SE 3XA3: Test Plan
Random Flag Generator

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Table 1: **Revision History**

Date	Version	Notes
March 3, 2022	1.0	Initial Document
March 3, 2022	1.1	Added initial draft of Tests for Proof of Concept section
March 8/9, 2022	1.2	Made edits to draft of Tests for Proof of Concept section; Added initial draft of System Test Description section
March 10, 2022	1.3	Made edits, added to draft of Tests for Proof of Concept section; Added to draft of System Test Description section
March 11, 2022	1.4	Added Comparison to Existing Implementation, Unit Testing Plan and Appendix sections content; made edits
April 11/12, 2022	2.0	Updated Test Plan documentation for Revision 1 submission

This document describes the plan for the software testing of the **Random Flag Generator** program.

1 General Information

1.1 Purpose

The purpose of this test plan is to describe the testing and validation process of The Random Flag Generator (**RFG**) in detail. This test plan will properly assess the **functional** and **non-functional requirements** of the software as well as its performance and usability. The **test cases** will address each individual unit of source code and can be referred to or updated with future implementations. The test plan aims to minimize the probability of errors occuring when being run by the **user**.

1.2 Scope

The test plan considers and tests all **functional** and **non-functional requirements** through different testing procedures. Proof of concept tests are also demonstrated. In addition, the Random Flag Generator program is compared to the existing **PAGAN** implementation, and is discussed to compare its functionality and improve the design. The unit testing plan for internal functions and output files is also outlined. Finally, the usability survey questions will evaluate user experience(s). The test plan will be conducted accordingly, and the document will be revised as the project's development progresses.

1.3 Acronyms, Abbreviations, and Symbols

Table 2: **Table of Abbreviations**

Abbreviation	**Definition**
FR	Functional Requirement
GUI	Graphical User Interface
LF	Look and Feel test
NFR	**Non-Functional Requirement**
PAGAN	**Python Avatar Generator for Absolute Nerds**
PE	Performance test
RFG	**Random Flag Generator**
RGB	Red Green Blue
SRS	Software Requirements Specification
UH	Usability and Humanity test
UI	User Interface

Table 3: **Table of Definitions**

Term	**Definition**
Gallery	Collection of previously generated flags.
Graphical User Interface	A form of UI that allows users to use electronic devices using interactive graphics.
Hashing	Algorithm that converts input data to a fixed-size value. A hashing function usually outputs a string or hexadecimal value.
Input String	The input of type string from the user.
Pytest	Python testing tool that allows testers to write test code and create simple and scalable test cases.
Python	The programming language used in this project.
Software Requirements Specification	A document that details what the program/software will do and how it will accomplish the expected performance/tasks.
System/Program	Collection of instructions or components that tell a computer how to operate.
Tester	An individual testing the software via the user interface or the code/test cases.
Test Case	a specification of inputs, execution conditions, procedure and expected results for testing a program's behaviour.
Typeform	Website that is a software as a service that specializes in creating and building online surveys.
User	Person who uses or operates a computer program.
User Interface	Where interactions between machines and humans occur.

1.4 Overview of Document

The test plan describes how the team is going to test the software and what automated testing tools will be used. All **functional** and most **non-functional requirements** included in the **SRS** will be tested. Proof of concept tests, as well as comparisons to the existing **PAGAN** implementation, unit testing, and usability survey questions are also described.

2 Plan

2.1 Software Description

The Random Flag Generator (**RFG**) is a user-friendly software that allows users to uniquely create a personalized randomly generated flag based on the entered input string. It is built using Python and is inspired by **PAGAN**, an open source project that randomly generates an avatar from an input string. The user will be able to select different hash functions and specify different features of the flag, such as changing the flag image resolution and including certain symbols, colours, and stripes. It will also have a flag **gallery** that lets users look through previously created flags.

2.2 Test Team

All members of Group ~~group~~ 2 are responsible for creating, executing, and documenting tests described in this document, as well as any new tests that are created later. The testing team is comprised of:

- Akram Hannoufa
- Ganghoon (James) Park
- Nathaniel Hu

Upon completing the final stage of development, TAs, students, and other volunteers would be asked to provide feedback through the usability survey questions.

2.3 Automated Testing Approach

To review and validate the software product, automated testing for each output will be conducted. It will be performed automatically by running the **test case** set. The hash functions along with the flag generator functions will be tested automatically to ensure that the input string gives the expected output string and that the result is repeatable.

2.4 Testing Tools

The main software testing framework that will be used is **Pytest**, which will allow testers to write **test cases** in **Python** and report the test results. It is a simple, efficient and effective way to handle increasingly complex testing requirements by creating simple unit tests. **Typeform** will be used to obtain feedback from different students, TAs, and other volunteers.

2.5 Testing Schedule

Please refer to the project Gantt chart: ../ProjectSchedule/3XA3Ganttchart.pdf

3 System Test Description

3.1 Tests for Functional Requirements

3.1.1 User Interface Testing

User Interface Test

1. FR-01

   Type: Functional, Dynamic, Manual

   Initial State: UI is uninitialized

   Input: command to initialize and run the UI

   Output: UI is initialized

   How test will be performed: a command will be entered at the command line (by the tester ~~user~~). The Random Flag Generator main menu UI should open and allow the tester ~~user~~ to enter text into the

input string field. The main menu should also present buttons for the instructions, flag gallery and settings menus.

