

SEGP 23 Deliverable 4 - Increment 3

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1 Introduction

2 Design

2.1 Design Architecture

We have continued using the model-view-controller (MVC) design pattern in our code, which makes development easier due to separation of concerns. This system allows for certain team members to focus on the UI while others dedicate their effort to the backend the program. We also continue to make heavy use of FXML and the JavaFX SceneBuilder for rapid development of the user interface, as it allows the developer to visualise their changes as they design, without needing to restart a JavaFX program every time.

We have also made heavy use of JavaFX properties, as they are especially useful in the context of programs with user interfaces, since values can be bound to UI elements. For example, the value of the TORA of a runway can be bound to a label in the UI displaying it. We also used properties in cases where code needed to be ran when updating a variable. For instance, when the active obstacle is changed, the class storing the variable does not have knowledge of the outer world. In this case, the runway model classes store the active obstacle, but the controller classes need to update the views with the new obstacle. The controller classes add listeners to the obstacle property to have a lambda function ran when the obstacle is updated.

2.2 Storyboards



Figure 1: User Story 17 - Setting / Entering a password.

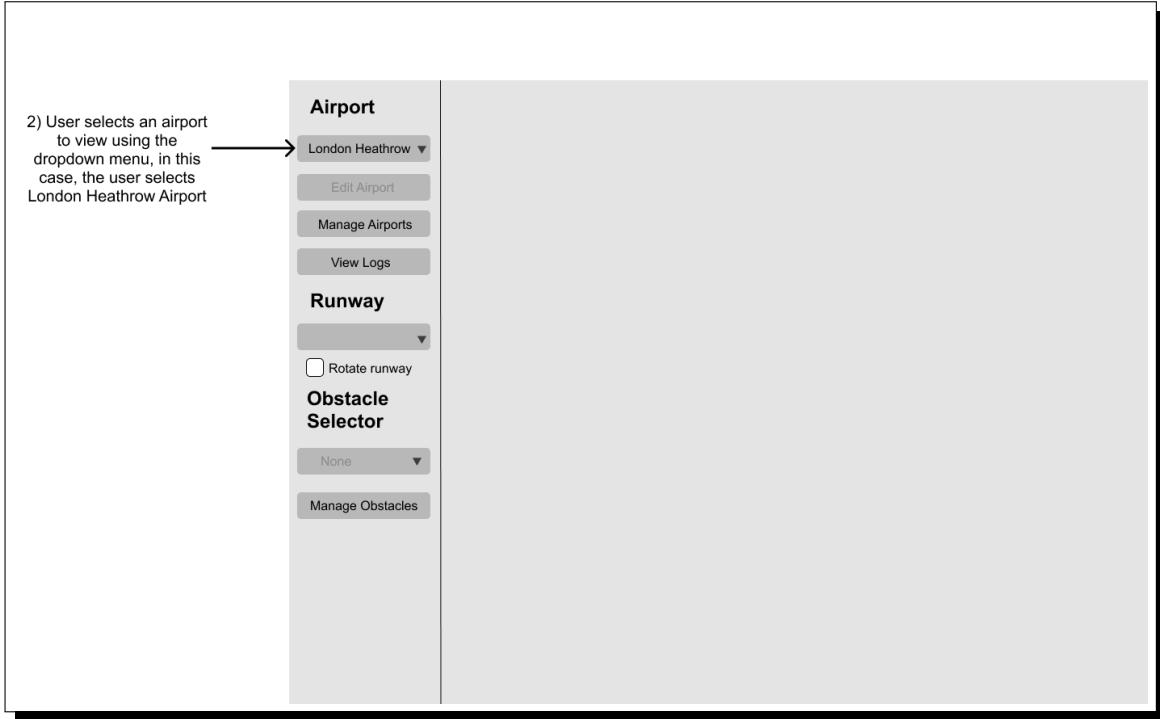


Figure 2: User Story 16 - Applicable to all commercial UK airports.

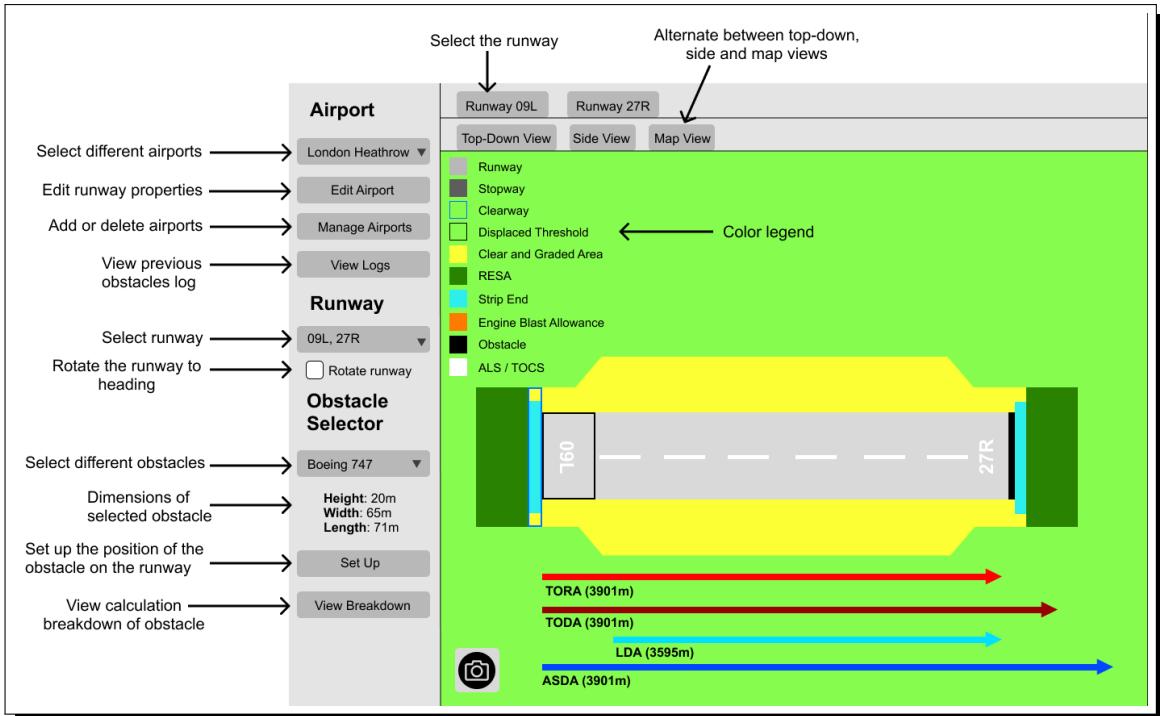


Figure 3: Functionality of each button and dropdown menu in the root scene.

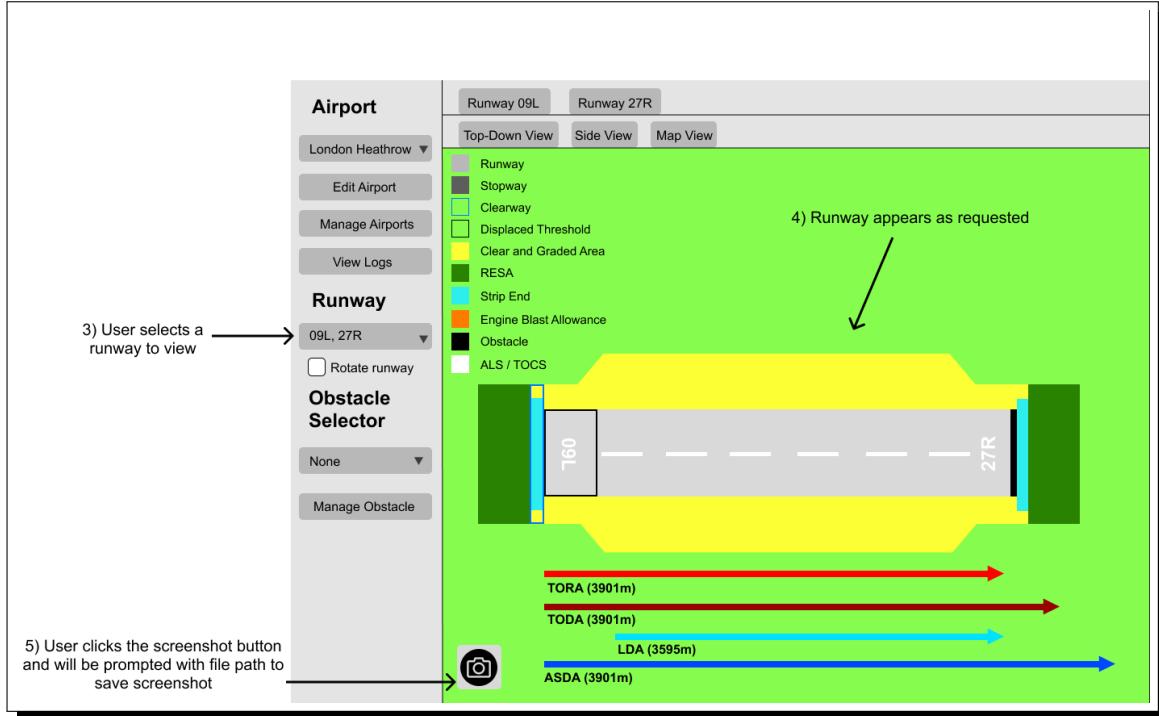


Figure 4: User Story 6 - Exporting a screenshot.

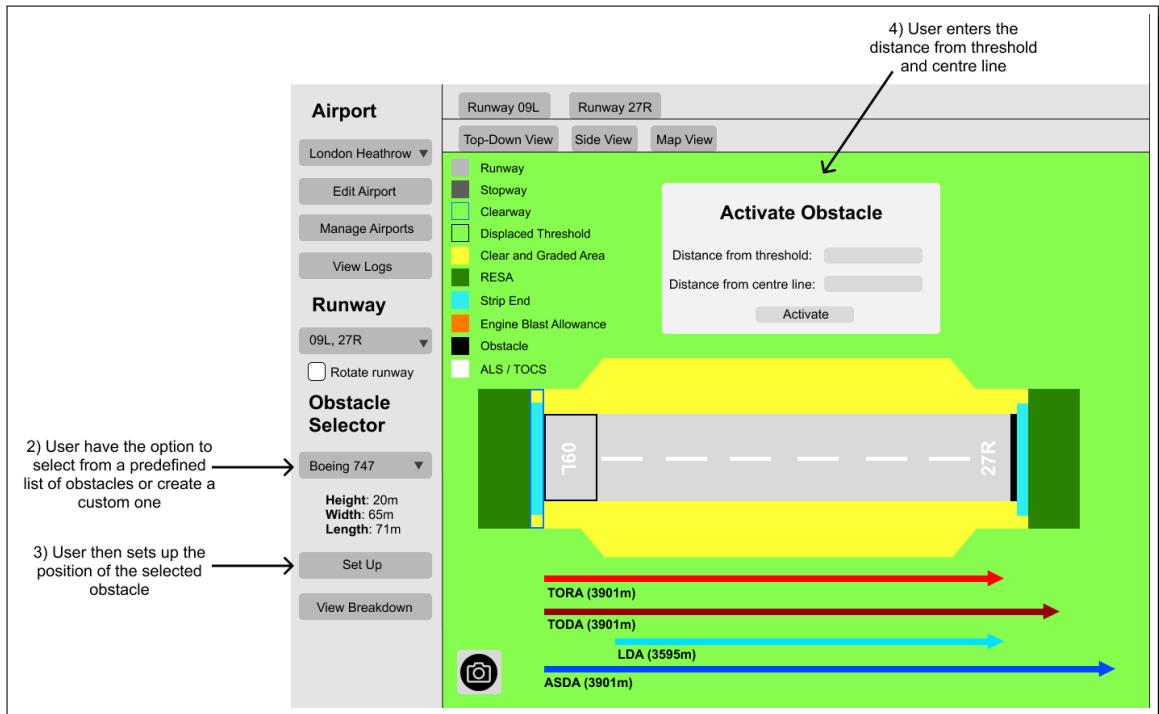


Figure 5: User Story 8 (part 1) - Viewing TOCS and ALS.

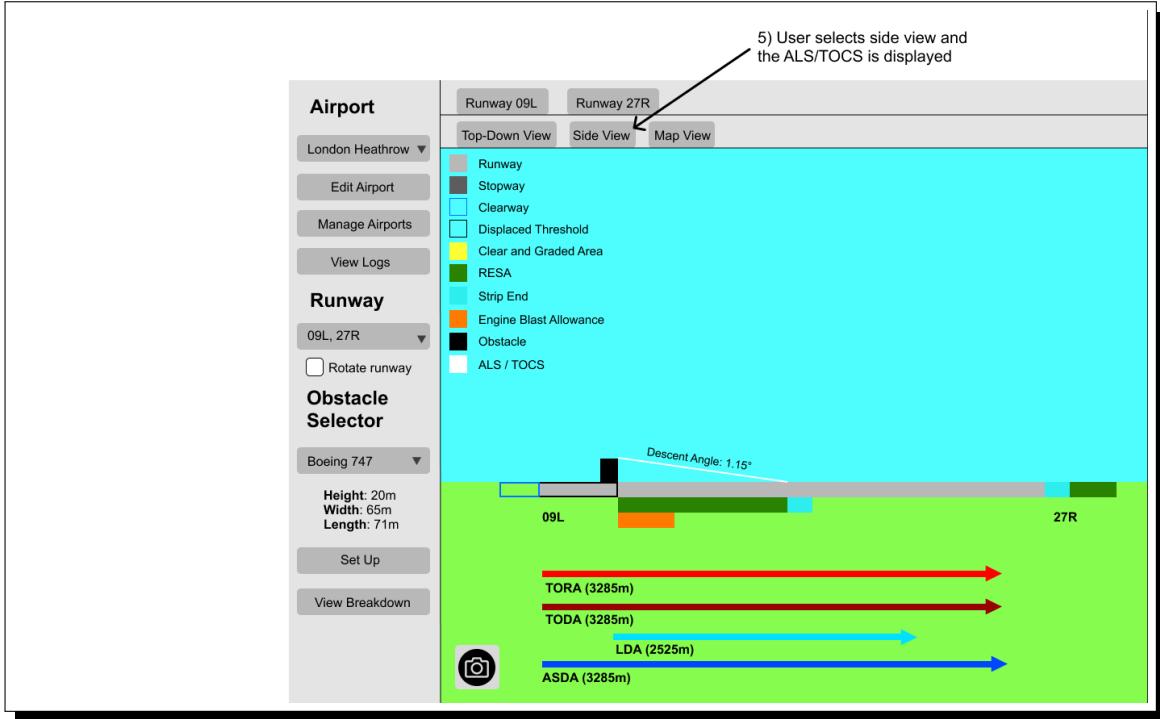


Figure 6: User Story 8 (part 2) - Viewing TOCS and ALS.

2.3 Personas

Name	Photo	Position title	Description
Mark		Air traffic controller	Mark is a highly skilled and detail-oriented individual who takes his responsibilities as an aircraft safety officer very seriously. He understands the importance of his job in ensuring the safety of both the aircraft and its passengers. Mark is adept at making quick decisions and remaining calm under pressure, even in the face of unexpected challenges. In addition to his strong focus on safety, Mark is also deeply passionate about technology and is always looking for new ways to improve the efficiency of air traffic control. He recognizes the critical role that technology plays in aviation and is constantly seeking out ways to leverage technology to make air travel safer and more efficient. Mark takes immense pride in his job and feels a strong sense of responsibility for the safety of those in the air. He understands that his decisions and actions can have a profound impact on the lives of passengers and crew members, and he always strives to make the best possible choices in every situation.

