California State University, Long Beach, Department of Electrical Engineering

EE 400D Verification and Validation Test Plan, Fall 2017

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Project: Goliath

Project Manager: Mark Huffman

Electronics & Control Engineer: John Ocampo

Mission, Systems, and Test Engineer: Nornubari Kanabolo,014683225

Manufacturing Engineer: Vanessa Enriquez

1 **<u>Table of Contents</u>**

1   Introduction

This is the Goliath Fall 2017 Verification and Validation Test Plan

1.1   Purpose

The purpose of this document is to provide a comprehensive Verification and Validation (V&V) Test Plan of the Fall 2017 Goliath, including the Project ConOps/Mission, Test Methodology, Verification and Validation Matricies, and Test Cases.

1.2   Project ConOps/Mission

Create a toy robot capable of being manually "RC" driven through a 2D maze, and then be capable of repeating the route autonomously. In a second event the robot must travel through a predetermined route in the maze while avoiding running into other robots

1.3   Document Overview

This document is organized as follows:

- Section 2 contains links to relevant and applicable project reference documents and presentations for this Test Plan.
- Section 3 contains a description of the Testing Methodology utilized in this Test Plan, including the Master Verification and Validation Matrix, a description of the 4 types of V&V testing performed, the Test Environment description, and a Master Test Case List of all (number #) Test Cases for this project.
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2 Applicable Documents

This section contains a table of all relevant and applicable project reference documents and presentations for the Goliath Fall 2017 Verification and Validation Test Plan.

Document Name	Document Description	Document Link
PDD	Preliminary Design Document	Blog Post
PDR	Preliminary Design Review Presentation. Contains L1 and L2 Requirements, System Block Diagram, Resource Allocation Reports,	PDR
NASA Systems Engineering Handbook (2007)	Document containing Test Methodologies in Section 3	http://www.acq.osd.mil/se/docs/NASA-SP-2007-6105-Rev-1-Final-31Dec2007.pdf

3   Testing Methodology

This section contains the Master Verification and Validation Matrix, as well as detailed descriptions of the various Test Methods and Test Cases utilized in this Test Plan.

3.1   Master Verification and Validation (V&V) Matrix

This matrix provides complete traceability of every requirement. Specifically, every requirement is mapped to its description, success criteria, V&V testing designation and method, and Test Case(s) where the requirement will be tested. Note that some overlap between Test Cases' requirements V&V is okay.

Requirement Number	Requirement Text	V&V Success Criteria	V&V Designation (Verification, Validation?)	V&V Method (Analysis, Demonstration, Inspection, Test?)	Test Case(s) where Requirement is Tested
L1-1	Project shall be ready by Wednesday December 13th, 2017	Customer feels Goliath meets expectations	Validation	Inspection	12
L1-2	The Goliath will have the functionality to be connected remotely using Arxterra	Goliath must be responsive to user input commands from both the ArxRobot mobile app and Arxterra Control Panel	Verification	Test	1
L1-3	The Goliath will behave like a toy	Golaith is disassembled and reassembled within 20 minutes	Validation	Inspection	3, 7
L1-4	The Goliath will be able to drive on flat surfaces	Goliath travels whole length of 61cm continuously	Verification	Test	1, 6

L1-5	The Goliath shall traverse on cloth, paper and linoleum	Goliath moves across cloth, paper and linoleum at least 61cm	Verification	Test	1
L1-6	All modifications shall allow the Goliath to be printed under a total print time of 6 hours with no part taking longer than 2 hours	Altogether Goliath parts take under 2 hours to print	Verification	Test	4
L1-8	The Goliath will use the 3DoT Board	Goliath contains 3DoT board upon inspection	Validation	Inspection	14
L1-9	The Goliath should appear in scale to the real Goliath 302 tank	Newly designed Goliath is in scale to Goliath 302 tank	Verification	Analysis	15
L1-10	The Goliath should be told to move remotely using Arxterra	Goliath reaches 61cm mark	Verification	Test	6
L1-11	The total cost of the Goliath shall remain under $350	Customer sees project was built under $350 budget on budget report	Validation	Inspection	16
L1-12	The Goliath should traverse a maze under remote control	Customer can control Goliath using the ArxRobot mobile app	Validation	Demonstration	17
L1-13	The Goliath should traverse the maze without user input	Customer sees Goliath complete maze without user input	Validation	Demonstration	18

L1-14	The Goliath should remember the manual instructions given, in terms of navigating the maze	Customer sees Goliath successfully re-navigate maze	Validation	Demonstration	19
L1-15	The Goliath should display the next turn direction on LED grid display	LED array successfully displays direction pressed on the D-pad	Verification	Test	1, 2, 6
L1-16	The Goliath should have easy access for charging and programing hookup	Charging indicator turns on before 5 second timer runs out	Verification	Test	7
L1-17	The Goliath shall remain operating for at least an hour	Goliath runs for 1 hour	Verification	Test	8
L1-18	The Goliath should be smaller than the final design of the previous version	Customer sees that current Goliath is visibly smaller than the Fall 2016 design	Validation	Inspection	21
L1-19	All of the Goliath electronics and motors should disassemble and reassemble within 20 minutes	Customer sees the Goliath is successfully assembled and disassembled in 20 minutes	Validation	Demonstration	13

L1-20	The Goliath should detect and avoid running into other bots on the maze	Customer sees Goliath complete maze without touching other robots in maze	Validation	Demonstration	22
L2-2	Mass of Goliath should not exceed 350 grams	Goliath is under 350 grams	Verification	Test	9
L2-3	Voltage drawn from the 3DOT must not exceed 3.6V	Goliath voltage is under 3.6V	Verification	Test	10
L2-4	Goliath should detect objects in a 8 inch radius	IR sensor senses object 8 inches away	Verification	Test	1, 6, 11
L2-5	Goliath should withstand impact of wall and other robots	Customer sees Goliath operational after collisions	Validation	Demonstration	1, 6
L2-6	Total current drawn from the 3DOT must not exceed 650mAh	3DoT battery shows current limit is 650mAh	Verification	Inspection	10
L2-7	8x8 LED display shall be placed on top of Goliath	Customer sees LED array on top of Goliath	Validation	Inspection	2, 3, 7
L2-8	The wires in Goliath should be clean so no interference during disassembly	Customer sees Goliath has clean arrangement of wires inside	Validation	Inspection	3, 7
L2-9	Goliath should be able to keep track and identify its location on the maze internally	Customer sees Goliath accurately knows where it is in the maze	Validation	Demonstration	1

| L2-10 | The Goliath will be smaller than 4.71x 3.77 x 1.8 inches (Fall 2016 size) | Goliath is smaller than 4.71x 3.77 x 1.8 inches | Verification | Test | | 5 |

3.2 Testing Types and Methods

This subsection contains the 4 types of Verification and Validation (V&V) testing, as derived from the NASA Systems Engineering Handbook referenced above in Section 2. Material is taken from Chapter 5 in the NASA Handbook, and replicated below.

Verification proves that a realized product for any system model within the system structure conforms to the build-to requirements (for software elements) or realize-to specifications and design descriptive documents (for hardware elements, manual procedures, or composite products of hardware, software, and manual procedures). In other words, <u>Verification is requirements driven;</u> verification shows proof of compliance with requirements; that the product can meet each "shall" statement as proven through performance of a test, analysis, inspection, or demonstration.

