAYS	12 HOURS	2 HOURS	30 MINUTES	2 MINUTES
HOW 1 MINUTE	8 WEEKS	6 DAYS	1 DAY	4 HOURS	1 HOUR	5 MINUTES
YOU 5 MINUTE	6 9 MONTHS	4 WEEKS	6 DAYS	21 HOURS	5 HOURS	25 MINUTES
OFF 30 MINUTES	9	6 MONTHS	5 WEEKS	5 DAYS	1 DAY	2 HOURS
1 HOUR	R	IO MONTHS	2 MONTHS	10 DAYS	2 DAYS	5 HOURS
6 HOUR	5			2 MONTHS	2 WEEKS	1 DAY
1 DAM	1				8 WEEKS	5 DAYS

Re-use

- There are already great tools for solving a lot of common problems.
- There is often still a (time) cost to integrate free tools.

In-Unity Tools

- Property Drawer
- Custom Inspector
- Editor Window
- Gizmos

Property Drawer

- Change how fields of a particular type are drawn in the inspector
- Good for removing the need to expand serialized classes

Max Pressure	100		
▼ Fluid Item			
Туре	None (Fluid Type) O	Max Pressure	100
Amount	0	Fluid Item	0 × None (Fluid Type) ⊙
Temperature	0	▼ Connections	
Connections		Size	4
Size	4		

Property Drawer

- Create a script in a folder called 'Editor'
 - A magic folder that excludes the scripts from standalone builds
- Inherit 'UnityEditor.PropertyDrawer'
- Add a [CustomPropertyDrawer] attribute
- Use methods on UnityEngine.GUI[Layout], UnityEditor.EditorGUI[Layout]

```
⊡using UnityEditor;
14
      using UnityEngine;
      [CustomPropertyDrawer(typeof(Item))]
     public class ItemPropertyDrawer : PropertyDrawer
      ł
          private GUIContent m separatorContent;
          public override void OnGUI(Rect position, SerializedProperty property, GUIContent label)
              // find the nested fields on the serialized object to draw
              SerializedProperty qtyProp = property.FindPropertyRelative("Ouantity");
              SerializedProperty typeProp = property.FindPropertyRelative("m_type");
              // create a multiplication sign string
              if (m_separatorContent == null)
                  m_separatorContent = new GUIContent("\u00D7");
              // draw the name of the field
              position = EditorGUI.PrefixLabel(position, label);
              // temporarily reset the indentLevel so it doesn't throw off the elements we're about to draw
              int indent = EditorGUI.indentLevel;
              EditorGUI.indentLevel = 0;
              Rect qtyBox = new Rect(position);
              qtyBox.width = 60f;
              Rect separatorBox = new Rect(
                  qtyBox.xMax + EditorGUIUtility.standardVerticalSpacing,
                  position.y,
                  EditorStyles.label.CalcSize(m_separatorContent).x,
                  position.height);
              Rect itemTypeBox = new Rect(
                  separatorBox.xMax + EditorGUIUtility.standardVerticalSpacing,
                  position.y,
                  position.width - separatorBox.width - qtyBox.width - EditorGUIUtility.standardVerticalSpacing * 2,
                  position.height);
              EditorGUI.PropertyField(qtyBox, qtyProp, GUIContent.none);
              EditorGUI.LabelField(separatorBox, m_separatorContent);
              EditorGUI.PropertyField(itemTypeBox, typeProp, GUIContent.none);
              EditorGUI.indentLevel = indent;
```

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Custom Inspector

- Change how an entire component is drawn in the inspector
- Can also append custom controls to the default inspector

🔻 🍠 🗹 Script	t Event (Script)	🕅 🌣,
OnPartyMem	berEnter)(c	S 🔻 🔺 🗶
Condition	Boolean I	sAnyCompanionActiveInParty()	
And			
Condition	Boolean I	sGlobalValue(String, Operator, Int32)	
Tag			× ()
Operator		Equal To	
Value		0	
Script	Void Star	tConversation(Guid, Guid, Int32)	
Object		Player	
Convers	ation	00_bs_poi_poko_kohara_desert	🔎 🎑
Convers	ation Noc		
		Add Event	
		Total Time: 2 ms	
		GameData Requests: 0; Cache Misses: 0; Bundles: 0; Override:	