Amy		Pilot	<p>Amy is a highly competent and experienced airline pilot, with a reputation for being a confident and decisive leader. She has excellent problem-solving skills and is able to think quickly and creatively to resolve unexpected issues that arise during flights. Amy's ability to stay calm under pressure is one of her greatest strengths, and she is known for remaining level-headed in even the most challenging situations. In addition to her strong problem-solving abilities, Amy is also incredibly detail-oriented and meticulous in her planning and execution of flights. She is always carefully checking and double-checking her work to ensure that everything is in order and is never satisfied with anything less than the highest level of excellence. As a natural communicator, Amy works well with her crew members and is able to build strong relationships with those around her. She is able to give clear instructions and guidance and is always willing to listen to the perspectives and ideas of others.</p>
John		Passenger	<p>John is a seasoned traveller who has logged countless hours in the air, both for business and leisure. He understands the value of a well-planned trip, and always takes care to book his flights well in advance to ensure that he gets the best possible seat and fare. As someone who values efficiency and convenience, John is always on the lookout for ways to streamline his travel experience. Whether it's using a mobile boarding pass to skip the check-in lines, or packing only a carry-on bag to avoid waiting at the baggage carousel, John is willing to go the extra mile to make his travel as hassle-free as possible. Added comfort and convenience often come at a premium, and John is willing to pay a little extra to get the amenities he wants. Whether it's booking a seat with extra legroom or upgrading to business class for access to a more comfortable seat and better in-flight amenities, John is always on the lookout for ways to make his travel experience more enjoyable.</p>
Kay		Runway Manager	<p>Kay, a 46-year-old employee of Cambridge City airport, has been working there for 7 years. They find managing the runway to be challenging, and they take pride in ensuring the safety of pilots and passengers. Kay has lived in Cambridgeshire their whole life and has no plans to move away. Their daily tasks involve assisting staff in directing pilots around the airfield and ensuring safety protocols are followed. In their managerial role, they maintain radio and radar contact with pilots, and they primarily deal with issues related to the management of traffic around the airfield.</p>

Kingsley		Runway Analyst	<p>Kingsley has worked as a Runway Analyst at Southampton airport for the past 20 years, and he has a track record of providing accurate calculations that have prevented any issues on the runways. Whenever he has disagreed with another person's calculations, Kingsley has found it easy to compare the results to identify the root of the problem. He currently works remotely and is responsible for performing calculations for multiple commercial airports across the UK. Although the work is more intense, he has all the necessary measurements readily available for his use. Kingsley's job function involves managing the use and space of the runway and the general airfield by assisting pilots in making critical decisions.</p>
Keith		Chief ATC	<p>Keith is a 57-year-old man who has been working at London Heathrow for the past 20 years. He finds the complexity of working at a busy airport to be challenging and welcomes any tools that can help him and his team increase their efficiency. He has previous experience as a manager at a smaller airport, which has provided him with valuable experience in managing people. During his time at Heathrow, he has dealt with several runway incidents and has also experienced similar situations at smaller airports. As an Air Traffic Controller, Keith is responsible for controlling the air traffic coming into and going out from London Heathrow. He helps guide planes taking off and landing as well as taxiing. Additionally, he coordinates with other ATCs to ensure good communication and teamwork within the group.</p>

2.4 User Stories

#	User story	MoSCoW priority	Req ID
1	As an Air Traffic Controller, I want a tool that quickly calculates revised runway parameters and obstacle visualization, to ensure safe and efficient flight operations.	Must	3
2	As an Air Traffic Controller, I need a tool that can display details about all the runways at the airport I work that I need to consider in my decision making process, as well as being able to easily switch between them, so that I can coordinate air traffic to land at a runway different from the planned one if necessary.	Must	13
3	As an Air Traffic Controller, I would like the tool to be able to rotate the runway view according to compass north at the click of a button, so that I can unambiguously and unmistakably communicate direction to pilots.	Must	10
4	As an Air Traffic Controller, I would like the tool to be able to see both a top-down and side-on perspective simultaneously so that I can consider all the variables in play when I make my decisions.	Must	2
5	As an Air Traffic Controller, I want real-world images of the runway to be overlaid on the diagrams so that I can better visualise the landings.	Could	20
6	As an Air Traffic Controller, I want to be able to export simulations as images so that I can refer to them later without having to re-enter the parameters.	Could	17

7	As a Pilot, I want to quickly and easily determine whether it's safe to land or take off from a runway with an obstruction on it so that I can make informed decisions about my flight operations.	Must	8
8	As a Pilot, I need to be accurately informed of a representation of the TOCS (Take-Off Climb Surface) or ALS (Approach / Landing Surface) in the case of an obstructed runway so that I know exactly how to use an obstructed runway.	Must	12
9	As a Passenger, I want the airline to use a tool that quickly calculates revised runway parameters and obstacle visualization, to ensure a timely arrival when faced with obstacles on the runway.	Must	5
10	As a Passenger, I want the software used by the airport to display all relevant information in its views so that nothing that might compromise my safety is missed when taking off and landing.	Must	8
11	As a Runway Manager, I need to be able to easily and quickly determine if an obstruction would be an issue for any soon-incoming airplanes, so that I can properly prioritise its removal from the airway.	Must	3
12	As a Runway Manager, I would like to be able to see the cleared and graded area of each runway on the software, as it is helpful to have a birds-eye diagram of the region that myself and my team are responsible for keeping clear of obstacles.	Must	11
13	As a Runway Analyst I would like to be able to see a breakdown of calculations so that I can compare them with my paper results, in order to see where I may have gone wrong and where the software has potentially gone wrong.	Must	6
14	As a Runway Analyst I would like to be able to store all past calculations so that I can review when the software has made accurate predictions and when it may have made mistakes.	Should	15
15	As a Runway Analyst I would like for the tool to come with a built-in list of possible obstacles that can be added, so that I can simulate hypothetical scenarios that could threaten the runway's function.	Must	4
16	As a Runway Analyst I would like for this tool to be applicable to all UK commercial airports so that I can receive guidance for any airport I must do calculations for.	Must	1
17	As a Chief ATC I would like the XML file to be password protected so that runway parameters cannot be updated by malicious attackers.	Could	18
18	As a Chief ATC I would like the system to have API support for the use of assistive technologies so that the disabled members of my team can use the system.	Could	19
19	As a Chief ATC responsible for several subordinates, I would like to be able to see a log of the actions made by my team when interacting with the system, so that I know what state the system is in when I look at it.	Must	14
20	As a Chief ATC, it would be useful for the lowest runway thresholds to be oriented on the left so that my team can identify runways unambiguously.	Must	9
21	As a Chief ATC, I would like the tool to be able to show a 3D representation of the runway in order to give me concise overview of the state of affairs of the runway at a given point can be easily and quickly taken in.	Won't	21

22	As an Airline Representative, I want the system to be as reliable as possible to minimise delays and cancellations and thus reduce complaints and improve customer experience.	Should	16
23	As an Accident Investigation Officer, I want to retrieve the data from the system to conduct an investigation, determine the cause of the accident, and identify who is responsible.	Should	7
24	As an Insurance Company Representative, I want the data exported from the system to be clear about what was involved in the incident so that an accurate sum for the insurance payout can be calculated.	Should	7

2.5 Scenarios

2.5.1 User Story 1: Fast recalculations (Increment 2)

1. The user opens the runway re-declaration program on their computer.
2. The user selects a pre-defined airport from a dropdown list.
3. The user selects a pre-defined runway from a dropdown list.
4. The user selects a pre-defined obstacle from a dropdown list and confirms they want to add it to the runway.
5. The user is prompted to enter the location of the obstacle, relative to the threshold and centre line of the runway.
6. The application displays the obstacle on the runway and correctly recalculates the parameters.
7. This whole process should be completed in under 30 seconds.

2.5.2 User Story 2: Adding a new single direction runway (Increment 1)

1. The user opens the runway re-declaration program on their computer.
2. An empty runway view loads.
3. The user selects an airport from the airport dropdown menu.
4. The user clicks the 'Edit Airport' button, and the runway manager window appears.
5. The user reviews the runways currently in the program, and clicks the 'Create New Runway' button. The runway creation window opens.
6. The user adjusts the slider to select the runway heading number.
7. The user then enters values for the runways's TORA, Clearway length, Stopway length, and displaced threshold.
8. The user clicks the 'Create Runway' button. If all values entered are valid, the window disappears and the runway they created can now be viewed from the runway dropdown.
9. If some value entered is invalid, such as the TORA being under 600m, an error message appears and the user must reenter values.

2.5.3 User Story 2: Adding a new dual direction runway (Increment 1)

1. The user opens the runway re-declaration program on their computer.
2. An empty runway view loads.
3. The user selects an airport from the airport dropdown menu.
4. The user clicks the 'Edit Airport' button, and the runway manager window appears.
5. The user reviews the runways currently in the program, and clicks the 'Create New Runway' button. The runway creation window opens.

6. The user adjusts the slider and uses the dropdown to select the runway heading number for the main runway direction.
7. The user then enters values for the main runways's TORA, Clearway length, Stopway length, and displaced threshold.
8. The user then enters values for the inverted runways's Clearway length, Stopway length, and displaced threshold.
9. The user clicks the 'Create Runway' button. If all values entered are valid, the window disappears and the runway they created can now be viewed from the runway dropdown.
10. If some value entered is invalid, such as the values not being numeral, an error message appears and the user must reenter values.
11. If a runway with the same heading and position already exists, the user will not be able to create it.
12. In the runway view, the runway they created can now be seen with the values for the TORA, TODA, LDA and ASDA in both directions.

2.5.4 User Story 2: Editing a runway (Increment 1)

1. The user opens the runway re-declaration program on their computer.
2. An empty runway view loads.
3. The user clicks on the 'Edit Airport' button to manage the runways on the airport.
4. The Airport Editor scene loads.
5. The user looks for the runway they want to edit, selects it, and clicks the 'Edit Runway' button.
6. The Runway Editor loads.
7. The user can change any input parameter, including heading, position, runway duality, TORA, Clearway and Stopway lengths, and Displaced Threshold position.
8. If the runway already exists, the user will not be able to save the changes.

2.5.5 User Story 2: Deleting a runway (Increment 1)

1. The user opens the runway re-declaration program on their computer.
2. An empty runway view loads.
3. The user clicks on the 'Edit Airport' button to manage the runways on the airport.
4. The Airport Editor scene loads.
5. The user looks for the runway they want to remove, selects it, and clicks the 'Delete Runway' button.
6. If everything worked as expected, the user should no longer see the runway in the Airport Editor nor in the main scene.

2.5.6 User Story 3: Rotating the top-down view (Increment 2)

1. The user opens the runway re-declaration program on their computer.
2. An empty runway view loads.
3. The user selects an airport to view.
4. The user selects a runway to view.
5. The user clicks the 'Rotate' button in the runway view.
6. The runway rotates in the runway view such that it is angled according to its compass headings.

2.5.7 User Story 4: Viewing the side-on perspective (Increment 2)

1. The user opens the runway re-declaration program on their computer.
2. An empty runway view loads.
3. The user selects an airport to view.
4. The user selects a runway to view.
5. The user selects the 'Side View' tab at the top of the runway view.
6. The runway view changes to a side-on perspective.
7. The user can view the relevant values for the runway, including the ALS and TOCS, in the runway view.

2.5.8 User Story 5: Overlay real-world images of the runway (Increment 3)

Instead of having the real-world images overlayed on the simulations, we chose to display a map of the airport in a new tab. It would have proved too difficult to have the simulations and the map merged in one view, and impossible to have it be aesthetically pleasing, due to differing dimensions of runways, etc.

1. The user opens the runway re-declaration program on their computer.
2. An empty runway view loads.
3. The user selects an airport with real world coordinates assigned to it to view.
4. The user selects a runway to view.
5. The user selects the 'Map View' tab at the top of the runway view.
6. A birds eye view map of the runway is displayed using OpenStreetMap.

2.5.9 User Story 6: Exporting a screenshot (Increment 3)

1. The user opens the runway re-declaration program on their computer and inputs their password.
2. An empty runway view loads.
3. The user selects an airport to view.
4. The user selects a runway to view.
5. The user clicks the screenshot button, and the file selection screen appears.
6. The user selects a location, and the current runway view is exported as a PNG file.

2.5.10 User Story 7: Determining safety of landing and take off (Increment 2)

1. The user opens the runway re-declaration program on their computer.
2. The user selects an airport from a dropdown list.
3. The user selects a runway from a dropdown list.
4. The user selects an obstacle from a dropdown list and confirms they want to add it to the runway.
5. The user is prompted to enter the location of the obstacle, relative to the threshold and centre line of the runway.
6. The application displays the obstacle on the runway and **correctly** recalculates the parameters.
7. The pilot then uses the recalculated parameters (e.g. TORA, LDA) and existing knowledge of their aircraft to determine whether the runway has enough clear space to take off or land.

2.5.11 User Story 8: Viewing TOCS and ALS (Increment 3)

1. The user opens the runway re-declaration program on their computer, and inputs their password
2. An empty runway view loads.
3. The user selects an airport to view.
4. The user selects a runway to view.

5. The user selects an obstacle from the obstacle dropdown.
6. The user clicks the 'Set Up' Button
7. The user selects one of the obstacles from the list.
8. The user inputs the obstacle's position relative to the runway length and runway centreline.
9. The user clicks the 'Activate' button, and the obstacle is added to the runway.
10. The user selects the 'Side View', and the ALS/TOCS is displayed.

2.5.12 User Story 9: Recalculating Runway Parameters (Increment 2)

1. The user opens the runway re-declaration program on their computer.
2. An empty runway view loads.
3. The user selects an airport to view.
4. The user selects a runway to view.
5. The user selects an obstacle from the obstacle dropdown.
6. The user clicks the 'Set Up' Button
7. The user selects one of the obstacles from the list.
8. The user inputs the obstacle's position relative to the runway length and runway centreline.
9. The user clicks the 'Activate' button.
10. The runway view updates with the new parameters.

2.5.13 User Story 10: Display all relevant information in views (Increment 3)

1. The user opens the runway re-declaration program on their computer, and inputs their password
2. An empty runway view loads.
3. The user selects an airport to view.
4. The user selects a runway to view.
5. Both runway views display the threshold designators, displaced thresholds, stopways, clearways, RESAs and runway parameters (TORA, TODA, ASDA and LDA).
6. The user selects and activates an obstacle.
7. Both views display the blast protection area and recalculated runway parameters (TORA, TODA, ASDA and LDA).
8. The side view displays the recalculated TOCS / ALS slope.

2.5.14 User Story 11: Adding a predefined obstacle (Increment 2)

1. The user opens the runway re-declaration program on their computer.
2. An empty runway view loads.
3. The user selects an airport to view.
4. The user selects a runway to view.
5. The user selects an obstacle from the obstacle dropdown.
6. The user clicks the 'Set Up' button.
7. The user selects one of the obstacles from the list.
8. The user inputs the obstacle's position relative to the runway length and runway centreline.
9. The user clicks the 'Activate' button.
10. On the Airport Editor menu, the runway is marked as having an obstacle.
11. In the runway view, a black box is placed on the runway at the correct position demarcating the obstacle.

2.5.15 User Story 12: Cleared and graded area (Increment 2)

1. The user opens the runway re-declaration program on their computer.
2. An empty runway view loads.
3. The user selects an airport to view.
4. The user selects a runway to view.
5. The cleared and graded area around the runway is correctly calculated and displayed.

2.5.16 User Story 13: Viewing calculation breakdowns (Increment 2)

1. The user opens the runway re-declaration program on their computer.
2. An empty runway view loads.
3. The user selects an airport to view.
4. The user selects a runway to view.
5. The user selects an obstacle from the obstacle dropdown.
6. The user clicks the 'Set Up' button.
7. The user selects one of the obstacles from the list.
8. The user inputs the obstacle's position relative to the runway length and runway centreline.
9. The user clicks the 'Activate' button.
10. The user clicks the 'View Breakdown' button.
11. A Calculation Breakdown window appears where the user can view the calculation steps for each value recalculated.

2.5.17 User Story 14: Viewing activity log (Increment 3)

1. The user opens the runway re-declaration program on their computer.
2. An empty runway view loads.
3. Some activity takes places that can be logged.
4. The user clicks 'View Log'.
5. The user selects the recalculations tab.
6. The user filters the log by the airport they are concerned with.
7. The user clicks on log entries to view the details of the runway at that time.

2.5.18 User Story 15: Predefined obstacles (Increment 1)

1. The user opens the runway re-declaration program on their computer.
2. An empty runway view loads.
3. The user selects an airport to view.
4. The user selects a runway to view.
5. The user opens the obstacle dropdown.
6. There are predefined obstacles in the program for the user to use that they have not defined themselves.

2.5.19 User Story 16: Applicable to all commercial UK airports (Increment 3)

1. The user opens the runway re-declaration program on their computer.
2. The user opens the airport selector dropdown.
3. All large commercial UK airports are present.
4. The user selects an airport of their choice.

5. The user opens the runway dropdown.
6. All runways at the airport are present in the dropdown.
7. The user selects any runway of their choice.
8. The runway loads in the program, with the same parameters (e.g. TORA) it has in real life.

2.5.20 User Story 17: Setting / Entering a password (Increment 3)

1. The user opens the runway re-declaration program on their computer.
2. A dialog box appears prompting the user to set or enter a password.
3. The user inputs a password of at least 8 characters.
4. The user clicks the submit button.
5. The empty runway view loads.

2.5.21 User Story 18: Accessibility (Not Implemented)

User story 18 was marked as a "could" task, and was not implemented due to time constraints.

1. The user opens the runway re-declaration program on their computer.
2. The user selects that they would like to use text-to-speech functionality.
3. When the user selects an element in the application or hovers over it with their mouse, the name is read aloud with text-to-speech.
4. The user adds an obstacle to the runway.
5. The recalculated parameters are read aloud using text-to-speech.