Validation is conducted under realistic conditions (or simulated conditions) on any end product for the purpose of determining the effectiveness and suitability of the product for use in mission operations by typical users; and the evaluation of the results of such tests. Testing is the detailed quantifying method of both verification and validation. However, testing is required to validate final end products to be produced and deployed. In other words, <u>Validation is ConOps/Mission driven;</u> validation shows that the product accomplishes the intended purpose in the intended environment; that product meets the expectations of the customer and other stakeholders as shown through performance of a test, analysis, inspection, or demonstration.

3.2.1 Verification by <u>Analysis</u>

The use of mathematical modeling and analytical techniques to predict the suitability of a design to stakeholder expectations based on calculated data or data derived from lower system structure end product verifications. Analysis is generally used when a prototype; engineering model; or fabricated, assembled, and integrated product is not available. Analysis includes the use of modeling and simulation as analytical tools. A model is a mathematical representation of reality. A simulation is the manipulation of a model.

3.2.2 Verification by <u>Demonstration</u>

Showing that the use of an end product achieves the individual specified requirement. It is generally a basic confirmation of performance capability, differentiated from testing by the lack of detailed data gathering. Demonstrations can involve the use of physical models or mockups; for example, a requirement that all controls shall be reachable by the pilot could be verified by having a pilot perform flight-related tasks in a cockpit mockup or simulator. A demonstration could also be the actual operation of the end product by highly qualified personnel, such as test pilots, who perform a one-time event that demonstrates a capability to operate at extreme limits of system performance, an operation not normally expected from a representative operational pilot.

3.2.3 Verification by <u>Inspection</u>

The visual examination of a realized end product. Inspection is generally used to verify physical design features or specific manufacturer identification. For example, if there is a requirement that the safety arming pin has a red flag with the words "Remove Before Flight"

stenciled on the flag in black letters, a visual inspection of the arming pin flag can be used to determine if this requirement was met.

3.2.4 Verification by Test

The use of an end product to obtain detailed data needed to verify performance, or provide sufficient information to verify performance through further analysis. Testing can be conducted on final end products, breadboards, brass boards or prototypes. Testing produces data at discrete points for each specified requirement under controlled conditions and is the most resource-intensive verification/validation technique. As the saying goes, "Test as you fly, and fly as you test." (See Subsection 5.3.2.5.).

3.2.5 Validation by Analysis

The use of mathematical modeling and analytical techniques to predict the suitability of a design to stakeholder expectations based on calculated data or data derived from lower system structure end product validations. It is generally used when a prototype; engineering model; or fabricated, assembled, and integrated product is not available. Analysis includes the use of both modeling and simulation.

3.2.6 Validation by Demonstration

The use of a realized end product to show that a set of stakeholder expectations can be achieved. It is generally used for a basic confirmation of performance capability and is differentiated from testing by the lack of detailed data gathering. Validation is done under realistic conditions for any end product within the system structure for the purpose of determining the effectiveness and suitability of the product for use in NASA missions or mission support by typical users and evaluating the results of such tests.

3.2.7 Validation by Inspection

The visual examination of a realized end product. It is generally used to validate physical design features or specific manufacturer identification.

3.2.8 Validation by Test

The use of a realized end product to obtain detailed data to validate performance or to provide sufficient information to validate performance through further analysis. Testing is the detailed quantifying method of both verification and validation but it is required in order to validate final end products to be produced and deployed.

3.3 Master Test Case List

A **Test Case** can be described as *a scenario containing a sequence of detailed test steps, in order to perform verification/validation testing on multiple requirements that are similar in nature.*

For example, if a group has multiple requirements regarding starting up their robot project, they can group all these requirements to be verified/validated in a single test case. Similarly, if a group has multiple requirements that can be verified/validated via inspection, they can group all of them together in a single test case.

The purpose of this subsection is to provide a High-Level overview of all Test Cases utilized in this Test Plan. Each item in this subsection will contain the following: Test Case Number and Name, High Level Scenario Description, and Test Environment Description.

3.3.1 TC-01: Goliath move forward
Description: The Goliath will use overwritten MOVE commands uploaded to the 3DoT board in order to move forward.
Test Environment: Occurs inside, on a flat surface with 0% grade

3.3.2 TC-02: Turn Direction
Description: Display turn direction on the LED array.
Test Environment: Inside a classroom

3.3.3 TC-03: Assembly and Disassembly
Description: Assemble and disassemble the Goliath within a specified amount of time.
Test Environment: Inside a classroom

3.3.4 TC-04: 3D printing
Description: Print 3D models in less than 6 hours, and no part takes longer than 2.
Test Environment: In room that has an accessible 3D printer

3.3.5 TC-05: Goliath dimensions
Description: Measure the dimensions of the newly designed and assembled Goliath.
Test Environment: Inside a classroom

3.3.6 TC-06: Arxterra Control Panel
Description: Control the newly designed and assembled Goliath using the Arxterra Control Panel.
Test Environment: Inside a classroom

3.3.7 TC-07: Charging Goliath
Description: Testing the ease of access of the charging port.
Test Environment: Inside a classroom

3.3.8 TC-08: Battery Life
Description: Running the Goliath motors continuously for 1 hour.
Test Environment: Inside a classroom

3.3.9 TC-09: Weighing Goliath
Description: Placing the fully assembled newly designed Goliath on a weighing scale.
Test Environment: Inside a classroom

3.3.10 TC-10: Measuring Goliath Voltage and Current
Description: Measuring the voltage of the sensor header and finding the current rating.
Test Environment: Inside a classroom

3.3.11 TC-11: Detecting objects
Description: Detecting objects within a specified range.

Test Environment: Inside a classroom

3.3.12 TC-12: Due Date
Description: The Goliath will be completed by December 13, 2017.
Test Environment: Occurs inside classroom

3.3.13 TC-13: Toy behavior
Description: Will be disassembled and reassembled in specified amount of time.
Test Environment: Inside a classroom

3.3.14 TC-14: Using the 3DoT board
Description: Goliath will use the 3DoT board.
Test Environment: Inside a classroom

3.3.15 TC-15: In scale to Goliath 302
Description: Goliath should be in scale to Goliath 302.
Test Environment: In classroom

3.3.16 TC-16: Final Cost
Description: Final cost should be under specified budget.
Test Environment: Inside a classroom

3.3.17 TC-17: Traversing the maze by remote control
Description: Goliath will be controlled remotely.
Test Environment: Inside a classroom

3.3.18 TC-18: Traversing maze without user input
Description: Goliath will complete maze with predetermined path.
Test Environment: Inside a classroom

3.3.19 TC-19: Traversing maze by remembering previous course
Description: Goliath utilizing a playback mode.
Test Environment: Inside a classroom

3.3.20 TC-20: Charger port ease of access
Description: Customer making sure the port is easily accessed.
Test Environment: Inside a classroom

3.3.21 TC-21: Goliath is smaller than Fall 2016 version
Description: Making sure Goliath was made smaller.
Test Environment: Inside a classroom

3.3.22 TC-22: Goliath avoids other robots
Description: Avoiding other robots in the maze.
Test Environment: Inside a classroom

3.3.23 TC-23: Goliath withstands hit with wall and other robots
Description: Goliath should be able to take a hit and still operate.

