Number Tile Game Project

DUE DATES

This handout documents the requirements for the Number Tile Game Project, the required project for the course. You'll develop the project in 5 different increments; when you finish the final increment, you'll have a (small) complete game.

	Due Date
Increment 1	End of Week 3
Increment 2	End of Week 4
Increment 3	End of Week 5
Increment 4	End of Week 6
Increment 5	End of Week 7

ASSIGNMENT DESCRIPTION

Write a game that randomly generates a number from 1 to 9. The player guesses numbers by clicking on the number tile corresponding to their guess. Tiles are highlighted when the mouse is over them. If the player clicks the left mouse button on a tile that's an incorrect guess, the tile slowly shrinks until it's no longer visible. When the player clicks the left mouse button on the tile that's the correct guess, the tile blinks for a few seconds. The game then randomly generates a new number and resets the board. The player keeps playing until they press <Esc>.

The game plays appropriate sounds on incorrect guesses, correct guesses, and the start of a new game.

I've posted a project that you should use as your starting point for this project to the Required Assessment Materials course page (RequiredProjectMaterials.zip, OsxMonoGameRequiredProjectMaterials, or LinuxMonoGameRequiredProjectMaterials). The project contains all the classes you need as well as stubs for all the methods you need. I even threw in some extra code snippets where I thought they might be helpful. Use this project as your starting point for the game project!

The zip file also contains the graphic and sound assets I used for my game. The focus for this project is on the programming, so you should use the provided assets to get your code working. If you want to mess around with the graphics and sounds later, that's fine, but the code is what's actually worth points.

PEER GRADING

After submitting your work (described also in the two question parts below), you'll get the chance to grade the work of **five** of your peers. Your own work will also be assessed by your peers, from which we'll get your grade. Since you've worked hard on your submission and would like your peers to do a good job of assessing your submission, please take your time and do a good job of assessing your peer's submission in return.

HONOR CODE

Please remember that you have agreed to the Honor Code, and your submission should be entirely yours. Our definition of plagiarism follows from standard literature: passing off someone else's work as your own, whether from your peer or Wikipedia.

AUDIO ASSET DETAILS

XNA Users

Audio Component	Name
AudioEngine	"sounds.xgs"
WaveBank	"Wave Bank.xwb"
SoundBank	"Sound Bank.xsb"

Cue Name	Description
"correctGuess"	Explosion sound
"incorrectGuess"	Loser sound
"newGame"	Applause sound

MonoGame Users

Asset Name	Description
explosion	Explosion sound
loser	Loser sound
applause	Applause sound

REQUIREMENTS

You are not in any way required to follow the steps below. I thought it might be useful, however, for you to know the sequence of steps I followed to complete the game project. In most cases, I followed the steps in the order below, but in rare cases I actually decided I should have completed a particular step at a different point. That realization is reflected in the steps below.

All the instructions below talk about adding png files as graphical assets, which is the way we do it in XNA. Rather than muddying up all those instructions with extra text, I'll just make an important note here instead. MonoGame users need to add the xnb files I provided in the zip file rather than png files. In addition, there are a couple more steps you need to take when adding content to a MonoGame project, so you should go to the MonoDevelop Resources course page and follow the link that tells you how you do that.

As a final comment, you should note that I compiled and tested the game after every step listed below.

Increment 1

This increment displays the opening screen.

1. Run the project as provided to make sure it compiles and runs for you
2. Add code to the `Game1` constructor to set the window width to 800 and height to 600 and to make the mouse visible (Chapter 5, Week 2)
3. Add the openingscreen.png file to the GameProjectContent project. This is the graphical asset that will be displayed when the game starts (Chapter 5, Week 2)
4. Declare a `Texture2D` field in the `Game1` class to hold the opening screen image. As usual, we'll load content into this field then draw it as appropriate (Chapter 5, Week 2)
5. Declare a `Rectangle` field in the `Game1` class to hold the draw rectangle for the opening screen image. We'll use this field to draw the opening screen image as the appropriate size (Chapter 5, Week 2)
6. In the `Game1` `LoadContent` method, load the opening screen texture into the field from Step 4 (Chapter 5, Week 2)
7. In the `Game1` `LoadContent` method, create a new `Rectangle` object and put it in the field from Step 5. The rectangle should be created so the opening screen takes up the entire window (Chapter 5, Week 2)
8. In the `Game1` `Draw` method, draw the opening screen texture in the opening screen draw rectangle (Chapter 5, Week 2)