2. FR-02

   Type: Functional, Dynamic, Manual

   Initial State: UI is initialized and running

   Input: mouse clicks on the instructions, flag gallery or settings menu buttons, or the appropriate keyboard strokes assigned to open each menu

   Output: the instructions, flag gallery or settings menu will be pulled up and can be viewed in its entirety

   How test will be performed: The tester ~~user~~ will have the Random Flag Generator main menu UI already running, and then either click on the buttons or press the appropriate keyboard strokes to pull up each menu.

3. FR-03

   Type: Functional, Dynamic, Manual

   Initial State: UI is initialized and running

   Input: keyboard strokes to (re)enter text into the input string field

   Output: text appears in the input string field

   How test will be performed: The tester ~~user~~ will have the Random Flag Generator main menu UI already running, and then (re)enter text into the input string field.

4. FR-04-08

   Type: Functional, Dynamic, Manual

   Initial State: UI is initialized and running

   Input: (text in input string field and) mouse click on generate flag button

Output: flag will be generated using the input string and saved on the local machine (in generated_flags directory)

How test will be performed: The tester ~~user~~ will have the Random Flag Generator main menu UI already running, and then click the generate flag button to start flag generation.

5. FR-05-09

   Type: Functional, Dynamic, Manual

   Initial State: UI is initialized and running, a flag has already finished generating

   Input: (text in the input string field and) mouse click on the display flag button.

   Output: generated flag with be displayed to the tester ~~user~~ through the UI

   How test will be performed: The tester ~~user~~ will have the The Flag Generator main menu UI already running and already have a flag generated, and then click the display flag button to display the flag in the UI.

6. FR-06-10

   Type: Functional, Dynamic, Manual

   Initial State: UI is initialized and running, a flag has already finished generating

   Input: (text in the input string field,) saved changes to the settings and mouse click on the display flag button

   Output: flag will be regenerated using the input string and changed settings, and saved on the local machine (in generated_flags directory)

   How test will be performed: The tester ~~user~~ will have the Random Flag Generator main menu UI already running and already have a flag generated (and displayed). The tester ~~user~~ then makes and saves some changes to the settings, and reruns the flag generation with the new settings in effect.

7. FR-07-11

   Type: Functional, Dynamic, Manual

   Initial State: UI is initialized and running

   Input: (text in the input string field and) mouse click on the generate flag button.

   Output: flag will be generated using the input string and saved on the local machine (in generated_flags directory) using the input string as its (default) name

   How test will be performed: The tester ~~user~~ will have the Random Flag Generator main menu UI already running, and then click the generate flag button to start flag generation. The tester ~~user~~ will then open up the flag gallery menu, and the new generated flag should be displayed there.

8. FR-12-13

   Type: Functional, Dynamic, Manual

   Initial State: UI is initialized and running

   Input: mouse click on the instructions button, or the appropriate keyboard stroke assigned to open the instructions menu

   Output: the instructions menu will be pulled up and can be viewed in its entirety, and a button will be displayed that the tester ~~user~~ can click on to close the instructions menu and return to the main menu

   How test will be performed: The tester ~~user~~ will have the Random Flag Generator main menu UI already running, and then either click on the instructions button or press the appropriate keyboard stroke to pull up the instructions menu. After viewing the instructions menu, the tester ~~user~~ will then click on the return to main menu button to close the instructions window and return to the main menu.

9. FR-14

   Type: Functional, Dynamic, Manual

Initial State: UI is initialized and running

Input: mouse click on the settings button, or the appropriate keyboard stroke assigned to open the settings menu, and clicks/dragging to change settings

Output: the settings menu will be pulled up where settings can be changed

How test will be performed: The tester ~~user~~ will have the Random Flag Generator main menu UI already running, and then either click on the settings button or press the appropriate keyboard stroke to pull up the settings menu and change settings.

10. FR-15

    Type: Functional, Dynamic, Manual

    Initial State: UI is initialized and running

    Input: mouse click on the settings button, or the appropriate keyboard stroke assigned to open the settings menu

    Output: the settings menu will be pulled up where the flag generator version will be displayed

    How test will be performed: The tester ~~user~~ will have the Random Flag Generator main menu UI already running, and then either click on the settings button or press the appropriate keyboard stroke to pull up the settings menu to confirm that the flag generator version number is displayed properly.

11. FR-16

    Type: Functional, Dynamic, Manual

    Initial State: UI is initialized and running

    Input: mouse click on the settings button, or the appropriate keyboard stroke assigned to open the settings menu

    Output: the settings menu will be pulled up where a return to main menu button will be displayed that the tester ~~user~~ can click on to close the settings menu and return to the main menu

How test will be performed: The tester ~~user~~ will have the Random Flag Generator main menu UI already running, and then either click on the settings button or press the appropriate keyboard stroke to pull up the settings menu. After viewing the settings menu, the tester ~~user~~ will then click on the return to main menu button to close the instructions window and return to the main menu.