2.5.22 User Story 19: Log of actions (Increment 3)

1. The user opens the runway re-declaration program on their computer.
2. The user performs some actions in the program, such as editing a runway or adding an obstacle to the runway.
3. The user clicks on the "View Logs" button.
4. The user is shown a list of all modification actions in the program, along with the timestamp of the event and the user who performed it.

2.5.23 User Story 20: Lowest runway threshold oriented to the left (Increment 2)

1. The user opens the runway re-declaration program on their computer.
2. The user selects an airport.
3. The user selects a dual direction runway.
4. By default, the runway with the lowest threshold (e.g. 09 | 27) is on the left of the runway, with takeoff going to the right.

2.5.24 User Story 22: Reliability (Increment 2)

1. The user opens the runway re-declaration program on their computer.
2. The user selects an airport.
3. The user selects a runway.
4. The user applies an obstacle to the runway.
5. The user switches between the different views.
6. The user repeats these actions a number of times with different airports, runways and obstacles.
7. The application continues to produce correct functionality.

2.5.25 User Story 23 & 24: Accident investigation logs (Increment 3)

1. The user moves an encrypted log file from another instance of the application into the logs folder of the application on their computer.
2. The user opens the runway re-declaration program on their computer.
3. The user clicks the "View Logs" button.
4. The user is prompted for the location of the log file, and selects it.
5. The user is prompted for the password used to encrypted the log file.
6. All actions in the log are displayed to the user with all details available.

2.6 Design Artifacts

2.6.1 UML Activity Diagram

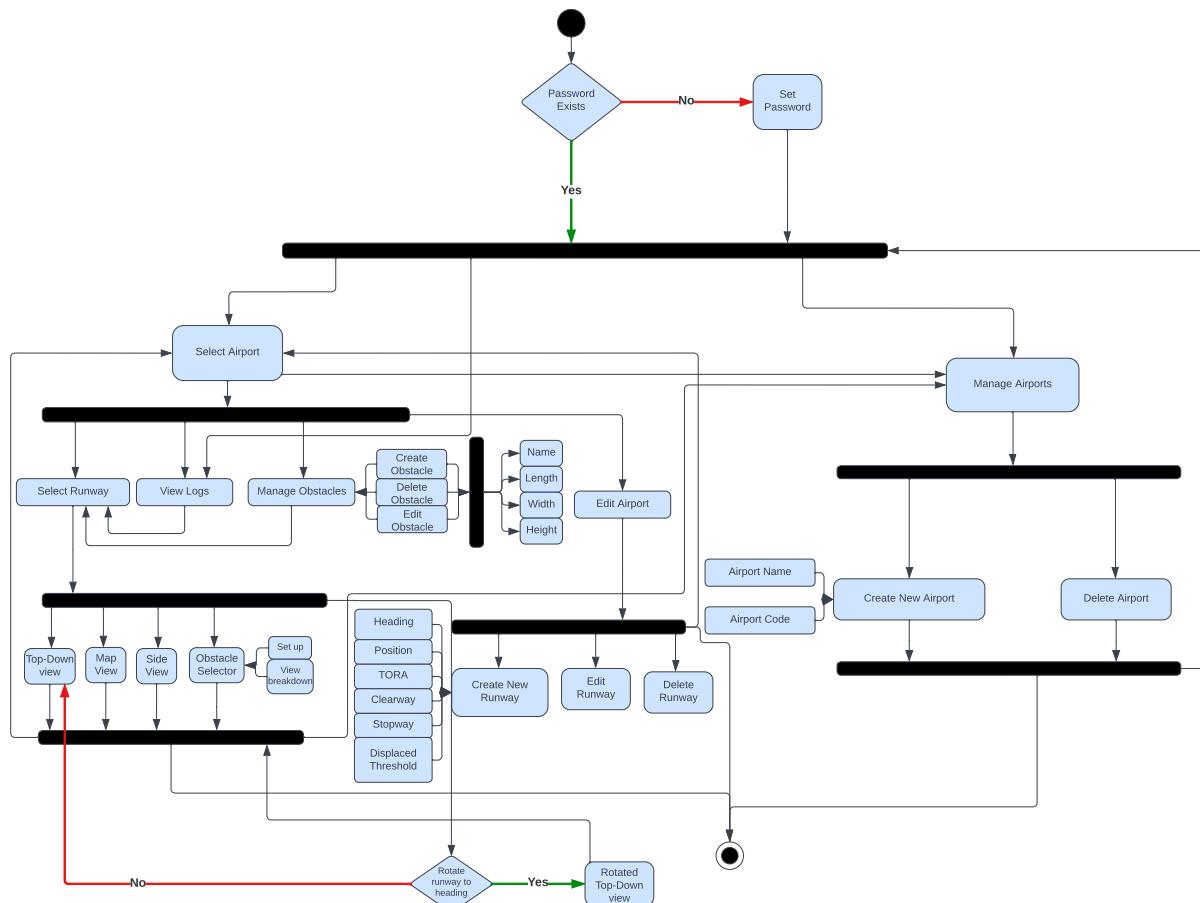


Figure 7: UML Activity Diagram for Increment 3 created using LucidChart

2.6.2 UML Class Diagram

Please see figure 8 for the UML Class Diagram.

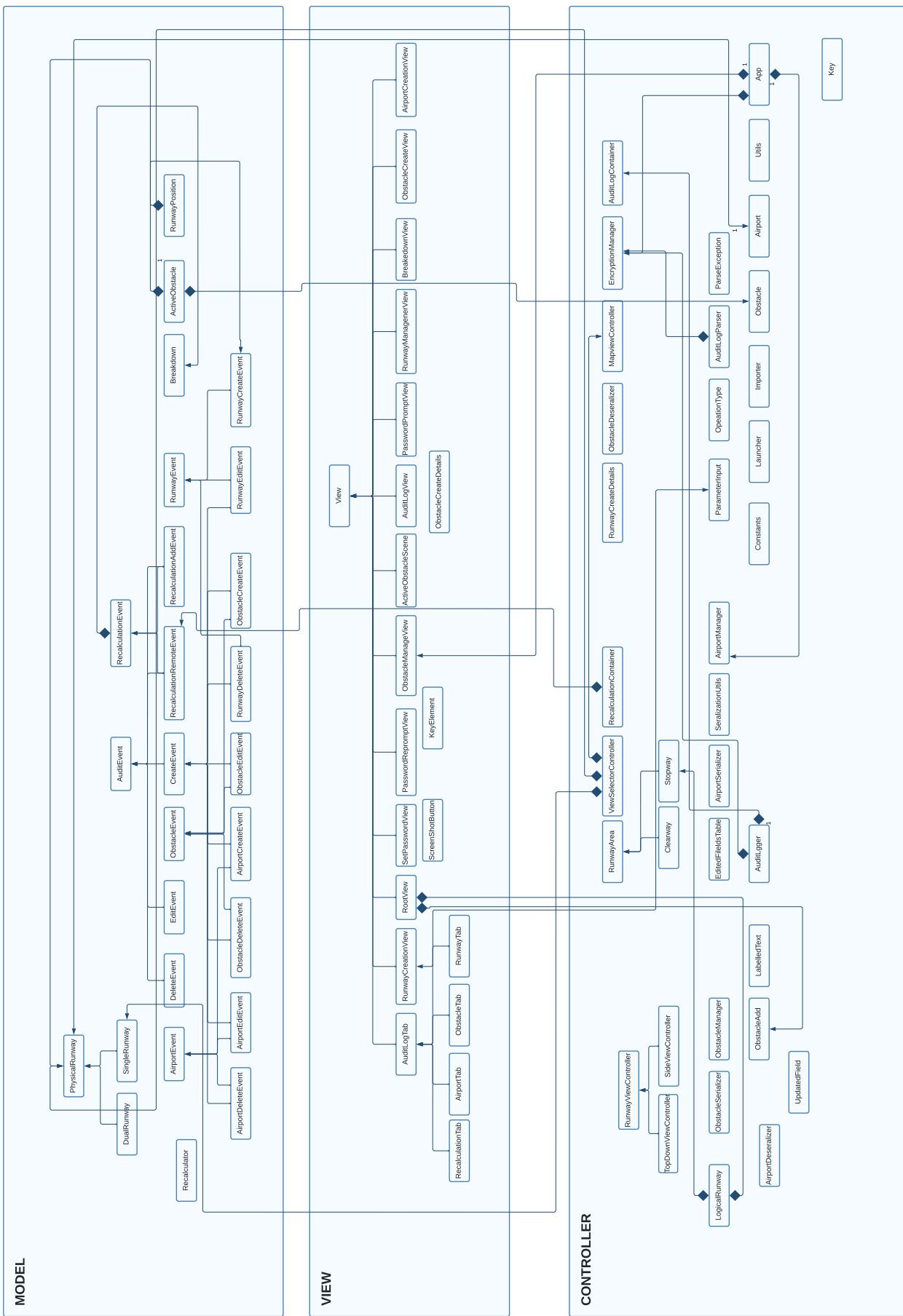


Figure 8: UML Class Diagram for Increment 3 created using LucidChart

2.7 Response To Feedback

- It was advised to reformat the user guide as an elongated table to make clear which screenshots pertained to which explanatory text, so we have done this in the final version of the user guide.
- Acceptance criteria have been negotiated, written and tested for each user story.
- Storyboards have been linked to their respective scenarios via the user story they are for as advised.
- Each scenario test now has a checklist that the tests are performed against.
- Our burndown chart now shows the reduction in time left to complete for each task over the sprint.

3 Testing

3.1 Unit Testing

We continued to use JUnit, the industry standard Java unit testing library, to implement automated unit testing. This allows us to run all our unit tests automatically on each git commit in our CI/CD pipeline using Github Actions to ensure that all new tests pass, and there are no regressions that cause existing tests to fail.

```
[INFO] -----
[INFO] T E S T S
[INFO] -----
[INFO] Running uk.ac.soton.comp2211.CalculationTest
[INFO] Tests run: 4, Failures: 0, Errors: 0, Skipped: 0, Time elapsed: 0.088 s - in uk.ac.soton.comp2211.CalculationTest
[INFO] Running uk.ac.soton.comp2211.EncryptionTest
[INFO] Tests run: 104, Failures: 0, Errors: 0, Skipped: 0, Time elapsed: 2.501 s - in uk.ac.soton.comp2211.EncryptionTest
[INFO] Running uk.ac.soton.comp2211.RecalculationTest
[INFO] Tests run: 36, Failures: 0, Errors: 0, Skipped: 0, Time elapsed: 0.078 s - in uk.ac.soton.comp2211.RecalculationTest
[INFO] Running uk.ac.soton.comp2211.SerializationTest
[INFO] Tests run: 4, Failures: 0, Errors: 0, Skipped: 0, Time elapsed: 0.134 s - in uk.ac.soton.comp2211.SerializationTest
[INFO] Running uk.ac.soton.comp2211.UITest
Success: Airport successfully created
[INFO] Tests run: 1, Failures: 0, Errors: 0, Skipped: 0, Time elapsed: 2.958 s - in uk.ac.soton.comp2211.UITest
[INFO]
[INFO] Results:
[INFO]
[INFO] Tests run: 149, Failures: 0, Errors: 0, Skipped: 0
```

Figure 9: mvn test output

Some examples of unit tests we have written include:

- Recalculation tests based upon the 4 scenarios provided in the coursework specification for recalculations on both Heathrow runways.
- Serialization and deserialization tests for the airport and runway XML files to ensure that any configurations provided by the user are correctly stored and loaded across sessions. This is tested using both single and dual direction runways, and a larger test using the entire Heathrow airport file.
- Encryption tests to ensure that the encrypted data files of the application can be safely encrypted and decrypted across sessions. Most notably, we wrote a repeated test with randomised encryption keys to ensure that the encryption algorithm can handle any password the user chooses.
- A UI test using the [TestFX](#) library that simulates running the application with a headless JavaFX library and using a "robot" to interact with the program. This ensures that the program successfully launches, and the frontend views interact with the controllers in the correct way.

3.2 Acceptance Criteria

#	User story	Acceptance Criteria (Proposed)
1	As an Air Traffic Controller, I want a tool that quickly calculates revised runway parameters and obstacle visualization, to ensure safe and efficient flight operations.	Test that a user can add an obstacle and retrieve the updated runway parameters in under 30 seconds.
2	As an Air Traffic Controller, I need a tool that can display details about all the runways at the airport I work at that I need to consider in my decision making process, as well as being able to easily switch between them, so that I can coordinate air traffic to land at a runway different from the planned one if necessary.	User can switch between runways quickly and easily, and runway view shows all redeclared distances.

3	As an Air Traffic Controller, I would like the tool to be able to rotate the runway view according to compass north at the click of a button, so that I can unambiguously and unmistakably communicate direction to pilots.	Program contains a toggle that rotates the runway view to compass north.
4	As an Air Traffic Controller, I would like the tool to be able to see both a top-down and side-on perspective so that I can consider all the variables in play when I make my decisions.	Program contains two views of the runway, top-down and side-on. It should be reasonably easy to switch between them.
5	As an Air Traffic Controller, I want real-world images of the runway to be overlaid on the diagrams so that I can better visualise the landings.	Program contains a toggle that includes a real world image overlaying the top-down runway view.
6	As an Air Traffic Controller, I want to be able to export simulations as images so that I can refer to them later without having to re-enter the parameters.	Program contains a button that exports the runway view as an image and saves it to the disk.
7	As a Pilot, I want to quickly and easily determine whether it's safe to land or take off from a runway with an obstruction on it so that I can make informed decisions about my flight operations.	Program must have a mechanism to add obstacles onto the runway that can be used quickly.
8	As a Pilot, I need to be accurately informed of a representation of the TOCS (Take-Off Climb Surface) or ALS (Approach / Landing Surface) in the case of an obstructed runway so that I know exactly how to use an obstructed runway.	Program must display the the TOCS (Take-Off Climb Surface) or ALS (Approach / Landing Surface) in the side view when an obstacle is present on the runway.
9	As a Passenger, I want the airline to use a tool that quickly calculates revised runway parameters and obstacle visualization, to ensure a timely arrival when faced with obstacles on the runway.	Test that a user can add an obstacle and retrieve the updated runway parameters in under 30 seconds.
10	As a Passenger, I want the software used by the airport to display all relevant information in its views so that nothing that might compromise my safety is missed when taking off and landing.	Program must contain a representation of the TORA, TODA, ASDA, LDA, RESA, Blast Allowance, Clearway, Stopway, Displaced Threshold and Threshold Indicator in both views when applicable.
11	As a Runway Manager, I need to be able to easily and quickly determine if an obstruction would be an issue for any soon-incoming airplanes, so that I can properly prioritise its removal from the airway.	Program must have a mechanism to add obstacles onto the runway that can be used quickly.
12	As a Runway Manager, I would like to be able to see the cleared and graded area of each runway on the software, as it is helpful to have a birds-eye diagram of the region that myself and my team are responsible for keeping clear of obstacles.	Program must contain a representation of the cleared and graded area in the top-down view.
13	As a Runway Analyst I would like to be able to see a breakdown of calculations so that I can compare them with my paper results, in order to see where I may have gone wrong and where the software has potentially gone wrong.	Program must be able to display the calculations performed to obtain the redeclared distances.
14	As a Runway Analyst I would like to be able to store all past calculations so that I can review when the software has made accurate predictions and when it may have made mistakes.	Program should have a log of all redeclarations performed.
15	As a Runway Analyst I would like for the tool to come with a built-in list of possible obstacles that can be added, so that I can simulate hypothetical scenarios that could threaten the runway's function.	Program must come with a list of predefined obstacles to place on the runway view.
16	As a Runway Analyst I would like for this tool to be applicable to all UK commercial airports so that I can receive guidance for any airport I must do calculations for.	Program must be capable of adding a runway of any configuration valid under UK law.

17	As a Chief ATC I would like the XML file to be password protected so that runway parameters cannot be updated by malicious attackers.	Program's save data is protected from editing by a password lock.
18	As a Chief ATC I would like the system to have API support for the use of assistive technologies so that the disabled members of my team can use the system.	N/A
19	As a Chief ATC responsible for several subordinates, I would like to be able to see a log of the actions made by my team when interacting with the system, so that I know what state the system is in when I look at it.	Program contains a log of all actions made: changes to the runways, changes to the airport list, addition of obstacles.
20	As a Chief ATC, it would be useful for the lowest runway thresholds to be oriented on the left so that my team can identify runways unambiguously.	The top-down runway view must have the threshold indicator on the left, with the direction of the runway horizontal.
21	As a Chief ATC, I would like the tool to be able to show a 3D representation of the runway in order to give me concise overview of the state of affairs of the runway at a given point can be easily and quickly taken in.	N/A
22	As an Airline Representative, I want the system to be as reliable as possible to minimise delays and cancellations and thus reduce complaints and improve customer experience.	Calculate 5 redeclarations manually, then carry out the same redeclarations on the system to check that the values are identical.
23	As an Accident Investigation Officer, I want to retrieve the data from the system to conduct an investigation, determine the cause of the accident, and identify who is responsible.	User must be able to extract a concise log of everything that has happened on the system.
24	As an Insurance Company Representative, I want the data exported from the system to be clear about what was involved in the incident so that an accurate sum for the insurance payout can be calculated.	Log should detail which obstacle is deployed, when one is on the runway.