Increment 2

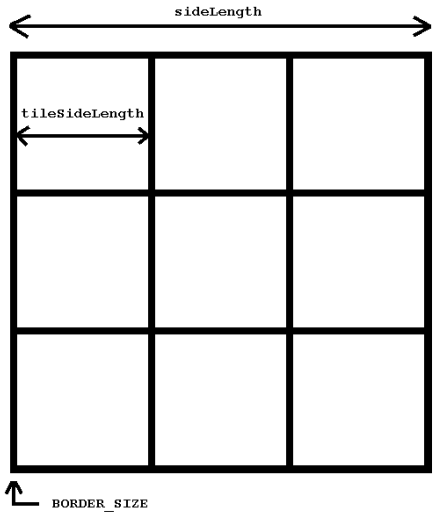
When the player presses Enter, the opening screen disappears and the board (without any number tiles) is displayed.

9. You don't need to do anything for this step; it just provides information you need for the next step. I've declared a `GameState` field called `gameState` in the `Game1` class and I've set it to `GameState.Menu`. This field is used to keep track of the current game state
10. In the `Game1` `Draw` method, add an if statement that checks if the current game state is `GameState.Menu` before drawing the opening screen texture in the opening screen draw rectangle (Chapter 7, Week 3)

    This step uses something called an enumeration, which we haven't discussed yet. You can read about enumerations in Section 8.1 of the book if you'd like, but for this step you just need to know that

    ```
    gameState == GameState.Menu
    ```

    is a Boolean expression that will evaluate to `true` if the value of the `gameState` variable is currently `GameState.Menu`.
11. Declare a `NumberBoard` field in the `Game1` class. This field will be used to hold the number board for the current game (Chapter 4, Week 2)
12. In the `Game1` `LoadContent` method, create a new `NumberBoard` object and put it in the field from Step 11. Use the window width and height to calculate the board side length and the board center before calling the constructor. The board should be centered in the window and should be smaller than the window width and height. At this point, I just set the correct number to 8 and the sound bank to `null` (Chapter 4, Week 2)
13. Add the board.png file to the GameProjectContent project. This is the graphical asset we'll use for the board background (Chapter 5, Week 2)
14. You don't need to do anything for this step; it just provides information you need for the next step. In the `NumberBoard` class, I've declared `Texture2D` field called `boardTexture` to hold the board texture and I've declared a `Rectangle` field called `drawRectangle` to hold the draw rectangle for the board texture
15. Write the `NumberBoard` `LoadContent` method (Chapter 5, Week 2)
16. Write the `NumberBoard` constructor, which loads the content (by calling the `LoadContent` method you wrote in the previous step), creates a new draw rectangle object, and calculates the size of the number tiles on the board. Be sure to include borders around the tiles using the `BORDER_SIZE` constant; the picture below might help you generate the appropriate calculation. Don't create the number tiles yet (Chapter 5, Week 2)



17. Write the `NumberBoard` `Draw` method to draw the board texture in the board draw rectangle. Don't draw the number tiles yet. (Chapter 5, Week 2)
18. In the `Game1` Update method, add an if statement that changes the game state to `GameState.Play` if the current game state is `GameState.Menu` and the Enter key is pressed. The following code returns `true` if the Enter key is pressed and `false` otherwise:

    ```
    Keyboard.GetState().IsKeyDown(Keys.Enter)
    ```

    and the following code changes the game state to `GameState.Play`

    ```
    gameState = GameState.Play;
    ```

    (Chapter 7, Week 3)
19. In the `Game1` `Draw` method, add an else clause to the if statement from Step 10 to have the board draw itself if the current game state is `GameState.Play`
    (Chapter 7, Week 3)

Increment 3

This increment displays all the number tiles on the board.

