PART 1: GAME MECHANICS

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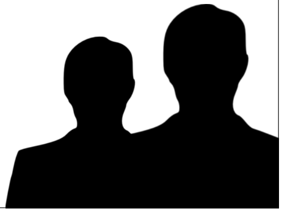
Introduction To BowlMaster



What BowlMaster Teaches

Manipulating a 3D world.

Test driven development.

Introducing Unity 5.

BowlMaster GDD

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About the Game Design Doc

This part of the section notes is a simple reference for the important specifications of the game.

This is just for reference, we'll refer to it as needed during the videos.

Bowling Pin Specification

Maple wood. Density about 0.6 g cm^-3

Mass 1.53 kg (3 lbs 6 oz).

38.0 cm (15 inches) tall.

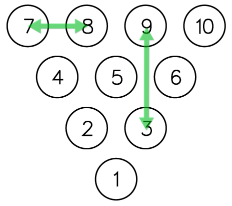
12.1 cm (4.75 inches) at their widest point.

http://en.wikipedia.org/wiki/Bowling_pin

Bowling Pin Layout

30.48 cm (12 inches) apart sideways (7-8)

52.71 cm (20.75 inches) every 2 rows (9-3)



Ball Specification

Mass <= 7.3 kg (16 lbs).

Density <= 3.80 g cm^-3

But some float* so call it 1 g cm^-3

Diameter: (21.59 to 21.83) cm (call it 21.7 cm)

**https://www.youtube.com/watch?v=FeKb_xfr608*

Bowling Lane Specifications

1829 cm from the foul line to the head pin.

Make it 2000 cm long in total.

105 cm wide.

Give some height e.g.1cm

http://en.wikipedia.org/wiki/Ten-pin_bowling

Rules 1 of 4

The game consists of 10 frames as shown above. In each frame the player has two opportunities to knock down 10 pins. The score for the frame is the total number of pins knocked down, plus bonuses for strikes and spares.

Rules 2 of 4

A spare is when the player knocks down all 10 pins in two tries. The bonus for that frame is the number of pins knocked down by the next roll. So in frame 3 above, the score is 10 (the total number knocked down) plus a bonus of 5 (the pins knocked down on the next roll.)

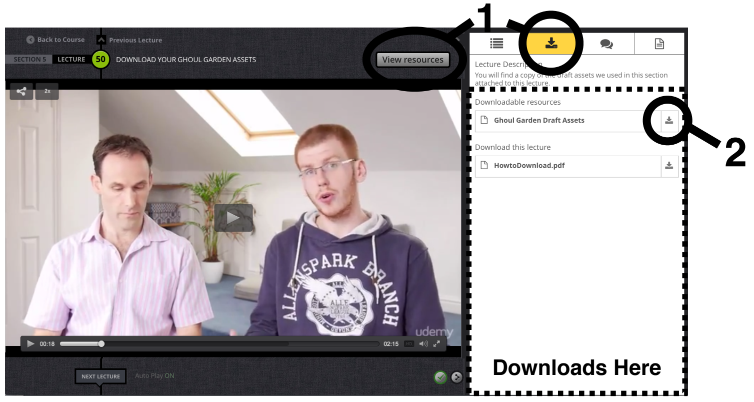
Rules 3 of 4

A strike is when the player knocks down all 10 pins on his first try. The bonus for that frame is the value of the next two balls rolled.

Rules 4 of 4

In the tenth frame a player who rolls a spare or strike is allowed to roll the extra balls to complete the frame. However no more than three balls can be rolled in tenth frame.

Your BowlMaster Assets



You will find a copy of the draft assets we used in this section attached to this lecture.

Section Notes (This Document)

Time To Install Unity 5

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In this video...

How to keep Unity 4.6.3 as well.

Installing the latest Unity 5.

Backup before upgrading projects.

A brief tour of what's different*

Get Unity 5 Working

Ensure you can open Unity 5.

Take a look around.

Create a new project called Bowlmaster.

Create 3D Cube Floor

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In this video...

Get used to 3D controls.

Create a bowling lane floor according to GDD.

Set your Main Camera to look down the lane.

Create a lane floor

Refer to the GDD for the dimensions.

Use X for width, Y for height, Z for length.

Apply a texture, and tweak look from above.

Hint: Use a cube for the floor.

How To Install Blender

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In this video...

Blender is a 3D art program.

We need it to import **.blend** files.

It’s amazingly powerful, but tricky to get started.

You only need to install for this course, not use.

www.CompleteBlenderCreator.com to learn more.

Install Blender

Visit www.Blender.org

Pick the right version for your machine.

Install then close the program.

Test by importing the pin in the next video.

Good luck!

Import Pin From Blender

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In this video...

Import our bowling pin from Blender*

Learn about render and collider meshes.

Create a pin prefab.

Lay-out all 10 bowling pins on the floor.

** Find out more at www.CompleteBlenderCreator.com*

Create your pin prefab

Feel free to create or source your own.

Ensure that the dimensions match the GDD.

Test that the pin sits on the lane properly.

Setup all 10 pins according to the GDD.