Test Environment: Inside a classroom

3.3.24 TC-24: Wires clean inside Goliath

Description: There should be no messy wiring.
Test Environment: Inside a classroom

3.3.25 TC-25: Goliath Position

Description: Goliath will know its position in the maze using telemetry.
Test Environment: Inside a classroom

4   Test Procedures

This section contains details of every Test Case utilized for V&V of project requirements. Each Test Case subsection within this section will contain the following: Test Case number and name, detailed scenario description, Test Case Traceability Matrix, detailed success criteria, detailed Test Environment description, Test Assumptions/Preconditions, Detailed Test Procedure Steps, and a Pass/Fail Matrix of success criteria per Test Case.

4.1   TC-01: Goliath move forward

4.1.1   Detailed Description

This test case provides the steps needed to move the Goliath in the forward direction. These steps are similar across a multitude of requirements. The point of this test case is to prevent repetition of the basic steps needed for movement. This includes the uploading of the code to the 3DoT, connecting to the 3DoT via Bluetooth using the mobile app, and using the D-pad for choosing a direction to move.

4.1.2   Test Case Traceability and Pass/Fail Matrix

Requirement Number	Requirement Text	V&V Success Criteria	V&V Designation	V&V Method	Procedure Step(s) where Requirement is tested	Pass/Fail?
L1-4	The Goliath will be able to drive on flat surfaces	Goliath travels whole length of 61cm continuously	Verification	Inspection	1, 2, 3, 4, 5, 6, 7, 8	Pass
L1-5	The Goliath shall traverse on cloth, paper and linoleum	Goliath moves across cloth, paper and linoleum at least 61cm	Verification	Test	1, 2, 3, 4, 5, 6, 7, 8	Pass
L1-10	The Goliath should be told to move remotely using Arxterra	Goliath reaches 61cm mark	Verification	Test	1, 2, 3, 4, 5, 6, 7, 8	Pass

L1-15	The Goliath should display the next turn direction on LED grid display	LED array successfully displays direction pressed on the D-pad	Verification	Test	1, 2, 3, 4, 5, 6, 7, 8	Pass
L2-4	Goliath should detect objects in a 8 inch radius	IR sensor senses object 8 inches away	Verification	Test	1, 2, 3, 4, 5, 6, 7, 8	Pass

4.1.3   Detailed Success Criteria

For this test case to be successful, the Goliath must be able to continuously move forward for a distance of 61cm(2ft). The timer will verify that the Goliath did indeed move forward and complete the distance.

4.1.4   Test Environment

The test will be conducted in the Engineering and Computer Science building on the 3rd floor in room 316.

4.1.5   Assumptions and Preconditions

- Battery is fully charged
- Goliath is fully assembled
- Custom commands on mobile app are already configured

4.1.6   Procedure Steps

Step Number	Step Description	Pass Criteria	Recorded Data	Requirement(s) Tested	Test Type	Test Method

1	Place Goliath on flat surface	Goliath is on flat surface		L1-4, 5, 10, 15, L2-4	Verification	Test
2	Place measuring tape at front of Goliath and extend tape to 61cm(2ft)	Measuring tape is placed		L1-4, 5, 10, 15, L2-4	Verification	Test
3	Upload overwritten MOVE commands to 3DoT	Code is uploaded	N/A	L1-4, 5, 10, 15, L2-4	Verification	Test
4	Connect ArxRobot mobile app via bluetooth to the 3DoT	Bluetooth symbol on app turns blue	N/A	L1-2, 4, 5, 15, 17, L2-4, 9	Verification	Test
5	Use overwritten MOVE commands on ArxRobot mobile app	Custom command is on ArxRobot app	N/A	L1-4, 5, 15, L2-4	Verification	Test

6	Press forward D-pad button on mobile app	Forward D-pad button is pressed		L1-4, 5, 15, L2-4	Verification	Test
7	Start stopwatch	Stopwatch starts counting		L1-4, 5, 15, L2-4	Verification	Test
8	Stop stopwatch once Goliath passes 61cm mark	Goliath is past 61cm		L1-4, 5, 15, L2-4	Verification	Test

4.2   TC-02: Turn Direction

4.2.1   Detailed Description

This test case provides the steps needed to display the turn direction of the Goliath. These steps are similar for only 2 requirements. The point of this test case is to observe any turn signal that appears on the LED array display when any button on the D-pad is pressed.

4.2.2   Test Case Traceability and Pass/Fail Matrix

Requirement Number	Requirement Text	V&V Success Criteria	V&V Designation	V&V Method	Procedure Step(s) where Requirement is tested	Pass/Fail ?
L1-15	The Goliath should display the next turn direction on LED grid display	LED array successfully displays direction pressed on the D-pad	Verification	Test	1	Pass

L2-7	8x8 LED display shall be placed on top of Goliath	Customer sees LED array on top of Goliath	Verification	Inspection	1	pass

4.2.3   Detailed Success Criteria

For this test case to be successful, the LED array on top of the Goliath must display a turn direction when any button on the D-pad is pressed. This can be the up, down, left, or right arrow that is display on the LED array.

4.2.4   Test Environment
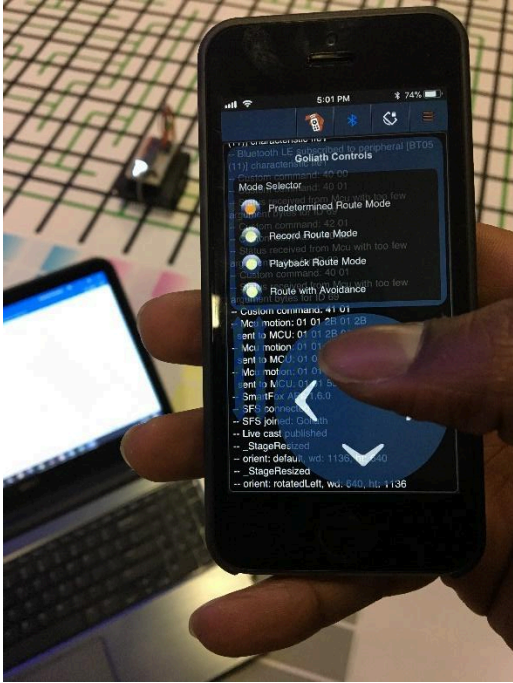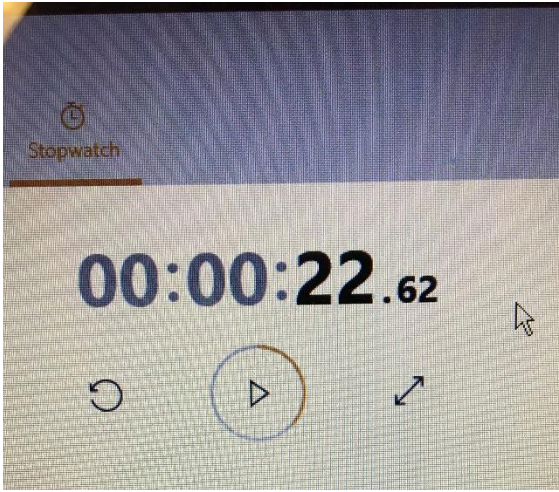
The test will be conducted in the Engineering and Computer Science building on the 3rd floor in room 316.