3.3 Scenario Testing

3.3.1 User Story 1: Fast Recalculations (Increment 2)

As an Air Traffic Controller, I want a tool that quickly calculates revised runway parameters and obstacle visualization, to ensure safe and efficient flight operations.

Action	Result
The user opens the runway re-declaration program on their computer.	Pass
The user selects a pre-defined airport from a dropdown list.	Pass
The user selects a pre-defined runway from a dropdown list.	Pass
The user selects a pre-defined obstacle from a dropdown list.	Pass
The user clicks the 'Set Up' Button.	Pass
The user inputs the obstacle's position relative to the runway length and runway centreline.	Pass
The application displays the obstacle on the runway and correctly recalculates the parameters.	Pass
This whole process should be completed in under 30 seconds.	Pass

Acceptance Criteria	Result
Test that a user can add an obstacle and retrieve the updated runway parameters in under 30 seconds.	Pass

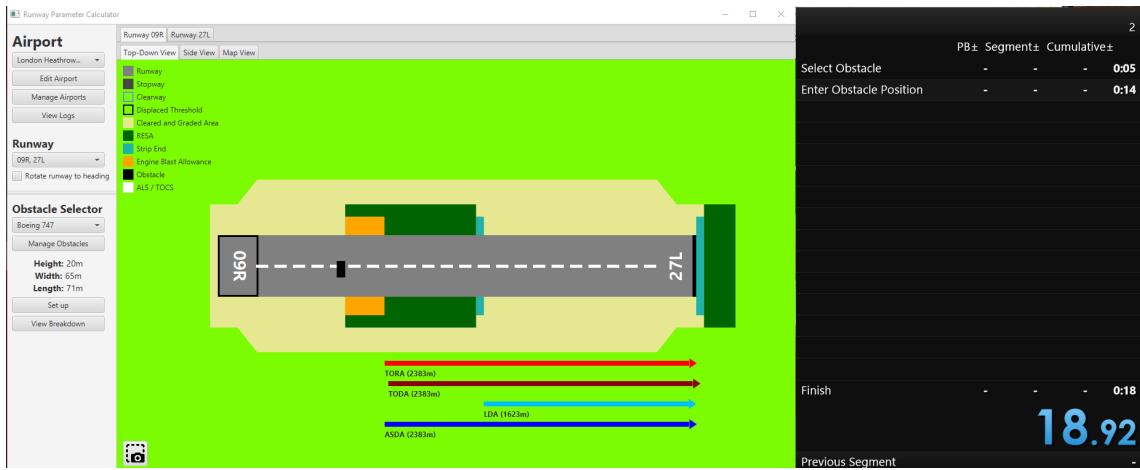


Figure 10: User Story 1 - Test Complete

3.3.2 User Story 2: Adding a new single direction runway (Increment 1)

As an Air Traffic Controller, I need a tool that can display details about all the runways at the airport I work at that I need to consider in my decision making process, as well as being able to easily switch between them, so that I can coordinate air traffic to land at a runway different from the planned one if necessary.

Action	Result
The user opens the runway re-declaration program on their computer.	Pass
An empty runway view loads.	Pass
The user selects an airport from the airport dropdown menu.	Pass
The user clicks the 'Edit Airport' button, and the runway manager window appears.	Pass
The user reviews the runways currently in the program, and clicks the 'Create New Runway' button. The runway creation window opens.	Pass
The user adjusts the slider to select the runway heading number.	Pass
The user then enters values for the runways's TORA, Clearway length, Stopway length, and displaced threshold.	Pass
The user clicks the 'Create Runway' button. If all values entered are valid, the window disappears and the runway they created can now be viewed from the runway dropdown.	Pass
If some value entered is invalid, such as the TORA being under 600m, an error message appears and the user must reenter values.	Pass

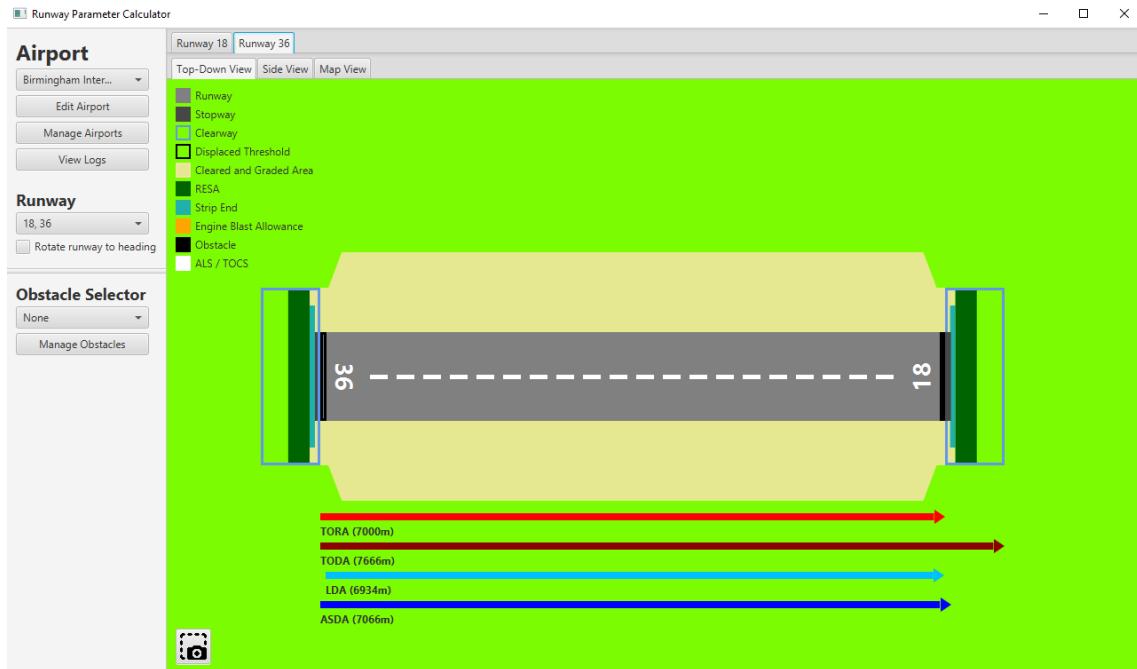


Figure 11: User Story 2 - Test Complete

Acceptance Criteria	Result
User can switch between runways quickly and easily, and runway view shows all redeclared distances.	Pass

3.3.3 User Story 2: Adding a new dual direction runway (Increment 1)

As an Air Traffic Controller, I need a tool that can display details about all the runways at the airport I work at that I need to consider in my decision making process, as well as being able to easily switch between them, so that I can coordinate air traffic to land at a runway different from the planned one if necessary.

Action	Result
The user opens the runway re-declaration program on their computer.	Pass
An empty runway view loads.	Pass
The user selects an airport from the airport dropdown menu.	Pass
The user clicks the 'Edit Airport' button, and the runway manager window appears.	Pass
The user reviews the runways currently in the program, and clicks the 'Create New Runway' button. The runway creation window opens.	Pass
The user adjusts the slider and uses the dropdown to select the runway heading number for the main runway direction.	Pass
The user then enters values for the main runways's TORA, Clearway length, Stopway length, and displaced threshold.	Pass
The user then enters values for the inverted runways's Clearway length, Stopway length, and displaced threshold.	Pass
The user clicks the 'Create Runway' button. If all values entered are valid, the window disappears and the runway they created can now be viewed from the runway dropdown.	Pass
If some value entered is invalid, such as the values not being numeral, an error message appears and the user must reenter values.	Pass
If a runway with the same heading and position already exists, the user will not be able to create it.	Pass
In the runway view, the runway they created can now been seen with the values for the TORA, TODA, LDA and ASDA in both directions.	Pass

Acceptance Criteria	Result
User can switch between runways quickly and easily, and runway view shows all redeclared distances.	Pass

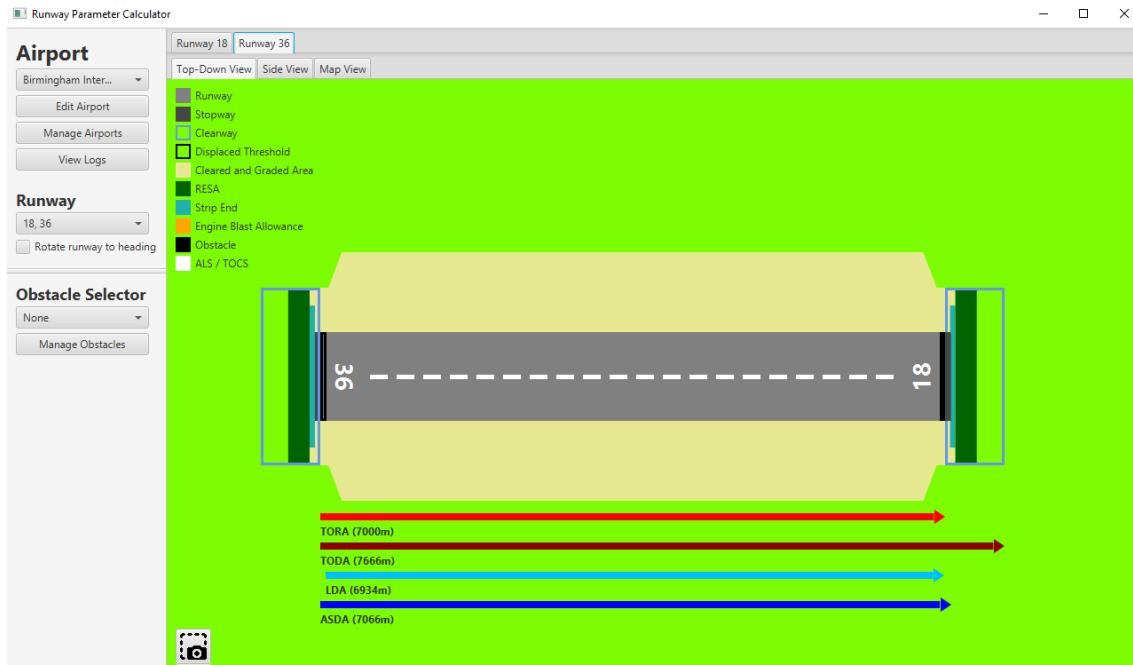


Figure 12: User Story 2 - Test Complete

3.3.4 User Story 2: Editing a runway (Increment 1)

As an Air Traffic Controller, I need a tool that can display details about all the runways at the airport I work that I need to consider in my decision making process, as well as being able to easily switch between them, so that I can coordinate air traffic to land at a runway different from the planned one if necessary.

Action	Result
The user opens the runway re-declaration program on their computer.	Pass
An empty runway view loads.	Pass
The user clicks on the 'Edit Airport' button to manage the runways on the airport.	Pass
The Airport Editor scene loads.	Pass
The user looks for the runway they want to edit, selects it, and clicks the 'Edit Runway' button.	Pass
The Runway Editor loads.	Pass
The user can change any input parameter, including heading, position, runway duality, TORA, Clearway and Stopway lengths, and Displaced Threshold position.	Pass
If the runway already exists, the user will not be able to save the changes.	Pass
Acceptance Criteria	Result
User can switch between runways quickly and easily, and runway view shows all redeclared distances.	Pass

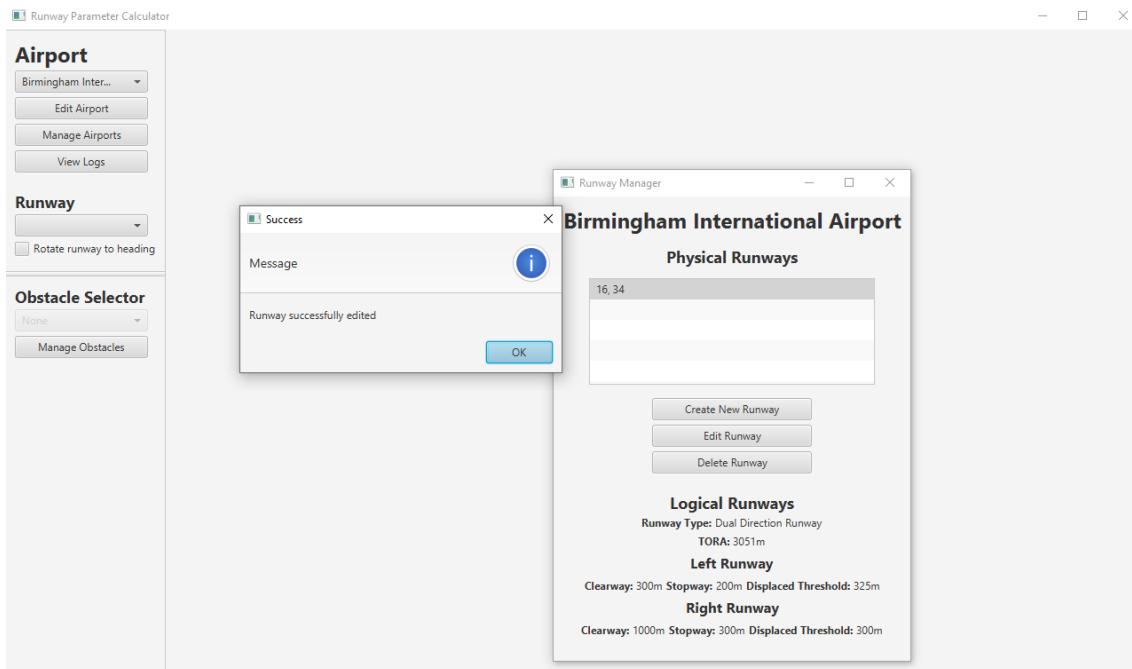


Figure 13: User Story 2 - Test Complete

3.3.5 User Story 2: Deleting a runway (Increment 1)

As an Air Traffic Controller, I need a tool that can display details about all the runways at the airport I work that I need to consider in my decision making process, as well as being able to easily switch between them, so that I can coordinate air traffic to land at a runway different from the planned one if necessary.