You could also use snap-to-grid

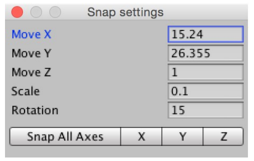
Go to Edit > Snap Settings

Use the settings shown here =>

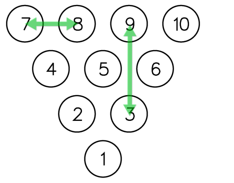
This is 1/2 of the pin spacing

30.48 / 2 = 15.24 X spacing

52.71 / 2 = 26.355 Y spacing


Snap settings

Move X	15.24
Move Y	26.355
Move Z	1
Scale	0.1
Rotation	15



3D Sphere As Bowling Ball

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In this video...

Create a 3D sphere of the right size.

Apply a temporary texture so we can see it roll.

Add a sphere collider.

Add a Rigidbody (3D) and set properties.

Make the ball roll down the lane.

Ball Specification

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Density <= 3.80 g cm^-3

But some float* so call it 1 g cm^-3

Diameter: (21.59 to 21.83) cm (call it 21.7 cm)

**https://www.youtube.com/watch?v=FeKb_xfr608*

Get the ball hitting the pins

Give an appropriate initial velocity from script.

Point so it passes through the pins*

Play a rolling sound.

** It won't hit them yet, that's next lecture*

Control Camera To Track Ball

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In this video...

Create **CameraControl.cs** for the Main Camera.

Make the camera track the ball.

Stop when it gets close to the headpin.

Write CameraControl.cs script

Keep the camera a fixed offset from the ball

Use an **if** statement in your **Update()** loop

Stop the camera at headpin (z = 1829)

Test it works.

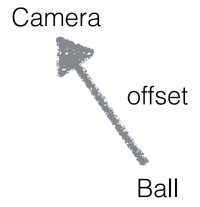
How offset vectors work

We want **Ball + Offset = Camera**

Subtract **Ball** from both sides

Gives: **Offset** = **Camera** - **Ball**

Remember head - tail in future



3D Collisions & Convex Meshes

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In this video...

Add **Rigidbody** to the pins.

Adjust physics so that collisions work*

Create new, richer pin prefab.

** We will make this more lifelike later.*

Adjust physics parameters to taste

Adjust parameters to taste…

- Project Settings > Physics > Gravity
- Ball’s mass and drag
- Pin’s mass and drag.

Play test ensuring collisions looks right.

About adjusting gravity

Sometimes in games gravity isn’t realistic.

For example fast cars jump too far if it is.

In our case, we’re using 1 World Unit = 1 cm.

Unity default is 1 World Unit = 1 m.

Therefore increase gravity to max -981 m s^-2.

About convex meshes

Convex means curved like the exterior of a sphere

Mesh Colliders must be convex to self-collide*

Maximum triangles in collider = 255.

These are performance limitations of the engine

* http://docs.unity3d.com/Manual/class-MeshCollider.html

Top Camera Render Texture

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In this video...

Create a render texture* ready for camera output.

Position a top-down camera looking at pins.

Create a user interface panel.

Embed a “Raw Image” with this render texture.

* *http://docs.unity3d.com/Manual/class-RenderTexture.html*

Create & position “Top View” camera

Put the camera above the pins looking down.

Make the pins fill about 80% of its view.

Set “Target Texture” to TopCamera.renderTexture.

Test game still runs (you won’t see the cam yet).

Setup camera view UI

Create GameObject > UI > Raw Image.

Position it on the UI Left Panel.

Set the Texture to “TopCamera.renderTexture”.

Test you can see the top-down view in Game.

Improve UI Scaling

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In this video...

Add new UI > Panel ready for swipe gesture.

Set scaling & anchors for UI panels

Make sure it scales well.

Simple Touch Control System

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In this video...

Re-factor **Ball.cs** to create **public Launch ()**

Write **DragLaunch.cs** component for ball.

Wire the UI Panel’s events to **DragLaunch.cs**

Test new drag control system.

Refactor Ball.cs

Separate launch code into public method.

Use signature **public Launch (Vector3 velocity)**

rigidBody.useGravity = false on **Start ()**

rigidBody.useGravity = true on **Launch ()**

Test by calling from **Start ()**

Write DragLaunch.cs

public **DragStart()** stores time & position.

public **DragEnd()** launches ball.

Launch depends on length & speed of drag.

Should be no need for scaling factors.

Adding Arrows To Nudge Ball

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In this video...

Add another UI panel at bottom of screen.

Ensure this panel “occludes” the touch input.

Add two arrows, for moving ball left and right.

Write a simple method to allow this at start.

Finish arrows panel

Get scaling how you want it.

Set anchor and pivot points.

Wire-up to **MoveStart(float xNudge)**

Log to console for now.

Ensure doesn’t conflict with swipe.

Get start position working

Approach it however you like.

Goal is to be able to drag the ball left and right.

Only allow moving before the ball is launched.

Clamp the ball to within the lane width.

Test it feels right.

Animation Sub-State Machines

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In this video...

Overview the pinsetter and our end-goal.

Setup “swiper” bar to tidy & reset pins.

Add a “Swipe” animation for pin clearing.

About animation sub state-machines.

Managing pin tidying and resetting.

Create a swipe animation

Create a “Swipe” animation.

Be careful not to hit any standing pins.

Go out and back smoothly.

Working Around Nested Prefabs

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In this video...

Unity doesn’t support “nested prefabs”.