Editor Window

Create a new editor window that can be docked or float

Fast Sprite Slic		■× *≡
() Select the textures yo	u want to split in the Project view.	
1 textures selected.		
Columns	2	
Rows	2	
	Slice	

⊕Editor Config	- × +≡
Preferences	
🥅 Autoload String Database	
🔲 Use Animation Controller Blending	
🔽 Generate Appearances In Edit Mode	
🥅 Use Backer Beta Data	
🔲 Enable Scene Streaming (Increases Time Ent	e
Performance ▼ Preload Expensive Animator Controllers	
Programmers	
🔽 Inline Profile Inspectors	
🔽 Edit UIs	
🔽 Load Assets Directly	
V Use GameData Thread	- H

Editor Window

- Create a class that extends
 EditorWindow
- Implement OnGUI
- Add a way to show the window

```
using UnityEditor;
using UnityEngine;
public class FastSpriteSlicer : EditorWindow
{
    [MenuItem("Window/Fast Sprite Slicer")]
    static void ShowWindow()
    {
        GetWindow<FastSpriteSlicer>().Focus();
    }
    private void OnEnable()
    {
        titleContent = new GUIContent("Fast Sprite Slicer");
    }
    private void OnGUI()
    {
        EditorGUILayout.HelpBox("Select the textures you want to split in
        // code here
    }
}
```

Gizmos

Draw controls and other helpful information in the scene view





- Problem: is this asset/prefab script used? Where?
- This can come up when:
 - You want to delete an unused asset
 - You (or a producer) wants to evaluate work to e.g. add audio to all creatures
 - You want to make a change to it and check that it's safe
 - Many other cases

- Unity makes it very easy to navigate to the object being referenced.
- But there's no easy way to go the other direction.

▼人 Transform						2	\$,
Position	X 0	Y	0	Z	0		
Rotation	X 0	Y	0	Z	0		
Scale	X 1	Y	1] Z	1	_	
🔻 🕼 🗹 Game State (Sc	ript)						\$,
Script	GameState	3					\odot
Player Prefab	😺 PlayerRob	ot					0
▶ Controls							
▶ Powerups							
Drop Reticule Prefab	🗑 DropReticu	le					0
▶ Drop Reticules							
Game Active							
Kills Text	TKills (Text)						0
Logo	📲Logo (Ima	ge)					0

- For starters, we can use grep.
- Each file in a Unity project has a unique 'guid'

his PC > HDD (E:) > Projects > Armore	dDecore	> A	ssets ⇒	Prefabs			~ Ū	Search Pre	fabs	
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Guns.meta	15						a a a a a a a a a a a a a a a a a a a			Банна

 Edit -> Project Settings -> Editor -> Asset Serialization -> Mode

 References have the 'guid' of the file and a 'fileID'



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DronReticule.prefab - SciTE

• 'guid' identifies the file

• 'fileID' identifies the object inside the file

	•
	File Edit Search View Tools Options Language Buffers Help
	1 DropReticule.prefab
	11 m ParentPrefab: {fileID: 0}
Main.unity - SciTE	12 m_RootGameObject: {fileID: 1926519258509486}
	13 m_IsPrefabParent: 1
File Edit Search View Tools	14 !u!1 81926519258509486
1 Main unity	15 GameObject:
T Main.unity	16 m_ObjectKideFlags: 0
1004 m_IsActive: 1	<pre>17 m_PrefabParentObject: {fileID: 0}</pre>
1005 !u!114 &160422504	18 m_PrefabInternal: {fileID: 100100000}
1006 MonoBehaviour:	19 serializedVersion: 5
1007 m_ObjectHideFlags:	20 m_Component:
1008 m_PrefabParentObjec	t 21 - component: {fileID: 4444989479848500}
1009 m_PrefabInternal: {	f 22 - component: {fileID: 212860541670955134}
1010 m_GameObject: {file	23 - component: {fileID: 114386756248514454}
1011 m_Enabled: 1	24 m_Layer: 0
1012 m_EditorHideFlags:	25 m_Name: DropReticule
1013 m_Script: {fileID:	26 m_TagString: Untagged
1014 m_Name:	27 m_Icon: {fileID: 0}
1015 m_EditorClassIdenti	28 m_NavMeshLayer: 0
1016 PlayerPrefab: {file	29 m_StaticEditorFlags: 0
101/ type: 2}	30 m_IsActive: 1
1018 Controls:	
1019 - {fileID: 11400000	, guid: //seb4631e40d0624aab13at4545e62d5, type: 2}
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1024 m_dropketicdlepreta	7. (111610, 1320313230303400) guiu: 0330331203207024/d36dd434d112TDZ
1025 Cype, 27	
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П

