Project Name: RFIDice Tray	
User Requirement Number: 1	**Version: 1**
Originator: Andrew Troyer	**Approval:**

Requirement:

The RFIDice Tray shall stay powered and run for long play sessions on battery alone

Rationale:

The device should be able to be played along with long board games, and therefore needs to be powered long enough for time-consuming games.

Project Name: RFIDice	
System Requirement Number: 1.0	**Version: 1**
Originator: Andrew Troyer	**Approval:**

Requirement:

The RFIDice Tray shall stay powered and run for a minimum of 8 hours per Battery

Rationale:

In my experience 8 hours is an extremely long play session. 8 hours should be long enough.

Verification Plan:

Turn the device on and measure how long it takes to turn itself off. Press buttons and input RFID tags for die rolls every once in a while.

Verification Data:

Battery starting voltage: 4.2 Volts. Display states "BATTERY FULL" in top-right corner
Display states: "BATTERY LOW" 50 minutes into testing
Display states: "BATTERY DEAD" 2 hours and 5 minutes into testing

RFIDice Tray turns off at 2 hours 22 minutes.

The battery used for this test was a 270mAh battery. If I use the 2200mAh battery that I have on hand the RFIDice Tray would have lasted at least 16hrs.

Project Name: RFIDice	
System Requirement Number: 1.1	**Version: 1**
Originator: Andrew Troyer	**Approval:**

Requirement:

The RFIDice Tray shall draw no more than 300 mA while powered on

Rationale:

300 mA is a lot for a desk toy. The device should not exceed this value easily.

Verification Plan:

Stress test the RFIDice Tray and measure the max current exiting the battery.

Verification Data:

The maximum current was 123.8mA.

Project Name: RFIDice	
System Requirement Number: 1.2	**Version: 1**
Originator: Andrew Troyer	**Approval:**

Requirement:

The RFIDice Tray shall draw no more than 50µA while powered off

Rationale:

The device shouldn't waste power while it is off.

Verification Plan:

Connect the battery to the RFIDiceBoard through a multi-meter measuring current. Check the current load over a few minutes.

Verification Data:

The RFIDice Tray powered off peaked at a current of 42µA.

Project Name: RFIDice	
System Requirement Number: 1.3a	**Version: 2**
Originator: Andrew Troyer	**Approval:**

Requirement:

The battery of the RFIDice Tray shall be rechargeable

Rationale:

If the battery dies the device should not die with it

Verification Plan:

Verify that the RFIDice Tray has a battery that is rechargeable

Verification Data:

The RFIDice Tray has a LiPo battery that is chargeable via USB C on the RFIDice Tray.

Project Name: RFIDice Tray	
User Requirement Number: 2	**Version: 1**
Originator: Andrew Troyer	**Approval:**
Requirement: The RFIDice Tray shall be space efficient	
Rationale: Nobody will want a dice-solution that takes up much more space than normal dice.	

Project Name: RFIDice	
System Requirement Number: 2.0	**Version: 1**
Originator: Andrew Troyer	**Approval:**

Requirement:

The RFIDice Tray shall be smaller than 20 centimeters wide and 7 centimeters tall (20cm x 20cm x 7cm)

Rationale:

These are generous dimensions. The device should not be a quarter the area of a board game.

Verification Plan:

Verify that the RFIDice Tray is smaller than 20x20x7cm

Verification Data:

The RFIDice Tray measures in at 15cm x 15cm x 5cm.

Project Name: RFIDice	
System Requirement Number: 2.1	**Version: 1**
Originator: Andrew Troyer	**Approval:**

Requirement:

The RFIDice Tray shall not exceed a mass of 3 kg

Rationale:

The device should be easy to carry around.

Verification Plan:

Verify the mass of the RFIDice Tray by weighing it and making sure it is under 3kg.

Verification Data:

The RFIDice Tray weighs 155 grams.

Project Name: RFIDice Tray	
User Requirement Number: 3	**Version: 1**
Originator: Andrew Troyer	**Approval:**

Requirement:

The RFIDice will respond to die rolls via the initial dice sensor within a reasonable amount of time

Rationale:

The device should not be more inconvenient than normal dice, therefore should not make users wait for a random number.

Project Name: RFIDice	
System Requirement Number: 3.0	**Version: 1**
Originator: Andrew Troyer	**Approval:**

Requirement:

The RFIDice Tray shall display the randomly generated number to the user within 300 milliseconds of detecting a dice roll via the initial dice sensor

Rationale:

The microcontroller should be able to generate and display a random number within 300 milliseconds rather easily.

Verification Plan:

In software, measure the time it takes for the dice to be detected and the number to finish displaying. Display the time in milliseconds on the display.

Verification Data:

According to the software, the RFIDice Tray responds with a random number within less than a millisecond.