Care: the pins in Pins assembly are unlinked.

Adding **Pin.cs** to the right place(s).

About **transform.rotation.eulerAngles**.

Writing code to detect if pins are standing.

Detect if pins are standing

Add **public float standingThreshold** to **Pin.cs**

Write **public bool IsStanding ()** method

Returns true if the pin’s transform is rotated less than the threshold from vertical

Returns false otherwise

Counting Upright Objects

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In this video...

About setting-up game object communication.

Setup a simple UI Text display for pin count.

Create a PinSetter box, and **PinSetter.cs**

Continuously count standing pins.

Only find standing pins after ball enters box.

Count standing pins

Write **int CountStanding()** method

Loops through all pins in the scene

Keeps track of number of standing pins

Returns current number of standing pins

Detecting Pins Have Settled

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In this video...

Use the PinSetter's trigger collider to detect ball.

Only start counting upright pins when ball enters.

Detect when pins have stopped wobbling.

Update pin count display to green.

Set lastStandingCount to -1 when settled.

Setup Pin Setter Triggers

Add to **PinSetter.cs** script.

Set pin count to red when ball enters box.

Set **ballEnteredBox** instance variable to true.

Destroy pins when they leave the box.

Write CheckStanding ()

If **ballEnteredBox** then call **CheckStanding().**

Wait for standing count to stop changing for 3s.

When pins settle call **PinsHaveSettled().**

Update display to green.

Write Reset() in Ball.cs

- Create an manage **public bool inPlay;**
- Capture ball start position on **Start().**
  - Reset position to start.
  - Set velocity & angular velocity to zero.
  - Prevent the ball falling before 2nd launch.

Raise & Lower Standing Pins

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Sub-states & Default States

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In this video...

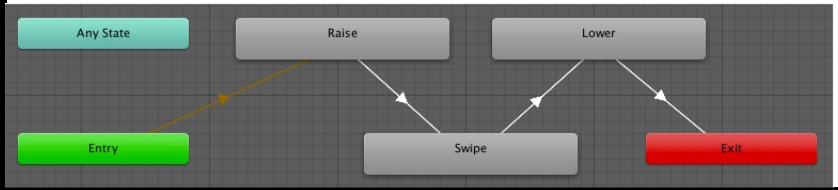
- Overview how Tidy & Reset will work.
- Modify the architecture of the game.
- Learn about sub-state machines.
- Learn about default transitions.
- Setup Tidy & Reset sub-states.

Setup your Tidy animation

Create Tidy sub-state, and it's inner states.

Setup a "tidyTrigger" parameter

Include all the following steps…

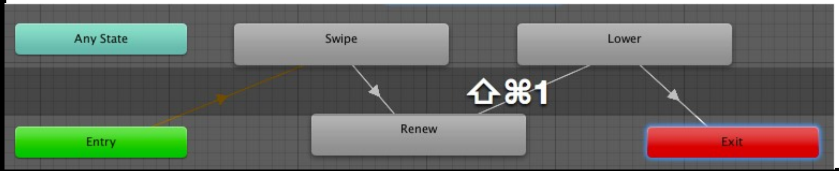


Setup your Reset animation

Create Reset sub-state, and it's inner states.

Setup a "resetTrigger" parameter

Include all the following steps…



Calling Animator Helper Scripts

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In this video...

Add temporary UI Buttons for Reset and Tidy.

Write **RaisePins()** to lift all the standing pins up.

Write **LowerPins()** to lower them down again.

Test state machines work properly.

Create Reset & Tidy UI Buttons

Add two buttons to your UI.

Connect them to the Pin Setter game object.

Work out how to trigger animation states*

Note the UI systems's ResetTrigger is different to ours!

Finish RaisePins() and LowerPins()

Flesh-out these two methods in **PinSetter.cs.**

Create two temporary UI buttons, Tidy & Reset.

Test that the game is now fully playable*

** Later the scoring system will "push" these buttons.*

Find the bug(s) in the system

Save your work before you start fiddling.

See if you can work-out what's going on.

We'll address the debugging strategy next.

Some Debugging Tips

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In this video...

A bit more about **Transform.Translate()**.

Using the Step button to slow things down.

The perils of moving static colliders.

How default animation blends can cause issues.

Warnings about moving motion clips around.

Refactor raise / lower into Pin.cs

Move **RaisePins()** and **LowerPins()** into **Pin.cs**

Rename to **Raise()** & **Lower()**

Create **distToRaise** instance variable.

Disable and re-enable gravity as required.

Test animation sequence works well.

Common Physics Issues

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In this video...

A reminder about Fixed Timestep.

About bounciness & default materials.

Issues of scale & effect on Physics Settings.

Stopping rigidbody’s passing through each other.

Ensure Your Pins Renew Properly

No passing through the floor.

No exploding outwards.

No other funny business!

Tidying & Refactoring Code

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In this video...

About re-factoring your code.

Single Responsibility Principle*

Wider framework of **S**OLID.

* http://en.wikipedia.org/wiki/Single_responsibility_principle

Refactor Your Code

Save your current, working state.

Go through all your methods.

Add “why” comments as necessary.

Move code between classes as required.

Test it still works regularly.