4.2.5   Assumptions and Preconditions

- Battery is fully charged
- Goliath is fully assembled
- Custom commands on mobile app are already configured

4.2.6   Procedure Steps

Step Number	Step Description	Pass Criteria	Recorded Data	Requirement(s) Tested	Test Type	

| 1 | Observe if LED array displays the direction pressed on D-pad | LED array displays directio n of button on D-pad pressed | | L1- 15, L2- 7 | Verificatio n | I r |

4.3   TC-03: Assembly and Disassembly

4.3.1   Detailed Description

This test case provides the steps needed to assemble and disassemble the Goliath within a specified amount of time. These steps are connected to 3 requirements. The point of this test case is to ensure the Goliath can be put together and taken apart within a reasonable amount of time of 20 minutes.

4.3.2   Test Case Traceability and Pass/Fail Matrix

Requirement Number	Requirement Text	V&V Success Criteria	V&V Designation	V&V Method	Procedure Step(s) where Requirement is tested	Pass/Fail?
L1-3	The Goliath will behave like a toy	Goliath is disassembled and reassembled within 20 minutes	Validation	Inspection	1, 2, 3, 4, 5	
L2-7	8x8 LED display shall be placed on top of Goliath	Customer sees LED array on top of Goliath	Validation	Inspection	1, 2, 3, 5	pass
L2-8	The wires in Goliath should be clean so no interference during disassembly	Customer sees Goliath has clean arrangement of wires inside	Validation	Inspection	1, 2, 3, 5	fail

4.3.3   Detailed Success Criteria

For this test case to be successful, the Goliath must be able to be assembled and disassembled in the specified time of 20 minutes. The timer that is set for 20 minutes will help verify that this test procedure was successful. A completely assembled goliath is one that is fully operational and responds to commands given by the ArxRobot mobile app.
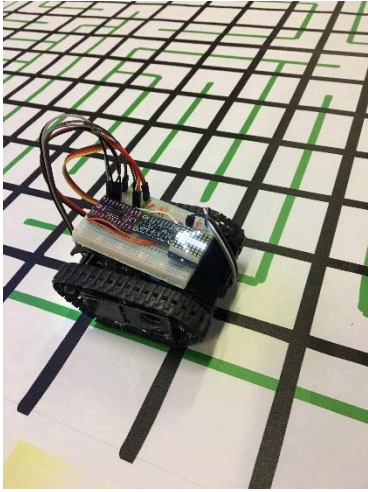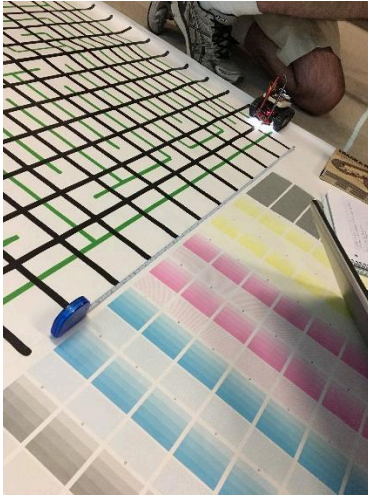
4.3.4   Test Environment

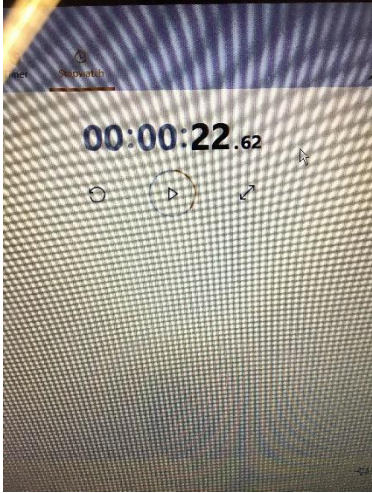The test will be conducted in the Engineering and Computer Science building on the 3rd floor in room 316.

4.3.5   Assumptions and Preconditions

- Battery is fully charged
- Custom commands on mobile app are already configured

- 3D parts are already fully printed

4.3.6 Procedure Steps

Step Number	Step Description	Pass Criteria	Recorded Data	Requirement(s) Tested	Test Type	Test Method
1	Collect all hardware and electronics of new Goliath model(3D models, screws, wires, motors, 3DoT board, color sensors, LED array)	All parts collected	N/A	L1-3, L2-7, 8	Validation	Test
2	Set timer for 20 minutes and press start	Timer starts counting down	N/A	L1-3, L2-7, 8	Validation	Test
3	Assemble Goliath	Goliath is assembled	N/A	L1-3, L2-7, 8	Validation	Test
4	Disassemble Goliath	Goliath is disassembled	N/A	L1-3	Validation	Test
5	Stop timer	Goliath is disassembled before 20 minutes runs out	picture	L1-3, L2-7, 8	Validation	Test

4.4 TC-04: 3D Printing

4.4.1 Detailed Description

This test case provides the steps needed to 3D print all the parts for the newly designed Goliath within 6 hours total. No 1 part should take longer than 2 hours to print. These steps are only for 1 requirement. The point of this test case is to prevent extended time occupying

the 3D printing resources. It also forces the manufacturing division to design parts that are optimally designed to have a shorter print time.

4.4.2   Test Case Traceability and Pass/Fail Matrix

Requirement Number	Requirement Text	V&V Success Criteria	V&V Designation	V&V Method	Procedure Step(s) where Requirement is tested	Pass/Fail?
L1-6	All modifications shall allow the Goliath to be printed under a total print time of 6 hours with no part taking longer than 2 hours	Altogether Goliath parts take under 2 hours to print	Verification	Test	1, 2	pass

4.4.3   Detailed Success Criteria

For this test case to be successful, the parts for the newly designed Goliath must printed within 6 hours total, with no 1 part taking longer than 2 hours to print.

4.4.4   Test Environment

The test will be conducted in the Engineering Technology building on the 1st floor in room 111.

4.4.5   Assumptions and Preconditions

- 3D models have already been created
- 3D printer is accessible

4.4.6   Procedure Steps

Step Number	Step Description	Pass Criteria	Recorded Data	Requirement(s) Tested	Test Type	Test Method
1	Collect 3D models	All 3D models collected	N/A	L1- 6	Verification	Test

| 2 | Use 3D printer and retrieve print times for each part | Print times available on print document | picture | L1- 6 | | Verification | Test |

4.5 TC-05: Goliath dimensions

4.5.1 Detailed Description

This test case provides the steps needed to measure the dimensions of the newly designed and assembled Goliath. These steps are similar across only 2 requirements. The point of this test case is to attain proper measurements of the printed Goliath parts so the measurements can be applied to the 2 requirements.

4.5.2 Test Case Traceability and Pass/Fail Matrix

Requirement Number	Requirement Text	V&V Success Criteria	V&V Designation	V&V Method	Procedure Step(s) where Requirement is tested	Pass/Fail?
L1-9	The Goliath should appear in scale to the real Goliath 302 tank	Newly designed Goliath is in scale to Goliath 302 tank	Verification	Test	1	fail
L2-10	The Goliath will be smaller than 4.71x 3.77 x 1.8 inches (Fall 2016 size)	Goliath is smaller than 4.71x 3.77 x 1.8 inches	Verification	Test	1	fail

4.5.3 Detailed Success Criteria

For this test case to be successful, the dimensions are to be recorded and compared to the dimensions of the Fall 2016 version of the Goliath.

4.5.4 Test Environment

The test will be conducted in the Engineering and Computer Science building on the 3rd floor in room 316.