20. Add the eight.png file to the GameProjectContent project. This is the graphical asset for the number 8 tile (Chapter 5, Week 2)
21. You don't need to do anything for this step; it just provides information you need for the next step. In the `NumberTile` class, I've declared `Texture2D` field called `texture` to hold the tile texture and I've declared `Rectangle` fields called `drawRectangle` to hold the draw rectangle and `sourceRectangle` to hold the source rectangle. We need both draw and source rectangles because the tile textures we'll be using are sprite strips with multiple frames. The draw rectangle will tell us where to draw the tile and the source rectangle will tell us which texels from the `Texture2D` field we should draw (see Chapter 7, Week 3 for source rectangle idea from explosion animation example)
22. Write the `NumberTile` `LoadContent` method. I already provided code that uses the `ConvertIntToString` helper method to convert the integer to the string for the tile number (e.g., converting 8 to "eight"). We use this string in the `LoadContent` method so we can load the correct graphics content. You also need to create a new source rectangle object in this method; make it "cover" the left half of the texture you just loaded (Chapter 7, Week 3)
23. You don't need to do anything for this step; it just provides information you need for the next step. I've declared a `NUM_ROWS` by `NUM_COLUMNS` array field in the `NumberBoard` class to hold `NumberTile` objects and created the array object
24. In the `NumberBoard` constructor, add a nested for loop to initialize the `NumberTile` array. For now, I just create all the tiles with 8 for the tile number and correct number arguments and `null` for the sound bank argument. Note that we also have to calculate the center for each number tile to pass in to the `NumberTile` constructor. Use the `CalculateTileCenter` helper method I provided to help with this (Chapter 10, Week 5)
25. Write the `NumberTile` `Draw` method to draw the tile texture using the draw and source rectangles (Chapter 7, Week 3)
26. In the `NumberBoard` `Draw` method, add code to draw all the tiles. Using nested for loops is a reasonable way to do this (Chapter 10, Week 5)
27. At this point, when I run the game it draws the board with 9 "eight" tiles on it. Add the .png files for the rest of the numbers to the GameProjectContent project (Chapter 5, Week 2)
28. Change the calls to the `NumberTile` constructor to use the actual numbers for each of the tiles. The most intuitive way to do this is to use a counter variable that keeps track of the current tile number, but you can also do this by calculating the current tile number based on the loop control variables for the nested for loops. The board should now contain the correct number tiles when you run the game (Chapter 10, Week 5)

Increment 4

This increment displays all the number tiles, which highlight when the mouse is over them. When incorrect tiles are clicked, they shrink until they disappear.

29. In the `Game1` `Update` method, if the current game state is `GameState.Play` get the current mouse state and call the `NumberBoard` `Update` method (Chapter 8, Week 4)
30. In the `NumberBoard` `Update` method, add code to call the `Update` method for each of the tiles. Using nested for loops is a reasonable way to do this (Chapter 10, Week 5)
31. In the `NumberTile` `Update` method, add an if statement at the beginning of the method to set the source rectangle `X` property appropriately based on whether or not the mouse is over the draw rectangle for the tile. At this point, each of the tiles highlights when the mouse is over the tile and unhighlights when the mouse isn't over the tile (Chapter 8, Week 4)
32. Add fields to the `NumberTile` class to tell if the tile is visible, if the tile is blinking, and if the tile is shrinking. Initialize those fields appropriately (Chapter 12, Week 6)
33. Add `clickStarted` and `buttonReleased` fields to the `NumberTile` class. In the `NumberTile` `Update` method, change the if statement from Step 31 to detect mouse clicks on the number tile. You can use the `MenuButton` `Update` method code at the very end of Chapter 8 to help you with this (I also provided the code for that method in the zip file for this project). Replace the code (from Chapter 8) that changes the game state when a click is finished on the menu button with code that does the following instead: If the player just clicked on the tile and the tile corresponds to the correct number, set the tile is blinking field to `true`, otherwise set the tile is shrinking field to `true`. You need to detect clicks rather than left mouse button presses so the player can't just "sweep" the mouse over the tiles to guess numbers (Chapter 12, Week 6 for fields. Chapter 8, Week 4 for using Chapter 8 code)
34. You don't have to do anything for this step; it's just explaining our plan for moving forward. We now need to modify our `NumberTile` `Draw` method and continue to refine our `NumberTile` `Update` method to handle this new information. Specifically:

    a. Once the user has clicked the mouse button on the tile (it's blinking or shrinking), we don't want to use the if statement from the previous step to set any flags. That way, the user can only click the mouse button on a tile once
    b. Once a tile is blinking or shrinking, we need to update the blinking animation or the (shrinking) draw rectangle size on each update
    c. Once the tile is no longer visible (it shrunk away to nothing or finished blinking), we don't want to draw it at all any more