PART 2: CONTROL SYSTEM

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How 10-Pin Bowling Scoring Works

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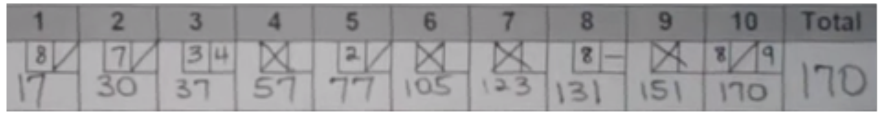
In this video...

Read how bowling scoring works*

Draw an Object Communication Diagram.

*https://www.youtube.com/watch?v=aBe71sD8o8c



1	2	3	4	5	6	7	8	9	10	Total
8 /	7 /	3 4	X	2 /	X	X	8 –	X	8 / 9	
17	30	37	57	77	105	123	131	151	170	170

*http://en.wikipedia.org/wiki/Ten-pin_bowling

Object Communication Diagram

Draw boxes for PinSetter and ScoreMaster.

Draw lines for API calls between them.

Decide what messages will be passed.

Decide what public properties (if any) you need.

Mentally rehearse how it may work.

Our Architecture

Very simple API for **ScoreMaster.cs**

Define **public enum Action {Reset, Tidy}**

Frame list will grow as frame scores are finalised.

public Action Roll (int pins)

PinSetter.cs **ScoreMaster.cs**

public List<int> GetFrames ()

Test Driven Development (TDD)

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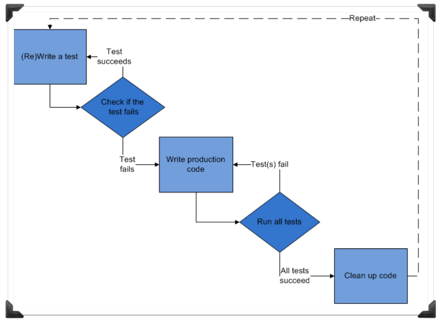
In this video...

An overview of Test Driven Development (TDD).

The Red > Green > Refactor loop.

NEVER refactor with a failing test.

An overview of TDD



http://en.wikipedia.org/wiki/Test-driven_development

“Red > Green > Refactor” Loop

Write a failing test.

Write code to make test pass.

Rinse and repeat.

Write Failing Test | Code A Solution | Refactor (rinse)

Read around about TDD

Have a look on YouTube.

Read the Wikipedia article.

Do a general Google search.

Talk to your friends about it!

Install Unity Test Tools

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In this video...

What Unity Test Tools are*

How to find and install them.

Setting up your first failing test.

*https://www.assetstore.unity3d.com/#!/content/13802

Install Unity Test Tools

Find Unity Test Tools in the Asset Store.

Install them into your project.

Making Your First Test Pass

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In this video...

Setup our **ActionMaster.cs** class.

Write our first real test code.

Code the solution until the test passes.

Refactor.

Get FirstStrikeReturnReset Passing

Write the simplest code that makes this test pass.

NO re-factoring at this stage.

Just make something work in **ActionMaster.cs**.

Red > Green > Refactor

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In this video...

Go through a few more TDD loops.

Remember **Red > Green > Refactor.**

Be strict with yourself, build the discipline.

Save a version snapsnot regularly.

Have fun!

Write one test of your own

Write a single test of your own.

Anything relating to correct return types.

Ensure it leads to the need to write new code.

Write the new code until the test passes.

Refactor, and re-check all tests pass.

Finishing Our Control Code

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Finish The Control Code

Go through Red > Green > Refactor loop strictly.

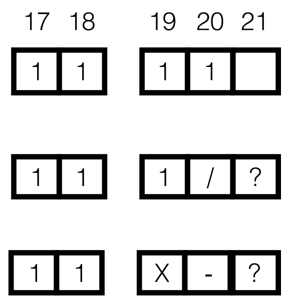
Focus your failing tests on edge cases.

Keep your **ActionMaster.cs** looking clean.

Stop when you're confident it's done.

Challenge the community to write a failing test!

The last frame



No bowl 21 awarded
endGame at bowl 20

Bowl 21 awarded
Reset at bowl 20

Bowl 21 awarded
Reset at bowl 19

Failing Tests Challenge

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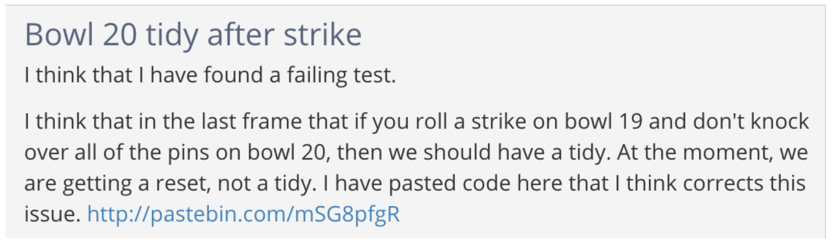
In this video...

Thanks to Daryl Kempthorne for this…



Bowl 20 tidy after strike

I think that I have found a failing test.

I think that in the last frame that if you roll a strike on bowl 19 and don't knock over all of the pins on bowl 20, then we should have a tidy. At the moment, we are getting a reset, not a tidy. I have pasted code here that I think corrects this issue. http://pastebin.com/mSG8pfgR

Daryl’s failing test

17	18	19	20	21
1	1	X	5	?