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- Integrated into the editor
- Drag-and-drop the target
- See the name of the referencing object
- Downside: still have to wait for the search

Atlas Maker 🛛 🔍 Ass	et Search	Game Data Se	Find Sprites	+≡
INOTE: This search that are referenced	is shallow - in the searc	it doesn't recursive hed scenes or prefai	ly search game data o os.	r assets
▼ Target Object(s)				۵
Size				
Element 0	CRE	_Bat_Bog		
Search Unity Assets	\checkmark			
Search Under: Asset	s/ Scenes	1		
Preset Path	Scenes			
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3 instances, 60	refs			
Ref: (x1) CRE_Bat_E	og_02{N⊦	IP}		
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Ref: (x23) CRE_Bat_	Bog_02{N	IHP}		
Ref: (x14) CRE_Bat_	Bog_01{E	NHP}		
Ref: (x23) CRE_Bat_	Bog_03{H	IP}		
	Sav	ve Counts to File		
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🚳 Unity Project Browser 🛛 📐				— C) X
File View					
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https://github.com/BrianMacIntosh/UnityProjectBrowser

1. Searching (Takeaways)

- Unity is, in part, a tool for editing its own files.
- You can circumvent it and edit them directly if it helps you.
- Read or edit them.

 Problem: Making changes to the game without breaking existing data.

• **VOK**: Moving or renaming files.

- Recall that all references are by GUID.
- The meta file also needs to be moved.
- This is done for you if you do it in Unity.

• VOK: Renaming serialized classes.

Script	💽 EncounterData		
Title	Fighting Pits		
Level	5	175	[Serializable]
Fail Result	L_Health (StatData)	176 💡	<pre>public class EncounterOutcomeByLevel : EncounterOutcome</pre>
▼ Options		177	{
Size	3	178	<pre>public bool IsFail { get: set: }</pre>
▼Try to get lucky in a l	battle.	179	
Display Description	Try to get lucky in a battle.	180	public EncounterOutcomeByLevel(EncounterOutcomeByLevel other)
Image	None (Sprite)	100	public EncouncerouccomebyLever(EncouncerouccomebyLever other)
Result Type	Random	181	: base(other)
Check	A_Luck (StatData)	182	{
Success Result	L_Reputation (StatData)	183	
▼Use your combat skil	l to be victorous in the Fight	184	}
Display Descriptio	Use your combat skill to be	185	
Image	None (Sprite)	186	public override EffectType GetEffect()
Result Type	Fixed	187	{
Check	🗋 A_Combat (StatData)	188	return EffectType PlayerStatAdjustment:
Success Result	L_Reputation (StatData)	190	1
▼Flee.		109	<i>I</i>
Display Description	Flee.		

• △OK: Renaming serialized fields.

Apply the [FormerlySerializedAs] attribute



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36 37 38

- AOK: Changing the type of serialized fields.
- ISerializationC allbackReceiver

```
□using System;
 using UnityEngine;
namespace Assets.Scripts
     public class TestScript : MonoBehaviour, ISerializationCallbackReceiver
         // OLD!
         [HideInInspector]
         [Obsolete("Use NewLevel instead.")]
         public int Level = 1;
         // NEW!
         public float NewLevel = 1.0f;
         #region ISerializationCallbackReceiver implementation
         public void OnAfterDeserialize()
 #pragma warning disable 612, 618
             if (Level \geq 0)
                 // assumes that -1 is an invalid value for Level
                  NewLevel = Level:
                  Level = -1:
 #pragma warning restore
         public void OnBeforeSerialize()
         #endregion
```

x BAD: Reordering enumerations.
 v OK: Renaming enum elements.