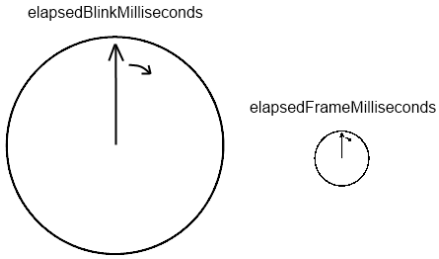
35. In the `NumberTile` `Draw` method, only draw the tile if it's visible (Chapter 7, Week 3)
36. Declare and initialize fields in the `NumberTile` class to keep track of the total milliseconds it takes the tile to shrink (this should be a constant) and the elapsed shrink milliseconds so far (this should be a variable) (Chapter 12, Week 6 for fields. Chapter 7, Week 3 for timers)
37. In the `NumberTile` `Update` method, add an if statement that checks if the tile is shrinking. If it is, update the elapsed shrink milliseconds field by adding `gameTime.ElapsedGameTime.Millisconds` to it. Calculate the new side length for the tile using the original side length and the ratio between (total shrink milliseconds - elapsed shrink milliseconds) and total shrink milliseconds. **CAUTION: Force the ratio to get calculated as a `float`, otherwise your tile will just disappear instead of gradually shrinking**. Doing it this way makes the shrinking tile start at (almost) full size, then shrink down to 0. If the new side length is > 0, set the width and height of the draw rectangle to the new side length; otherwise, set the visible flag for the tile to `false` (Chapter 7, Week 3 for timers)
38. At this point, clicking on any tile except the 8 tile should make the tile gradually shrink until it's disappeared. Unfortunately, if you move the mouse off the shrinking tile it's no longer highlighted, which doesn't look right. In the `NumberTile` `Update` method, move the entire if statement you wrote in Step 33 into an else clause for the if statement you wrote in Step 37 so the source rectangle is only changed if the tile isn't shrinking. There are other ways to make sure the tile stays highlighted, but doing it this way is required for later steps (Chapter 7, Week 3)

Increment 5

This increment finishes the game. When the correct tile is clicked, it blinks for a while, then a new game is started. The game also includes sound effects.

This increment has a lot more steps than the previous increments, in part because there are no programming assignments due in Week 7.

39. Next we want to make it so that when the correct tile is clicked, that tile starts blinking. Add all the blinking number .png files to the GameProjectContent project (Chapter 5, Week 2)
40. Declare a `Texture2D` field in the `NumberTile` class to hold the blinking tile texture (Chapter 12, Week 6 for fields)
41. In the `NumberTile` `LoadContent` method, add code to load the blinking tile texture into the field from the previous step. Note that you can use the string for the tile number to help build the name of the texture (all the blinking textures start with "blinking" followed by the number string) (Chapter 6, Week 3)
42. Now we have two textures we need to use for drawing: one for normal and shrinking tiles and the other for blinking tiles. That means we'll need to keep track of the current texture we're using so we draw the appropriate one. Declare a `Texture2D` field in the `NumberTile` class to hold the current texture we'll be drawing (Chapter 12, Week 6)
43. In the `NumberTile` `LoadContent` method, add code to set the current texture to the non-blinking texture (Chapter 3, Week 1)
44. In the `NumberTile` `Draw` method, change the code to draw the current texture (Chapter 5, Week 2)
45. In the `NumberTile` `Update` method, add two lines of code just after the line where you set the tile is blinking field to `true`. Your first new line of code should set the current texture to the blinking texture. Your second new line of code should set the `X` property for your source rectangle to 0 (Chapter 5, Week 2)
46. In the `NumberTile` `Update` method, change the original if clause (that checked if the tile is shrinking) for the if statement from Step 37 to an else if instead. Now add an if clause before that else if clause to check if the tile is blinking. You'll now have an if statement with an if clause that checks if the tile is blinking, an else if clause that checks if the tile is shrinking, and an else clause that highlights/unhighlights the tile and lets the player click the mouse button on the tile. Basically, we're doing different update processing on the tile based on the current tile state (blinking, shrinking, or normal). (Chapter 7, Week 3)
47. You don't have to do anything in this step, it's just explaining how the next two steps will work. For our blinking animation, we need to have two timers. We'll use one timer, `elapsedBlinkMilliseconds`, to tell us when the blinking animation should stop. We'll use the other (shorter) timer, `elapsedFrameMilliseconds`, to tell us when it's time to change frames in the animation. See the picture below.



