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# Software Design and Implementation

TrekStar Software System

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## Table of Contents

- Table of Contents
- Plagiarism Declaration
- Contributions
  - Callum Axon (N0727303) - Member A
  - Callum Carney (N0741707) - Member C
  - Matthew Robinson (N0724629) - Member B
- System Description
- Class Diagram
- Cohesion and Coupling Considerations
  - Cohesion
  - Coupling
- Interaction Design
  - Use Case
  - Sequence Diagram
  - State Machine Diagram
- Component Diagram
- Deployment Diagrams
  - Individual Installation
  - Company-Wide Installation
- Design Pattern
  - Factory Design Pattern
  - Singleton
- Planned Architecture
  - Architecture Presentation
    - \* Model-View-Controller
  - Utility Tree
- Included C++ Libraries
  - JSON for C++ (GitHub Link)
  - GTest (GitHub Link)
  - spdlog (GitHub Link)

- Internal Data Structures
- Search/Sorting Algorithm
  - Merge Sort
    - \* Explanation
    - \* Justification
  - Binary Search
    - \* Explanation
    - \* Justification
- Test Plan
- UI Screenshots
  - Main Menu
  - View Mode
    - \* List Projects
      - View Materials
      - View Crew
      - View Box Office Reports
    - \* Search Projects
      - Search Title
      - Search Actor
  - Maintenance Mode
    - \* Add Project
    - \* Update Project
      - Edit Title
      - Edit Summary
      - Edit Released
      - Edit Playing In Theaters
      - Edit Existing Keyword
      - Edit Crew
      - Edit Crew Name
      - Edit Crew Job Title
    - \* Remove Project
    - \* Add Project Materials
    - \* Add Project Materials - VHS
    - \* Update Project Materials
      - Edit Audio Format

- Edit Run Time
  - Edit Language
  - Edit Retail Price
  - Edit Subtitles
  - Edit Frame Aspect
  - Edit Content
  - Edit Additional Language Tracks
  - Edit Additional Subtitle Tracks
  - Edit Bonus Features
  - Edit Packaging
- \* Remove Project Materials
- \* Add Project Crew
- \* Update Project Crew
  - Edit Crew Name
  - Edit Crew Job Title
- \* Remove Project Crew
- \* Add Box Office Report
- \* Remove Box Office Report
- Software Testing Procedure
- User Manual
  - Software Introduction
  - Using the Main Menu
  - Using View Mode
    - \* Using List Projects
    - \* Using View Materials
    - \* Using View Crew
    - \* Using View Box Office Reports
    - \* Using Search Projects
      - Using Search By Title
      - Using Search By Actor
    - \* Using List Materials
  - Using Maintenance Mode
    - \* Using Add Project
    - \* Using Update Project
      - Edit Title
      - Edit Summary

- Edit Released
  - Edit Playing In Theaters
  - Edit Existing Keywords
  - Edit Crew
  - Edit Crew Name
  - Edit Crew Job Title
- \* Using Remove Project
- \* Using Add Project Materials
- \* Using Update Project Materials
  - Edit Audio Format
  - Edit Run Time
  - Edit Language
  - Edit Retail Price
  - Edit Subtitles
  - Edit Frame Aspect
  - Edit Packaging
  - Edit Content
  - Edit Additional Language Tracks
  - Edit Additional Subtitle Tracks
  - Edit Bonus Features
  - Edit Audio Track
- \* Using Remove Project Materials
- \* Using Add Crew
- \* Using Update Crew
  - Edit Crew Name
  - Edit Crew Job Title
- \* Using Remove Crew
- \* Using Add Box Office Report
- \* Using Remove Box Office Report
- Conclusion
- Appendix
  - Managing group work
  - Meeting Minutes
- References

## **Plagiarism Declaration**

This report and the software it documents is the result of my own work, other contributing group members are acknowledged. Any contributions to the work by third parties, other than tutors, are stated clearly below this declaration. Should this statement prove to be untrue I recognise the right and duty of the Board of Examiners to take appropriate action in line with the university's regulations on assessment.

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## Contributions

### **Callum Axon (N0727303) - Member A**

- S1 - Cohesion and coupling.
- S2 - Class diagram.
- S9 - Stack data structure.

### **Callum Carney (N0741707) - Member C**

- S5: Component diagram.
- S6: Deployment diagram.
- S10: Binary search algorithm.

### **Matthew Robinson (N0724629) - Member B**

- S3/S4: Use Case for Import Project.
- S3: A sequence diagram for import project use case.
- S4: State machine diagram for ProjectController.
- S10: Merge sort algorithm.
- S13: Console interface.

All other contributions have been completed as part of a group effort.

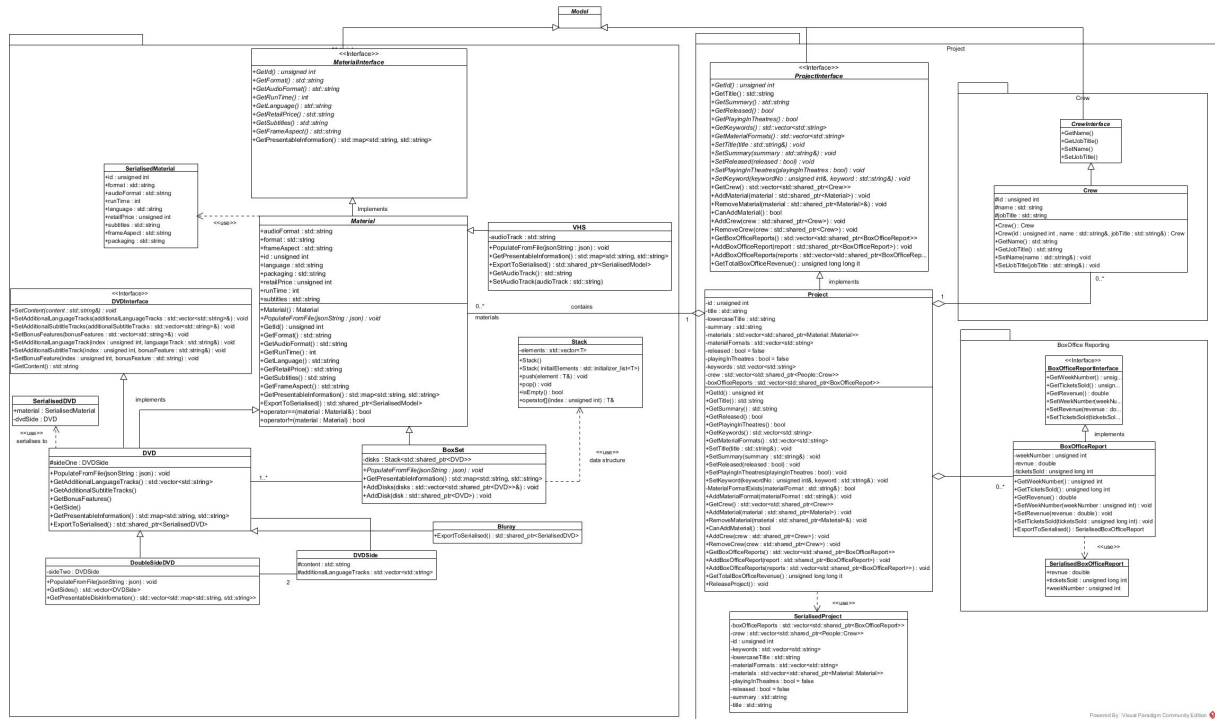
## **System Description**

The Trekstar system has been developed in order to allow TrekStar Pictures to accomplish the following

- Create and Manage Projects including any relevant metadata
- Create and Manage Project Materials (single-sided DVDs, Blu-rays, etc)
- Create Projects that are “unreleased” and cannot be modified once created
- Include details in regards to the crew working on a Project



## Class Diagram



**Figure 1:** Smaller version of class diagram

**See images/class-diagram.png for full sized image**

## Cohesion and Coupling Considerations

### Cohesion

The concept of cohesion is defined as “the degree to which all elements of a component are directed towards a single task, within a single component, or to which the responsibilities of a class are related”.

Within the design, it was important to separate out the logic for the presentation of the information from the business logic. We have achieved this using a Model - View - Controller architecture. In order for the views to gather data from the Models themselves, a large number of *so-called* getter functions are present. This is so that the models are not responsible for the presentation and **logical cohesion** does not occur. Utilising these functions also provides an example of how communicational cohesion has been considered within the design, whilst the separation of these elements has provided the situation of functional cohesion.

Another example of how **logical cohesion** has been avoided is the approach taken to importing data from files. This logic is contained within its own object and the only data which is passed into their respective objects is a *serialised* version - separating the concerns surrounding the importing of files.

Further details on cohesion, relating to specific design patterns, can be found in that section of the document.

### Coupling

Due to the relationships between different objects within the system, some coupling does occur. An example of this is that a Project has Materials associated with it - thus creating a dependency between the two objects. However, the relationships defined within the class diagram show that the two related objects don't modify the data of each other, but store data about each other independently. The data between these two objects could therefore be considered to be uncoupled.