Should be **tidy** (not reset)

Write test, and make it pass

RED: Write a test for Daryl’s failing condition.

GREEN: Write the code to make it pass.

- **REFACTOR**

How about this?

17	18	19	20	21
1	1	X	0	?

Should be **tidy**

Bug Reporting Cycle

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In this video...

A brief overview of a TDD bug reporting cycle.

Creating relevant tests from user bug reports.

Sticking to the TDD discipline.

A possible bug reporting cycle

User submits bug report.

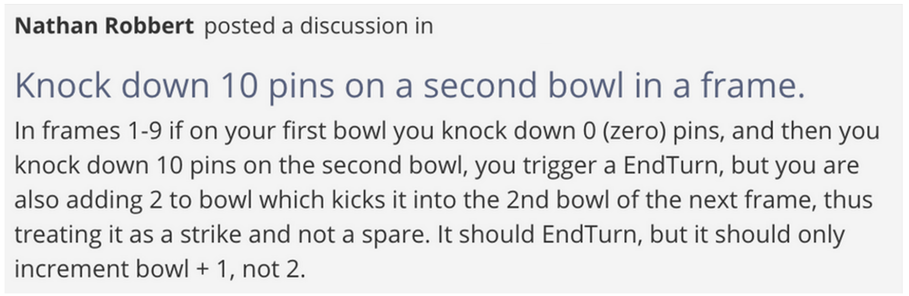
QA verify this bug is valid & can be reproduced.

Developer 1 writes a failing test.

Developer 2 writes code to make test pass.

User informed.

Create a test for SYMPTOMS…

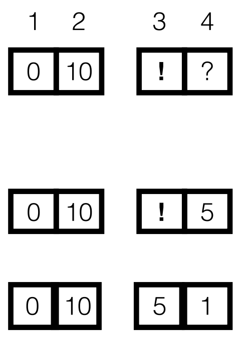


Nathan Robbert posted a discussion in

Knock down 10 pins on a second bowl in a frame.

In frames 1-9 if on your first bowl you knock down 0 (zero) pins, and then you knock down 10 pins on the second bowl, you trigger a EndTurn, but you are also adding 2 to bowl which kicks it into the 2nd bowl of the next frame, thus treating it as a strike and not a spare. It should EndTurn, but it should only increment bowl + 1, not 2.

Nathans Bowl Index Test



Bowl 3 skipped over in this case

3rd bowl gets entered in wrong place.
System wrongly returns a **tidy**.

Should return **endTurn**.

Make Dondi's test pass

```
[Test]
public void Dondi10thFrameTurkey () {
int[] rolls = {1,1, 1,1, 1,1, 1,1, 1,1, 1,1, 1,1, 1,1, 1,1};
foreach (int roll in rolls) {
 actionMaster.Bowl (roll);
}
 Assert.AreEqual (reset, actionMaster.Bowl (10));
 Assert.AreEqual (reset, actionMaster.Bowl (10));
 Assert.AreEqual (endGame, actionMaster.Bowl (10));
}
```

https://gist.github.com/BenTristem/958250aab975526adda8

Wire-Up ActionMaster.cs

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In this video...

Connect **PinSetter.cs** to **ActionMaster.cs**

Refactor **PinSetter.cs** to report pin fall.

Connect **PinSetter.cs** to the animator.

Remove the Tidy and Reset test buttons.

Ensure our game controls it's self now.

Refactor PinSetter.cs for pin fall

PinSetter.cs to call **ActionMaster.Bowl()**

It must pass in pins fallen, not standing.

Connect PinSetter.cs to animator

Get PinSetter directly triggering the animator.

Check it works.

Remove UI test buttons.

Using OnTriggerExit()

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In this video...

Recap the problem with the current setup.

Use **OnTriggerExit ()** for objects leaving colliders.

Refactor **PinSetter.cs** for the new paradigm.

Change the pinsetter paradigm

Change ballEnteredBox to ballLeftBox.

Create a new lane collider.

Connect a **GutterBall.cs** script.

OnTriggerExit() to set **pinSetter.ballLeftBox**

Test it all still works.

PART 3: FINISHING OFF

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Creating A Testable Architecture

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In this video...

Taking the time to refactor.

Being your own boss.

Our current / target architecture.

Keeping our tests in place.

Using **System.Collections.Generic** for lists.

Taking the time to refactor

It's part of the journey.

Know when it's worth it, and when it's not.

If you're stuck, it's worth it!

Being your own boss

You wear two hats.

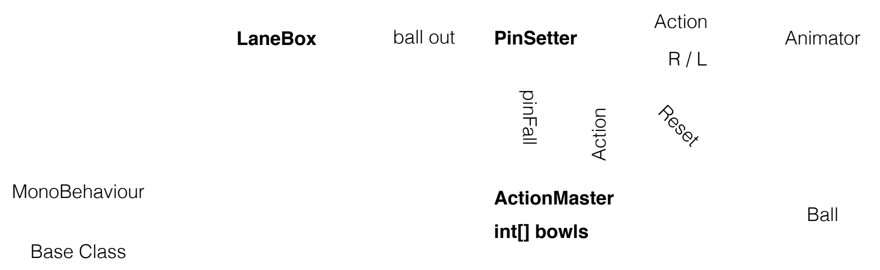
One is your boss, telling you what to do.