12. FR-17

    Type: Functional, Dynamic, Manual

    Initial State: UI is initialized and running

    Input: mouse click on the flag gallery button, or the appropriate keyboard stroke assigned to open the flag gallery menu

    Output: the flag gallery menu will be pulled up where a list of all flags and the input strings used to generate them will be displayed

    How test will be performed: The tester ~~user~~ will have the Random Flag Generator main menu UI already running, and then either click on the flag gallery button or press the appropriate keyboard stroke to pull up the flag gallery menu for viewing.

13. ~~FR-18~~

    ~~Type: Functional, Dynamic, Manual~~

    ~~Initial State: UI is initialized and running~~

    ~~Input: mouse click on the flag gallery button, or the appropriate keyboard stroke assigned to open the flag gallery menu~~

    ~~Output: the flag gallery menu will be pulled up where an input string field will allow the user to search for flags by input string~~

    ~~How test will be performed: The user will have the Random Flag Generator main menu UI already running, and then either click on the flag gallery button or press the appropriate keyboard stroke to pull up the flag gallery menu. The user will then input text in the input string field to search for flags by input string.~~

14. FR-19

Type: Functional, Dynamic, Manual

Initial State: UI is initialized and running

Input: mouse click on the flag gallery button, or the appropriate keyboard stroke assigned to open the flag gallery menu

Output: the flag gallery menu will be pulled up where a button will be displayed that the tester ~~user~~ can click on to close the flag gallery menu and return to the main menu

How test will be performed: The tester ~~user~~ will have the Random Flag Generator main menu UI already running, and then either click on the flag gallery button or press the appropriate keyboard stroke to pull up the flag gallery menu. After viewing the flag gallery menu, the tester ~~user~~ will then click on the return to main menu button to close the flag gallery window and return to the main menu.

3.1.2 Output Testing

Output Test

1. test_get_hash_algo

   Type: Functional, Dynamic, Automated

   Initial State:

   Input: input string of hashing algorithm name

   Output: hashlib hashing algorithm

   How test will be performed: automatically by running the test program containing the test set

2. test_get_hash_hex

   Type: Functional, Dynamic, Automated

   Initial State:

   Input: input string to be used to generate flag, hashlib hashing algorithm

   Output: hash digest of input string in hexadecimal form

How test will be performed: automatically by running the test program containing the test set

3. test_hash_generator

   Type: Functional, Dynamic, Automated

   Initial State:

   Input: input string to be used to generate flag

   Output: hash digest of input string in hexadecimal form

   How test will be performed: automatically by running the test program containing the test set

4. test_pad_hashcode

   Type: Functional, Dynamic, Automated

   Initial State:

   Input: output hash string to be used to generate flag

   Output: output hash string padded to minimum hash length

   How test will be performed: automatically by running the test program containing the test set

5. test_choose_from_list

   Type: Functional, Dynamic, Automated

   Initial State:

   Input: list of elements, float value to determine an index to be used to select an element from the list

   Output: element from the list with index larger than and closest to input float value

   How test will be performed: automatically by running the test program containing the test set

6. test_map_decision

   Type: Functional, Dynamic, Automated

   Initial State:

   Input: three numerical values representing the maximum possible option, the number of possible decisions and the digit to map within the possible options

   Output: float index value to be used to decide which element to select (presumably from a list)

   How test will be performed: automatically by running the test program containing the test set

7. test_split_sequence

   Type: Functional, Dynamic, Automated

   Initial State:

   Input: input string, integer value specifying the length of the substrings to be split from the input string

   Output: list of substrings from the input string with as many substrings of the specified length as possible

   How test will be performed: automatically by running the test program containing the test set

8. test_grind_hash_for_colors

   Type: Functional, Dynamic, Automated

   Initial State:

   Input: output hash string to be used to generate flag

   Output: list of five colors' RGB values (R, G, B)

   How test will be performed: automatically by running the test program containing the test set

9. test_grind_hash_for_base_stripe_style

   Type: Functional, Dynamic, Automated

   Initial State:

   Input: output hash string to be used to generate flag

   Output: output string of base stripe style to be used to generate flag

   How test will be performed: automatically by running the test program containing the test set

10. test_grind_hash_for_overlay_stripe_style

    Type: Functional, Dynamic, Automated

    Initial State:

    Input: output hash string to be used to generate flag

    Output: output string of overlay stripe style to be used to generate flag

    How test will be performed: automatically by running the test program containing the test set

11. test_grind_hash_for_stripe_number

    Type: Functional, Dynamic, Automated

    Initial State:

    Input: output hash string to be used to generate flag

    Output: output string of stripe number to be used to generate flag

    How test will be performed: automatically by running the test program containing the test set

12. test_grind_hash_for_symbol_locations

    Type: Functional, Dynamic, Automated

    Initial State:

    Input: output hash string to be used to generate flag

Output: output string of symbol location to be used to generate flag

How test will be performed: automatically by running the test program containing the test set

13. test_grind_hash_for_symbol_number

    Type: Functional, Dynamic, Automated

    Initial State:

    Input: output hash string to be used to generate flag

    Output: output string of symbol number to be used to generate flag

    How test will be performed: automatically by running the test program containing the test set

14. test_grind_hash_for_symbol_types

    Type: Functional, Dynamic, Automated

    Initial State:

    Input: output hash string to be used to generate flag

    Output: output string of symbol type to be used to generate flag

    How test will be performed: automatically by running the test program containing the test set