## Interaction Design

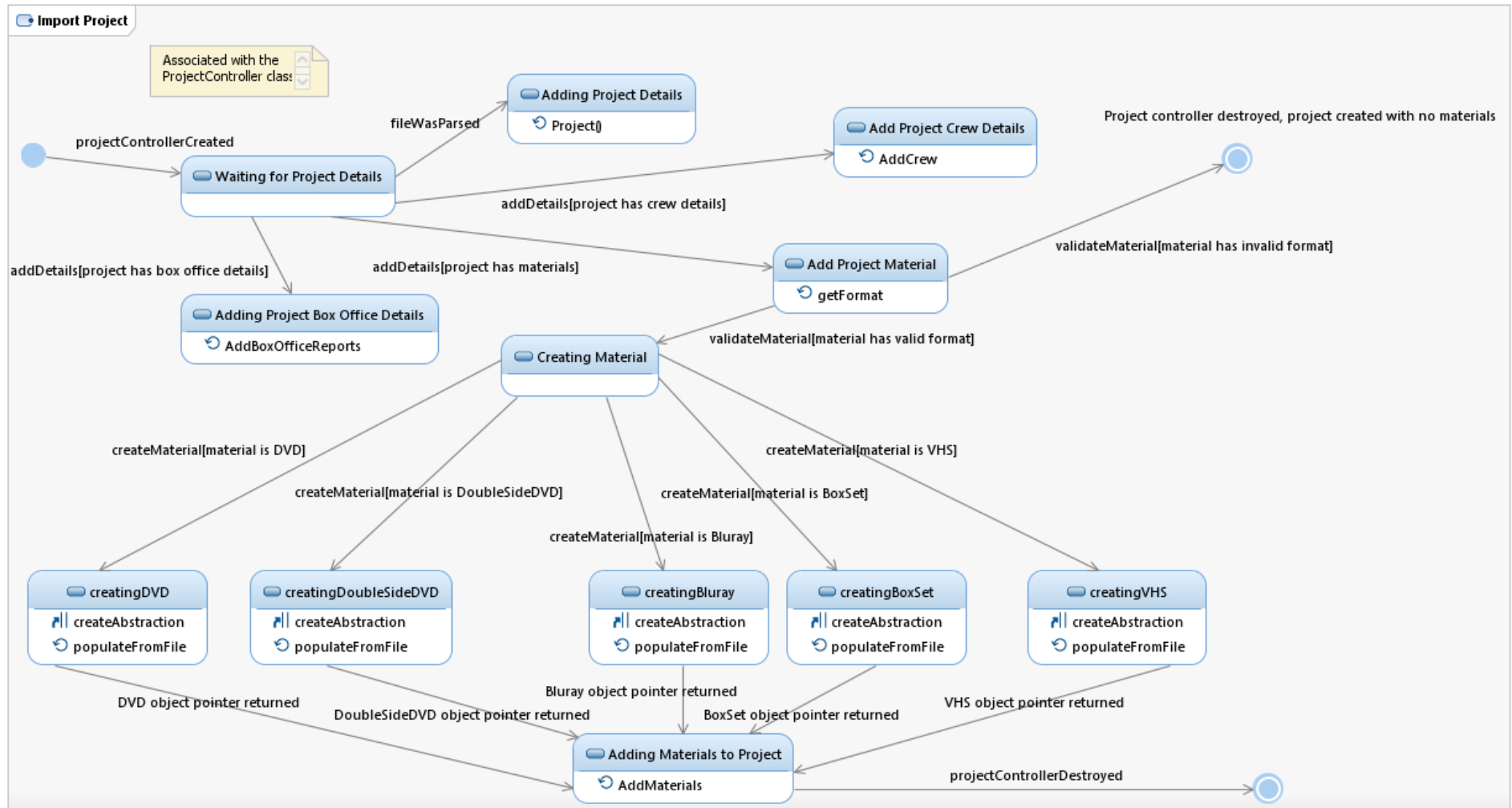
### Use Case

<b>Use Case Name:</b> Import Project			
<b>Short Description:</b> This describes how projects are imported from a JSON file along with their details, box office reports, crew and materials.			
<b>Trigger:</b> When the application is started and a JSON file is found.			
<b>Type:</b>		External / Temporal	
<b>Major Inputs:</b>		<b>Major Output:</b>	
<b>Description</b>	<b>Source</b>	<b>Description</b>	<b>Destination</b>
JSON file	File Stream	Imported projects	Project Model
<b>Major Steps Performed:</b>		<b>Information Required:</b>	
1. Open the JSON file.		File path to the JSON file.	
2. Parse the JSON file using the JSONReader.		File path to the JSON file.	
3. Obtain project details, including title, summary, released status and playing in theatres status.		Parsed JSON data.	
4. Obtain box office report details, including week number, revenue and tickets sold.		Parsed JSON data.	
5. Obtain crew details, including name and job title.		Parsed JSON data.	
6. Obtain material details, including format, audio format, run time, language, retail price, subtitles, frame aspect and packaging. An object containing additional information pertaining to a specific material type must also be retrieved.		Parsed JSON data.	
7. Construct a Project using the basic project details found in Step 3.		SerialisedProject.	
8. Add the box office reports to the project model.		BoxOfficeReport model.	
9. Add the crew to the project model.		Crew model.	
10. Get the format of the materials to be added to the project.		String in the "format" field of the material in the JSON file.	
11. Dynamically cast the material object to a DVD/DoubleSideDVD/BoxSet/Bluray/VHS.		Material JSON data.	
12. Populated the new object with information from the JSON file that specifically pertains to the casted material. For example, DVDs will have additional language tracks, additional subtitle tracks and bonus features.		The casted material object.	
13. Add all casted material objects to the project model.		Vector of casted material objects.	

**Figure 2:** Use case

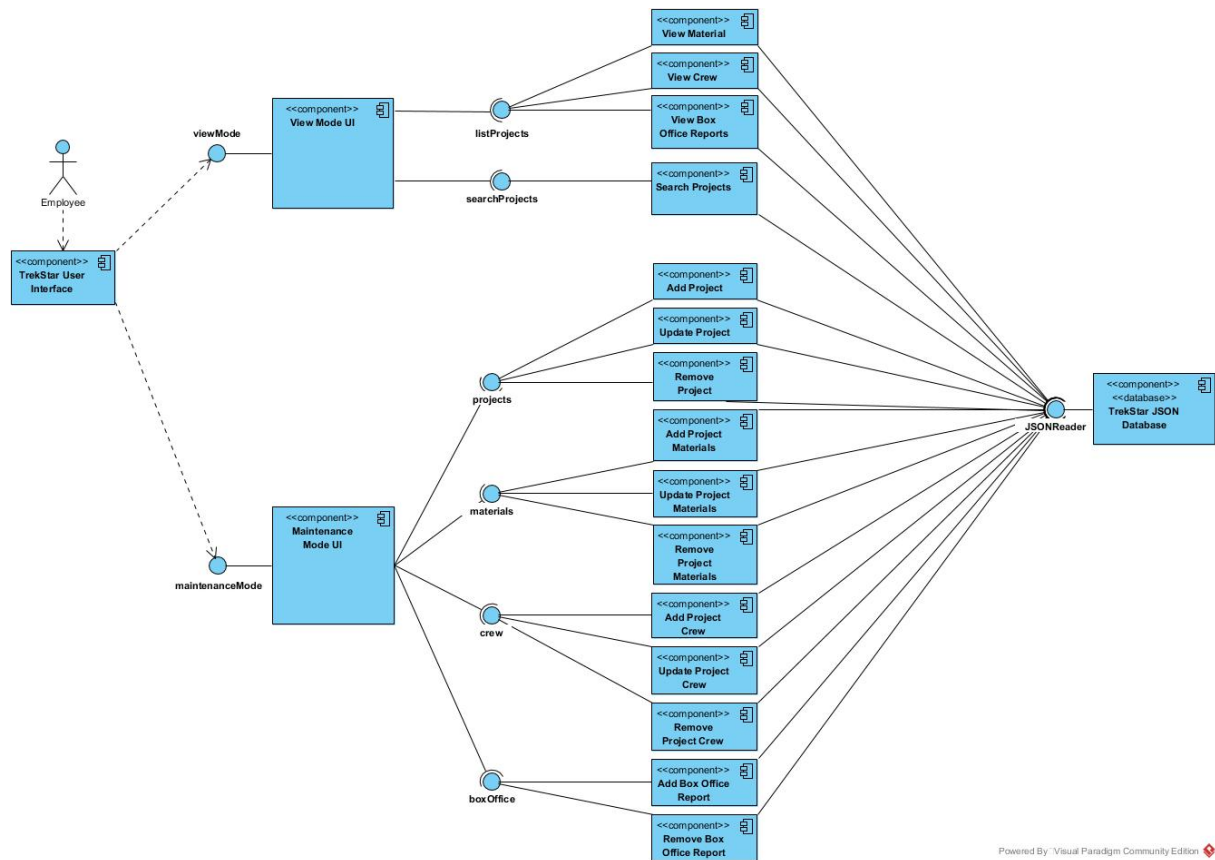


## State Machine Diagram



**Figure 4:** State machine diagram

## Component Diagram



**Figure 5:** Smaller version of component diagram

See [images/component-diagram.jpg](#) for full sized image

## Deployment Diagrams

There are two possible deployment scenarios for the TrekStar management system, these being:

1. An individual user will have the TrekStar project management system installed on their machine, using a locally stored JSON Database.
2. TrekStar Pictures will release the TrekStar project management system company-wide, using a shared JSON Database for each installation.

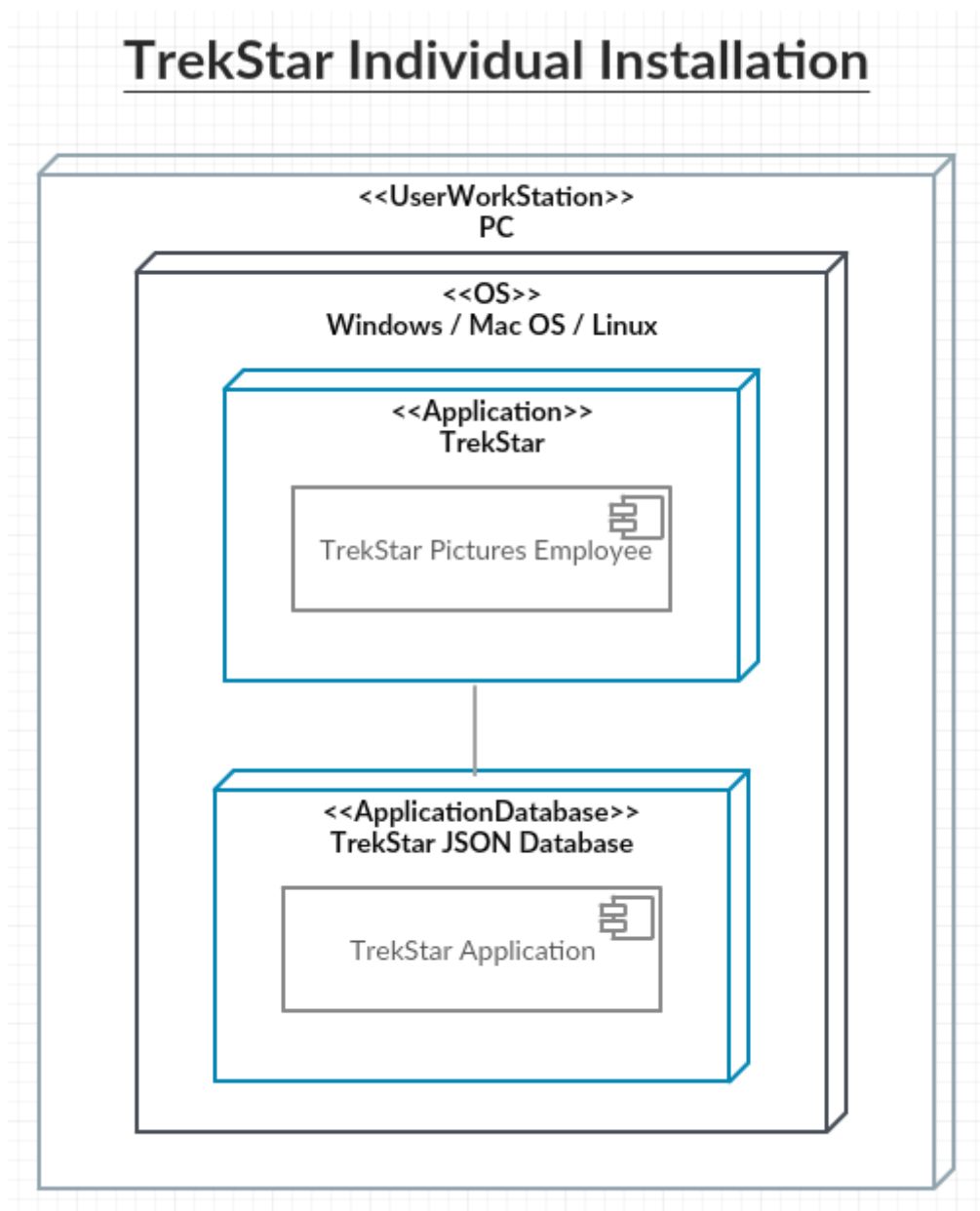
These two deployments are different due to the change in the data storage location, in which the latter will support company-wide collaboration through the application.