⊡puł	olic enum CardinalFacing
{	
	N,
	NE,
	Ε,
	SE,
	s,
	SW,
	W,
	NW
}	

3. Standalone Divergence

- Problem: The standalone build has a problem that the editor doesn't have.
- You don't have the ability to attach the debugger, look at objects in the inspector, etc.

3. Standalone Divergence

- Solution: Make a profile/dev build.
- Can attach the debugger
 (Debug →
 Attach Visual
 Studio
 Debugger)



3. Standalone Divergence

On-screen debug output

-- Mouse Cursor Debug --Mouse Screen Pos: (1208.0, 1155.0, 0.0) Mouse Delta: (20.0, 23.0, 0.0) Mouse World Pos: (25.8, 0.0, -8.5) Cursor: Normal, UI Cursor: Normal 3,000 ? Mode: Default Generic Object Under Cursor: Null Character Under Cursor: Null UI Under Cursor: DimBackground Collider Under Cursor: Null Unusable Under Cursor: Null Mouse0: Down: 1, Up: 1

.



Hierarchy		Inspector
► combat test poe2		Player_VS(Clone)
DirectionLight	Tag:	Untagged
► Trap_Test	Layer:	Dynamics
► TriggerVolume_Test	► UnityEngine.Tra	ansform
► AlarmTest	► UnityEngine.Rig	gidbody
SceneTransition_Stair_Up	Game.Animation	onController
TEMP	Game.Faction	
TransientLightProbe	 Game.Health 	
FogOfWar	Game.Player	
 StreamTileParent_combat_test_poe2 	Game.Character	erStatsMutable
Game Global Objects	Game.Equipme	ent
▼ Cross Scene Objects	(Game.Equipmen	t)
Store_CityMap_PortMaje_Crew	► TypeID	97213dc3-7dad-4559-866c-0da6ba0c0a1a
Store_CityMap_Takuro	SaveVersion	2
Store_CityMap_Crookspur	m_loadVersion	0
Store_CityMap_Tikawara	► m_persistentEqu	lipment
Store_CityMap_SplinteredReef	► BaseEquipment	Empty
Store_CityMap_PortMaje	► StartingItems	
Store_CityMap_Neketaka	m_activeProps	null
Store_CityMap_Dunnage	m_isSwappingSum	moned
▼ Player_VS(Clone)	<ischangeformeq< td=""><td>uip></td></ischangeformeq<>	uip>
Mesh	► OnEquipmentCh	anged
► Skeleton	► OnEquipmentVis	sualsCha
Selection_Circle(Clone)	► s_equipmentSlo	tNames
Destination_Circle(Clone)	(Onyx.OnyxBeha	vior)
Target_Circle(Clone)	► EnabledEvent	
► Companion_Maia(Clone)	► DisabledEvent	
Destination_Circle(Clone)	m_defaultValuesSe	et 💿
Target_Circle(Clone)	m_preactivated	•
► Companion_Xoti(Clone)	m_awakeCalled	
Destination_Circle(Clone)	m_startCalled	

Inspector

Reflection: What is it?

- .NET API for examining the structure of your code at runtime
- Object.GetType()

Reflection: What can it do?

- Command line
- A static class with static methods
- Call any static method from the command line



Reflection: What can it do?

Scripting

🖅 🗹 Script Event (Script)		🔊 🌣,	
OnPartyMemberEnter		×	
Condition	Condition Boolean IsAnyCompanionActiveInParty()		
And	And		 ¢
Condition	Boolean Is	GlobalValue(String, Operator, Int32)	A -
Tag			_ () X
Operator	Operator Equal To		
Value		0	
Script	Void Start	Conversation(Guid, Guid, Int32)	
Object Player		Player	
Conversation 00_bs_poi_poko_kohara_desert		00_bs_poi_poko_kohara_desert	- 🗩 💽 -
Conversation No: 7			
		Add Event	
		ameData Requests: 0; Cache Misses: 0; Bundles: 0; Overrides	

Thanks!

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- @BrianAMacIntosh