Action	Result
The user opens the runway re-declaration program on their computer.	Pass
An empty runway view loads.	Pass
The user clicks on the 'Edit Airport' button to manage the runways on the airport.	Pass
The Airport Editor scene loads.	Pass
The user looks for the runway they want to remove, selects it, and clicks the 'Delete Runway' button.	Pass
The runway is no longer present in the airport editor or runway selector of the main scene	Pass

Acceptance Criteria	Result
User can switch between runways quickly and easily, and runway view shows all redeclared distances.	Pass

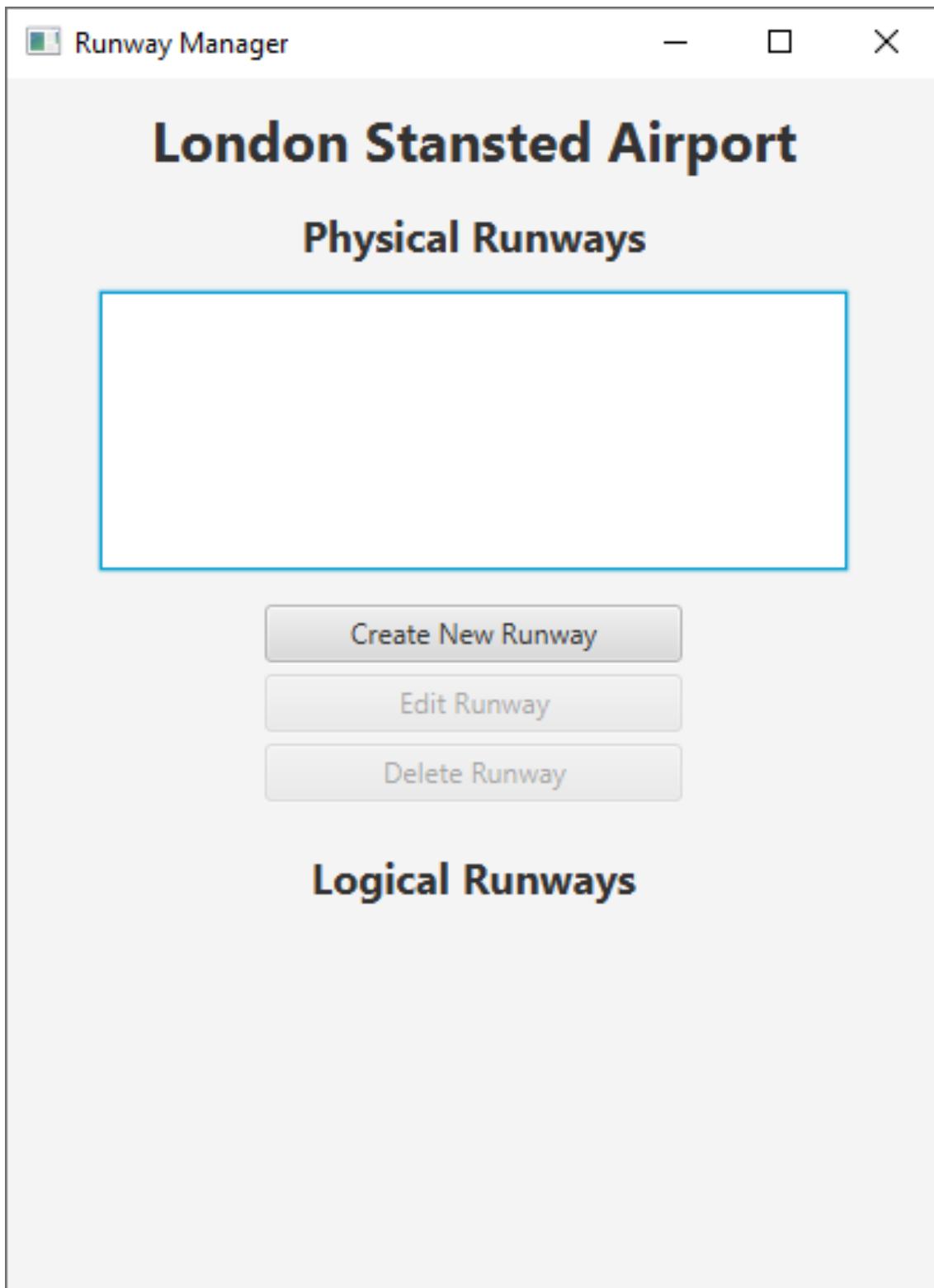


Figure 14: User Story 2 - Test Complete

3.3.6 User Story 3: Rotating the top-down view (Increment 2)

As an Air Traffic Controller, I would like the tool to be able to rotate the runway view according to compass north at the click of a button, so that I can unambiguously and unmistakably communicate direction to pilots.

Action	Result
The user opens the runway re-declaration program on their computer.	Pass
An empty runway view loads.	Pass
The user selects an airport to view.	Pass
The user selects a runway to view.	Pass
The user clicks the 'Rotate' button in the runway view.	Pass
The runway rotates in the runway view such that it is angled according to its compass headings.	Pass

Acceptance Criteria	Result
Program contains a toggle that rotates the runway view to compass north.	Pass

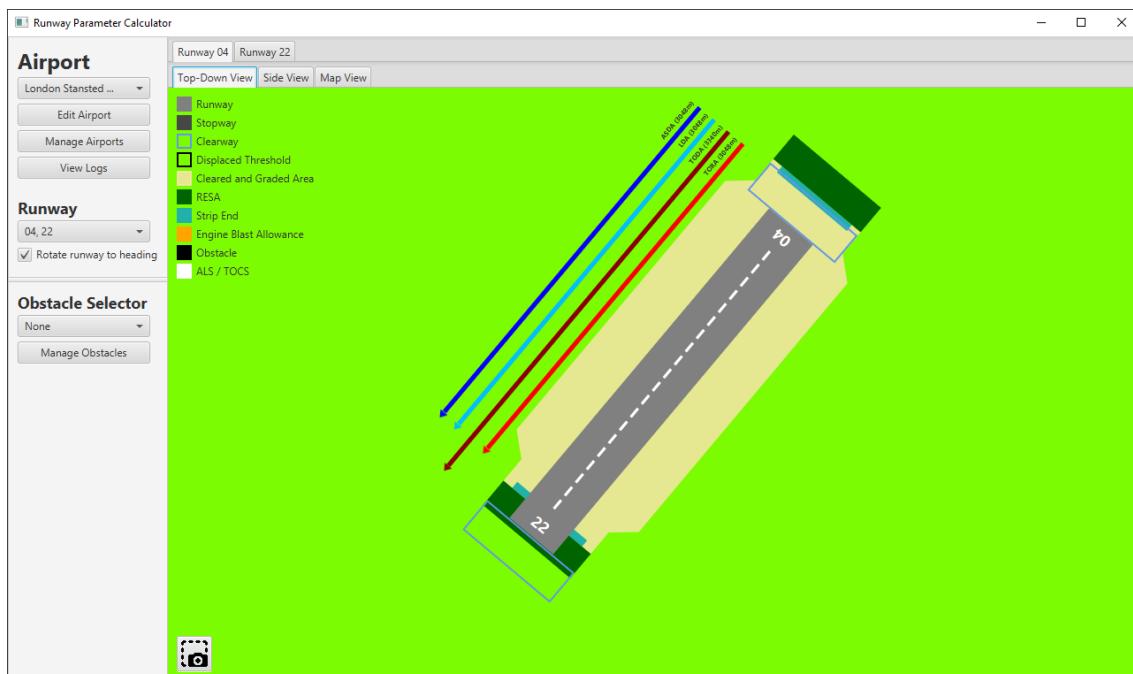


Figure 15: User Story 3 - Test Complete

3.3.7 User Story 4: Viewing the side-on perspective (Increment 2)

As an Air Traffic Controller, I would like the tool to be able to see both a top-down and side-on perspective so that I can consider all the variables in play when I make my decisions.

Action	Result
The user opens the runway re-declaration program on their computer.	Pass
An empty runway view loads.	Pass
The user selects an airport to view.	Pass
The user selects a runway to view.	Pass
The user selects the 'Side View' tab at the top of the runway view.	Pass
The runway view changes to a side-on perspective.	Pass
The user can view the relevant values for the runway, including the ALS and TOCS, in the runway view.	Pass

Acceptance Criteria	Result
Program contains two views of the runway, top-down and side-on. It should be reasonably easy to switch between them.	Pass

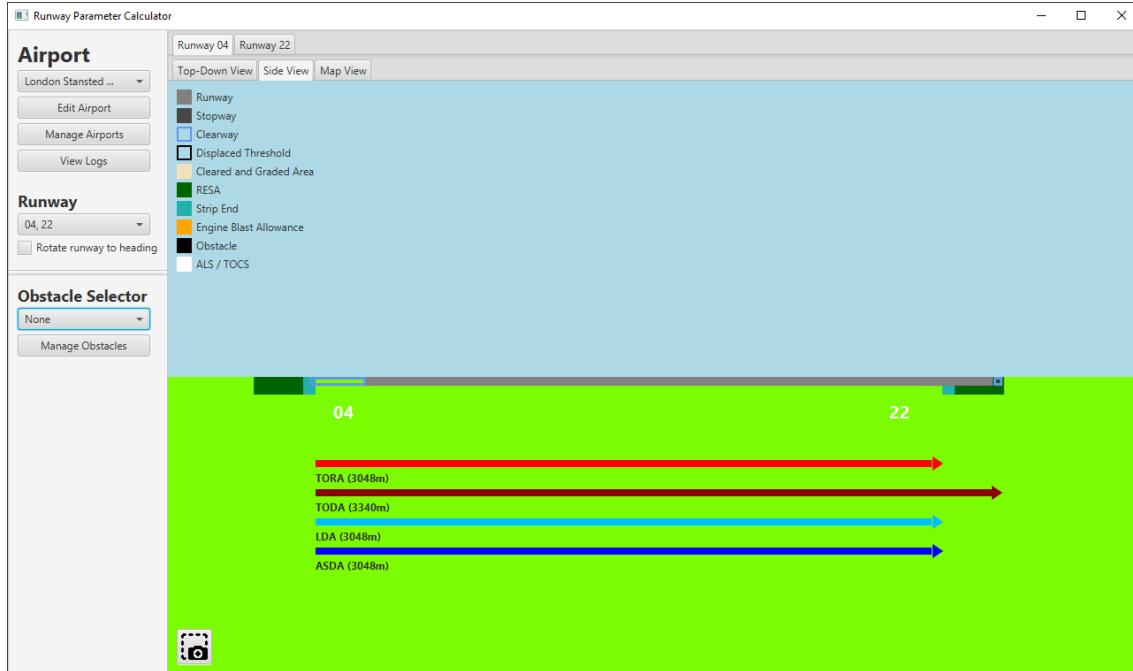


Figure 16: User Story 4 - Test Complete

3.3.8 User Story 5: Overlay real-world images of the runway (Increment 3)

As an Air Traffic Controller, I want real-world images of the runway to be overlaid on the diagrams so that I can better visualise the landings.

Note: This user story was replaced by a map, as we believed it would provide the ATC more useful information than a static image, such as visualizing the runways together, the whole airport complex, and the surrounding areas. The following actions and acceptance criteria have been reconsidered.

Action	Result
The user opens the runway re-declaration program on their computer.	Pass
An empty runway view loads.	Pass
The user selects an airport with real-world coordinates assigned to it to view.	Pass
The user selects a runway to view.	Pass
The user selects the 'Map View' tab at the top of the runway view.	Pass
An instance of OpenStreetMap centered at the airport is shown.	Pass

Acceptance Criteria	Result
Program displays an embedded instance of OpenStreetMap with a marker on the airport.	Pass

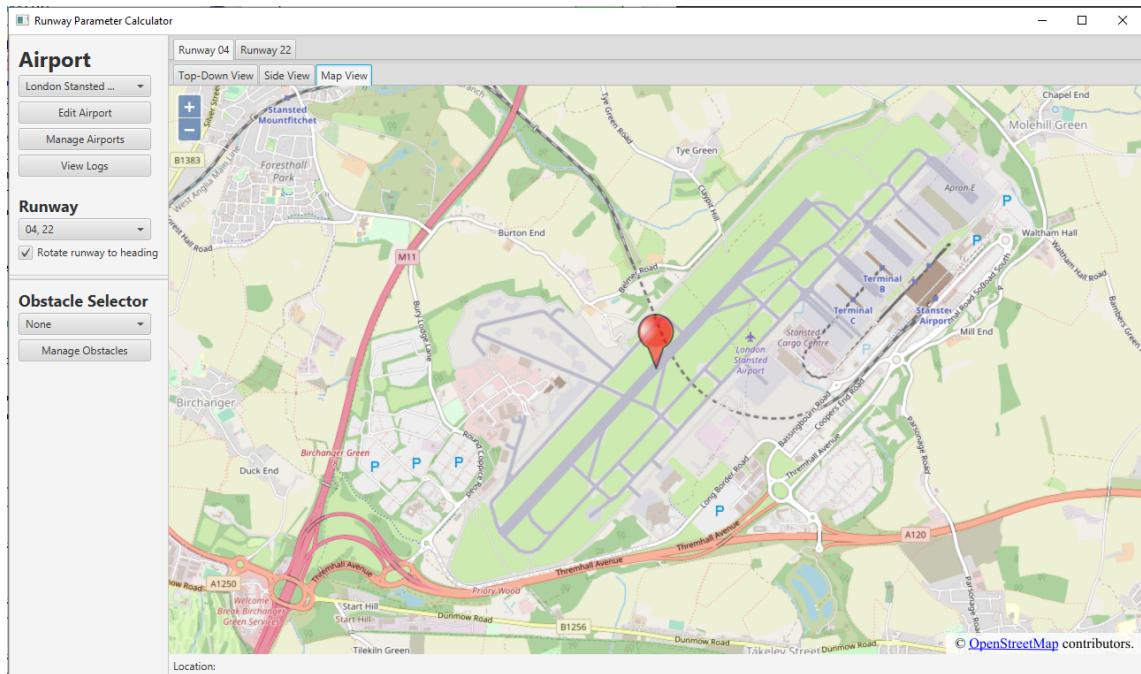


Figure 17: User Story 5 - Test Complete

3.3.9 User Story 6: Exporting a screenshot (Increment 3)

As an Air Traffic Controller, I want to be able to export simulations as images so that I can refer to them later without having to re-enter the parameters.

Action	Result
The user opens the runway re-declaration program on their computer.	Pass
An empty runway view loads.	Pass
The user selects an airport to view.	Pass
The user selects a runway to view.	Pass
The user clicks the screenshot button, and the file selection screen appears.	Pass
The user selects a location, and the current runway view is exported as a PNG file.	Pass

Acceptance Criteria	Result
Program contains a button that exports the runway view as an image and saves it to the disk.	Pass

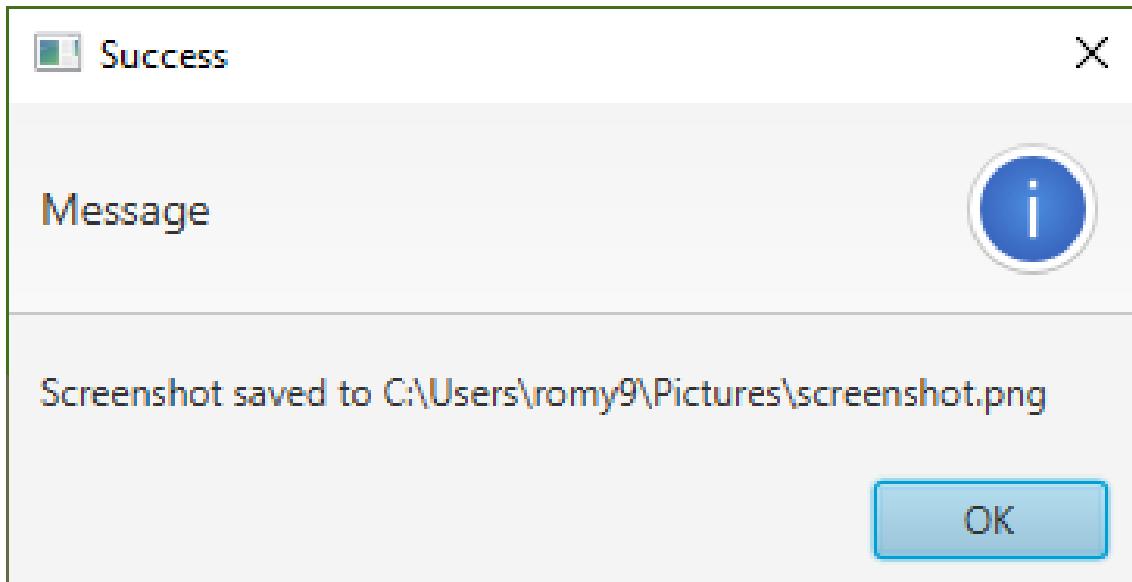


Figure 18: User Story 6 - Test Complete

3.3.10 User Story 7: Determining safety of landing and take off (Increment 2)

As a Pilot, I want to quickly and easily determine whether it's safe to land or take off from a runway with an obstruction on it so that I can make informed decisions about my flight operations.

Action	Result
The user opens the runway re-declaration program on their computer.	Pass
The user selects an airport from a dropdown list.	Pass
The user selects a runway from a dropdown list.	Pass
The user selects an obstacle from a dropdown list and confirms they want to add it to the runway.	Pass
The user is prompted to enter the location of the obstacle, relative to the threshold and centre line of the runway.	Pass
The application displays the obstacle on the runway and correctly recalculates the parameters.	Pass
The pilot then uses the recalculated parameters (e.g. TORA, LDA) and existing knowledge of their aircraft to determine whether the runway has enough clear space to take off or land.	Pass
Acceptance Criteria	Result
Program must have a mechanism to add obstacles onto the runway that can be used quickly.	Pass

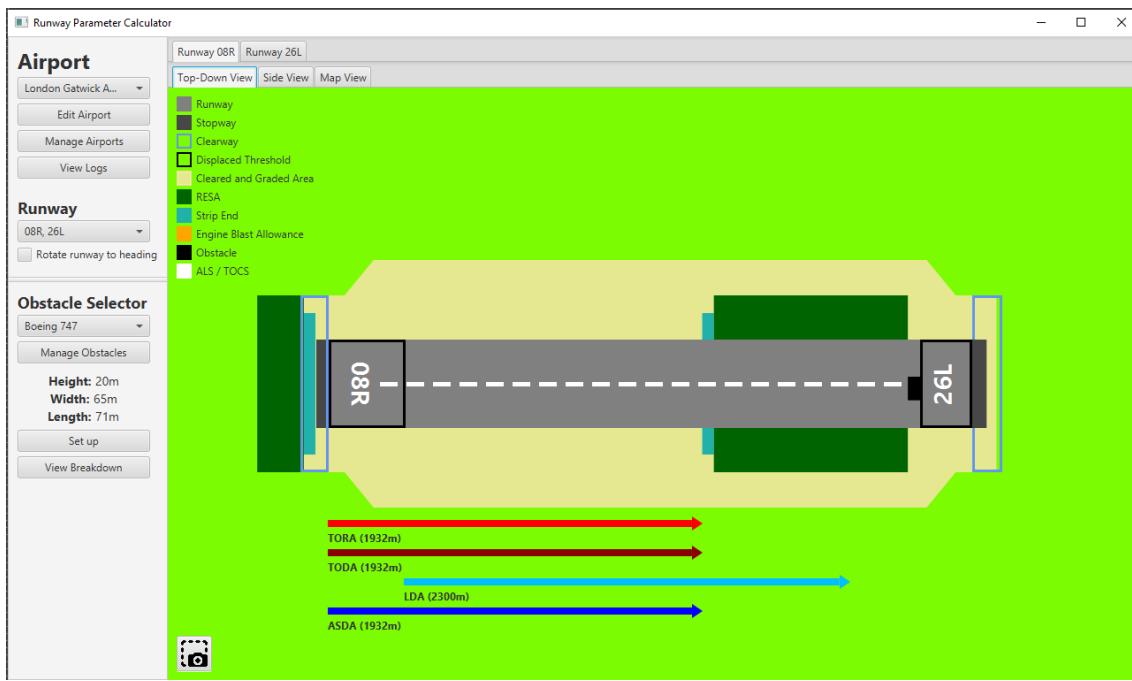


Figure 19: User Story 7 - Test Complete

3.3.11 User Story 8: Viewing TOCS and ALS (Increment 3)

As a Pilot, I need to be accurately informed of a representation of the TOCS (Take-Off Climb Surface) or ALS (Approach / Landing Surface) in the case of an obstructed runway so that I know exactly how to use an obstructed runway.