15. test_hex2rgb

    Type: Functional, Dynamic, Automated

    Initial State:

    Input: output hexidecimal color code string to be used to generate flag

    Output: output tuple of RGB values for color derived from heximdecimal color code string to be used to generate flag

    How test will be performed: automatically by running the test program containing the test set

16. test_diff

    Type: Functional, Dynamic, Automated

    Initial State:

    Input: two float values

    Output: absolute value of the difference between the two given float values

    How test will be performed: automatically by running the test program containing the test set

17. test_generate_flag

    Type: Functional, Dynamic, Automated ~~Manual~~

    Initial State:

    Input: input string, hashing algorithm name string and dictionary of settings (i.e. chosen colours, elements) to be used to generate flag

    Output: generated flag image file

    How test will be performed: automatically by running the test program containing the test set ~~manually by running the test program containing the test set, and then doing a manual visual comparison of the generated flag with its expected generated flag output~~

18. test_generate_flag_data

    Type: Functional, Dynamic, Automated

    Initial State:

    Input: input string, hashing algorithm name string to be used to generate flag

    Output: tuple consisting of list of 5 tuples of RGB values, tuple of stripe style, number and tuple of symbol location, number and type

    How test will be performed: automatically by running the test program containing the test set

19. test_parse_jka_file

    Type: Functional, Dynamic, Automated

    Initial State:

    Input: input string of flag asset (.jka) file name to be parsed for pixel data

    Output: list consisting of tuples of (x, y) coordinates of the position of all filled pixels that compose the selected flag asset

    How test will be performed: automatically by running the test program containing the test set

3.2 Tests for Nonfunctional Requirements

3.2.1 Look and Feel Testing

Appearance Test

1. LF-01

   Type: Manual, Dynamic

   Initial State: UI is initialized and running

   Input/Condition:

   Output/Result: verification of UI simplicity, intuitivity, and clutterlessness

   How test will be performed: The Random Flag Generator UI will be analyzed for how simple, intuitive and non-cluttered it is for users by several testers ~~users~~. The testers ~~users~~ will provide their answer to question 1 of the Usability Survey. Their responses will be assessed to determine if the UI is simple, intuitive and not cluttered.

Style Test

1. LF-02

   Type: Manual, Functional, Dynamic

Initial State: UI is initialized and running

Input/Condition: input string, hashing algorithm name string to generate a flag

Output/Result: flag generated using input string and hashing algorithm

How test will be performed: The testers ~~users~~ will enter input strings and hashing algorithm string names to generate flags. The testers ~~users~~ will then review the generated flags for image quality and aesthetics, and provide their answer to question 2 of the Usability Survey. Their responses will be assessed to gauge how aesthetically pleasing the generated flags look to the users.

2. LF-03

   Type: Manual, Functional, Dynamic

   Initial State: UI is initialized and running

   Input/Condition: input string, hashing algorithm name string to generate a flag

   Output/Result: flag generated using input string and hashing algorithm

   How test will be performed: The tester ~~user~~ will enter an input string and hashing algorithm string name to generate a flag. The ~~Then~~ tester ~~user~~ will then review the generated flag to ensure the colours used are within certain colour ranges.

3. LF-04

   Type: Manual, Functional, Dynamic

   Initial State: UI is initialized and running

   Input/Condition: input string, hashing algorithm name string to generate a flag

   Output/Result: flag generated using input string and hashing algorithm

How test will be performed: The tester ~~user~~ will enter an input string and hashing algorithm string name to generate a flag. The ~~Then~~ tester ~~user~~ will then review the generated flag to ensure all flag components are visible in the generated image.

3.2.2 Usability and Humanity Testing

Ease of Use Test

1. UH-01

   Type: Manual, Dynamic

   Initial State: UI is initialized and running

   Input/Condition:

   Output/Result: verification of the logical flow of the UI components

   How test will be performed: The Random Flag Generator UI will be analyzed for the logical flow of the UI components by several testers ~~users~~. The testers ~~users~~ will then provide their answer to question 3 of the Usability Survey. Their responses will be assessed to determine if the UI components flow follow a logical flow.

2. UH-02

   Type: Manual, Functional, Dynamic

   Initial State: UI is initialized and running

   Input/Condition:

   Output/Result: verification that all tasks can be done within one interface

   How test will be performed: Various tasks will be performed (e.g. reading the instructions, changing the settings) by testers to ensure all tasks can be done within one interface, and that no tasks need interactions with more than one interface to be completed.

3. UH-03

Type: Manual, Dynamic

Initial State: UI is initialized and running

Input/Condition:

Output/Result: verification that the Random Flag Generator is easy to use for people aged MIN_AGE ~~7~~ or older

How test will be performed: Various tasks will be performed (e.g. reading the instructions, changing the settings) by testers to ensure all tasks can be easily understood and completed by people aged MIN_AGE ~~7~~ or older.

4. ~~UH-04~~

   ~~Type: Manual, Dynamic~~

   ~~Initial State: UI is initialized and running~~

   ~~Input/Condition:~~

   ~~Output/Result: verification that all keyboard inputs to perform actions are intuitive for users~~

   ~~How test will be performed: Various tasks will be performed (e.g. reading the instructions, changing the settings) to ensure all tasks can be easily understood and completed using keyboard inputs that are intuitive and easy to remember and use.~~

Personalization Test

1. UH-05

   Type: Manual, Functional, Dynamic

   Initial State: UI is initialized and running

   Input/Condition:

   Output/Result: verification of the modifiability of output specifications for flag generation (e.g. type of hashing, image file, etc.)