48. Inside the if clause you added in Step 46, add code to determine when to make the tile invisible (after it's done blinking). Note that I've already included `elapsedBlinkMilliseconds` and `TOTAL_BLINK_MILLISECONDS` fields for you to use for this. You'll need to update the elapsed blink milliseconds field by adding `gameTime.ElapsedGameTime.Milliseconds` to it before deciding whether or not to stop the blinking animation (Chapter 7, Week 3 for timers)
49. After the code you added in the previous step (but still inside the if clause you added in Step 48), add code to update the animation frame as appropriate. I've already included `elapsedFrameMilliseconds` and `TOTAL_FRAME_MILLISECONDS` fields for you to use for this. Add

`gameTime.ElapsedGameTime.Milliseconds` to the elapsed frame milliseconds field, then use the new value to decide when to change to a new animation frame. To change frames in the blinking animation, you need to move the source rectangle left or right (depending on where the source rectangle currently is) after each frame ends to change the texels being displayed (Chapter 7, Week 3)

50. You don't have to do anything for this step, it's just a check on your progress. At this point, clicking the 8 tile should make it blink between yellow and green for a few seconds, then the tile should disappear. Clicking on all the other tiles should make them shrink down until they're no longer visible
51. You don't have to do anything for this step either; it's just explaining what you'll be doing next. Now we're faced with a difficult problem. When the correct number is guessed, we're supposed to reset the board and start a new game. We allocated the responsibility of determining whether or not the correct number was guessed to each individual number tile (this was the correct design decision), but how does the number tile let the game know that the correct number was guessed? The `NumberTile` class doesn't know anything about the `Game1` or `NumberBoard` classes, so how can it communicate this information to them? There's a very slick way to do this in C# using something called *event handlers*, but that's not introductory-level material. Instead, I've made the `NumberBoard` `Update` method and the `NumberTile` `Update` method return a `bool` instead of the typical `void`. A `false` will mean the correct number hasn't been guessed yet and a `true` will mean it has. This isn't the best general solution (event handlers are), but it's the best solution using what we know at this point
52. In the `NumberBoard` `Update` method, we need to return `true` if one of the `NumberTile` `Update` calls returns `true` (indicating that the correct number was guessed), otherwise we need to return `false`. Change the call to the `NumberTile` `Update` method to put the result into a `bool` variable; the syntax is similar to when you called the `Deck` `TakeTopCard` method and put the returned value into a `Card` variable (in Lab 4). If this `bool` variable is `true` after the call to the method, immediately return `true` from the `NumberBoard` `Update` method. Doing it this way ensures the method immediately returns `true` if the correct number is guessed and also lets us skip the updates for the rest of the number tiles. There are more complicated ways to do this to make sure all the tiles get updated (to make sure we don't skip updating shrinking animations for 1/60 of a second, for example, for tiles that are currently shrinking), but this approach works fine here (Chapter 13, Week 6 for method return)
53. You don't have to do anything for this step, but you might be wondering if the `NumberBoard` `Update` method returns `false` correctly. The answer is yes, because the only way we get to the last line of code in the method is if none of the `NumberTile` `Update` method calls return `true`, which means the correct number wasn't guessed on this update. Slick, huh?
54. In the `Game1` `Update` method, change the call to the `NumberBoard` `Update` method to declare a variable to tell whether or not the correct number has been guessed and put the returned value from the method call into that variable (Chapter 4, Week 2)
55. Cut the code you added to the `Game1` `LoadContent` method to calculate the board size and actually create the board and paste that code into the `StartGame` method I provided at the end of the `Game1` class. Call the `StartGame` method from the `Game1` `LoadContent` method where you used to have that code. You'll see why we need to do this soon (Chapter 4, Week 2)
56. In the `Game1` `Update` method, add an if statement right after the call to the `NumberBoard` `Update` method to check if the correct number has been guessed. If it has, call the `StartGame` method (Chapter 7, Week 3)
57. At this point, we never actually end up restarting a game. That's because the `NumberTile` `Update` method always returns `false`. In the code in that method that sets visible for a blinking tile to `false` (see step 48), change the code that sets visible to `false` to return `true`; instead. We don't want to return `true` from this method right when the user picks the correct number because then they won't get to see any blinking, so we return `true` when the blinking is done (Chapter 13, Week 6 for return)
58. At this point, our game always has 8 as the correct number. Declare a `Random` field in the `Game1` class and use `new Random()` to instantiate the object for the field (Chapter 12, Week 6)
59. In the `StartGame` method, declare a variable to hold the correct number for the current game and set it to a random number (from 1 to 9 inclusive) you generate using the field from the previous step. Pass that number as the correct number argument when you call the `NumberBoard` constructor in the `StartGame` method (Chapter 4, Week 2)