4.5.5   Assumptions and Preconditions

- Goliath is fully assembled

4.5.6   Procedure Steps

Step Number	Step Description	Pass Criteria	Recorded Data	Requirement(s) Tested	Test Type	Test Method
1	Measure height, length, width of newly designed and assembled Goliath	N/A	N/A	L1- 9, L2-10	Verification	Test

4.6   TC-06: Arxterra Control Panel

4.6.1   Detailed Description

This test case provides the steps needed to control the Goliath using the Arxterra Control Panel. The critical step is used for testing only 1 requirement. The point of this test case is to be able to control the Goliath from the control panel.

4.6.2   Test Case Traceability and Pass/Fail Matrix

Requirement Number	Requirement Text	V&V Success Criteria	V&V Designation	V&V Method	Procedure Step(s) where Requirement is tested	Pass/Fail ?
L1-4	The Goliath will be able to drive on flat surfaces	Goliath travels whole length of 61cm continuously	Verification	Inspection	1, 2, 4, 5, 6, 7, 8	Pass
L1-5	The Goliath shall traverse on cloth, paper and linoleum	Goliath moves across cloth, paper and	Verification	Test	1, 2, 4, 5, 6, 7, 8	pass

		linoleum at least 61cm				
L1-10	The Goliath should be told to move remotely using Arxterra	Goliath reaches 61cm mark	Verification	Test	1, 2, 3, 4, 5, 6, 7, 8	pass
L1-15	The Goliath should display the next turn direction on LED grid display	LED array successfully displays direction pressed on the D-pad	Verification	Test	1, 2, 4, 5, 6, 7, 8	Pass
L2-4	Goliath should detect objects in a 8 inch radius	IR sensor senses object 8 inches away	Verification	Test	1, 2, 4, 5, 6, 7, 8	pass

4.6.3   Detailed Success Criteria

For this test case to be successful, the Goliath shows up on the map displayed on the Arxterra Control Panel and custom commands defined on ArxRobot mobile app appear on Arxterra Control Panel.

4.6.4   Test Environment

The test will be conducted in the Engineering and Computer Science building on the 3rd floor in room 316.

4.6.5   Assumptions and Preconditions

- Goliath is fully assembled
- Control recognizes the name of the robot

4.6.6   Procedure Steps

Step Number	Step Description	Pass Criteria	Recorded Data	Requirement(s) Tested	Test Type	Test Method

3	Connect 3DoT to the Arxterra Control panel by locating Goliath on GPS inteface of Control panel	Goliath shows up on map of Control Panel and custom commands defined on ArxRobot mobile app appear on Control Panel		L1-10	Verification	Test

4.7   TC-07: Charging Goliath

4.7.1   Detailed Description

This test case provides the steps needed to test the ease of access of the charging port on the 3DoT while the newly designed Goliath is fully assembled. The critical step is used for testing only 1 requirement. The point of this test case is to be able to plug in the charger within 5 seconds.

4.7.2   Test Case Traceability and Pass/Fail Matrix

Requirement Number	Requirement Text	V&V Success Criteria	V&V Designation	V&V Method	Procedure Step(s) where Requirement is tested	Pass/Fail?
L1-3	The Goliath will behave like a toy	Goliath is disassembled and reassembled within 20 minutes	Verification	Test	1	

L1-16	The Goliath should have easy access for charging and programing hookup	Charging indicator turns on before 5 second timer runs out	Verification	Test	1, 2, 3, 4	pass
L2-7	8x8 LED display shall be placed on top of Goliath	Customer sees LED array on top of Goliath	Verification	Inspection	1	Pass
L2-8	The wires in Goliath should be clean so no interference during disassembly	Customer sees Goliath has clean arrangement of wires inside	Verification	Inspection	1	fail

4.7.3   Detailed Success Criteria

For this test case to be successful, the charger must be plugged in and the charging indicator must turn on before timer that was set for 5 seconds runs out.

4.7.4   Test Environment

The test will be conducted in the Engineering and Computer Science building on the 3rd floor in room 316.

4.7.5   Assumptions and Preconditions

- Newly designed Goliath is fully assembled
- USB charger is available

4.7.6   Procedure Steps

Step Number	Step Description	Pass Criteria	Recorded Data	Requirement(s) Tested	Test Type	Test Method
1	Fully reassemble newly designed Goliath	Goliath	picture	L1-3, 16, L2-7, 8	Verification	Test

2	Set timer to 5 seconds and start timer	N/A	N/A	L1-16	Verification	Test
3	Attempt to plug in charger into charging port of the 3DoT	N/A	N/A	L1-16	Verification	Test
4	Stop timer	Charging indicator turns on before timer runs out	timer reading	L1-16	Verification	Test

4.8   TC-08: Battery Life

4.8.1   Detailed Description

This test case provides the steps needed to test the run time of the battery. The critical step is used for testing only 1 requirement. The point of this test case is to test how long the Goliath can operate for before the battery runs out.

4.8.2   Test Case Traceability and Pass/Fail Matrix

Requirement Number	Requirement Text	V&V Success Criteria	V&V Designation	V&V Method	Procedure Step(s) where Requirement is tested	Pass/Fail ?
L1-17	The Goliath shall remain operating for at least an hour	Goliath runs for 1 hour	Validation	Inspection	1, 2, 3	fail

4.8.3   Detailed Success Criteria

For this test case to be successful, the Goliath must still be running when the 1 hour timer runs out or dies right when the timer runs out.

4.8.4   Test Environment

The test will be conducted in the Engineering and Computer Science building on the 3rd floor in room 316.

4.8.5   Assumptions and Preconditions

- Newly designed Goliath is fully assembled
- USB charger is available

4.8.6   Procedure Steps

Step Number	Step Description	Pass Criteria	Recorded Data	Requirement(s) Tested	Test Type	Test Method
1	Set timer for 1 hour and start	N/A	N/A	L1-17	Verification	Test
2	Run motors and monitor position to make sure it does not hit a wall	Goliath does not hit wall	N/A	L1-17	Verification	Test
3	Stop timer	Goliath is still running after timer runs out	N/A	L1-17	Verification	Test

4.9   TC-09: Weighing Goliath

4.9.1   Detailed Description

This test case provides the steps needed to weigh the Goliath. The critical step is used for testing only 1 requirement. The point of this test case is to test if the newly designed fully assembled Goliath has a mass of less than 350 grams.

4.9.2   Test Case Traceability and Pass/Fail Matrix

Requirement Number	Requirement Text	V&V Success Criteria	V&V Designation	V&V Method	Procedure Step(s) where Requirement is tested	Pass/Fail?

	Mass of Goliath should not exceed 350 grams	Goliath is under 350 grams	Verification	Test	1	pass
L2-2						

4.9.3 Detailed Success Criteria

For this test case to be successful, the Goliath must have a mass of less than 350 grams.

4.9.4 Test Environment

The test will be conducted in the home of the project manager, who has a scale.

4.9.5 Assumptions and Preconditions

- Newly designed Goliath is fully assembled

4.9.6 Procedure Steps

Step Number	Step Description	Pass Criteria	Recorded Data	Requirement(s) Tested	Test Type	Test Method
1	Set fully assembled newly designed Goliath on weighing scale	Number that appears on scale is under 350 grams	mass	L2-2	Verification	Test

4.10 TC-10: Measuring Goliath Voltage and Current

4.10.1 Detailed Description

This test case provides the steps needed to measure the voltage of the sensor header and find the voltage rating of the battery the 3DoT. The critical step is used for testing only 1 requirement. The point of this test case is to test if the 3DoT is providing the right amount of voltage, which is 3.6V. And to determine what the rating of the current is for the battery.