However, no matter where the application is installed the following Operating Systems are supported:

- Windows
- Mac OS
- Linux

On the following pages you can find a visual representation of the aforementioned Deployment scenarios.

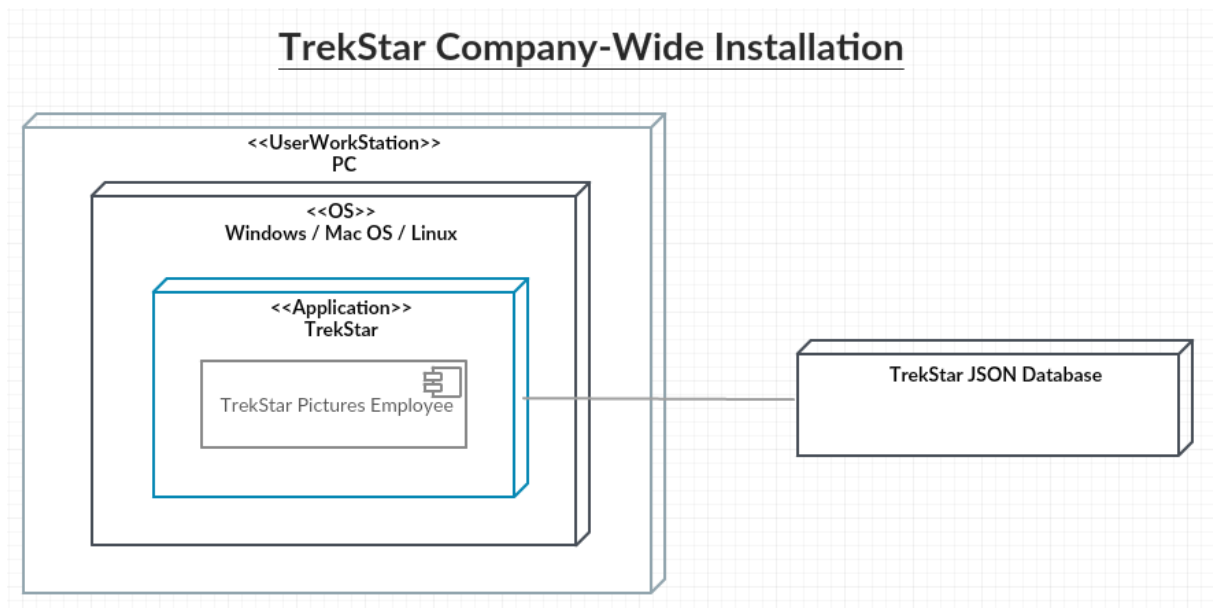
## Individual Installation



**Figure 6:** Visual Representation of Individual TrekStar installation



## Company-Wide Installation



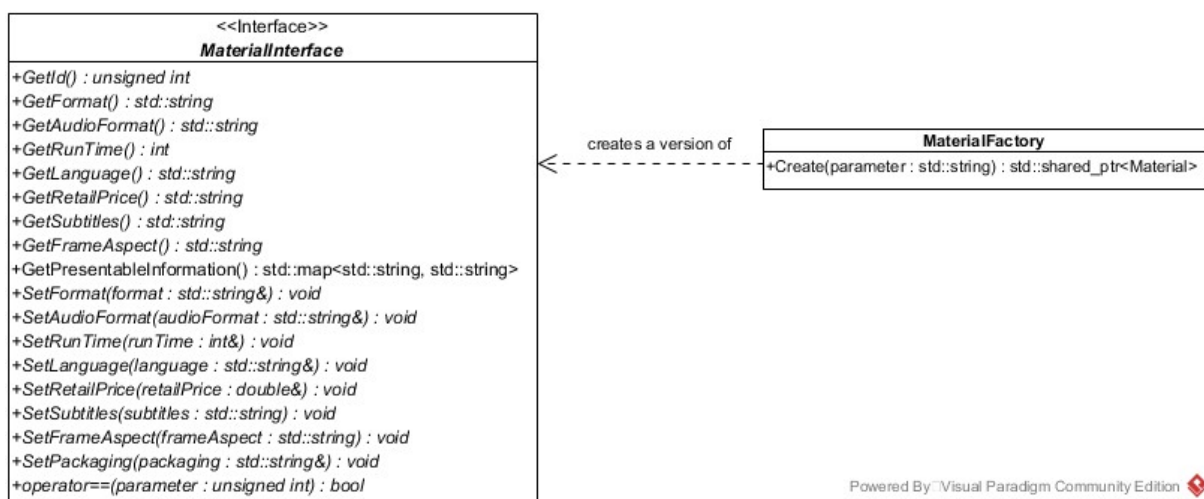
**Figure 7:** Visual Representation of Company-Wide TrekStar installation

## Design Pattern

### Factory Design Pattern

Include explanation of any design patterns used

With a large number of *materials* defined within the business rules, it was appropriate to use a **factory design pattern** to generate different material types based upon an input provided by the user. The specific implementation involved defining a return type as the base material class - allowing a covariant return type. This design pattern was possible as we have a common interface for every material. A UML representation of this pattern can be found below.



**Figure 8:** MaterialFactory UML Class Diagram

The advantages of this pattern is that new materials types can easily be added by adding a small conditional statement in this class. This provides a level of abstraction and means that this class has only a single responsibility - to construct materials - removing this logic from the consuming object. This helps with the issue of coupling as functional cohesion is achieved. Because of the abstraction, it wouldn't mean any changes would necessarily have to occur in the consuming class.

### Singleton

Through the logging library spdlog, a singleton pattern was used in order to ensure a single logging instance is present within the application. This involved creating this instance as soon as the application was launched, and then accessed (using the library) within the areas of the application logging is used e.g. in the application.

A common issue with this pattern is the issue of multithreading, particularly with respect to file handling. There could be multiple components within the application that could be trying to access the log, which is why it's important to have a single instance.

## **Planned Architecture**

### **Architecture Presentation**

Architecture tradeoff analysis method (ATAM) was used to decide on an architecture which was to be followed for the development of the Trekstar Project Management System.

### **Model-View-Controller**

MVC is driven by interaction. The use of views to prompt their respective controllers to modify the model and subsequently update the view in real time fits the requirements of the Trekstar system. Models act as the data store for all of the related objects within the system. Controllers manipulate the data in the models through an exposed interface on the model objects

### **Microservices**

The idea of a microservice architecture is to have a collection of small, modular components which are brought together to make an application (Wayner, 2019). This approach allows components of the system to be independent of each other - creating an application which is significantly decoupled from its components. This will result in a better standard of cohesion and a more maintainable application in the long-run, potentially facilitating easier further development.

In order for these components of the system to integrate together, to make an application, communication has to be established between them. This adds another layer of complexity to the system which might not be present with other software architectures. Given the time constraints with the project, it might be a challenge to meet all the requirements and meet the respective time constraints.

### **Utility Tree**

The management of projects requires fast, realtime interaction (Unknown, 2017). The requirements gathered from Trekstar meant that some of the data needs to be presented in a different manner (e.g. displaying the contents of a double sided DVD). Due the benefit of MVC being able to present data in multiple formats, this made it an ideal choice. One of the stretch goals of the project was to provide the user with a Graphical User Interface (GUI). By using MVC, it will be easier to produce views for a GUI rather than a console based interface as only one component of the system (the views) will need to be changed out.

As previously mentioned in other sections, separating the logic for presenting and performing the business model provides benefits with regards to de-coupling and setting clear boundaries within the

system. Given that the components of the MVC architecture are independent of each other, they can be developed in isolation. Within the context of the project, where individual members are responsible for different sections of the project - e.g. one for data structures & one for the user interface - the development of these components could happen in tandem. This will allow the project to develop at a faster rate and have less dependencies with respect to interrelated tasks.

## Included C++ Libraries

Within the TrekStar project management application we have used some C++ Libraries for parsing data, providing access to unit tests and including core functionality that would otherwise not be present. Below you can find an explanation of the included C++ libraries and why we chose to use them:

### JSON for C++ ([GitHub Link](#))

It was decided to use the JSON for C++ library within the application because we are using JSON as our database to store all of the users data. The JSON for C++ library allows us to parse JSON data, request data based on certain keys within a JSON Array or Object and create new JSON Arrays or Objects to be inserted into the database. The JSON for C++ library is quite easily the most feature complete and well documented library for parsing and creating JSON in C++, this was the main driving force behind using this library as we required something that is reliable and suitable for the applications use cases.