   How test will be performed: The Random Flag Generator UI will be analyzed by several testers ~~users~~ to ensure the output specifications for flag generation can (easily) be modified. The testers ~~users~~ will

then provide their answer to question 5 of the Usability Survey. Their responses will be assessed to determine how much more or less ability the users should have to set certain parts of the generated flag.

2. ~~UH-06~~

   ~~Type: Manual, Functional, Dynamic~~

   ~~Initial State: UI is initialized and running~~

   ~~Input/Condition:~~

   ~~Output/Result: verification of the modifiability of the flag gallery~~

   ~~How test will be performed: The Random Flag Generator UI will be analyzed by several users to ensure the flag gallery can (easily) be modified (i.e. add, delete flags). The users will then provide their answer to question 6 of the Usability Survey. Their responses will be assessed to determine the value of and ease of use of the flag gallery.~~

Learning Test

1. UH-07

   Type: Manual, Dynamic

   Initial State: UI is initialized and running

   Input/Condition:

   Output/Result: verification of the learnability of the Random Flag Generator program

   How test will be performed: The Random Flag Generator UI will be analyzed by several users to ensure they can learn to use the program with no prior experience. The users with no prior experience will also attempt to use the program ~~(and 85% of users should be able to with ease)~~. The users will then provide their answer to question 8 of the Usability Survey. Their responses will be assessed to determine what parts of the GUI were unclear or could be improved.

2. UH-08

Type: Manual, Dynamic

Initial State: UI is initialized and running

Input/Condition:

Output/Result: verification of the accessibility of the instructions menu

How test will be performed: The Random Flag Generator UI will be analyzed by several users to ensure they can (easily) access the instruction menu for help. The users will also attempt to use the program (and ~~85% of users~~ should be able to pull up the instructions menu within MAX_FIND_TIME ~~5~~ seconds). The users will then provide their answer to question 4 of the Usability Survey. Their responses will be assessed to determine if the instructions/help menu button was helpful to users or not and how it could be improved.

3. UH-09

   Type: Manual, Dynamic

   Initial State: UI is initialized and running

   Input/Condition:

   Output/Result: verification of the intuitivity/informativeness of the main UI

   How test will be performed: The Random Flag Generator UI will be analyzed by several testers ~~users~~ to ensure the user can (easily) use the program by following the main UI instructions. A sample group of users will also attempt to use the program (and ~~85% of users~~ should be able to do so just using the main UI instructions).

Understandability Test

1. UH-10

   Type: Manual, Dynamic

   Initial State: UI is initialized and running

   Input/Condition:

Output/Result: verification of consistent language use throughout the program

How test will be performed: The Random Flag Generator UI will be analyzed by testers to ensure that consistent language is used throughout the program.

2. UH-11

   Type: Manual, Dynamic

   Initial State: UI is initialized and running

   Input/Condition:

   Output/Result: verification of simplified terminology being used wherever possible

   How test will be performed: The Random Flag Generator UI will be analyzed by testers to ensure that simplified terminology is used wherever possible in the program.

Accessibility Test

1. UH-12

   Type: Manual, Dynamic

   Initial State: UI is initialized and running

   Input/Condition:

   Output/Result: verification of easy-to-read fonts and font sizes being used throughout the program

   How test will be performed: The Random Flag Generator UI will be analyzed by testers and compared with the web accessibility standards to ensure that easy-to-read fonts and font sizes are used throughout the program.

2. ~~UH-13~~

   ~~Type: Manual, Dynamic~~

~~Initial State: UI is initialized and running~~

~~Input/Condition:~~

~~Output/Result: verification of a colour-blind friendly Random Flag Generator UI~~

~~How test will be performed: The Random Flag Generator UI will be analyzed to ensure that a colour-blind friendly UI is provided.~~

3.2.3 Performance Testing

Speed Test

1. PE-01-02

   Type: Manual, Functional, Dynamic

   Initial State: UI is initialized and running

   Input/Condition: input string and hashing algorithm name string to generate flag, mouse click

   Output/Result: output generated flag image

   How test will be performed: The Random Flag Generator program will be given an input string and hashing algorithm name string, and the time it takes to generate/download a flag image shall be timed. The generation and download time shall not exceed MAX_LOAD_TIME ~~5~~ seconds.

2. PE-03

   Type: Manual, Functional, Dynamic

   Initial State: UI is initialized and running

   Input/Condition: mouse click

   Output/Result: user's flag gallery should be loaded in the UI

   How test will be performed: The Random Flag Generator UI program will open the user's flag gallery and the duration shall be timed. The loading time shall not exceed MAX_LOAD_TIME ~~5~~ seconds.

Precision or Accuracy Test

1. PE-04

   Type: Manual, Functional, Dynamic

   Initial State: UI is initialized and running

   Input/Condition: input string and hashing algorithm name string to generate flag

   Output/Result: output hexadecimal hash digest (per the selected hashing algorithm)

   How test will be performed: The Random Flag Generator program will be given an input string and hashing algorithm name string, and the output hexadecimal hash digest (per the selected hashing algorithm) will be compared with the hash digest generated with the input string using an external hashing program.