4.10.2 Test Case Traceability and Pass/Fail Matrix

Requirement Number	Requirement Text	V&V Success Criteria	V&V Designation	V&V Method	Procedure Step(s) where Requirement is tested	Pass/Fail?
L2-3	Voltage drawn from the 3DOT must not exceed 3.6V	Goliath voltage is under 3.6V	Verification	Test	1	pass
L2-6	Total current drawn from the 3DOT must not exceed 650mAh	3DoT battery shows current limit is 650mAh	Verification	Test	2	pass

4.10.3   Detailed Success Criteria

For this test case to be successful, the Goliath must have a voltage of 3.6V and the current rating must be found to be 650mAh.

4.10.4   Test Environment

The test will be conducted in the Engineering and Computer Science building on the 3rd floor in room 316.

4.10.5   Assumptions and Preconditions

- 3DoT is available

4.10.6   Procedure Steps

Step Number	Step Description	Pass Criteria	Recorded Data	Requirement(s) Tested	Test Type	Test Method
1	Use voltmeter to measure the voltage on the sensor header	Voltage is at or below 3.6V	N/A	L2-3	Verification	Test

2	Read current rating on RCR123 battery	Current rating is 650mAh	N/A	L2-6	Verification	Test

4.11 TC-11: Detecting Objects

4.11.1 Detailed Description

This test case provides the steps needed to detect objects. The critical step is used for testing only 1 requirement. The point of this test case is to test the code created for detecting objects works and the Goliath can detect what is in front of it.

4.11.2 Test Case Traceability and Pass/Fail Matrix

Requirement Number	Requirement Text	V&V Success Criteria	V&V Designation	V&V Method	Procedure Step(s) where Requirement is tested	Pass/Fail?
L2-4	Goliath should detect objects in a 8 inch radius	IR sensor senses object 8 inches away	Verification	Test	1	pass

4.11.3 Detailed Success Criteria

For this test case to be successful, the Goliath must detect a piece of paper that is placed 8 inches away from the front of the Goliath.

4.11.4 Test Environment

The test will be conducted in the Engineering and Computer Science building on the 3rd floor in room 316.

4.11.5 Assumptions and Preconditions

- 3DoT is available
- IR sensor is attached to the front of the Goliath

4.11.6 Procedure Steps

Step Number	Step Description	Pass Criteria	Recorded Data	Requirement(s) Tested	Test Type	Test Method
1	Place paper 8 inches from the front of Goliath	Golaith detects the object and stops	N/A	L2-4	Verification	Test

4.12 TC-12: Due Date

4.12.1 Detailed Description

This test case provides the steps needed for the customer to ensure the Goliath is completed oon the due date December 13, 2017to measure the dimensions of the newly designed and assembled Goliath. The critical step is used for testing only 1 requirement. The point of this test case is to ensure the Goliath is completed.

4.12.2 Test Case Traceability and Pass/Fail Matrix

Requirement Number	Requirement Text	V&V Success Criteria	V&V Designation	V&V Method	Procedure Step(s) where Requirement is tested	Pass/Fail?
L1-1	Project shall be ready by Wednesday December 13th, 2017	Customer feels Goliath meets expectations	Validation	Inspection	1	

4.12.3 Detailed Success Criteria

For this test case to be successful, the customer must feel like the Goliath meets expectations.

4.12.4 Test Environment

The test will be conducted in the Engineering and Computer Science building on the 3rd floor in room 316.

4.12.5 Assumptions and Preconditions

- Goliath is fully assembled

4.12.6   Procedure Steps

Step Number	Step Description	Pass Criteria	Recorded Data	Requirement(s) Tested	Test Type	Test Method
1	Customer will demo the project	Customer feels Goliath meets expectations	N/A	L1-1	Validation	Demonstration

4.13   TC-13: Toy behavior

4.13.1   Detailed Description

This test case provides the steps needed for the customer to see if the Goliath behaves like a toy and can be disassembled and reassembled within 20 minutes. The critical step is used for testing only 2 requirements. The point of this test case is to be able to let the customer know if the Goliath can be relatively easy to assemble and disassemble.

4.13.2   Test Case Traceability and Pass/Fail Matrix

Requirement Number	Requirement Text	V&V Success Criteria	V&V Designation	V&V Method	Procedure Step(s) where Requirement is tested	Pass/Fail?
L1-3	The Goliath will behave like a toy	Golaith is disassembled and reassembled within 20 minutes	Validation	Test	1	

L1-19	All of the Goliath electronics and motors should disassemble and reassemble within 20 minutes	Customer sees the Goliath is successfully assembled and disassembled in 20 minutes	Validation	Test	1, 2, 3, 4	

4.13.3 Detailed Success Criteria

For this test case to be successful, the customer sees the group disassemble and reassemble the newly designed Goliath within 20 minutes

4.13.4 Test Environment

The test will be conducted in the Engineering and Computer Science building on the 3rd floor in room 316.

4.13.5 Assumptions and Preconditions

- Timer is available

4.13.6 Procedure Steps

Step Number	Step Description	Pass Criteria	Recorded Data	Requirement(s) Tested	Test Type	Test Method
1	Customer uses timer to see if Goliath can be disassembled and reassembled within 20 minutes	Golaith is disassembled and reassembled within 20 minutes	N/A	L1-3, 19	Validation	Demonstration

4.14 TC-14: Using the 3DoT Board

4.14.1 Detailed Description

This test case provides the steps needed for the customer to see whether a 3DoT board is used or not. The critical step is used for testing only 1 requirement. The point of this test case is to make sur the Goliath meets customer expectation.

4.14.2 Test Case Traceability and Pass/Fail Matrix

Requirement Number	Requirement Text	V&V Success Criteria	V&V Designation	V&V Method	Procedure Step(s) where Requirement is tested	Pass/Fail?
L1-8	The Goliath will use the 3DoT Board	Goliath contains 3DoT board upon inspection	Validation	Inspection	1	

4.14.3 Detailed Success Criteria

For this test case to be successful, the Goliath must have a 3DoT inside it when the professor inspects it.

4.14.4 Test Environment

The test will be conducted in the Engineering and Computer Science building on the 3rd floor in room 316.

4.14.5 Assumptions and Preconditions

- Newly designed Goliath is fully assembled

4.14.6 Procedure Steps

Step Number	Step Description	Pass Criteria	Recorded Data	Requirement(s) Tested	Test Type	Test Method

1	Customer observe to see if a 3DoT board is used inside the Goliath	Customer sees a 3DoT inside the Goliath	N/A	L1-8	Validation	Inspection

4.15 TC-15: In scale to Goliath 302

4.15.1   Detailed Description

This test case provides the steps for the customer to observe whether Goliath is in scale to the real like Goliath 302 tank. The critical step is used for testing only 1 requirement. The point of this test case is to make sure this requirement is met since it was customer defined

4.15.2   Test Case Traceability and Pass/Fail Matrix

<u>Requirement Number</u>	<u>Requirement Text</u>	<u>V&V Success Criteria</u>	<u>V&V Designation</u>	<u>V&V Method</u>	<u>Procedure Step(s) where Requirement is tested</u>	<u>Pass/Fail?</u>
L1-9	The Goliath should appear in scale to the real Goliath 302 tank	Newly designed Goliath is in scale to Goliath 302 tank	Validation	Test	1	

4.15.3   Detailed Success Criteria

For this test case to be successful, the customer must see that the newly designed Goliath is in scale to the Goliath 302.