### GTest ([GitHub Link](#))

It was decided to use GTest as our primary unit testing library within the application, whilst we could have used Boost for unit testing, we decided that GTest had the following advantages which solidified our decision to use GTest:

- GTest is much more lightweight when compared to Boost, while GTest is specifically a testing library, Boost has more functionality that also needs to be imported to allow for the Unit Testing section of the library to function, consequently making it larger and less lightweight.
- When compared to other Unit Testing libraries there are more features that we can make use of in the project within GTest, for example, we can use GTests ability to mock objects, this is useful when we need to test the interaction between objects as we can achieve this more efficiently when compared to other libraries. We can also avoid duplication of test setup (creating objects, etc) within each unit test by specifying test fixtures which can be referenced within the unit tests.

### spdlog ([GitHub Link](#))

It was decided to use spdlog for our logger library, when compared to other libraries spdlog is lightweight, fast and only requires header imports to get started. spdlog also supports all of the operating systems that our application has been developed to work on, which is an important feature to have.

spdlog also allows us to easily generate the required daily reports based on the data we pass from the JSON database, the simplicity of this library was an important consideration as it allows future developers to quickly understand how this function works incase a new feature or bug needs to be added/fixed.

## Internal Data Structures

During the design phase of the TrekStar project management application it was decided that an internal data structure of Stack would be used. While there are pros and cons to each data structure, ultimately it was decided that the Stack data structure fit the best with the requirements of our application, you can find the in-depth reasoning behind the decision to use Stack below:

- The Stack data structure allows for the sequential ordering of disks, and make sense within our use cases. For example, if you have a box set of 4 disks and you would like to add a new disk, its likely that the new disk will be the latest episode, therefore it will be inserted sequentially at the end of the list. Another example would be when a user would like to remove a disk from a boxset, it is unlikely that you will want to remove the 3rd episode within the boxset, however if the 3rd episode was to be removed then the 4th episode (the last one in the underlying vector) can be removed allowing for the 3rd episode to then be removed, therefore the Stack data structure is still appropriate.
- Another advantage to the Stack data structure is that data can be accessed quicker sequentially, this is because you can iterate though the underlying vectors data finding items that a requested.
- A final advantage to the Stack data structure is that it uses general programming through the use of templating, as a consequence of this, the Stack data structure supports multiple data types. This allows the stack to be used in different contexts, if required.



## **Search/Sorting Algorithm**

### **Merge Sort**

#### **Explanation**

The merge sort algorithm was used to sort a list of projects based on their title.

Merge sort is a divide and conquer sorting algorithm where the list recursively partitioned in to halves, until each sublist is of length one, and therefore sorted by definition as the single project is the smallest and the largest in that sublist. The sublists are then sorted and merged into larger sublists until they are recombined into a single sorted list.

The list of projects is split into two halves. Each half then goes through a similar process whereby the halves are repeatedly split until they are of length one, which is, by definition, a sorted list.

The sublists in each half are then merged together by following this process until all projects are in the merged list: - compare the first project in the left half with the first project in the right half; - if the project in the left half is less than the project in the right half, add the project from the left half to the merged list and read the next project from the left half; - if the project in the right half is less than the project in the left half, add the project from the right half to the merged list and read the next project from the right half; and - once either list is empty, any remaining projects are added to the merged list.

The two halves are then merged together by following the same process above until all projects are in the merged list. As merge sort is an “in-place” sorting algorithm and the list of project was passed by reference, there is no return value. The list of projects is now sorted and can be used as such from where the merge sort function was originally called.

#### **Justification**

The implementation of a merge sort algorithm was determined to be necessary in order to benefit from the higher efficiency of sorting using the binary search algorithm, as described below. The merge sort algorithm was used as when compared to other alternatives, such as quick sort, merge sort is more efficient on larger datasets. While the testing was completed with small numbers of projects, it is likely that, if this software was to be used in the real world, there may be hundreds of thousands of projects sorted in the projects list.

Further discussion of the time complexity of merge sort can be found in Computational Efficiency.

## Binary Search

### Explanation

Binary search algorithm was used to find a project based on its title. The merge sort algorithm described above is performed before, as the binary search has a prerequisite that the list of projects be sorted.

An overload equals operator was created on the *Project* class; this was used to check if the search criteria of a project title was equal to the title attribute in the project when checking if the item at *mid* was the desired project.

The binary search algorithm requires the following variables: \* an integer variable *result* set to -1; \* an integer variable *low* set to 0; \* an integer variable *high* set to the index of the last project in the list; and \* an integer variable *mid*.

While the integer variable *result* is equal to -1 no project has been found that matches the search criteria, and the following steps should be taken repeatedly until a project is found or it has been determined that the project does not exist in the list: \* calculate a midpoint by using the equation  $mid = low + ((high - low) / 2)$ ; \* if the project at the midpoint is equal to the search criteria, *result* can be set to this project; \* if the project at the midpoint is less than the search criteria, set the *low* to  $mid + 1$ ; and \* if the project at the midpoint is greater than the search criteria, set the *high* to  $mid - 1$ .

After these stages have been completed, the value of *result* can be returned. The subsequent code can then display that the project was not found if -1 is returned. Otherwise, the *result* can be used as an index value to access the project in the list and display its detail to the user.

### Justification

A movie company, such as TrekStar, may have a large number of projects. It is important that searching these projects is efficient; the binary search algorithm avoids checking every project in the list. This is because comparisons are made to determine which half of the list the target project resides within. As a result, on each iteration, half of the project list is discarded.

Further discussion of the time complexity of binary search can be found in Computational Efficiency.

## Test Plan

Test No	Requirement	Type of Test	Expected Result	Actual Result	Workaround	Retest
1	The application opens and displays the main menu with options	Valid	The application opens and displays 3 options	The application opens and displays 3 options	N/A	N/A
2	Pressing 1 will open the View Mode	Valid	View mode will open	View mode opens	N/A	N/A
3	Pressing 2 will open Maintenance Mode	Valid	Maintenance Mode will open	Maintenance mode opens	N/A	N/A
4	Pressing 3 will close the application gracefully	Valid	The application will close gracefully	The application closes gracefully	N/A	N/A
4	Inserting an invalid value on the main menu will throw "Invalid Command"	Invalid	The application will throw "Invalid Command"	The application throws invalid command	N/A	N/A
5	Maintenance Mode menu loads	Valid	The maintenance mode view will open and display 12 options	The maintenance mode menu opens and shows 12 options	N/A	N/A
6	Pressing 1 will open the Add Project functionality	Valid	Add Project will open	Add Project opens	N/A	N/A
7	Pressing 2 will open the Update Project functionality	Valid	Update Project will open	Update Project opens	N/A	N/A

Test No	Requirement	Type of Test	Expected Result	Actual Result	Workaround	Retest
8	Pressing 3 will open the Remove Project functionality	Valid	Remove Project will open	Remove Project opens	N/A	N/A
9	Pressing 4 will open the Add Project Materials functionality	Valid	Add Project Materials will open	Add Project Materials opens	N/A	N/A
10	Pressing 5 will open the Update Project Materials functionality	Valid	Update Project Materials will open	Update Project Materials opens	N/A	N/A
11	Pressing 6 will open the Remove Project Materials functionality	Valid	Remove Project Materials will open	Remove Project Materials opens	N/A	N/A
12	Pressing 7 will open the Add Project Crew functionality	Valid	Add Project Crew will open	Add Project crew opens	N/A	N/A
13	Pressing 8 will open the Update Project Crew functionality	Valid	Update Project Crew will open	Update Project crew opens	N/A	N/A
14	Pressing 9 will open the Remove Project Crew functionality	Valid	Remove Project Crew will open	Remove Project crew opens	N/A	N/A
15	Pressing 10 will open the Add Box Office Report functionality	Valid	Add Box Office Report will open	Add Box Office Report opens	N/A	N/A
16	Pressing 11 will open the Remove Box Office Report functionality	Valid	Remove Box Office Report will open	Remove Box Office Report opens	N/A	N/A

Test No	Requirement	Type of Test	Expected Result	Actual Result	Workaround	Retest
17	Pressing 12 will return back to the main menu	Valid	The main menu will open	The main menu opens	N/A	N/A
18	Inserting an invalid value on the maintenance menu will throw "Invalid Command"	Invalid	The application will throw "Invalid Command"	The application throws invalid command	N/A	N/A
19	Inserting a value into the Title input on Add Project saves the value to the database	Valid	The value saves to the database	The value is saved to the database	N/A	N/A
20	Inserting a value into the Summary input on Add Project saves the value to the database	Valid	The value saves to the database	The value is saved to the database	N/A	N/A
21	Inserting a value into the Released input on Add Project saves the value to the database	Valid	The value saves to the database	The value is saved to the database	N/A	N/A
22	Inserting a value into the Playing In Theatres input on Add Project saves the value to the database	Valid	The value saves to the database	The value is saved to the database	N/A	N/A
23	Inserting a value into the Number of Keywords input on Add Project saves the value to the database	Valid	The value saves to the database	The value is saved to the database	N/A	N/A

Test No	Requirement	Type of Test	Expected Result	Actual Result	Workaround	Retest
24	Inserting a value into the Keyword input on Add Project saves the value to the database	Valid	The value saves to the database	The value is saved to the database	N/A	N/A
25	Inserting an invalid value into the Released input on Add Project requests the information to be typed again	Invalid	The value will be requested again	The value is requested again	N/A	N/A
26	Inserting an invalid value into the Playing in Theatres input on Add Project requests the information to be typed again	Invalid	The value will be requested again	The value is requested again	N/A	N/A
27	Inserting an invalid value into the Number of Keywords input on Add Project requests the information to be typed again	Invalid	The value will be requested again	The value is requested again	N/A	N/A
28	Pressing 1 will open the Edit Title functionality	Valid	Edit Title will open	Edit Title opens	N/A	N/A
29	Pressing 2 will open the Edit Summary functionality	Valid	Edit Summary will open	Edit Summary opens	N/A	N/A
30	Pressing 3 will open the Edit Released functionality	Valid	Edit Released will open	Edit Released opens	N/A	N/A