2. PE-05

   Type: Manual, Functional, Dynamic

   Initial State: UI is initialized and running

   Input/Condition: input string and hashing algorithm name string to generate flag, mouse click

   Output/Result: output generated flag image

   How test will be performed: The Random Flag Generator program will be given an input string and hashing algorithm name string, and the generated flag image will be analyzed to ensure the various components are accurately placed (i.e. they match the template files).

3. PE-06

   Type: Manual, Functional, Dynamic

   Initial State: UI is initialized and running

   Input/Condition: input string and hashing algorithm name string to generate flag, mouse click

Output/Result: output generated flag image

How test will be performed: The Random Flag Generator program will be given an input string and hashing algorithm name string, and the generated flag image will be analyzed to ensure the various colours used match the hexadecimal RGB colour values derived from the hash digest. The RGB volour values will be run through an external colour tool, and those colours will be compared with the generated flag's colours to ensure they match.

Reliability and Availability Test

1. PE-07

   Type: Manual, Dynamic

   Initial State: GUI is uninitialized

   Input/Condition: command to initialize and run the GUI

   Output/Result: GUI is initialized and running

   How test will be performed: The Random Flag Generator program will be initialized and run from the command line at several different times during the day to ensure its availability.

Capacity Test

1. ~~PE-08~~

   ~~Type: Manual, Functional, Dynamic~~

   ~~Initial State: UI is initialized and running, maximum number of generated flags currently stored in user's gallery~~

   ~~Input/Condition: input string and hashing algorithm name string to generate flag, mouse click~~

   ~~Output/Result: program displays an error message telling the user the maximum number of generated flags has been reached, and to delete flags in the gallery to make more space for new flags.~~

   ~~How test will be performed: The Random Flag Generator program will be running and the user will attempt to generate a new flag despite the~~

~~gallery being full (i.e. the flag generation should fail and an error message should pop up).~~

2. PE-09

   Type: Manual, Functional, Dynamic

   Initial State: GUI is uninitialized

   Input/Condition: command to initialize and run the GUI

   Output/Result: GUI is initialized and running

   How test will be performed: The Random Flag Generator program will be initialized and run from the command line, and only one user is initialized per machine (i.e. all generated flags are stored in the same gallery/directory on the machine).

Scalability or Extensibility Test

1. PE-10

   Type: Manual, Functional, Dynamic

   Initial State: GUI is uninitialized

   Input/Condition: a new hashing algorithm/function option is added, command to initialize and run the GUI

   Output/Result: program should be able to generate new flags using the new hashing algorithm/function without any changes needing to be made to the existing code.

   How test will be performed: A new hashing algorithm/function will be added to the Random Flag Generator program, and then the GUI will be initialized. The user will attempt to generate a new flag using the new hashing algorithm and an input string, and the generated flag should be different from all of the other flags generated using that input string and all other existing hashing algorithms.

2. PE-11

   Type: Manual, Functional, Dynamic

Initial State: GUI is uninitialized

Input/Condition: new flag components are added (i.e. new .jka flag asset files), command to initialize and run the GUI

Output/Result: program should be able to generate new flags using the new flag asset files with only minor to no changes being made to the existing code.

How test will be performed: A new (or several) flag asset(s) will be added to the Random Flag Generator program, and then the GUI will be initialized. The users will attempt to generate a new flag using the new flag asset(s) with specific input strings (determining by trial and error), and the generated flag should use the new flag asset(s). The users will then provide their answer to question 7 of the Usability Survey. Their responses will be assessed to determine what new designs the users would like to see become available.

3.2.4 Operational and Environmental Testing

Expected Physical Environment Test

1. PE-13

   Type: Manual, Functional, Dynamic

   Initial State: GUI is uninitialized

   Input/Condition: local machine has Wi-Fi disabled, command to initialize and run the GUI

   Output/Result: GUI is initialized and running

   How test will be performed: The Random Flag Generator program will be initialized and run from the command line on a local machine with the Wi-Fi disabled. This program should still function as it would even with the Wi-Fi enabled.

2. PE-14

   Type: Manual, Functional, Dynamic

   Initial State: GUI is uninitialized

Input/Condition: local machine can support (running) the Python language, command to initialize and run the GUI

Output/Result: GUI is initialized and running

How test will be performed: The Random Flag Generator program will be initialized and run from the command line on several different local machines that can support (running) the Python language. This program should still function the same on all the different local machines.

3.2.5 Interfacing with Adjacent Systems Testing

Interfacing with Adjacent Systems Test

1. PE-15

   Type: Manual, Functional, Dynamic

   Initial State: GUI is uninitialized

   Input/Condition: command to initialize and run the GUI, user generates some flag(s)

   Output/Result: GUI is initialized and running, new flag(s) generated and saved to the user's local machine

   How test will be performed: The Random Flag Generator program will be initialized and run from the command line, and the user will attempt to generate some flag(s). The user will then check that the program has only created/altered files within its working directory (i.e. generated_flags directory), and no where else on the local machine.