4.15.4   Test Environment

The test will be conducted in the Engineering and Computer Science building on the 3rd floor in room 316.

4.15.5   Assumptions and Preconditions

- Newly designed Goliath is fully assembled

- USB charger is available

4.15.6 Procedure Steps

Step Number	Step Description	Pass Criteria	Recorded Data	Requirement(s) Tested	Test Type	Test Method
1	Customer checks meausrements taken of newly designed Goliath and compares to Goliath 302	Customer confirms the Goliath is in scale to Goliath 302	N/A	L1-9	Validation	Analysis

4.16 TC-16: Final cost

4.16.1 Detailed Description

This test case provides the steps needed to ensure the Goliath was built and designed within the budget. The critical step is used for testing only 1 requirement. The point of this test case is to make sure the customer expectation of staying within budget was met.

4.16.2 Test Case Traceability and Pass/Fail Matrix

Requirement Number	Requirement Text	V&V Success Criteria	V&V Designation	V&V Method	Procedure Step(s) where Requirement is tested	Pass/Fail?
L1-11	The total cost of the Goliath shall remain under $350	Customer sees project was built under $350 budget on budget report https://drive.google.com/open?id=1lK4HKJfOgyuRqM6g7a4k4xeRFpjzGBn18eFv7prc6wE	Validation	Inspection	1	

4.16.3   Detailed Success Criteria

For this test case to be successful, the Goliath must have cost less than $350.

4.16.4   Test Environment

The test will be conducted in the Engineering and Computer Science building on the 3rd floor in room 316.

4.16.5   Assumptions and Preconditions

- Budget report is up to date

4.16.6   Procedure Steps

Step Number	Step Description	Pass Criteria	Recorded Data	Requirement(s) Tested	Test Type	Test Method
1	Customer reviews budget sheet	Customer confirms the cost of new Goliath is below $350	N/A	L1-11	Validation	Inspection

4.17 TC-17: Traversing the maze under remote control

4.17.1   Detailed Description

This test case provides the steps needed to let the customer know the project can be remote controlled. The critical step is used for testing only 1 requirement. The point of this test case is to make sure the requirement of the robot being remote controlled is met.

4.17.2   Test Case Traceability and Pass/Fail Matrix

Requirement Number	Requirement Text	V&V Success Criteria	V&V Designation	V&V Method	Procedure Step(s) where Requirement is tested	Pass/Fail ?

L1-12	The Goliath should traverse a maze under remote control	Customer can control Goliath using the ArxRobot mobile app	Verification	Demonstratio n	1	

4.17.3 Detailed Success Criteria

For this test case to be successful, the Goliath must complete the maze when the customer takes it through the maze.

4.17.4 Test Environment

The test will be conducted in the Engineering and Computer Science building on the 3rd floor in room 316.

4.17.5 Assumptions and Preconditions

- Goliath is fully assembled and operational

4.17.6 Procedure Steps

Step Numbe r	Step Descriptio n	Pass Criteria	Recorde d Data	Requirement(s) Tested	Test Type	Test Method
1	Customer uses ArxRobot mobile app to control Goliath is "Remote Control" mode	Customer complete s maze in Remote Control mode	N/A	L1-12	Validatio n	Demonstratio n

4.18 TC-18: Traversing maze without user input

4.18.1 Detailed Description

This test case provides the steps for the customer to use the Goliath to traverse the maze without user input. The critical step is used for testing only 1 requirement. The point of this test case is to make sure the Goliath can complete the maze autonomously.

4.18.2   Test Case Traceability and Pass/Fail Matrix

Requirement Number	Requirement Text	V&V Success Criteria	V&V Designation	V&V Method	Procedure Step(s) where Requirement is tested	Pass/Fail?
L1-13	The Goliath should traverse the maze without user input	Customer sees Goliath complete maze without user input	Validation	Demonstration	1	

4.18.3   Detailed Success Criteria

For this test case to be successful, the Goliath complete the maze in predetermined mode

4.18.4   Test Environment

The test will be conducted in the Engineering and Computer Science building on the 3rd floor in room 316.

4.18.5   Assumptions and Preconditions

- Goliath is fully assembled and operational
- ArxRobot mobile app is fully configured

4.18.6   Procedure Steps

Step Number	Step Description	Pass Criteria	Recorded Data	Requirement(s) Tested	Test Type	Test Method

| 1 | Customer uses ArxRobot mobile app to put Goliath in "Predetermined" mode | Customer observes that Goliath completes maze in predetermined mode | N/A | L1-13 | Validation | Demonstration |

4.19 TC-19: Traversing maze by remembering previous course

4.19.1 Detailed Description

This test case provides the steps needed for the customer to see that the Goliath can run in playback mode. The critical step is used for testing only 1 requirement. The point of this test case is to be able to let the customer know if the Goliath can remember the path it last took by using the "Record Button".

4.19.2 Test Case Traceability and Pass/Fail Matrix

Requirement Number	Requirement Text	V&V Success Criteria	V&V Designation	V&V Method	Procedure Step(s) where Requirement is tested	Pass/Fail ?
L1-14	The Goliath should remember the manual instructions given, in terms of navigating the maze	Customer sees Goliath successfully re-navigate maze	Validation	Demonstration	1	

4.19.3 Detailed Success Criteria

For this test case to be successful, the customer sees the Goliath complete the maze in play back mode

49

4.19.4   Test Environment

The test will be conducted in the Engineering and Computer Science building on the 3rd floor in room 316.

4.19.5   Assumptions and Preconditions

- Goliath is fully assembled and operational
- ArxRobot mobile app is fully configured

4.19.6   Procedure Steps

Step Number	Step Description	Pass Criteria	Recorded Data	Requirement(s) Tested	Test Type	Test Method
1	Customer uses ArxRobot mobile app to put Goliath in "Playback" mode	Customer observes that Goliath completes maze in playback mode	N/A	L1-14	Validation	Demonstration

4.20 TC-20: Charger port ease of access

4.20.1   Detailed Description

This test case provides the steps needed for the customer to see whether the charging port on the 3DoT is easily accessible. The critical step is used for testing only 1 requirement. The point of this test case is to make sure the Goliath meets customer expectation.

4.20.2   Test Case Traceability and Pass/Fail Matrix

Requirement Number	Requirement Text	V&V Success Criteria	V&V Designation	V&V Method	Procedure Step(s) where Requirement is tested	Pass/Fail ?

L1-16	The Goliath should have easy access for charging and programing hookup	Charging indicator turns on before 5 second timer runs out	Validation	Demonstratio n	1	

4.20.3 Detailed Success Criteria

For this test case to be successful, the customer must connect the charger and see the charging indicator within 5 seconds.

4.20.4 Test Environment

The test will be conducted in the Engineering and Computer Science building on the 3rd floor in room 316.