Project Name: RFIDice	
System Requirement Number: 3.1	**Version: 1**
Originator: Andrew Troyer	**Approval:**

Requirement:

The RFIDice Tray shall generate a random number for a minimum of 1 RFID die

Rationale:

The device needs at least one dice to be a dice tray that generates random number for dice.

Verification Plan:

Verify that the RFIDice Tray works with at least 1 RFID die.

Verification Data:

The RFIDice Tray works with 4 Dice as of writing.

Project Name: RFIDice Tray	
User Requirement Number: 4	**Version: 1**
Originator: Andrew Troyer	**Approval:**

Requirement:

The RFID dice of the RFIDice Tray shall be as durable as normal dice

Rationale:

If the dice of the device destroy more easily and are more expensive than normal dice then nobody would purchase the device.

Project Name: RFIDice	
System Requirement Number: 4.0 b	**Version: 1**
Originator: Andrew Troyer	**Approval:**

Requirement:

The dice of the RFIDICE Tray shall not shatter or otherwise become unusable after being dropped from 30 centimeters onto concrete five times

Rationale:

The dice tray will be put under much less stress than this in normal operation. If they can pass this then they will be as durable as normal dice.

Verification Plan:

Drop the dice of the RFIDice Tray onto concrete five times and verify that the dice still works with the RFIDice Tray.

Verification Data:

The RFIDice Tray still operates after dropping it on concrete five times from 30cm up.

Project Name: RFIDice Tray	
User Requirement Number: 5	**Version: 1**
Originator: Andrew Troyer	**Approval:**
Requirement: The RFIDice Tray shall notify the user if the battery is running low on power	
Rationale: The device should not shut down seemingly randomly. That would lead to a frustrating experience.	

Project Name: RFIDice	
System Requirement Number: 5.0	**Version: 1**
Originator: Andrew Troyer	**Approval:**

Requirement:

The RFIDice Tray shall turn on a visible notification visible in low-light conditions if the battery reaches a voltage level of 80% of nominal voltage

Rationale:

60% of nominal voltage is the normal range when a battery should be replaced. 80% should give the user enough time to locate new batteries.

Verification Plan:

Verify that when the device notifies the user that the battery is low it is at or below 80% nominal voltage. Measure the Li-Po battery's voltage.

Verification Data:

In the test for the RFIDice Tray battery life it displayed BATTERY LOW whilst at 80% nominal voltage.

Project Name: RFIDice Tray	
User Requirement Number: 6	**Version: 1**
Originator: Andrew Troyer	**Approval:**

Requirement:

The RFIDice Tray shall have a way for the user to turn the device on or off other than unplugging the battery or USB

Rationale:

The user should be able to keep the battery plugged in while turning the device off. Unplugging the device to turn it on and off would lead to unnecessary wear and tear.

Project Name: RFIDice	
System Requirement Number: 6.0	**Version: 1**
Originator: Andrew Troyer	**Approval:**

Requirement:

The user interface of the RFIDice Tray shall at minimum have a switch or button to activate/deactivate the device

Rationale:

A switch or button are easy on and off interfaces for the user to understand and also are meant to be used repeatedly. Unplugging the device to turn it off would lead to more wear and tear.

Verification Plan:

Verify that a switch exists that turns the device on and off.

Verification Data:

There is indeed a switch on the RFIDice Tray that turns it on and off.

Project Name: RFIDice Tray	
User Requirement Number: 7	**Version: 1**
Originator: Andrew Troyer	**Approval:**
Requirement: The random number generated by the RFIDice Tray shall not be easily predictable by the user	
Rationale: The goal of the device is to emulate real dice. If the device spits out predictable numbers then the device is not like real dice.	

Project Name: RFIDice	
System Requirement Number: 7.0 a	**Version: 1**
Originator: Andrew Troyer	**Approval:**

Requirement:

The random number generated by the RFIDice Tray shall be generated by a Wichmann-Hill generator triggered by the current time recorded on the MCU based on when the MCU is powered on

Rationale:

The Wichmann-Hill generator is a simple random number generation algorithm that generates pseudo-random numbers. If it generates numbers fast enough (triggered by current time) the numbers it creates look random to users.

Verification Plan:

Verify that the software for the RFIDice Tray contains an implementation of the Wichmann-Hill generator.

Verification Data:

The software does indeed include an implementation of the Wichmann-Hill generator.

Project Name: RFIDice	
System Requirement Number: 7.1	**Version: 1**
Originator: Andrew Troyer	**Approval:**

Requirement:

The seeds for the random number generator shall be 100, 100, 100.

Rationale:

Something simple to start the algorithm on.

Verification Plan:

Verify that the seeds in the source code for the Wichmann-Hill generator start at 100, 100, and 100.

Verification Data:

The software does indeed include an implementation of the Wichmann-Hill generator.

Project Name: RFIDice Tray	
User Requirement Number: 8	**Version: 1**
Originator: Andrew Troyer	**Approval:**

Requirement:

The MSRP RFIDice Tray and dice shall have an MSRP of less than $150

Rationale:

The device will in general be more expensive than normal dice but anything over $150 is incredibly expensive for a desk toy. The device should not reach anything near $150 MSRP in reality.