3.3 Traceability Between Test Cases and Requirements

In terms of traceability, most **test cases** and requirements have a one to one relationship, with exceptions and special cases noted. Some **functional requirements** are covered using the same tests, because they are essentially the same requirements, but are a part of different business events. See the following traceability matrices for more details.

Table 4: **Traceability Matrix for Functional Requirements I**

	Requirements													
Test Cases	FR1	FR2	FR3	FR4	FR5	FR6	FR7	FR8	FR9	FR10	FR11	FR12	FR13	FR14
FR-01	X													
FR-02		X												
FR-03			X											
FR-04-08				X				X						
FR-05-09					X				X					
FR-06-10						X				X				
FR-07-11							X				X			
FR-12-13												X	X	
FR-14														X

Table 5: **Traceability Matrix for Functional Requirements II/Non-Functional Requirements I**

	Requirements													
Test Cases	FR15	FR16	FR17	~~FR18~~	FR19	LF1	LF2	LF3	LF4	UH1	UH2	UH3	~~UH4~~	UH5
FR-15	X													
FR-16		X												
FR-17			X											
~~FR-18~~				~~X~~										
FR-19					X									
LF-01						X								
LF-02							X							
LF-03								X						
LF-04									X					
UH-01										X				
UH-02											X			
UH-03												X		
~~UH-04~~													~~X~~	
UH-05														X

Table 6: **Traceability Matrix for Non-Functional Requirements II**

	Requirements													
Test Cases	~~UH6~~	UH7	UH8	UH9	UH10	UH11	UH12	~~UH13~~	PE1	PE2	PE3	PE4	PE5	PE6
~~UH-06~~	~~X~~													
UH-07		X												
UH-08			X											
UH-09				X										
UH-10					X									
UH-11						X								
UH-12							X							
~~UH-13~~								~~X~~						
PE-01-02									X	X				
PE-03											X			
PE-04												X		
PE-05													X	
PE-06														X

Table 7: **Traceability Matrix for Non-Functional Requirements III**

	Requirements							
Test Cases	PE7	~~PE8~~	PE9	PE10	PE11	PE13	PE14	PE15
PE-07	X							
~~PE-08~~		~~X~~						
PE-09			X					
PE-10				X				
PE-11					X			
PE-13						X		
PE-14							X	
PE-15								X

4 Tests for Proof of Concept

4.1 Hash Generator

test_get_hash_algo

1. test-01

   Type: Functional, Dynamic, Automated

   Initial State:

   Input: 'sha256'

   Output: hashlib.sha256

   How test will be performed: automatically by running the test program containing the test set

2. test-02

   Type: Functional, Dynamic, Automated

   Initial State:

   Input: 'md5'

   Output: hashlib.md5

   How test will be performed: automatically by running the test program containing the test set

test_get_hash_hex

1. test-03

   Type: Functional, Dynamic, Automated

   Initial State:

   Input: 'test', hashlib.sha256

   Output: '9f86d081884c7d659a2feaa0c55ad015a3bf4f1b2b0b822cd15d6c15b0f00a08'

   How test will be performed: automatically by running the test program containing the test set

test_hash_generator

1. test-04

   Type: Functional, Dynamic, Automated

   Initial State:

   Input: ‘sample’

   Output: ’af2bdbe1aa9b6ec1e2ade1d694f41fc71a831d0268e9891562113d8a62add1bf’

   How test will be performed: automatically by running the test program containing the test set

4.2 Hash To Flag

test_pad_hashcode

1. test-05

   Type: Functional, Dynamic, Automated

   Initial State:

   Input: ‘575758’

   Output: ’57575857575857575858575758575758’

   How test will be performed: automatically by running the test program containing the test set

test_grind_hash_for_colors

1. test-06

   Type: Functional, Dynamic, Automated

   Initial State:

   Input: ‘0396233d5b28eded8e34c1bf9dc80fae34756743594b9e5ae67f4f7d124d2e3d’

   Output: [(3, 150, 35), (61, 91, 40), (237, 237, 142), (52, 193, 191), (157, 200, 15)]

   How test will be performed: automatically by running the test program containing the test set

test_grind_hash_for_stripe_style

1. test-07

   Type: Functional, Dynamic, Automated

   Initial State:

   Input: '5555556c48be1c0b87a7d575c73f6e42fnfhasdf341123abadbdbd'

   Output: 'VERTICAL'

   How test will be performed: automatically by running the test program containing the test set

test_grind_hash_for_stripe_number

1. test-08

   Type: Functional, Dynamic, Automated

   Initial State:

   Input: '5555556c48be1c0b87a7d575c73f6e42fnfhasdf341123abadbdbd'

   Output: 'THREE'

   How test will be performed: automatically by running the test program containing the test set

test_grind_hash_for_symbol_locations

1. test-09

   Type: Functional, Dynamic, Automated

   Initial State:

   Input: '5555556c48be1c0b87a7d575c73f6e42fnfhasdf341123abadbdbd'

   Output: 'TOP_LEFT'

   How test will be performed: automatically by running the test program containing the test set

test_grind_hash_for_symbol_number

1. test-10

   Type: Functional, Dynamic, Automated

   Initial State:

   Input: '5555556c48be1c0b87a7d575c73f6e42fnfhasdf341123abadbdbd'

   Output: 'ONE'