The other is the worker, obeying the boss.

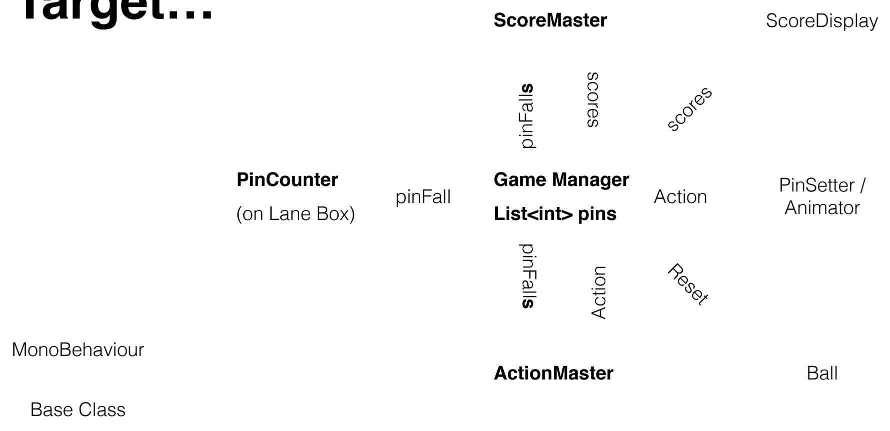
Neither can improve if the lines are blurred.

It takes discipline, and it's worth it.

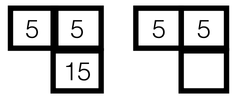
Our current architecture…



Target…



Example score timing



Keeping our tests in place

We'll need to refactor the ActionMaster tests.

Build ScoreMaster using TDD.

We will have the option to merge these classes.

The merge would be protected by the tests.

Using System.Collections.Generic

To use lists you need to import a new namespace.

using System.Collections.Generic;

Define a list like this…

List<T> listName = new List<T>();

… where T is the type, **int** in our case.

Tidying Before Moving On

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In this video...

Removing unnecessary Unity Testing folders.

Importing an animated gif texture

Quaternion.Euler() & **Quaternion.Identity()**

Using a boolean flag to prevent dragging.

Using continuous dynamic collision detection.

Change you ball's texture

If you're not happy with yours already.

Go and find a new one.

You could even create one in Blender!

Reset rotation of ball and pins

Pins should be reset to vertical when raised.

Ball should be reset to neutral when reset.

Consider **Quaterion.Euler ()** for the pins.

You could use **Quaternion.identity** for the ball.

Prevent double dragging

Make sure you can't drag the ball once launched.

Similar solution already in…

Thanks to Dondi for noticing this

Refactoring Code & Tests

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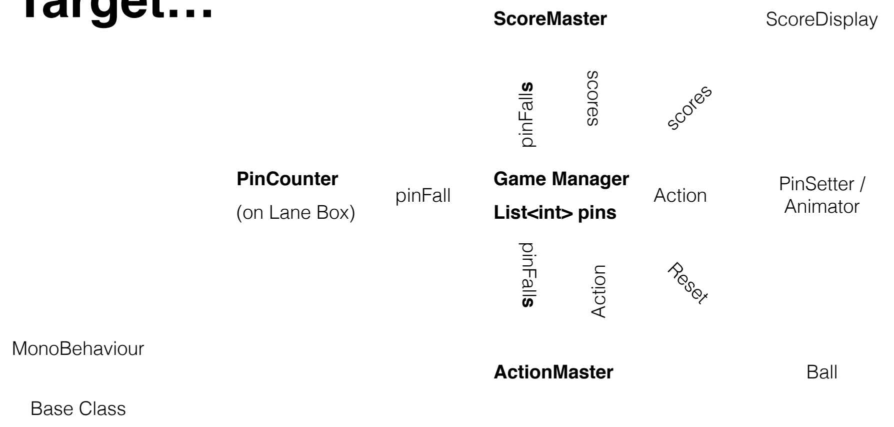
In this video...

Refactor your **ActionMaster** tests for new API.

Refactor your code to single responsibility*

**http://en.wikipedia.org/wiki/Single_responsibility_principle*

Target…



Refactor ActionMaster.cs

Still return an **Action** enum.

Create the new *static* method below.

Call your existing **Bowl** method for each pinFall.

New API passes a list of pitfalls, write this method

public static Action NextAction (List<int> pinFalls)

A Game Manager With State

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In this video...

Correcting a bug due to incorrect responsibility.

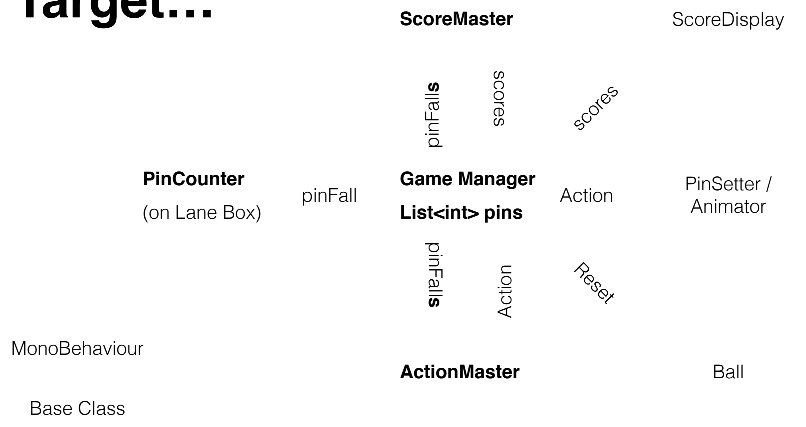
Create **GameManager.cs** and **PinCounter.cs**.