Test No	Requirement	Type of Test	Expected Result	Actual Result	Workaround	Retest
31	Pressing 4 will open the Edit Playing in Theatres functionality	Valid	Playing in Theatres will open	Playing in Theatres opens	N/A	N/A
32	Pressing 5 will open the Edit Existing Keywords functionality	Valid	Edit Existing Keywords will open	Edit Existing Keywords opens	N/A	N/A
33	Pressing 6 will open the Edit Crew functionality	Valid	Edit Crew will open	Edit Crew opens	N/A	N/A
34	Pressing 7 will return to the Maintenance Menu	Valid	Maintenance Menu will open	Maintenance Menu opens	N/A	N/A
35	Inserting an invalid value on the update project menu will throw "Invalid Command"	Invalid	The application will throw "Invalid Command"	The application throws invalid command	N/A	N/A
36	Inserting a value into the Title input on Update Project saves the value to the database	Valid	The value saves to the database	The value is saved to the database	N/A	N/A
37	Inserting a value into the Summary input on Update Project saves the value to the database	Valid	The value saves to the database	The value is saved to the database	N/A	N/A
38	Inserting a value into the Released input on Update Project saves the value to the database	Valid	The value saves to the database	The value is saved to the database	N/A	N/A

Test No	Requirement	Type of Test	Expected Result	Actual Result	Workaround	Retest
39	Inserting a value into the Playing In Theatres input on Update Project saves the value to the database	Valid	The value saves to the database	The value is saved to the database	N/A	N/A
40	Inserting a value into the Number of Keywords input on Update Project selects the keyword	Valid	The value is selected and the application moves onto the update keyword functionality	The value is successfully selected and the application moves onto the update keyword screen	N/A	N/A
41	Inserting a value into the Keyword input on Update Project saves the value to the database	Valid	The value saves to the database	The value is saved to the database	N/A	N/A
42	Inserting an invalid value into the Released input on Update Project requests the information to be typed again	Invalid	The value will be requested again	The value is requested again	N/A	N/A
43	Inserting an invalid value into the Playing in Theatres input on Update Project requests the information to be typed again	Invalid	The value will be requested again	The value is requested again	N/A	N/A



Test No	Requirement	Type of Test	Expected Result	Actual Result	Workaround	Retest
44	Inserting an invalid value into the Number of Keywords input on Update Project requests the information to be typed again	Invalid	The value will be requested again	The value is requested again	N/A	N/A
45	Inserting a value into the Crew ID input on Update Project selects the keyword	Valid	The value is selected and the application moves onto the update crew functionality	The value is successfully selected and the application moves onto the update crew screen	N/A	N/A
46	Inserting a value into the Crew input on Update Project saves the value to the database	Valid	The value saves to the database	The value is saved to the database	N/A	N/A
47	Inserting a Project ID into the Remove Project function removes the Project	Valid	The project will be removed	The project is removed	N/A	N/A
48	Inserting an invalid Project ID into the Remove Project function requests the ID to be entered again	Invalid	The ProjectID will be requested again	The project is requested again	N/A	N/A

Test No	Requirement	Type of Test	Expected Result	Actual Result	Workaround	Retest
49	Inserting a Project ID into the Add Project Material function moves onto the Project Material Selection Screen	Valid	The project ID will be inserted and the material selection screen will be loaded	The project ID is inserted and the material selection screen is loaded	N/A	N/A
50	Pressing 1 will select a DVD as the Material Format and move onto entering details	Valid	DVD will be selected and the application will move onto the input information screen	DVD is selected and the application moves onto the input information screen	N/A	N/A
51	Pressing 2 will select a Double Sided DVD as the Material Format and move onto entering details	Valid	Double Sided DVD will be selected and the application will move onto the input information screen	Double Sided DVD is selected and the application moves onto the input information screen	N/A	N/A
51	Pressing 3 will select a Bluray as the Material Format and move onto entering details	Valid	Bluray will be selected and the application will move onto the input information screen	Bluray is selected and the application moves onto the input information screen	N/A	N/A

Test No	Requirement	Type of Test	Expected Result	Actual Result	Workaround	Retest
52	Pressing 4 will select a VHS as the Material Format and move onto entering details	Valid	VHS will be selected and the application will move onto the input information screen	VHS is selected and the application moves onto the input information screen	N/A	N/A
53	Pressing 5 will select a Box Set as the Material Format and move onto entering details	Valid	Box Set will be selected and the application will move onto the input information screen	Box Set is selected and the application moves onto the input information screen	N/A	N/A
54	Inserting an invalid value on the add project material menu will throw "Invalid Command"	Invalid	The application will throw "Invalid Command"	The application throws invalid command	N/A	N/A
55	Inserting a value into the Audio Format input on Add Project Material saves the value to the database	Valid	The value saves to the database	The value is saved to the database	N/A	N/A
56	Inserting a value into the Run Time input on Add Project Material saves the value to the database	Valid	The value saves to the database	The value is saved to the database	N/A	N/A

Test No	Requirement	Type of Test	Expected Result	Actual Result	Workaround	Retest
57	Inserting a value into the Language input on Add Project Material saves the value to the database	Valid	The value saves to the database	The value is saved to the database	N/A	N/A
58	Inserting a value into the Retail Price input on Add Project Material saves the value to the database	Valid	The value saves to the database	The value is saved to the database	N/A	N/A
59	Inserting a value into the Subtitles input on Add Project Material saves the value to the database	Valid	The value saves to the database	The value is saved to the database	N/A	N/A
60	Inserting a value into the Frame Aspect input on Add Project Material saves the value to the database	Valid	The value saves to the database	The value is saved to the database	N/A	N/A
61	Inserting a value into the Content input on Add Project Material saves the value to the database	Valid	The value saves to the database	The value is saved to the database	N/A	N/A

Test No	Requirement	Type of Test	Expected Result	Actual Result	Workaround	Retest
62	Inserting a value into the Number of Additional Language Tracks input on Add Project Material selects the amount of Additional Language Tracks	Valid	The value is added and the application moves onto the add Additional Language Tracks functionality	The value is successfully added and the application moves onto the add Additional Language Tracks functionality	N/A	N/A
63	Inserting a value into the Additional Language Track input on Add Project Material saves the value to the database	Valid	The value saves to the database	The value is saved to the database	N/A	N/A
64	Inserting a value into the Number of Additional Subtitle Tracks input on Add Project Material selects the amount of Additional Subtitle Tracks	Valid	The value is added and the application moves onto the add Additional Subtitle Tracks functionality	The value is successfully added and the application moves onto the add Additional Subtitle Tracks functionality	N/A	N/A
65	Inserting a value into the Additional Subtitle Track input on Add Project Material saves the value to the database	Valid	The value saves to the database	The value is saved to the database	N/A	N/A

Test No	Requirement	Type of Test	Expected Result	Actual Result	Workaround	Retest
66	Inserting a value into the Number of Bonus Features input on Add Project Material selects the amount of Bonus Features	Valid	The value is added and the application moves onto the add Bonus Features functionality	The value is successfully added and the application moves onto the add Bonus Features functionality	N/A	N/A
67	Inserting a value into the Bonus Features input on Add Project Material saves the value to the database	Valid	The value saves to the database	The value is saved to the database	N/A	N/A
68	Inserting an invalid value into the Number of Additional Language Tracks input on Add Project Material requests the information to be typed again	Invalid	The value will be requested again	The value is requested again	N/A	N/A
69	Inserting an invalid value into the Number of Additional Subtitle Tracks input on Add Project Material requests the information to be typed again	Invalid	The value will be requested again	The value is requested again	N/A	N/A

Test No	Requirement	Type of Test	Expected Result	Actual Result	Workaround	Retest
70	Inserting an invalid value into the Number of Bonus Features input on Add Project Material requests the information to be typed again	Invalid	The value will be requested again	The value is requested again	N/A	N/A
71	Inserting a Project ID into the Update Project Material function moves onto the Project Material Selection Screen	Valid	The project ID will be selected and the select project material screen will be loaded	The project id is selected and the select project material screen is loaded	N/A	N/A
72	Inserting an invalid value on the Update Project Material menu will throw "Invalid Command"	Invalid	The application will throw "Invalid Command"	The application throws invalid command	N/A	N/A
73	Inserting a Material ID into the Update Project Material function moves onto the Update DVD functionality	Valid	The material ID will be selected and the update dvd screen will be loaded	The material id is selected and the update dvd screen is loaded	N/A	N/A

Test No	Requirement	Type of Test	Expected Result	Actual Result	Workaround	Retest
74	Inserting an invalid value on the Update Project Material Material ID menu will throw “Invalid Command”	Invalid	The application will throw “Invalid Command”	The application throws invalid command	N/A	N/A
75	Pressing 1 will open the Edit Audio Format functionality	Valid	Edit Audio Format will open	Edit Audio Format opens	N/A	N/A
76	Pressing 2 will open the Edit Run Time functionality	Valid	Edit Run Time will open	Edit Run Time opens	N/A	N/A
77	Pressing 3 will open the Edit Language functionality	Valid	Edit Language will open	Edit Language opens	N/A	N/A
78	Pressing 4 will open the Edit Retail Price functionality	Valid	Edit Retail Price will open	Edit Retail Price opens	N/A	N/A
79	Pressing 5 will open the Edit Subtitles functionality	Valid	Edit Subtitles will open	Edit Subtitles opens	N/A	N/A
80	Pressing 6 will open the Edit Frame Aspect functionality	Valid	Edit Frame Aspect will open	Edit Frame Aspect opens	N/A	N/A
81	Pressing 7 will open the Edit Content functionality	Valid	Edit Content will open	Edit Content opens	N/A	N/A
82	Pressing 8 will open the Edit Additional Language Tracks functionality	Valid	Edit Language Tracks will open	Edit Language Tracks opens	N/A	N/A



Test No	Requirement	Type of Test	Expected Result	Actual Result	Workaround	Retest
83	Pressing 9 will open the Edit Additional Subtitle Tracks functionality	Valid	Edit Subtitle Tracks will open	Edit Subtitle Tracks opens	N/A	N/A
84	Pressing 10 will open the Edit Bonus Features functionality	Valid	Edit Bonus Features will open	Edit Bonus Features opens	N/A	N/A
85	Pressing 12 will return back to the maintenance menu	Valid	The maintenance menu will open	The maintenance menu opens	N/A	N/A
86	Inserting an invalid value on the update project material menu will throw "Invalid Command"	Invalid	The application will throw "Invalid Command"	The application throws invalid command	N/A	N/A
87	Inserting a value into the Audio Format input on Edit Project Material saves the value to the database	Valid	The value saves to the database	The value is saved to the database	N/A	N/A
88	Inserting a value into the Run Time input on Edit Project Material saves the value to the database	Valid	The value saves to the database	The value is saved to the database	N/A	N/A
89	Inserting a value into the Language input on Edit Project Material saves the value to the database	Valid	The value saves to the database	The value is saved to the database	N/A	N/A