4.20.5 Assumptions and Preconditions

- Newly designed Goliath is fully assembled

4.20.6 Procedure Steps

Step Numbe r	Step Descriptio n	Pass Criteria	Recorde d Data	Requirement(s) Tested	Test Type	Test Method
1	Customer attempts to connect charger to 3DoT charging port while newly designed Goliath is fully assembled	Custome r connects the charger and sees the charging indicator withing 5 seconds	N/A	L1-16	Validatio n	Demonstratio n

4.21 TC-21: Goliath is smaller than Fall 2016 version

4.21.1 Detailed Description

This test case provides the steps for the customer to observe whether Goliath is smaller than the Fall 2016 version. The critical step is used for testing only 1 requirement. The point of this test case is to make sure space was optimized inside the Goliath.

4.21.2 Test Case Traceability and Pass/Fail Matrix

Requirement Number	Requirement Text	V&V Success Criteria	V&V Designation	V&V Method	Procedure Step(s) where Requirement is tested	Pass/Fail?
L1-18	The Goliath should be smaller than the final design of the previous version	Customer sees that current Goliath is visibly smaller than the Fall 2016 design	Validation	Inspection	1	

4.21.3 Detailed Success Criteria

For this test case to be successful, the customer must see that the newly designed Goliath is smaller than the Fall 2016 version.

4.21.4 Test Environment

The test will be conducted in the Engineering and Computer Science building on the 3rd floor in room 316.

4.21.5 Assumptions and Preconditions

- Newly designed Goliath is fully assembled

4.21.6 Procedure Steps

Step Number	Step Description	Pass Criteria	Recorded Data	Requirement(s) Tested	Test Type	Test Method

1	Customer compares size of new Goliath to size of Fall 2016 Goliath	Customer agrees that new Goliath is smaller	N/A	L1-18	Validation	Inspection

4.22 TC-22: Goliath avoids other robots

4.22.1 Detailed Description

This test case provides the steps needed to ensure the Goliath avoids the other robots in the maze. The critical step is used for testing only 1 requirement. The point of this test case is to make sure the customer expectation of avoiding other robots was met.

4.22.2 Test Case Traceability and Pass/Fail Matrix

Requirement Number	Requirement Text	V&V Success Criteria	V&V Designation	V&V Method	Procedure Step(s) where Requirement is tested	Pass/Fail?
L1-20	The Goliath should detect and avoid running into other bots on the maze	Customer sees Goliath complete maze without touching other robots in maze	Validation	Inspection	1	

4.22.3 Detailed Success Criteria

For this test case to be successful, the Goliath must not hit any other robots in the maze.

4.22.4 Test Environment

The test will be conducted in the Engineering and Computer Science building on the 3rd floor in room 316.

4.22.5 Assumptions and Preconditions

- Newly designed Goliath is fully assembled

4.22.6 Procedure Steps

Step Number	Step Description	Pass Criteria	Recorded Data	Requirement(s) Tested	Test Type	Test Method
1	Customer observes as Goliath avoids hitting other robots in maze	Customer sees Goliath hit no other robots in the maze	N/A	L1-20	Validation	Inspection

4.23 TC-23: Goliath withstands hit with wall and other robots

4.23.1 Detailed Description

This test case provides the steps needed to let the customer know the Goliath is built tough. The critical step is used for testing only 1 requirement. The point of this test case is to make sure the Goliath is kid friendly since it is a toy.

4.23.2 Test Case Traceability and Pass/Fail Matrix

Requirement Number	Requirement Text	V&V Success Criteria	V&V Designation	V&V Method	Procedure Step(s) where Requirement is tested	Pass/Fail?
L2-5	Goliath should withstand impact of wall and other robots	Customer sees Goliath operational after collisions	Validation	Inspection	1	

4.23.3 Detailed Success Criteria

For this test case to be successful, the Goliath must withstand impact from wall and other robots in the maze and still be operational.

4.23.4 Test Environment

The test will be conducted in the Engineering and Computer Science building on the 3rd floor in room 316.

4.23.5 Assumptions and Preconditions

- Goliath is fully assembled and operational

4.23.6 Procedure Steps

Step Number	Step Description	Pass Criteria	Recorded Data	Requirement(s) Tested	Test Type	Test Method
1	Customer observes as Goliath collides with wall and other robots in maze	Customer sees Goliath operational after collisions	N/A	L2-5	Validation	Inspection

4.24 TC-24: Wires clean inside Goliath

4.24.1 Detailed Description

This test case provides the steps for the customer to make sure the wiring arrangement is neat inside the Goliath. The critical step is used for testing only 1 requirement. The point of this test case is to make sure the Goliath can cleanly be taken apart.

4.24.2 Test Case Traceability and Pass/Fail Matrix

Requirement Number	Requirement Text	V&V Success Criteria	V&V Designation	V&V Method	Procedure Step(s) where Requirement is tested	Pass/Fail?

L2-8	The wires in Goliath should be clean so no interference during disassembly	Customer sees Goliath has clean arrangement of wires inside	Validation	Inspection	1	

4.24.3 Detailed Success Criteria

For this test case to be successful, the customer sees that the is a clean wire arrangement inside the Goliath

4.24.4 Test Environment

The test will be conducted in the Engineering and Computer Science building on the 3rd floor in room 316.

4.24.5 Assumptions and Preconditions

- Goliath is fully assembled and operational

4.24.6 Procedure Steps

Step Number	Step Description	Pass Criteria	Recorded Data	Requirement(s) Tested	Test Type	Test Method
1	Customer observes inside of Goliath	Customer sees Goliath has clean arrangement of wires inside	N/A	L2-8	Validation	Inspection

4.25 TC-25: Goliath Position

4.25.1 Detailed Description

This test case provides the steps for the customer to know where the Goliath is inside the maze. The critical step is used for testing only 1 requirement. The point of this test case is to make sure the Goliath uses telemetry to be aware of its position in the maze.

4.25.2   Test Case Traceability and Pass/Fail Matrix

Requirement Number	Requirement Text	V&V Success Criteria	V&V Designation	V&V Method	Procedure Step(s) where Requirement is tested	Pass/Fail?
L2-9	Goliath should be able to keep track and identify its location on the maze internally	Customer sees Goliath accurately knows where it is in the maze	Validation	Inspection	1	

4.25.3   Detailed Success Criteria

For this test case to be successful, the customer sees that the Goliath accurately knows where it is in the maze

4.25.4   Test Environment

The test will be conducted in the Engineering and Computer Science building on the 3rd floor in room 316.

4.25.5   Assumptions and Preconditions

- Goliath is fully assembled and operational
- ArxRobot mobile app is fully configured

4.25.6   Procedure Steps

Step Number	Step Description	Pass Criteria	Recorded Data	Requirement(s) Tested	Test Type	Test Method

| 1 | Customer observes the telemetry readings on control panel of the Goliath's position in the maze | Customer sees Goliath accurately knows where it is in the maze | N/A | L2-9 | Validation | Inspection |

5 Appendices

This section will contain any addition documentation needed to verify/validate requirements. For example, if a project has a cost constraint requirement, include the cost breakdown spreadsheet below as a subsection and reference the appendix subsection in the related Test Step in the Test Procedure. If another group needs to verify something by hand via calculation, include the calculations as a subsection below and reference the appendix subsection in the related Test Step in the Test Procedure.

5.1 Final Goliath Code

https://drive.google.com/open?id=1nBwMLvE2kZfvQudekFAZChmAtPOQxofxBACK3dL__8U

5.2 Final Budget

https://drive.google.com/open?id=1lK4HKJfOgyuRqM6g7a4k4xeRFpjzGBn18eFv7prc6wE