Project Name: RFIDice	
System Requirement Number: 8.0	**Version: 1**
Originator: Andrew Troyer	**Approval:**

Requirement:

The sum of total parts shall total less than $50

Rationale:

One third of the maximum MSRP.

Verification Plan:

Verify that the price of the materials for the RFIDice Tray are less than $50.00

Verification Data:

The price of the main components (MCU, RFID sensor, display) total $5.10. That gives a buffer of $44.90 for the rest of the components which are all cheaper than the individual main components.

Project Name: RFIDice Tray	
User Requirement Number: 9	**Version: 1**
Originator: Andrew Troyer	**Approval:**
Requirement: The RFIDice Tray shall have a way to display a randomly generated number to the user	
Rationale: If the random number generator does not display a random number to the user it is not a useful replacement for normal dice.	

Project Name: RFIDice	
System Requirement Number: 9.0	**Version: 1**
Originator: Andrew Troyer	**Approval:**

Requirement:

The RFIDice Tray shall be capable of displaying of no less than 3 digits to the user

Rationale:

A d100 dice is the largest die used in most board games. The device should be able to emulate a d100.

Verification Plan:

Verify that the RFIDice Tray can display at least 3 digits for random number generation.

Verification Data:

The RFIDice Tray can display more than 3 digits for random number generation.

Project Name: RFIDice Tray	
User Requirement Number: 10	**Version: 1**
Originator: Andrew Troyer	**Approval:**

Requirement:

The RFIDice Tray shall indicate to the user that it is in the 'power on' state

Rationale:

If the device does not show the user that it is on the user could attempt to roll dice and be frustrated by the device being powered off.

Project Name: RFIDice	
System Requirement Number: 10.0	**Version: 1**
Originator: Andrew Troyer	**Approval:**

Requirement:

The RFIDice Tray shall turn on a visible notification if the device is on

Rationale:

A visible notification like a light is more universally understandable than a sound or vibration.

Verification Plan:

Verify that the RFIDice Tray shows some sign of life whilst turned on.

Verification Data:

The TFT display of the RFIDice Tray is on and visible whilst powered on.

Project Name: RFIDice Tray	
User Requirement Number: 11 b	**Version: 1**
Originator: Andrew Troyer	**Approval:**
Requirement: The RFID dice of the RFIDice Tray shall roughly be the size of normal dice	
Rationale: If the dice of the device are larger or smaller than normal dice they will be difficult to transport.	

Project Name: RFIDice	
System Requirement Number: 11.0 c	**Version: 1**
Originator: Andrew Troyer	**Approval:**

Requirement:

The diameter of the RFID dice shall be larger than 5 millimeters and smaller than 4 centimeters (Combined 1.0 and 1.1)

Rationale:

Average dice are between 5 mm and 50 mm so the devices dice should be roughly the same size.

Verification Plan:

Verify that the size of the die are smaller than 4cm and larger than 5mm.

Verification Data:

The dice are disks that have a diameter of 2.5cm

Project Name: RFIDice Tray	
User Requirement Number: 12	**Version: 1**
Originator: Andrew Troyer	**Approval:**

Requirement:

The RFIDice Tray shall be capable of detecting dice rolls that come into contact with the device

Rationale:

The RFIDice Tray needs to respond to dice rolls specifically when the RFID dice come into contact with the tray. The dice needs to be thrown just like normal dice.

Project Name: RFIDice	
System Requirement Number: 12.0	**Version: 1**
Originator: Andrew Troyer	**Approval:**

Requirement:

The RFIDice Tray shall detect dice rolls that come into direct contact with the initial dice sensor

Rationale:

The dice tray need to respond to dice that come into contact with the tray, not just any RFID that is near the device.

Verification Plan:

Verify that the device reacts when an RFIDice Tray die comes into physical contact with the initial dice sensor

Verification Data:

The RFIDice Tray reacts to RFID tags when they are within 2cm of the dice sensor as well as when they make contact with the dice sensor.

Project Name: RFIDice Tray	
User Requirement Number: 13	**Version: 1**
Originator: Andrew Troyer	**Approval:**
Requirement: The RFIDice Tray shall detect RFID signals	
Rationale: The RFIDice Tray would not be called the RFIDice Tray if it did not detect RFID signals.	

Project Name: RFIDice	
System Requirement Number: 13.0	**Version: 1**
Originator: Andrew Troyer	**Approval:**

Requirement:

The RFIDice Tray shall use an RFID antenna to pick up and identify RFID tags

Rationale:

The device needs to detect RFID signals somehow. Most of the time RFID tags are picked up with RFID antennas.

Verification Plan:

Verify that RFID tags are detected by the RFIDice Tray.

Verification Data:

The RFIDice Tray does read unique ID's from RFID tags using an RFID antenna.