Test No	Requirement	Type of Test	Expected Result	Actual Result	Workaround	Retest
90	Inserting a value into the Retail Price input on Edit Project Material saves the value to the database	Valid	The value saves to the database	The value is saved to the database	N/A	N/A
91	Inserting a value into the Subtitles input on Edit Project Material saves the value to the database	Valid	The value saves to the database	The value is saved to the database	N/A	N/A
92	Inserting a value into the Frame Aspect input on Edit Project Material saves the value to the database	Valid	The value saves to the database	The value is saved to the database	N/A	N/A
93	Inserting a value into the Content input on Edit Project Material saves the value to the database	Valid	The value saves to the database	The value is saved to the database	N/A	N/A
94	Inserting a value into the Number of Additional Language Tracks input on Edit Project Material selects the ID of an Additional Language Tracks	Valid	The value is selected and the application moves onto the edit Additional Language Tracks functionality	The value is successfully selected and the application moves onto the edit Additional Language Tracks functionality	N/A	N/A

Test No	Requirement	Type of Test	Expected Result	Actual Result	Workaround	Retest
95	Inserting a value into the Additional Language Track input on Edit Project Material saves the value to the database	Valid	The value saves to the database	The value is saved to the database	N/A	N/A
96	Inserting a value into the Number of Additional Subtitle Tracks input on Edit Project Material selects the ID of an Additional Subtitle Tracks	Valid	The value is selected and the application moves onto the edit Additional Subtitle Tracks functionality	The value is successfully selected and the application moves onto the edit Additional Subtitle Tracks functionality	N/A	N/A
97	Inserting a value into the Additional Subtitle Track input on Edit Project Material saves the value to the database	Valid	The value saves to the database	The value is saved to the database	N/A	N/A
98	Inserting a value into the Number of Bonus Features input on Edit Project Material selects the ID of a Bonus Features	Valid	The value is selected and the application moves onto the edit Bonus Features functionality	The value is successfully selected and the application moves onto the edit Bonus Features functionality	N/A	N/A

Test No	Requirement	Type of Test	Expected Result	Actual Result	Workaround	Retest
99	Inserting a value into the Bonus Features input on Edit Project Material saves the value to the database	Valid	The value saves to the database	The value is saved to the database	N/A	N/A
100	Inserting an invalid value into the Number of Additional Language Tracks input on Edit Project Material requests the information to be typed again	Invalid	The value will be requested again	The value is requested again	N/A	N/A
101	Inserting an invalid value into the Number of Additional Subtitle Tracks input on Edit Project Material requests the information to be typed again	Invalid	The value will be requested again	The value is requested again	N/A	N/A
102	Inserting an invalid value into the Number of Bonus Features input on Edit Project Material requests the information to be typed again	Invalid	The value will be requested again	The value is requested again	N/A	N/A

Test No	Requirement	Type of Test	Expected Result	Actual Result	Workaround	Retest
103	Inserting a Project ID into the Remove Project Material function, the application requests a Material ID to delete	Valid	The project id will be used to select the associated materials and the select material id page will be loaded	The project id is be used to select the associated materials and the select material id page is loaded		N/A
104	Inserting an invalid Project ID into the Remove Project function requests the ID to be entered again	Invalid	The ProjectID will be requested again	The project id is requested again	N/A	N/A
105	Inserting a Material ID into the Remove Project Material function removes the material	Valid	The material will be deleted	The material is deleted	N/A	N/A
106	Inserting an invalid Material ID into the Remove Project function requests the ID to be entered again	Invalid	The MaterialID will be requested again	The project id is requested again	N/A	N/A

Test No	Requirement	Type of Test	Expected Result	Actual Result	Workaround	Retest
107	Inserting a Project ID into the Add Crew function moves onto the Crew Information Screen	Valid	The project ID will be selected and the add crew information screen will be loaded	The project id is selected and the add crew information screen is loaded	N/A	N/A
108	Inserting an invalid value on the Add Crew menu will throw "Invalid Command"	Invalid	The application will throw "Invalid Command"	The application throws invalid command	N/A	N/A
109	Inserting a value into the Name input on Add Crew saves the value to the database	Valid	The value saves to the database	The value is saved to the database	N/A	N/A
110	Inserting a value into the Job Title input on Add Crew saves the value to the database	Valid	The value saves to the database	The value is saved to the database	N/A	N/A
111	Inserting a Project ID into the Update Crew function moves onto the Crew Selection Screen	Valid	The project ID will be selected and the select crew id screen will be loaded	The project id is selected and the select crew id screen is loaded	N/A	N/A
112	Inserting an invalid Project ID into the Update Crew function requests the ID to be entered again	Invalid	The ProjectID will be requested again	The project id is requested again	N/A	N/A

Test No	Requirement	Type of Test	Expected Result	Actual Result	Workaround	Retest
111	Inserting a Crew ID into the Crew Selection function moves onto the Crew Information Update Screen	Valid	The crew ID will be selected and the crew information update screen will be loaded	The crew id is selected and the update crew information screen is loaded	N/A	N/A
112	Inserting an invalid Crew ID into the Remove Project function requests the ID to be entered again	Invalid	The ProjectID will be requested again	The project id is requested again	N/A	N/A
113	Pressing 1 will open the Edit Name functionality	Valid	Edit Name will open	Edit Name opens	N/A	N/A
114	Pressing 2 will open the Edit Job Title functionality	Valid	Edit Job Title will open	Edit Job Title opens	N/A	N/A
114	Pressing 3 will return to the maintenance menu	Valid	Maintenance Menu will open	Maintenance Menu opens	N/A	N/A
115	Inserting an invalid value on the update crew menu will throw "Invalid Command"	Invalid	The application will throw "Invalid Command"	The application throws invalid command	N/A	N/A
116	Inserting a value into the Name input on Update Crew saves the value to the database	Valid	The value saves to the database	The value is saved to the database	N/A	N/A

Test No	Requirement	Type of Test	Expected Result	Actual Result	Workaround	Retest
117	Inserting a value into the Job Title input on Update Crew saves the value to the database	Valid	The value saves to the database	The value is saved to the database	N/A	N/A
118	Inserting a Project ID into the Remove Crew function moves onto the Crew Removal Select ID Screen	Valid	The project ID will be selected and the crew removal select id screen will be loaded	The project id is selected and the crew removal select id screen is loaded	N/A	N/A
119	Inserting an invalid Project ID into the Remove Crew function requests the ID to be entered again	Invalid	The ProjectID will be requested again	The project id is requested again	N/A	N/A
120	Inserting a Material ID into the Crew Removal Select ID function Removes the selected crew member	Valid	The Crew ID will be selected and the crew member will be removed	The crew id is selected and the crew member is removed from the project	N/A	N/A
121	Inserting an invalid Material ID into the Remove Crew function requests the ID to be entered again	Invalid	The MaterialID will be requested again	The material id is requested again	N/A	N/A



Test No	Requirement	Type of Test	Expected Result	Actual Result	Workaround	Retest
122	Inserting a Project ID into the Add Box Office Report function moves onto the Add Box Office Report Screen	Valid	The project ID will be selected and the Add Box Office Report screen will be loaded	The project id is selected and the Add Box Office Report screen is loaded	N/A	N/A
123	Inserting an invalid Project ID into the Remove Crew function requests the ID to be entered again	Invalid	The ProjectID will be requested again	The project id is requested again	N/A	N/A
124	Inserting a value into the Week Number input on Add Box Office Report saves the value to the database	Valid	The value saves to the database	The value is saved to the database	N/A	N/A
125	Inserting an invalid value into the Week Number input on Add Box Office Report requests the information to be typed again	Invalid	The value will be requested again	The value is requested again	N/A	N/A
126	Inserting a value into the Revenue input on Add Box Office Report saves the value to the database	Valid	The value saves to the database	The value is saved to the database	N/A	N/A

Test No	Requirement	Type of Test	Expected Result	Actual Result	Workaround	Retest
127	Inserting an invalid value into the Revenue input on Add Box Office Report requests the information to be typed again	Invalid	The value will be requested again	The value is requested again	N/A	N/A
128	Inserting a value into the Tickets Sold input on Add Box Office Report saves the value to the database	Valid	The value saves to the database	The value is saved to the database	N/A	N/A
129	Inserting an invalid value into the Tickets Sold input on Add Box Office Report requests the information to be typed again	Invalid	The value will be requested again	The value is requested again	N/A	N/A
130	Inserting a Project ID into the Remove Box Office Report function moves onto the Remove Box Office Report Screen	Valid	The project ID will be selected and the Remove Box Office Report screen will be loaded	The project id is selected and the Remove Box Office Report screen is loaded	N/A	N/A

Test No	Requirement	Type of Test	Expected Result	Actual Result	Workaround	Retest
131	Inserting an invalid Project ID into the Remove Box Office Report function requests the ID to be entered again	Invalid	The ProjectID will be requested again	The project id is requested again	N/A	N/A
132	Inserting a Box Office Report ID into the Remove Box Office Report function removes the box office report	Valid	The box office report will be removed	The box office report is removed	N/A	N/A
133	Inserting an invalid Box Office Report ID into the Remove Box Office Report function requests the ID to be entered again	Invalid	The Box Office Report ID will be requested again	The box office report id is requested again	N/A	N/A
134	Pressing 1 will open the List Projects functionality within View Mode	Valid	List Projects will open	List Project opens	N/A	N/A
135	Pressing 2 will open the Search Projects functionality within View Mode	Valid	Search Projects will open	Search Projects opens	N/A	N/A
136	Pressing 3 will return to the Main Menu	Valid	The application will return to the main menu	The application returns to the main menu	N/A	N/A

Test No	Requirement	Type of Test	Expected Result	Actual Result	Workaround	Retest
137	Inserting an invalid value on the view mode menu will throw "Invalid Command"	Invalid	The application will throw "Invalid Command"	The application throws invalid command	N/A	N/A
138	Pressing y on the Sort By Title sorts the projects by title	Valid	The application will sort the projects by title when y is supplied	The application sorts the projects by title when y is supplied	N/A	N/A
139	Pressing n on the Sort By Title does not sort the projects by title	Valid	The application will not sort the projects by title when n is supplied	The application does not sort the projects by title when n is supplied	N/A	N/A
140	Inserting an invalid value on the sort by title functionality will throw "Invalid Command"	Invalid	The application will throw "Invalid Command"	The application throws invalid command	N/A	N/A
141	The list projects functionality lists projects	Valid	The application will list the projects when the list project functionality is accessed	The application lists projects when the list	N/A	N/A
142	Pressing 1 will open the Next Project functionality within View Mode	Valid	Next Project will show the next project	Next Project runs and shows the next project	N/A	N/A