60. In the `NumberBoard` constructor, change the call to the `NumberTile` constructor to pass the `correctNumber` parameter as the correct number argument (instead of 8 or whatever hard-coded number you used) (Chapter 4, Week 2)

    Note: The instructions below are correct for XNA users. Unfortunately, MonoGame doesn't support using XACT, so I'm working on the instructions for MonoGame users. I promise I'll have them before Week 7!

61. Holy smokes! The game is – finally – almost done. It should all be working properly for you by this point, with the sound effects the only thing that are missing. Copy the sounds.xap and .wav files into the GameProjectContent folder and add the sounds.xap file to the GameProjectContent project. Add a reference in the GameProject project to the Microsoft.Xna.Framework.Xact namespace by right clicking References, selecting Add Reference ..., selecting the .Net tab in the popup, scrolling down to the required namespace, selecting it, and clicking the OK button. (Chapter 14, Week 7)
62. Declare fields in the `Game1` class for the audio api components (see Chapter 14 in the book) (Chapter 14, Week 7)
63. In the `Game1` `LoadContent` method, add code to load the audio content (see Chapter 14 in the book) (Chapter 14, Week 7)
64. In the `StartGame` method, pass the sound bank as the sound bank argument to the `NumberBoard` constructor (instead of the `null` you've been passing) (Chapter 4, Week 2)
65. In the `NumberBoard` constructor, change the call to the `NumberTile` constructor to pass the `soundBank` parameter as the sound bank argument (instead of `null`) (Chapter 4, Week 2)
66. Declare a field in the `NumberTile` class to hold a `SoundBank` object (Chapter 12, Week 6)
67. In the `NumberTile` constructor, add code to set the field from the previous step to the `soundBank` parameter (Chapter 13, Week 6)
68. In the `NumberTile` `Update` method, add code to play the correctGuess cue when the player picks a tile corresponding to the correct number (right after you set the blinking flag to `true`) and to play the incorrectGuess cue when the player picks an incorrect tile (right after you set the shrinking flag to `true`) (Chapter 14, Week 7)
69. In the `Game1` `Update` method, add code to play the newGame cue before calling the `StartGame` method. We do this here rather than in the `StartGame` method because we don't want this cue to play for the first game (Chapter 14, Week 7)
70. Change the if statement at the top of the `Game1` `Update` method to exit if the <Esc> key is pressed (Chapter 15, Week 7)
71. That's it, you're done!

HELPFUL HINTS

If you decide to follow my recommendation and use the sequence of steps above, you can't skip any of the steps or do them out of order. You'll have to do every step, in order, to get the assignment done. If you get stuck on a particular step, you have to figure it out and make sure it's correct before moving on.

If you decide not to use the steps above, your turn-in for each increment needs to provide, at a minimum, the same functionality that would have been included in the increment if you had followed the steps.

OPTIONAL EXTRA CODING FUN

If you want to implement the game with a 360 controller, it's not worth any points, but you'll learn even more from the project. If you do this, though, make sure you submit the keyboard/mouse version of the project on the course page; this optional part is just for your personal enjoyment (and learning).

Change the game to use an Xbox 360 controller instead of the mouse and keyboard. You'll need to change the intro screen image and processing to have the player press a button on the controller to advance past the intro screen, change the number tile so the player changes the selected number tile using the left thumbstick, and have the player click a button on the controller to select the number tile that's currently highlighted. When a new game starts, be sure to highlight a number tile.

This is actually a lot of work. Making the changes above aren't as simple as you might think, but you should be able to use Section 9.7 from the book to help you figure out how to do a lot of the work here, including making the thumbstick navigation have a reasonable delay before moving to a new number tile. You aren't allowed to use the thumbstick to drive a "pointer" around the screen to replace the mouse; instead, changing between tiles should work as you'd typically see with a 360 controller (like it works on the menu in Section 9.7).