Action	Result
The user opens the runway re-declaration program on their computer.	Pass
An empty runway view loads.	Pass
The user selects an airport to view.	Pass
The user selects a runway to view.	Pass
The user selects an obstacle from the obstacle dropdown.	Pass
The user clicks the 'Set Up' Button	Pass
The user selects one of the obstacles from the list.	Pass
The user inputs the obstacle's position relative to the runway length and runway centreline.	Pass
The user clicks the 'Activate' button, and the obstacle is added to the runway.	Pass
The user selects the 'Side View', and the ALS/TOCS is displayed.	Pass

Acceptance Criteria	Result
Program must display the the TOCS (Take-Off Climb Surface) or ALS (Approach / Landing Surface) in the side view when an obstacle is present on the runway.	Pass

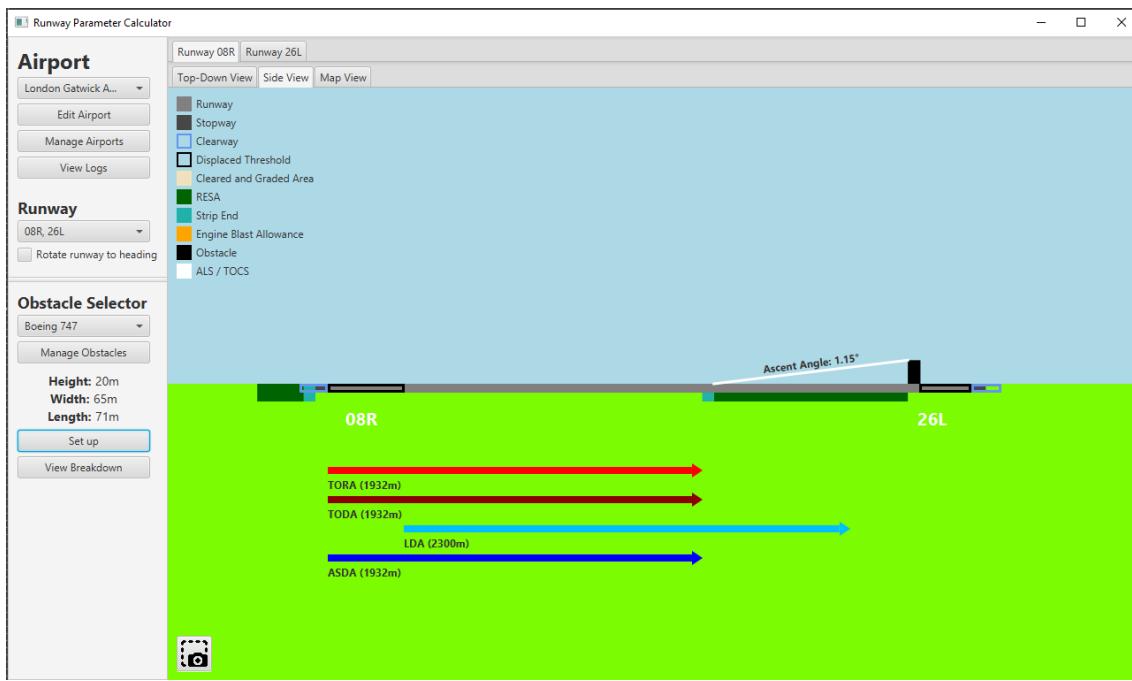


Figure 20: User Story 8 - Test Complete

3.3.12 User Story 9: Recalculating Runway Parameters (Increment 2)

As a Passenger, I want the airline to use a tool that quickly calculates revised runway parameters and obstacle visualization, to ensure a timely arrival when faced with obstacles on the runway.

Action	Result
The user opens the runway re-declaration program on their computer.	Pass
An empty runway view loads.	Pass
The user selects an airport to view.	Pass
The user selects a runway to view.	Pass
The user selects an obstacle from the obstacle dropdown.	Pass
The user clicks the 'Set Up' Button	Pass
The user selects one of the obstacles from the list.	Pass
The user inputs the obstacle's position relative to the runway length and runway centreline.	Pass
The user clicks the 'Activate' button.	Pass
The runway view updates with the new parameters.	Pass
Acceptance Criteria	Result
Test that a user can add an obstacle and retrieve the updated runway parameters in under 30 seconds.	Pass



Figure 21: User Story 9 - Test Complete

3.3.13 User Story 10: Display all relevant information in views (Increment 3)

As a Passenger, I want the software used by the airport to display all relevant information in its views so that nothing that might compromise my safety is missed when taking off and landing.

Action	Result
The user opens the runway re-declaration program on their computer.	Pass
An empty runway view loads.	Pass
The user selects an airport to view.	Pass
The user selects a runway to view.	Pass
Both runway views display the threshold designators, displaced thresholds, stopways, clearways, RESAs and runway parameters (TORA, TODA, ASDA and LDA).	Pass
The user selects and activates an obstacle.	Pass
Both views display the blast protection area and recalculated runway parameters (TORA, TODA, ASDA and LDA).	Pass
The side view displays the recalculated TOCS / ALS slope.	Pass
Acceptance Criteria	Result
Program must contain a representation of the TORA, TODA, ASDA, LDA, RESA, Blast Allowance, Clearway, Stopway, Displaced Threshold and Threshold Indicator in both views when applicable.	Pass

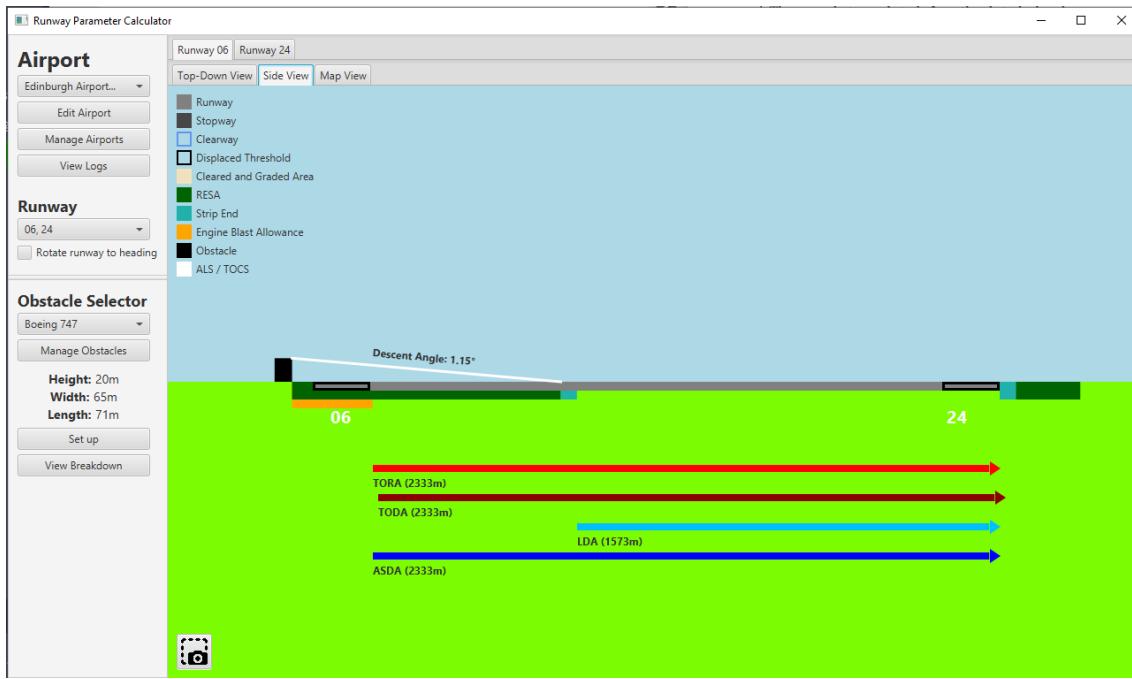


Figure 22: User Story 10 - Test Complete

3.3.14 User Story 11: Adding a predefined obstacle (Increment 2)

As a Runway Manager, I need to be able to easily and quickly determine if an obstruction would be an issue for any soon-incoming airplanes, so that I can properly prioritise its removal from the airway.

Action	Result
The user opens the runway re-declaration program on their computer.	Pass
An empty runway view loads.	Pass
The user selects an airport to view.	Pass
The user selects a runway to view.	Pass
The user selects an obstacle from the obstacle dropdown.	Pass
The user clicks the 'Set Up' button.	Pass
The user selects one of the obstacles from the list.	Pass
The user inputs the obstacle's position relative to the runway length and runway centreline.	Pass
The user clicks the 'Activate' button.	Pass
On the Airport Editor menu, the runway is marked as having an obstacle.	Pass
In the runway view, a black box is placed on the runway at the correct position demarcating the obstacle.	Pass
Acceptance Criteria	Result
Program must have a mechanism to add obstacles onto the runway that can be used quickly.	Pass

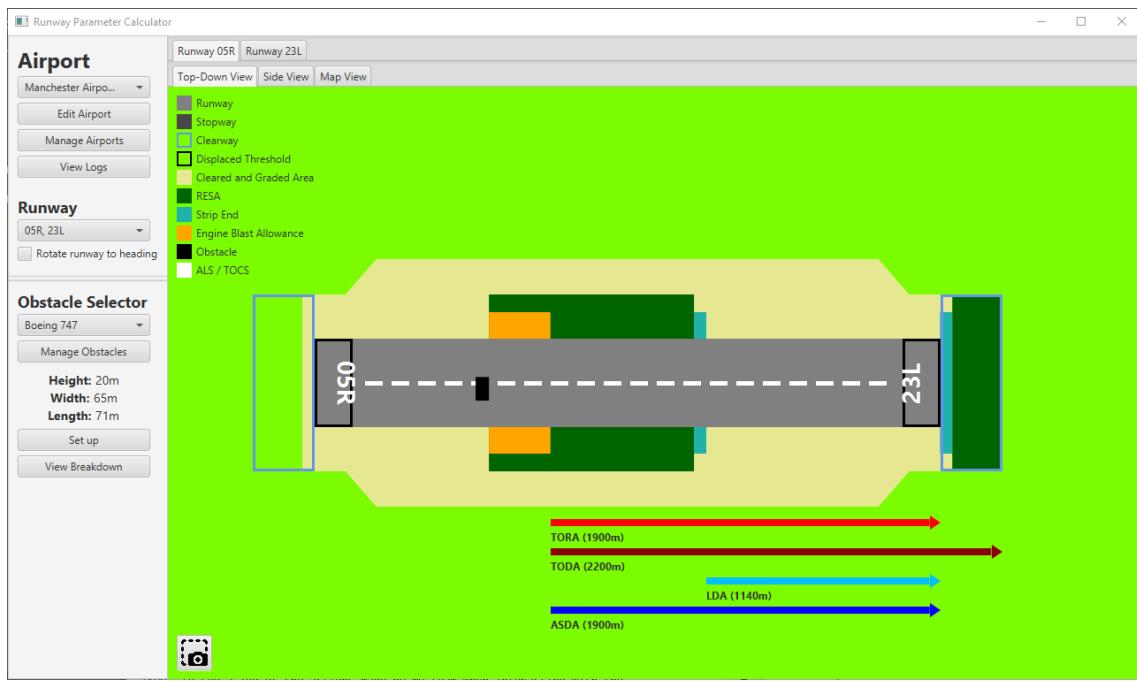


Figure 23: User Story 11 - Test Complete

3.3.15 User Story 12: Cleared and graded area (Increment 2)

As a Runway Manager, I would like to be able to see the cleared and graded area of each runway on the software, as it is helpful to have a birds-eye diagram of the region that myself and my team are responsible for keeping clear of obstacles.

Action	Result
The user opens the runway re-declaration program on their computer.	Pass
An empty runway view loads.	Pass
The user selects an airport to view.	Pass
The user selects a runway to view.	Pass
The cleared and graded area around the runway is correctly calculated and displayed.	Pass

Acceptance Criteria	Result
Program must contain a representation of the cleared and graded area in the top-down view.	Pass

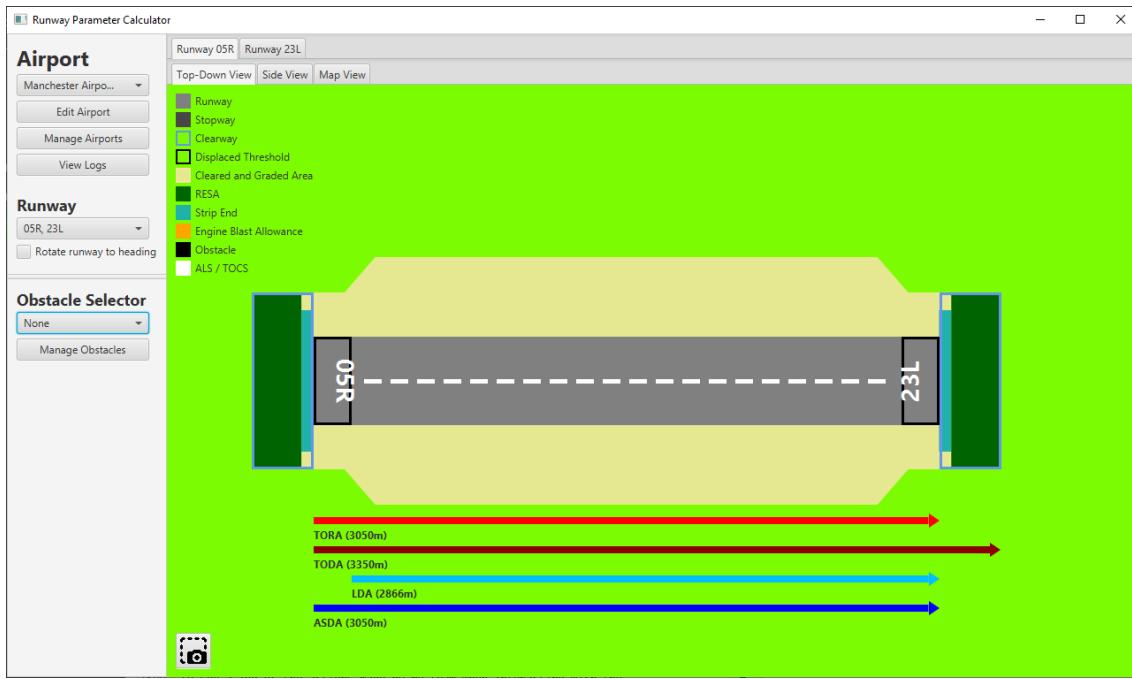


Figure 24: User Story 12 - Test Complete

3.3.16 User Story 13: Viewing calculation breakdowns (Increment 2)

As a Runway Analyst I would like to be able to see a breakdown of calculations so that I can compare them with my paper results, in order to see where I may have gone wrong and where the software has potentially gone wrong.