“Weed” PinSetter.cs into these new classes.

Call the static **ActionMaster.NextAction()**

Repeatedly test everything still works ok.

Target…



An Epic TDD Challenge

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In this video...

An overview of the challenge (and delight) ahead.

Find & move **ScoreMasterTest.cs** to Editor folder.

Temporarily disable **ActionMasterTest.cs**.

Write cumulative scorer in **ScoreMaster.cs**.

Set THE challenge.

Write cumulative scorer

Write cumulative scorer in **ScoreMaster.cs**.

We can write this now, without **ScoreFrames**.

It's a simple loop, the signature is below…

public static List <int> ScoreCumulative (List<int> rolls)

Get ScoreMaster.cs Working!

This took me over 2 full days!

It may take you much more, or less time.

Use the TDD Red > Green > Refactor strictly.

Un-comment the tests one at a time.

(My solution has 18 new lines in **ScoreFrames**)

Realtime Bowling Scoring Solution

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In this video...

How we solved the scoring problem.

A reminder that it's the destination that counts.

How tests protect your refactoring.

"Make things as simple as possible, but not simpler"
Albert Einstein

Refactor, refactor, refactor

Refactor your solution until it's beautiful.

Can you make it even simpler than ours?

Remember, it still needs to pass all tests!

Golden Copy Testing

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In this video...

What golden copies are.

Why they are useful for verification testing.

Using the **[Category ("Name")]** test annotation.

Using binary search to find the failing test(s).

Commenting our code for future readability.

Comment your code

Make your code as "pretty" as possible.

The shorter the easier to reason about.

Write comments about WHY you do things.

Let the code speak for it's self re the WHAT.

Make pretty using http://instacod.es & share.

An Array Of UI Text

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In this video...

Rearrange your UI to make space for scores.

Create your scoreboard.

Wire-up your scoreboard.

Create your scoreboard

Make space for up 21 bowls (single character).

Also ensure you have 10 frame score boxes.

Frame scores need to take up to 3 digits.

Wire-up your scoreboard

Create an array of Text in **ScoreDisplay.cs**.

Wire all the score boxes to this display.

Do the same for the frame scores.

Protecting Yourself From Bugs

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In this video...

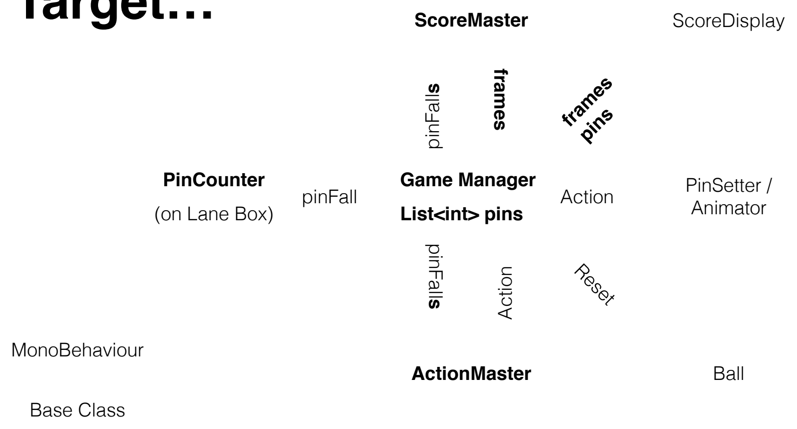
Break your whole game!

Trace your bug via console.

Discuss handling undefined states.

Discuss isolating and fixing bugs.

Target…



Break your whole game!

Add a method to **ScoreDisplay.cs**

Use the signature below.

Call this from GameManager, before **ball.Reset();**

Make it error, for example invalid array access.

public void FillRollCard (List<int> rolls)

Write down what's happening

Use the console trace.

Write 5+ bullet points as to what's going on.

Think about how you may fix this.

Tracing your bug via console

Once the ball has settled **Pin Counter** loops.

Every frame it calls **gameManager.Bowl ()**.

PinsHaveSettled () method never completes.

ballOutOfPlay stays true, hence infinite loop.

GameManager's pinfall list fills, leads to EndGame

Handling undefined states

Imagine this only happens 1 / 1000 games.

Failing hard vs. failing soft & reporting error.

Obviously we fix the bug and move on BUT…

… we also want to prevent show-stopping issues.

We'll catch the errors next, *and* fix the bug.

Try, Catch For Error Handling

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In this video...

How to decouple code with **try{}**, **catch{}**.

Mainly used in file handling applications.

Could be used in a team so one can move on.

Isolating our **ScoreDisplay.cs** issues.

Making our game fail gracefully.

Protect the offending line

Use the same **try{} catch {}** pattern.

Protect **scoreDisplay.FillRollCard (bowls)**

Check that your game now runs with warnings.

Static Classes In C#

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In this video...