Test No	Requirement	Type of Test	Expected Result	Actual Result	Workaround	Retest
143	Pressing 2 will open the Previous Project functionality within View Mode	Valid	Previous Project will show the previous project	Previous Project runs and shows the previous project	N/A	N/A
144	Pressing 3 will enter the View Materials functionality	Valid	The application will show materials for the selected project	The application shows materials for the selected project	N/A	N/A
145	Pressing 4 will enter the View Crew functionality	Valid	The application will show crew for the selected project	The application shows crew for the selected project	N/A	N/A
146	Pressing 5 will enter the View Box Office Reports functionality	Valid	The application will show box office reports for the selected project	The application will show box office reports for the selected project	N/A	N/A
147	Inserting an invalid value on the list projects menu will throw "Invalid Command"	Invalid	The application will throw "Invalid Command"	The application throws invalid command	N/A	N/A

Test No	Requirement	Type of Test	Expected Result	Actual Result	Workaround	Retest
148	Pressing 1 will run the Next Material functionality within List Materials	Valid	The next material function will execute and show the next material	Nothing occurs when pressing 1	The code surrounding the List Materials functionality was analysed and the bug was discovered.	Successful
149	Pressing 2 will run the Previous Material functionality within List Materials	Valid	The next material function will execute and show the next material	Nothing occurs when pressing 1	N/A	N/A
150	Pressing 3 will exit the List Materials functionality and return to the List Project functionality	Valid	The application exists List Materials and navigates to the list projects functionality	The application returns to the list projects functionality	N/A	N/A
151	Inserting an invalid value on the list crew materials will throw "Invalid Command"	Invalid	The application will throw "Invalid Command"	The application throws invalid command	N/A	N/A
152	Pressing 1 will run the Next Crew functionality within List Crew	Valid	The next crew function will execute and show the next crew member	The next crew functionality executes and shows the next member	N/A	N/A

Test No	Requirement	Type of Test	Expected Result	Actual Result	Workaround	Retest
153	Pressing 2 will run the Previous Crew functionality within List Crew	Valid	The previous crew function will execute and show the previous crew member material	The previous crew function executes and shows the previous crew member	N/A	N/A
154	Pressing 3 will exit the List Crew functionality and return to the List Project functionality	Valid	The application exists List Crew and navigates to the list projects functionality	The application returns to the list projects functionality	N/A	N/A
155	Inserting an invalid value on the list crew members menu will throw "Invalid Command"	Invalid	The application will throw "Invalid Command"	The application throws invalid command	N/A	N/A
156	Pressing 1 will run the Next Box Office Report functionality within View Box Office Reports	Valid	The next box office report function will execute and show the next box office report	The box office report functionality executes and shows the next box office report	N/A	N/A

Test No	Requirement	Type of Test	Expected Result	Actual Result	Workaround	Retest
157	Pressing 2 will run the Previous Box Office Report functionality within View Box Office Reports	Valid	The previous box office reports function will execute and show the previous box office report	The previous box office reports function executes and shows the previous box office report	N/A	N/A
158	Pressing 3 will exit the View Box Office Report functionality and return to the List Project functionality	Valid	The application exists List Crew and navigates to the list projects functionality	The application returns to the list projects functionality	N/A	N/A
159	Inserting an invalid value on the view box office reports menu will throw "Invalid Command"	Invalid	The application will throw "Invalid Command"	The application throws invalid command	N/A	N/A
160	Pressing 1 will run the Search By Title functionality within Search Projects functionality	Valid	The search by title function will execute and open the search projects screen	The search by title function opens	N/A	N/A
160	Pressing 2 will run the Search By Actor functionality within Search Projects functionality	Valid	The search by actor function will execute and open the search projects screen	The search by actor function opens	N/A	N/A



Test No	Requirement	Type of Test	Expected Result	Actual Result	Workaround	Retest
162	Pressing 3 will exit the Search Projects functionality and return to the Main Menu	Valid	The application exists the Search Project functionality and navigates to the main menu	The application returns to the main menu	N/A	N/A
163	Inserting an invalid value on the search project menu will throw "Invalid Command"	Invalid	The application will throw "Invalid Command"	The application throws invalid command	N/A	N/A
164	Entering a title value within Search by Title will return search results	Valid	The application will return results based on the title provided	The application returns results based on the title provided	N/A	N/A
165	Entering a title value within Search by Actor will return search results	Valid	The application will return results based on the actor provided	The application returns results based on the actor provided	N/A	N/A

## UI Screenshots

### Main Menu

```
#####  #####  #####  ##  ##  #####  #####  ###  #####
##  ##  ##  ##  ##  ##  ##  ##  ##  ##  ##  ##  ##
##  ##  ##  ##  ##  ##  ##  ##  ##  ##  ##  ##  ##
##  #####  #####  #####  #####  ##  ##  #####
##  ##  ##  ##  ##  ##  ##  ##  #####  ##  ##
##  ##  ##  ##  ##  ##  ##  ##  ##  ##  ##  ##
##  ##  ##  #####  ##  ##  #####  ##  ##  ##  ##

-----
Main Menu
-----
1 - View Mode
2 - Maintenance Mode
3 - Quit
-----
>
```

**Figure 9:** Visual representation of the Main Menu

## View Mode

```
-----
View Mode
-----
1 - List Projects
2 - Search Projects
3 - Cancel
-----
> _
```

**Figure 10:** Visual representation of View Mode

## List Projects

```
Sort by title? (y/n): y
-----
Project 3
-----
Title           : A Great Movie
Summary         : A super hero does stuff again
Released        : yes
Playing in theatres : no
Keywords        : Action, Superhero
Available on    : dvd, bluray, boxset, dsdvd, vhs
-----
List Projects
-----
1 - Next Project
2 - Previous Project
3 - View Materials
4 - View Crew
5 - View Box Office Reports
6 - Cancel
-----
>
```

**Figure 11:** Visual representation of List Projects

## View Materials

```
-----  
Material 0  
-----  
Additional Language Track 1 : FRA  
Additional Language Track 2 : GER  
Additional Subtitle Track 1 : FRA  
Additional Subtitle Track 2 : GER  
Audio Format : Dolby  
Bonus Features 1 : Director's Comments  
Content : big big movie  
Format : bluray  
Frame Aspect : 16:9  
Language : ENG  
Packaging : Plastic  
Retail Price : 13.990000  
Run Time : 655  
Subtitles : ENG  
-----  
List Materials  
-----  
1 - Next Material  
2 - Previous Material  
3 - Cancel  
-----  
> _
```

**Figure 12:** Visual representation of View Materials

### View Crew

```
Name      : Bob
Job Title : Actor
-----
List Crew
-----
1 - Next Crew
2 - Previous Crew
3 - Cancel
-----
> _
```

**Figure 13:** Visual representation of View Crew

### View Box Office Reports

```
-----  
Box Office Report for Week Number 1  
-----  
Revenue           : 100  
Tickets Sold      : 10  
-----  
List Box Office Reports  
-----  
1 - Next Box Office Report  
2 - Previous Box Office Report  
3 - Cancel  
-----  
>
```

**Figure 14:** Visual representation of View Box Office Reports

## Search Projects

```
-----  
Search Projects  
-----  
1 - Search by Title  
2 - Search by Actor  
3 - Cancel  
-----  
> _
```

**Figure 15:** Visual representation of Search Projects



### Search Title

```
Title: A great movie
-----
Project 3
-----
Title           : A Great Movie
Summary         : A super hero does stuff again
Released        : yes
Playing in theatres : no
Keywords        : Action, Superhero
Available on     : dvd, bluray, boxset, dsdvd, vhs

Show materials for this project? (y/n): y
```

**Figure 16:** Visual representation of Search Title

### Search Actor

```
Actor: Bob
-----
Project 3
-----
Title           : A Great Movie
Summary         : A super hero does stuff again
Released        : yes
Playing in theatres : no
Keywords        : Action, Superhero
Available on    : dvd, bluray, boxset, dsdvd, vhs

Show materials for this project? (y/n):
```

**Figure 17:** Visual representation of Search Actor

## Maintenance Mode

```
-----  
Maintenance Mode  
-----  
1 - Add Project  
2 - Update Project  
3 - Remove Project  
4 - Add Project Materials  
5 - Update Project Materials  
6 - Remove Project Materials  
7 - Add Project Crew  
8 - Update Project Crew  
9 - Remove Project Crew  
10 - Add Box Office Report  
11 - Remove Box Office Report  
12 - Cancel  
-----  
>
```

**Figure 18:** Visual representation of Maintenance Mode

## Add Project

```
Title: Deadpool 3  
Summary: Deadpool  
Released [current: no]: y  
Playing In Theatres [current: no]: y  
Number of Keywords: 1  
Keyword: Marvel
```

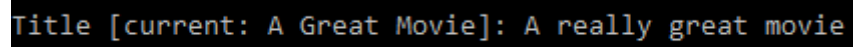
**Figure 19:** Visual representation of Add Project

## Update Project

```
-----  
Update Project  
-----  
1 - Edit Title  
2 - Edit Summary  
3 - Edit Released  
4 - Edit Playing In Theatres  
5 - Edit Existing Keywords  
6 - Edit Crew  
7 - Cancel  
-----  
>
```

**Figure 20:** Visual representation of Update Project

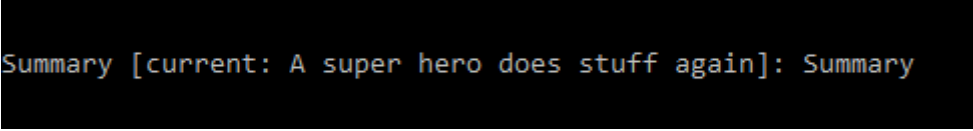
### Edit Title



```
Title [current: A Great Movie]: A really great movie
```

**Figure 21:** Visual representation of Edit Title

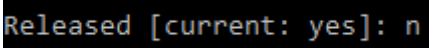
### Edit Summary



```
Summary [current: A super hero does stuff again]: Summary
```