   How test will be performed: automatically by running the test program containing the test set

test_grind_hash_for_symbol_types

1. test-11

   Type: Functional, Dynamic, Automated

   Initial State:

   Input: '00001000010000010000000999999'

   Output: 'CROSS'

   How test will be performed: automatically by running the test program containing the test set

test_hex2rgb

1. test-12

   Type: Functional, Dynamic, Automated

   Initial State:

   Input: '#ffffff'

   Output: (255, 255, 255)

   How test will be performed: automatically by running the test program containing the test set

4.3 Flag Generator

test_generate_flag

1. test-13

   Type: Functional, Dynamic, Manual

   Initial State:

   Input: 'Sword is pointy', 'sha256'

   Output: flag_Sword is pointy.png

   How test will be performed: manually by running the test program containing the test set, and then doing a manual visual comparison of the generated flag with its expected generated flag output

test_generate_flag_data

1. test-14

   Type: Functional, Dynamic, Automated

   Initial State:

   Input: 'test', 'sha256'

   Output: ([(159, 134, 208), (129, 136, 76), (125, 101, 154), (47, 234, 160), (197, 90, 208)], ('VERTICAL', 'THREE'), ('CENTER', 'ZERO', 'CROSS'))

   How test will be performed: automatically by running the test program containing the test set

4.4 GUI

test_GUI

1. test-15

   Type: Functional, Dynamic, Manual

   Initial State: GUI is uninitialized

Input: command to initialize and run the GUI

Output: GUI is initialized

How test will be performed: a command will be entered at the command line (by the user). The Random Flag Generator main menu UI should open and allow the user to enter text into the input string field. The main menu should also present buttons for generating and displaying flags, which the user will then click on to test that they are functioning as prescribed.

5 Comparison to Existing Implementation

The Random Flag Generator (**RFG**) program currently implements the majority of the core functionality found in the original **PAGAN** program. Mainly, the Random Flag Generator program currently implements hash generation using hashlib, mapping the generated hash digest to various flag design decisions (array indices), and generating the flag image. In addition, a minimal **GUI** has been implemented to handle user input and display flag output. The next steps are expanding **test cases** and test coverage, implementing more flag design options (including more resolution choices), and enhancing the **GUI**, which includes the addition of a flag gallery.

6 Unit Testing Plan

6.1 Unit testing of internal functions

The **Pytest** library will be used to carry out all unit testing for internal functions used in the Random Flag Generator (**RFG**) program. 5 **Python** files will be made that will contain the **Pytest** testing functions for the modules contained within each of the 5 main components of the project. FlagGenerator, GUI, HashGenerator, HashToFlag, and JKAReader will each have a corresponding **Python Pytest** file. Within each main component, most but not all internal functions are able to be unit tested. The others will require some manual testing. This is especially evident in the testing of the **GUI**, which will need to be done by the user to check functionality and usability requirements. The remaining Display, Gallery, Settings and Help modules all

need to be tested manually, since they are interaction-based **GUI** modules.

For the modules that are able to be unit tested (modules mentioned in 3.1.2), assert statements will be setup to check that the modules are returning the correct values (based on externally calculated values), and that they are behaving as expected. The "expected" cases, boundary/limit cases, and any exceptions and error handling will be tested through **Pytest** unit tests. Using the testing coverage matrices, any unit testable **functional requirements** will be covered in the unit tests. Use of external libraries (PIL, tkinter) will have less thorough testing, since they are commercially available software products, and are assumed to have some level of correctness and testing already done ~~testing~~.

6.2 Unit testing of output files

All ~~Some~~ aspects of the outputted flag image will be able to be validated through unit testing, including the generated flag image files (which will be tested by comparing the pixel map colour data of the generated flag image with the expected pixel map colour data) ~~but others will be a visual/manual check~~. Generated flag ~~Flag generated~~ images will have their width and height checked to ensure the user's resolution selection matches the output image resolution. Checking known hashing function outputs to make sure the corresponding flag design (colours, symbols, stripes, etc.) are all correct, will be done to verify some correctness in the generated symbols, although it will be unreasonable to find hashes for every single combination of possible output designs. Unit tests can also be done to check the naming of files, file storage, and gallery display correctness.

7 Appendix

7.1 Symbolic Parameters

The definition of the test cases will call for SYMBOLIC_CONSTANTS. Their values are defined in this section for easy maintenance.

$MIN\_AGE = 7$
$MAX\_FIND\_TIME = 5$
$MAX\_LOAD\_TIME = 2$

7.2 Usability Survey Questions?

Given that the Flag Generator program heavily relies on user input and their interactions with the GUI, as well as their opinion on the outputs of the program, survey questions to gauge user experience will be used.

1. On a scale of 1-10, how easy was it for your to navigate the program using the GUI?
2. On a scale of 1-10, how appealing/aesthetically pleasing would you consider the flag images being generated?
3. On a scale of 1-10, how straightforward was it to follow the intended flow of operations? (ie. entering input $\rightarrow$ accessing generated flag image)
4. On a scale of 1-10, how helpful was the "Help" button feature?
5. Would you like more (or less) ability to set certain parts of the flag?
6. Do you like having the flag gallery view? Is it worthwhile in your opinion?
7. What other designs would you like to see available for the flags being generated?
8. What parts of the GUI were not clear or straightforward to use?