What it means to define a class as static.

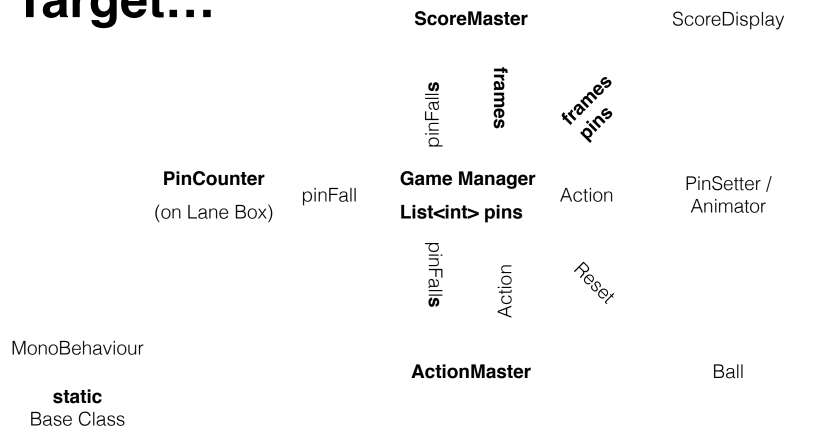
The perils (and advantages) of statics.

Why we're using static here.

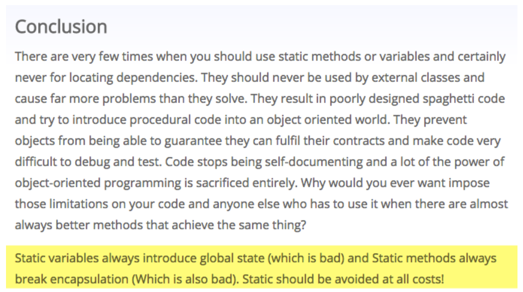
Refactoring a class to be static.

Learning to accept other people's code!

Target…



Tom Butler's view…


Conclusion

There are very few times when you should use static methods or variables and certainly never for locating dependencies. They should never be used by external classes and cause far more problems than they solve. They result in poorly designed spaghetti code and try to introduce procedural code into an object oriented world. They prevent objects from being able to guarantee they can fulfil their contracts and make code very difficult to debug and test. Code stops being self-documenting and a lot of the power of object-oriented programming is sacrificed entirely. Why would you ever want impose those limitations on your code and anyone else who has to use it when there are almost always better methods that achieve the same thing?

Static variables always introduce global state (which is bad) and Static methods always break encapsulation (Which is also bad). Static should be avoided at all costs!

https://r.je/static-methods-bad-practice.html

Optional: Refactor ActionMaster

Integrate **ActionMaster2.cs** from Start Pack.

Re-factor until beautiful.

Ensure all tests pass.

Paste your code in the discussions via PasteBin.

The less lines the better, if still readable.

Unit Testing Monobehaviours

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In this video...

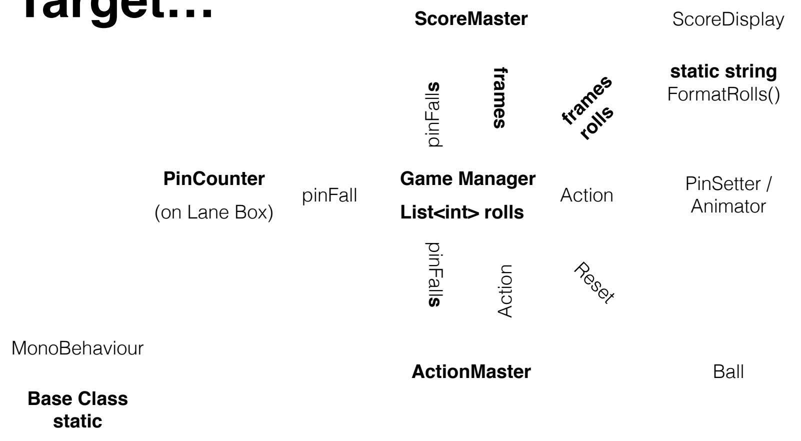
Monobehaviour classes are hard to test*

Code a testable static helper method.

Create our testing structure.

http://blogs.unity3d.com/2014/06/03/unit-testing-part-2-unit-testing-monobehaviours/*

Target…



Write FillRolls Method

public void FillRolls (List<int> rolls)

Calls FormatRolls and iterates the returned string.

Should be just 3 lines of code.

Designing Your Own Tests

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Use TDD To Write FormatRolls()

public static string FormatRolls (List<int> rolls)

Write your own tests as you go.

Stick to the red-green-refactor loop.

Aim for 20 lines or less of beautiful code.

Enjoy the process & share with [SPOILER].

Final Fixes & Finishing Off

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In this video...

Stopping nudging ball off the floor*

Make ball collisions detection continuous.

Suggestions for improvement.

** Thanks Yang https://db.tt/0LyfcZZr*

Stop the ball nudging off

Use whatever you've learnt so far.

Make sure you can't nudge off floor.

Make It Your Own

Add a menu system (start, prefs, end game).

Provide a 2nd ball, maybe a Death Star?

Save the high score to Player Prefs.

Make it portrait, and deploy to mobile.

Make it multi-player?

Section Wrap-Up