Action	Result
The user opens the runway re-declaration program on their computer.	Pass
An empty runway view loads.	Pass
The user selects an airport to view.	Pass
The user selects a runway to view.	Pass
The user selects an obstacle from the obstacle dropdown.	Pass
The user clicks the 'Set Up' button.	Pass
The user selects one of the obstacles from the list.	Pass
The user inputs the obstacle's position relative to the runway length and runway centreline.	Pass
The user clicks the 'Activate' button.	Pass
The user clicks the 'View Breakdown' button.	Pass
A Calculation Breakdown window appears where the user can view the calculation steps for each value recalculated.	Pass

Acceptance Criteria	Result
Program must be able to display the calculations performed to obtain the redeclared distances.	Pass

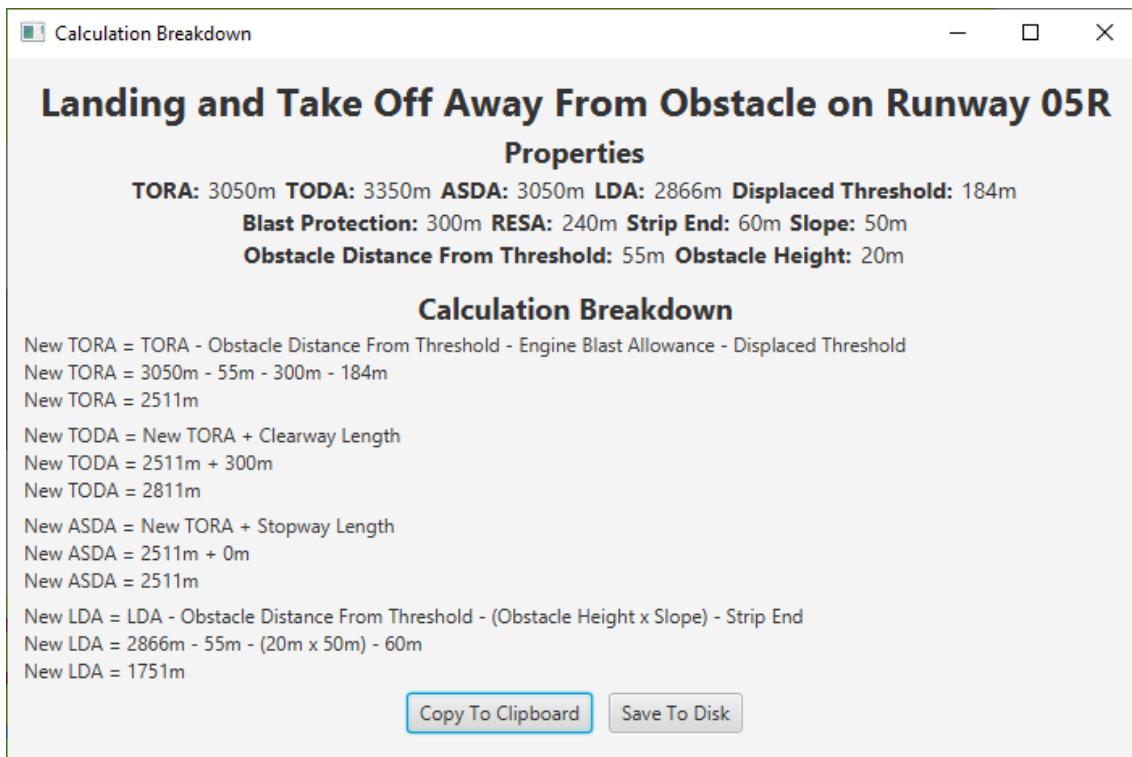


Figure 25: User Story 13 - Test Complete

3.3.17 User Story 14: Viewing activity log (Increment 3)

As a Runway Analyst I would like to be able to store all past calculations so that I can review when the software has made accurate predictions and when it may have made mistakes.

Action	Result
The user opens the runway re-declaration program on their computer.	Pass
An empty runway view loads.	Pass
Some activity takes places that can be logged.	Pass
The user clicks 'View Log'.	Pass
The user selects the recalculations tab.	Pass
The user filters the log by the airport they are concerned with.	Pass
The user clicks on log entries to view the details of the runway at that time.	Pass
Acceptance Criteria	Result
Program should have a log of all redeclarations performed.	Pass

Audit Logs									
Airports	Runways	Obstacles	Recalculations						
Obstacle Logs									
Filter By Airport <input type="text" value="SEA"/>									
Timestamp	User	Operation	Airport	Runway	Obstacle				
Wed May 03 12:47:34 BST 20...	romy9	Add	Sealand International Airport (...)	19	Boeing 747				
Wed May 03 12:47:44 BST 20...	romy9	Add	Sealand International Airport (...)	19	Boeing 747				
Wed May 03 12:55:01 BST 20...	romy9	Add	Sealand International Airport (...)	19	Car				
Wed May 03 12:54:45 BST 20...	romy9	Remove	Sealand International Airport (...)	19	Boeing 747				

Figure 26: User Story 14 - Test Complete

3.3.18 User Story 15: Predefined obstacles (Increment 1)

As a Runway Analyst I would like for the tool to come with a built-in list of possible obstacles that can be added, so that I can simulate hypothetical scenarios that could threaten the runway's function.

Action	Result
The user opens the runway re-declaration program on their computer.	Pass
An empty runway view loads.	Pass
The user selects an airport to view.	Pass
The user selects a runway to view.	Pass
The user opens the obstacle dropdown.	Pass
There are predefined obstacles in the program for the user to use that they have not defined themselves.	Pass

Acceptance Criteria	Result
Program must come with a list of predefined obstacles to place on the runway view.	Pass

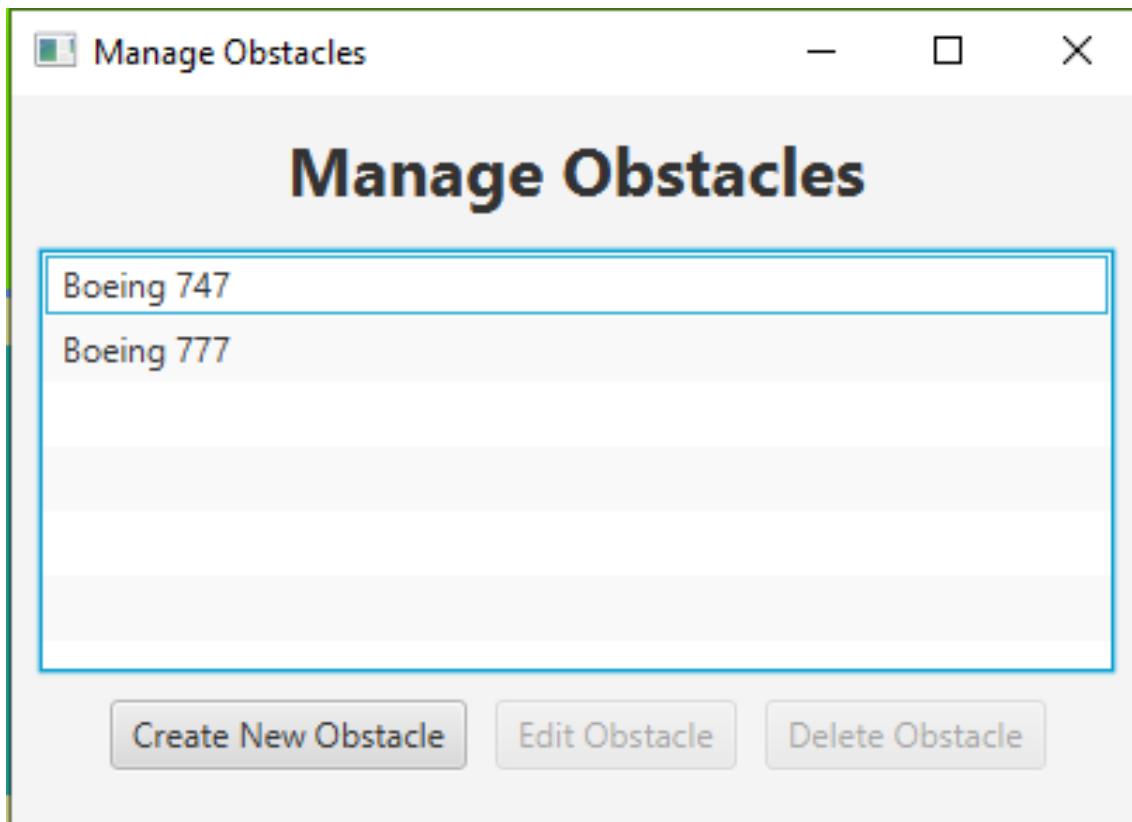


Figure 27: User Story 15 - Test Complete

3.3.19 User Story 16: Applicable to all commercial UK airports (Increment 3)

As a Runway Analyst I would like for this tool to be applicable to all UK commercial airports so that I can receive guidance for any airport I must do calculations for.

Action	Result
The user opens the runway re-declaration program on their computer.	Pass
The user opens the airport selector dropdown.	Pass
All large commercial UK airports are present.	Pass
The user selects an airport of their choice.	Pass
The user opens the runway dropdown.	Pass
All runways at the airport are present in the dropdown.	Pass
The user selects any runway of their choice.	Pass
The runway loads in the program, with the same parameters (e.g. TORA) it has in real life.	Mixed
Acceptance Criteria	Result
Program must be capable of adding a runway of any configuration valid under UK law.	Pass

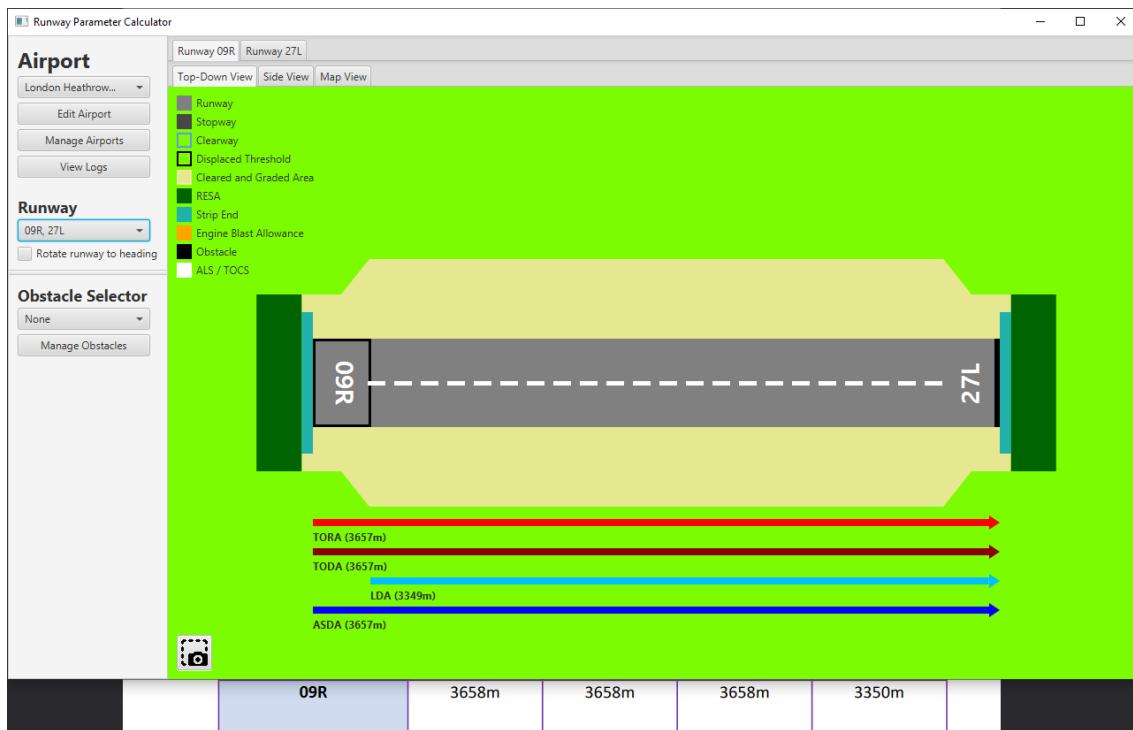


Figure 28: User Story 16 - Test Complete

3.3.20 User Story 17: Setting / Entering a password (Increment 3)

As a Chief ATC I would like the XML file to be password protected so that runway parameters cannot be updated by malicious attackers.

Action	Result
The user opens the runway re-declaration program on their computer.	Pass
A dialog box appears prompting the user to set or enter a password.	Pass
The user inputs a password of at least 8 characters.	Pass
The user clicks the submit button.	Pass
The empty runway view loads.	Pass
Acceptance Criteria	Result
Program's save data is protected from editing by a password lock.	Pass

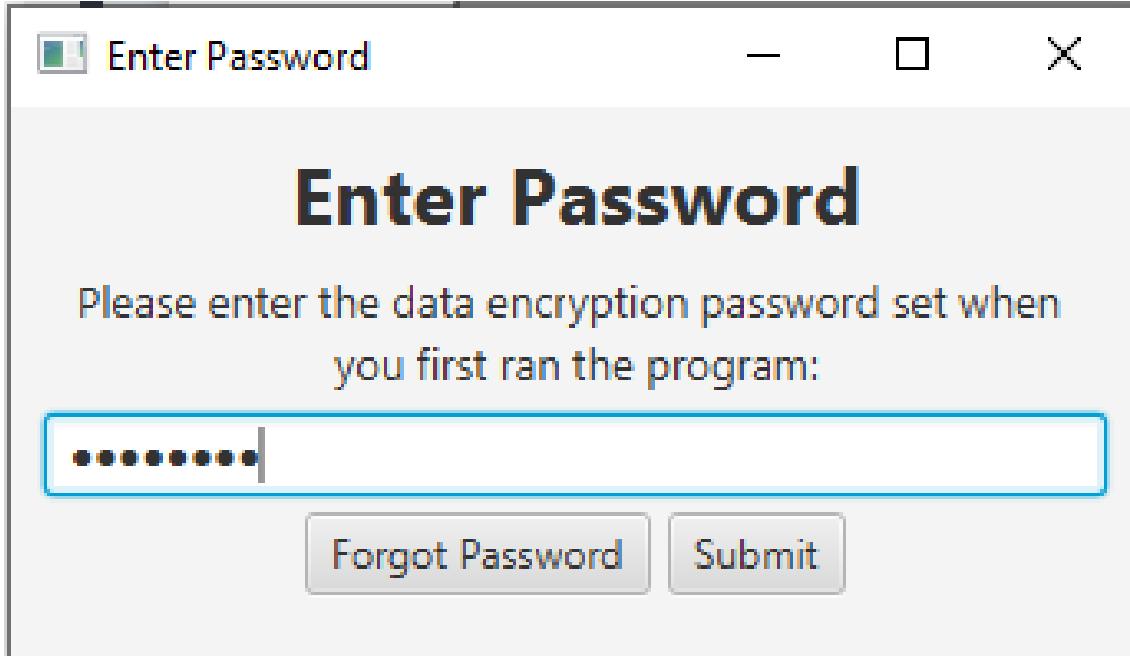


Figure 29: User Story 17 - Test Complete

3.3.21 User Story 19: Log of actions (Increment 3)

As a Chief ATC responsible for several subordinates, I would like to be able to see a log of the actions made by my team when interacting with the system, so that I know what state the system is in when I look at it.

Action	Result
The user opens the runway re-declaration program on their computer.	Pass
The user performs some actions in the program, such as editing a runway or adding an obstacle to the runway.	Pass
The user clicks on the "View Logs" button.	Pass
The user is shown a list of all modification actions in the program, along with the timestamp of the event and the user who performed it.	Pass

Acceptance Criteria	Result
Program contains a log of all actions made: changes to the runways, changes to the airport list, addition of obstacles.	Pass

Audit Logs				
Airports Runways Obstacles Recalculations				
Timestamp	User	Operation	Airport	Runway
Wed May 03 12:45:27 BST 2023	romy9	Create	Sealand International Airport (SEA)	19
Wed May 03 12:41:48 BST 2023	romy9	Edit	Birmingham International Airport (BHX)	15, 33

Edited Fields		
Property	Old Value	New Value
Main Runway Clearway	0	300
Main Runway Stopway	0	200

Figure 30: User Story 19 - Test Complete

3.3.22 User Story 20: Lowest runway threshold oriented to the left (Increment 2)

As a Chief ATC, it would be useful for the lowest runway thresholds to be oriented on the left so that my team can identify runways unambiguously.

Action	Result
The user opens the runway re-declaration program on their computer.	Pass
The user selects an airport.	Pass
The user selects a dual direction runway.	Pass
By default, the runway with the lowest threshold (e.g. 09 27) is on the left of the runway, with takeoff going to the right.	Pass
Acceptance Criteria	Result
The top-down runway view must have the threshold indicator on the left, with the direction of the runway horizontal.	Pass

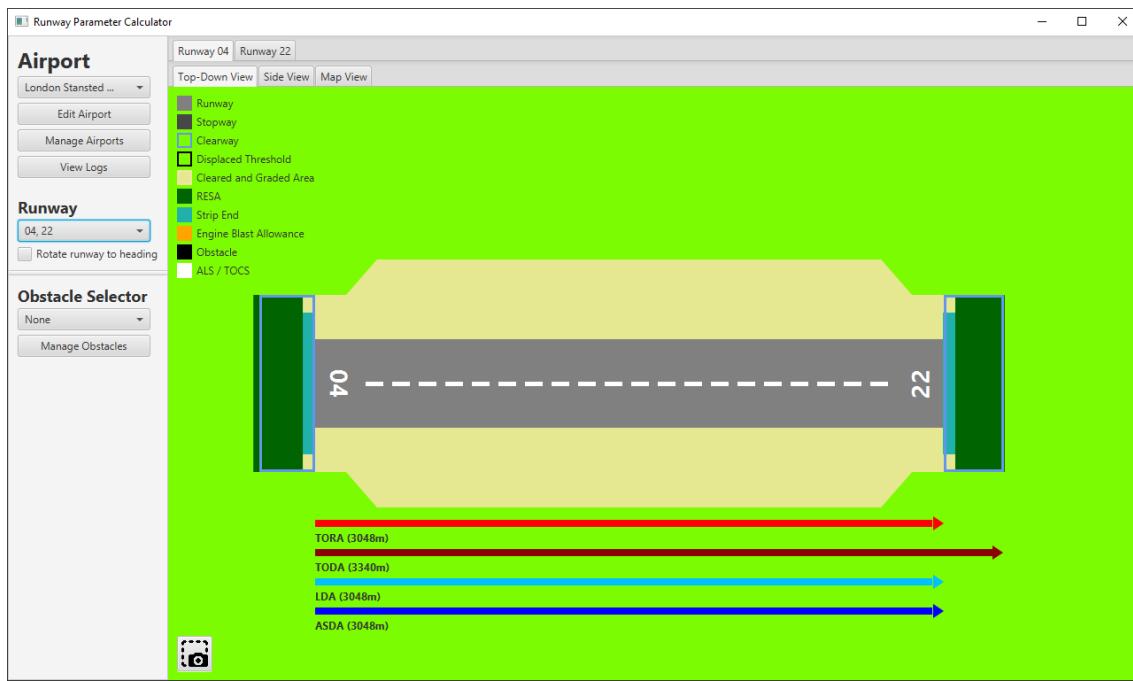


Figure 31: User Story 20 - Test Complete

3.3.23 User Story 22: Reliability (Increment 2)

As an Airline Representative, I want the system to be as reliable as possible to minimise delays and cancellations and thus reduce complaints and improve customer experience.

Action	Result
The user opens the runway re-declaration program on their computer.	Pass
The user selects an airport.	Pass
The user selects a runway.	Pass
The user applies an obstacle to the runway.	Pass
The user switches between the different views.	Pass
The user repeats these actions a number of times with different airports, runways and obstacles.	Pass
The application continues to produce correct functionality.	Pass

Acceptance Criteria	Result
Calculate 5 redeclarations manually, then carry out the same redeclarations on the system to check that the values are identical.	Pass

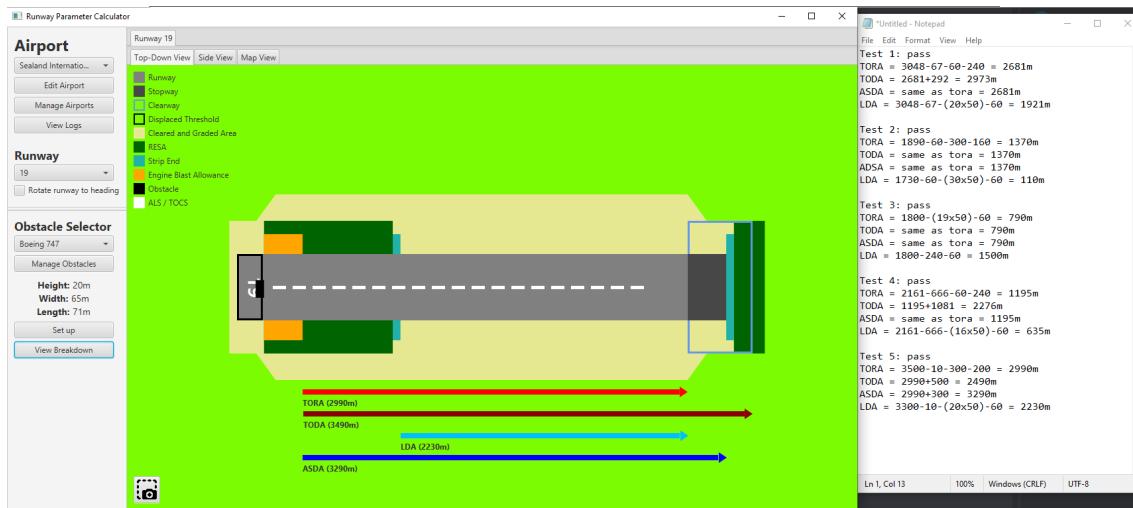


Figure 32: User Story 22 - Test Complete

3.3.24 User Story 23 & 24: Accident investigation logs (Increment 3)

- As an Accident Investigation Officer, I want to retrieve the data from the system to conduct an investigation, determine the cause of the accident, and identify who is responsible.
- As an Insurance Company Representative, I want the data exported from the system to be clear about what was involved in the incident so that an accurate sum for the insurance payout can be calculated.

Action	Result
The user moves an encrypted log file from another instance of the application into the logs folder of the application on their computer.	Pass
The user opens the runway re-declaration program on their computer.	Pass
The user clicks the "View Logs" button.	Pass
The user is prompted for the location of the log file, and selects it.	Pass
The user is prompted for the password used to encrypted the log file.	Pass
All actions in the log are displayed to the user with all details available.	Pass

Acceptance Criteria	Result
User must be able to extract a concise log of everything that has happened on the system.	Pass
Log should detail which obstacle is deployed, when one is on the runway.	Pass

Audit Logs

Obstacles Logs

Filter By Airport LHR

Timestamp	User	Operation	Airport	Runway	Obstacle
Wed May 03 12:47:44 BST 20...	romy9	Add	Sealand International Airport (...)	19	Boeing 747
Wed May 03 12:54:45 BST 20...	romy9	Remove	Sealand International Airport (...)	19	Boeing 747
Wed May 03 12:55:01 BST 20...	romy9	Add	Sealand International Airport (...)	19	Car
Wed May 03 12:55:26 BST 20...	romy9	Add	Birmingham International Airp...	15	Boeing 777
Wed May 03 12:55:45 BST 20...	romy9	Add	Manchester Airport (MAN)	05R	Car

Obstacle

Type: Car Original Values Recalculated Values

Length: 6m TORA: 3050m TORA: 2522m

Width: 3m TODA: 3350m TODA: 2822m

Height: 2m ASDA: 3050m ASDA: 2522m

LDA: 2866m LDA: 2522m

Distance From Threshold: 44m **Displaced Threshold:** 184m **Displaced Threshold:** 184m

Distance From Centre: 3m

Figure 33: User Story 23 & 24 - Test Complete

4 Planning

4.1 Product Backlog

Req ID	Name	MoSCoW	User Stories	Increment
1	Applicable to all UK airports	Must	16	Increment 3
2	Have both a side-on and top-down perspective	Must	4	Increment 2
3	Recalculate runway parameters	Must	1, 11	Increment 2
4	Pre-defined obstacle list	Must	15	Increment 1
5	View re-calculated values and the originals	Must	9	Increment 2
6	View calculation breakdown	Must	13	Increment 3
7	Import and export details using XML	Should	23, 24	Increment 3
8	Display relevant values in both views	Must	7, 10	Increment 3
9	Orient lowest threshold to the left	Must	20	Increment 1
10	Rotate the runway in the top-down view	Must	3	Increment 2
11	Display cleared and graded areas	Must	12	Increment 1
12	Represent TOCS and ALS in side-on view	Must	8	Increment 3
13	Switch between runways	Must	2	Increment 1
14	Display notifications to the user indicating any actions	Should	19	Increment 3
15	Store past calculations	Should	14	Increment 2
16	No errors in calculation	Must	22	Increment 2
17	Export simulations as images	Could	6	Increment 3
18	Exported XML password protected	Could	17	Increment 3
19	API support for assistive technologies	Could	18	Increment 3
20	Overlay real-world images on diagrams	Could	5	Increment 3
21	3D representation of the runway	Won't	21	

4.2 Increment Plan

Increment 1	Increment 2	Increment 3	No Increment
Switch between runways	Rotate the runway in the top-down view	Applicable to all UK airports	3D representation of the runway
Display cleared and graded areas	Have both a side-on and top-down perspective	Record log of actions made by users	
Predefined obstacle list	Store past calculations	Export data log	
Orient lowest threshold to the left	No errors in calculation	Overlay real-world images on diagrams	
	Recalculate runway parameters	Export simulations as images	
		Exported XML password protected	
		API support for assistive technologies	
		Represent TOCS and ALS in side-on view (Reprioritised)	
		Display relevant values in both views (Reprioritised)	
		View calculation breakdown (Reprioritised)	

4.3 Sprint 3 Sprint Plan (Concluded)

To-do	In Progress	Completed
Enable TTS software to read actions and logs out loud (Victor, est. 2 hours)		Get the runway dimensions and special areas of every UK commercial airport (Alex, est. 4 hours)
		Design XML structure and write template that can easily generate and interpret the files (Ryan, est. 2 hours)
		Add a button in the UI that can render the simulation and export it as a PNG or JPG (Ryan, est. 1 hour)
		Use GPG (or similar) to encrypt and decrypt XML files (Ryan, est. 2 hours)
		In the exporting scene, add a button that allows the user to password protect their exports (Ryan, est. 2 hours)
		Add a button in the UI to import the XML file (Ryan, est. 3 hours)
		Represent TOCS and ALS in side-on view (Ryan, est. 1 hour)
		Format calculation breakdown in a readable menu (Roman, est. 1 hour)
		Add a JavaFX alert after successfully completing an action (Roman, est. 2 hours)
		Prompt a JavaFX warning if there is something the user should be aware of (Victor, est. 3 hours)
		Find a way to embed Google Maps satellite view (or similar) in a JavaFX application (Alex, est. 4 hours)
		Display relevant values in both views (Rishabh, reprioritised from sprint 2, est. 2 hours)
		Add a JavaFX error alert after any illegal case (Roman, est. 2 hours)
		Check that the runway descriptions are consistent with the respective real-world runways (Alex, est. 3 hours)
		Display both logical runways in the same view (Ryan, reprioritised from sprint 2, est. 4 hours).
		Display the diagram on top of the map with limited opacity and orient it North, so it's aligned with the map. (Victor, est. 4 hours)

4.4 Sprint 3 Burndown Chart

Please refer to [34](#).

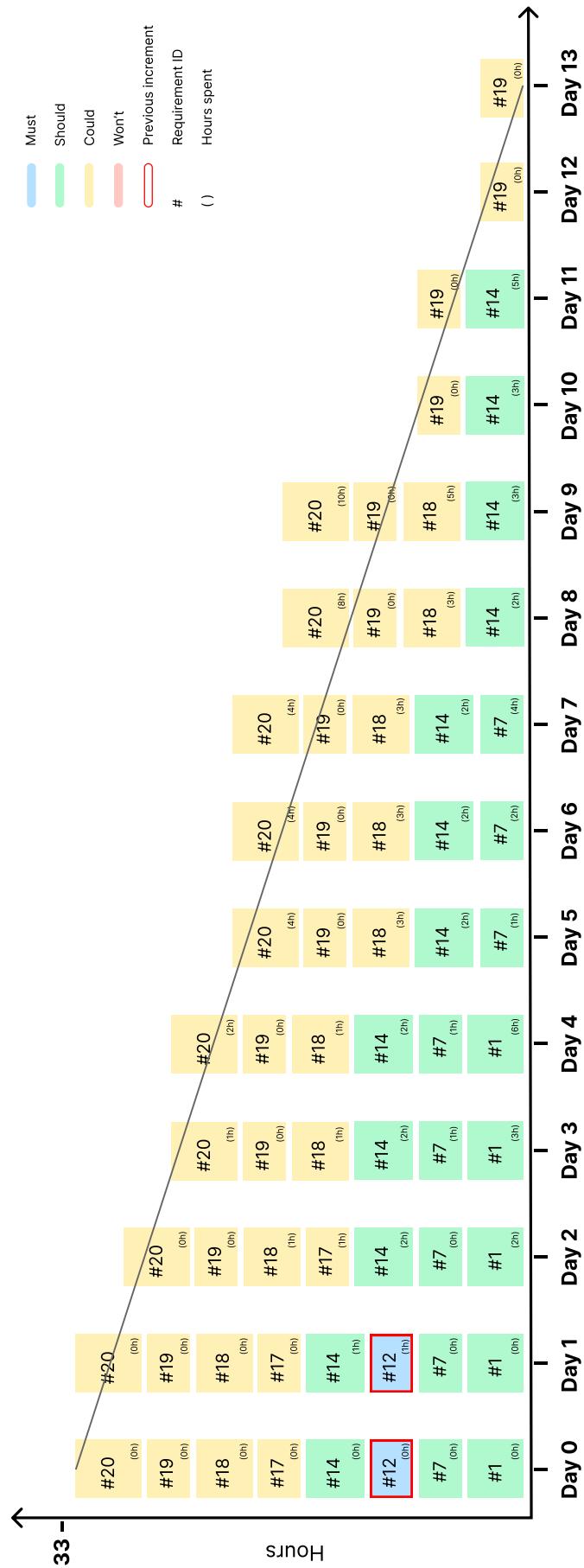


Figure 34: Burndown chart for Increment 3 indicating the number of hours worked on each requirement at any day (created using Figma)

4.5 Time Spent (Increment 3)

User Story Number (ReqID)	User Story	Estimated Time (33 hours)	Actual Time (32 hours)
16 (1)	As a Runway Analyst I would like for this tool to be applicable to all UK commercial airports so that I can receive guidance for any airport I must do calculations for.	7 hours	6 hours
23 (7)	As an Accident Investigation Officer, I want to retrieve the data from the system to conduct an investigation, determine the cause of the accident, and identify who is responsible.	3 hours	4 hours
19 (14)	As a Chief ATC responsible for several subordinates, I would like to be able to see a log of the actions made by my team when interacting with the system, so that I know what state the system is in when I look at it.	7 hours	5 hours
6 (17)	As an Air Traffic Controller, I want to be able to export simulations as images so that I can refer to them later without having to re-enter the parameters.	1 hour	1 hour
17 (18)	As a Chief ATC I would like the XML file to be password protected so that runway parameters cannot be updated by malicious attackers.	4 hours	5 hours
18 (19)	As a Chief ATC I would like the system to have API support for the use of assistive technologies so that the disabled members of my team can use the system.	2 hours	Not Completed
5 (20)	As an Air Traffic Controller, I want real-world images of the runway to be overlaid on the diagrams so that I can better visualise the landings.	8 hours	10 hours
8 (12)	As a Pilot, I need to be accurately informed of a representation of the TOCS (Take-Off Climb Surface) or ALS (Approach / Landing Surface) in the case of an obstructed runway so that I know exactly how to use an obstructed runway.	1 hour	1 hour

5 Footnotes

Requirement 19 was left undone due to not finding an appropriate accessibility library for JavaFX that could be feasible to implement in our application within the time frame estimated. As stated before, requirement 20 was reconsidered and we decided to implement a map instead, since it provides the ATCs more information and it could be automatically set up for any airport unlike a static satellite image and their diagram overlays.

Sometimes, when running on Unix (Mac OS / Linux) systems, the JVM crashes (not the application, **the actual JVM**, which only ever happens as a result of a bug in Java / JavaFX itself). This is caused by bugs in JavaFX when using a cross-platform JAR. When the application is compiled on Linux directly, this issue does not occur. The modern standard for distributing Java programs is to use [jlink](#) or [jpackage](#) to create a **binary executable file** (e.g. .exe) for **each individual operation system**. However, the coursework specification states that we must hand in a single JAR file instead. Creating a cross-platform JAR file is not supported nowadays and is in fact very difficult to get working at all. Nonetheless, we have produced a cross-platform JAR file which works perfectly on Windows (as it was compiled natively), but sometimes faces JVM crashes on Mac and Linux. Once again, this is due to the combination of being unable to use the modern standard of Java packaging due to the hand-in requiring a JAR file, and JavaFX bugs - there is no work around we could have used based on these requirements. If required, we are happy to provide natively compiled JARs for each operating system, or the program can be run using `mvn javafx:run`.

Running a JDK that ships with OpenJFX built-in *may* help in these situations - examples include [Azul Zulu JDK FX](#) and [Liberica JDK \(Full JDK package\)](#).