**Figure 22:** Visual representation of Edit Summary

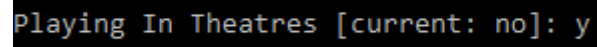
### Edit Released

A terminal window with a black background and light blue text. The text displayed is 'Released [current: yes]: n'.

```
Released [current: yes]: n
```

**Figure 23:** Visual representation of Edit Released

### Edit Playing In Theaters



```
Playing In Theatres [current: no]: y
```

**Figure 24:** Visual representation of Edit Playing In Theaters



### Edit Existing Keyword

```
Keyword #1: Action  
Keyword #2: Superhero  
Keyword [1 - 2]: 1  
Keyword #1 [current: Action]: Super Action
```

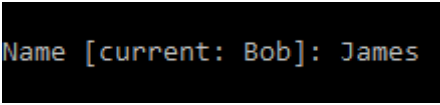
**Figure 25:** Visual representation of Edit Existing Keyword

## Edit Crew

```
[1]: Name: Bob
[2]: Name: Matt
Crew ID [1 - 2]: 1
-----
Update Crew
-----
1 - Edit Name
2 - Edit Job Title
3 - Cancel
-----
>
```

**Figure 26:** Visual representation of Edit Crew

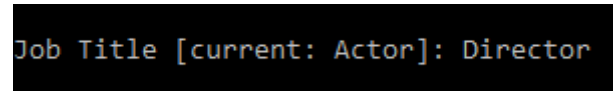
### Edit Crew Name



```
Name [current: Bob]: James
```

**Figure 27:** Visual representation of Edit Crew Name

### Edit Crew Job Title



```
Job Title [current: Actor]: Director
```

**Figure 28:** Visual representation of Edit Crew Job Title

## Remove Project

```
-----  
[1]: Title: A Great Movie  
[2]: Title: title  
-----  
Project ID [1 - 2]: 2
```

**Figure 29:** Visual representation of Remove Project

### Add Project Materials

```
Audio Format: hd
Run Time: 180
Language: ENG
Retail Price: 15
Subtitles: Subtitles
Frame Aspect:
16:19
Content: Content
Number of Additional Language Tracks: 1
Additional Language Track #1: FR
Number of Additional Subtitle Tracks: 1
Additional Subtitle Track #1: GR
Number of Bonus Features: 1
Bonus Feature #1: Bonus
```

**Figure 30:** Visual representation of Add Project Materials

### Add Project Materials - VHS

```
Audio Format: hd  
Run Time: 180  
Language: ENG  
Retail Price: 15  
Subtitles: Subtitles  
Frame Aspect: 16:9  
Audio Track: Audio  
[1] : Plastic  
[2] : Cardboard  
Packaging [1 - 2]: 1
```

**Figure 31:** Visual representation of Add Project Materials

## Update Project Materials

### Edit Audio Format

```
Audio Format: dolby
-----
Maintenance Mode
-----
1 - Add Project
2 - Update Project
3 - Update Project Materials
4 - Cancel
-----
> _
```

**Figure 32:** Visual representation of Edit Audio Format



### Edit Run Time

```
Run Time: 120
-----
Maintenance Mode
-----
1 - Add Project
2 - Update Project
3 - Update Project Materials
4 - Cancel
-----
> _
```

**Figure 33:** Visual representation of Edit Run Time

### Edit Language

```
Language: english
-----
Maintenance Mode
-----
1 - Add Project
2 - Update Project
3 - Update Project Materials
4 - Cancel
-----
> _
```

**Figure 34:** Visual representation of Edit Language

### Edit Retail Price

```
Retail Price [current: 120]: 500
-----
Maintenance Mode
-----
1 - Add Project
2 - Update Project
3 - Update Project Materials
4 - Cancel
-----
> _
```

**Figure 35:** Visual representation of Edit Retail Price

### Edit Subtitles

```
Subtitles: Hello
-----
Maintenance Mode
-----
1 - Add Project
2 - Update Project
3 - Update Project Materials
4 - Cancel
-----
> _
```

**Figure 36:** Visual representation of Edit Subtitles

### Edit Frame Aspect

```
Frame Aspect [current: 16:9]: 12:9
-----
Maintenance Mode
-----
1 - Add Project
2 - Update Project
3 - Update Project Materials
4 - Cancel
-----
> _
```

**Figure 37:** Visual representation of Edit Frame Aspect

## Edit Content

```
Content [current: big movie]: small movie
-----
Maintenance Mode
-----
1 - Add Project
2 - Update Project
3 - Remove Project
4 - Add Project Materials
5 - Update Project Materials
6 - Remove Project Materials
7 - Add Project Crew
8 - Update Project Crew
9 - Remove Project Crew
10 - Add Box Office Report
11 - Remove Box Office Report
12 - Cancel
-----
> _
```

**Figure 38:** Visual representation of Edit Content

### Edit Additional Language Tracks

```
Language Track #1: FRA
Language Track #2: GER
Additional Language Track [1 - 2]: 2
Additional Language Track #2 [current: GER]: ENG
-----
Maintenance Mode
-----
1 - Add Project
2 - Update Project
3 - Remove Project
4 - Add Project Materials
5 - Update Project Materials
6 - Remove Project Materials
7 - Add Project Crew
8 - Update Project Crew
9 - Remove Project Crew
10 - Add Box Office Report
11 - Remove Box Office Report
12 - Cancel
-----
> _
```

**Figure 39:** Visual representation of Edit Additional Language Tracks

### Edit Additional Subtitle Tracks

```
Subtitle Track #1: FRA
Subtitle Track #2: GER
Additional Subtitle Track [1 - 2]: 1
Additional Subtitle Track #1 [current: FRA]: ENG
-----
Maintenance Mode
-----
1 - Add Project
2 - Update Project
3 - Remove Project
4 - Add Project Materials
5 - Update Project Materials
6 - Remove Project Materials
7 - Add Project Crew
8 - Update Project Crew
9 - Remove Project Crew
10 - Add Box Office Report
11 - Remove Box Office Report
12 - Cancel
-----
> _
```

**Figure 40:** Visual representation of Edit Additional Subtitle Tracks



### Edit Bonus Features

```
Bonus Feature #1: Director's Comments
Bonus Feature [1 - 2]: 1
Bonus Feature #1 [current: Director's Comments]: Directors Cut
-----
Maintenance Mode
-----
1 - Add Project
2 - Update Project
3 - Remove Project
4 - Add Project Materials
5 - Update Project Materials
6 - Remove Project Materials
7 - Add Project Crew
8 - Update Project Crew
9 - Remove Project Crew
10 - Add Box Office Report
11 - Remove Box Office Report
12 - Cancel
-----
> _
```

**Figure 41:** Visual representation of Edit Bonus Features

## Edit Packaging

```
[1] : Plastic
[2] : Cardboard
Packaging [1 - 2]: 1
-----
Maintenance Mode
-----
1 - Add Project
2 - Update Project
3 - Remove Project
4 - Add Project Materials
5 - Update Project Materials
6 - Remove Project Materials
7 - Add Project Crew
8 - Update Project Crew
9 - Remove Project Crew
10 - Add Box Office Report
11 - Remove Box Office Report
12 - Cancel
-----
> _
```

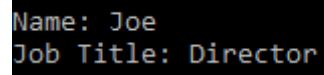
**Figure 42:** Visual representation of Edit Packaging

### Remove Project Materials

```
[1]: Format: dvd
[2]: Format: bluray
[3]: Format: boxset
[4]: Format: dsdvd
Material ID [1 - 4]: 4
-----
Main Menu
-----
1 - View Mode
2 - Maintenance Mode
3 - Quit
-----
> _
```

**Figure 43:** Visual representation of Remove Project Materials

### Add Project Crew

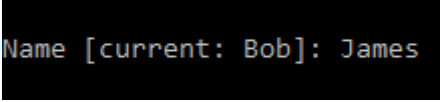


```
Name: Joe  
Job Title: Director
```

**Figure 44:** Visual representation of Add Project Crew

## Update Project Crew

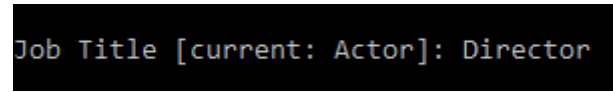
### Edit Crew Name



```
Name [current: Bob]: James
```

**Figure 45:** Visual representation of Edit Crew Name

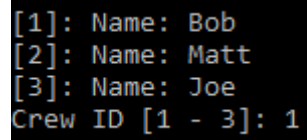
### Edit Crew Job Title



```
Job Title [current: Actor]: Director
```

**Figure 46:** Visual representation of Edit Crew Job Title

### Remove Project Crew



```
[1]: Name: Bob  
[2]: Name: Matt  
[3]: Name: Joe  
Crew ID [1 - 3]: 1
```

A terminal window with a black background and light blue text. It displays four lines of text: '[1]: Name: Bob', '[2]: Name: Matt', '[3]: Name: Joe', and 'Crew ID [1 - 3]: 1'.

**Figure 47:** Visual representation of Remove Project Crew

### Add Box Office Report

```
Week Number: 2
Revenue: 100
Tickets Sold: 10
-----
Maintenance Mode
-----
1 - Add Project
2 - Update Project
3 - Remove Project
4 - Add Project Materials
5 - Update Project Materials
6 - Remove Project Materials
7 - Add Project Crew
8 - Update Project Crew
9 - Remove Project Crew
10 - Add Box Office Report
11 - Remove Box Office Report
12 - Cancel
-----
> _
```

**Figure 48:** Visual representation of Add Box Office Report



### Remove Box Office Report

```
[1]: Week Number: 1
[2]: Week Number: 2
Crew ID [1 - 2]: 1
-----
Maintenance Mode
-----
1 - Add Project
2 - Update Project
3 - Remove Project
4 - Add Project Materials
5 - Update Project Materials
6 - Remove Project Materials
7 - Add Project Crew
8 - Update Project Crew
9 - Remove Project Crew
10 - Add Box Office Report
11 - Remove Box Office Report
12 - Cancel
-----
>
```

**Figure 49:** Visual representation of Remove Box Office Report

## Software Testing Procedure

Software Testing is an important part of the SDLC and within our project we have multiple constraints in place to ensure that tested, bug-free code is committed to the GitHub repository. Committing working code to the repository is important for a number of reasons, with some of these being:

- Developers will never pull broken code that will lead to a slow down in development.
- Developers will never have to fix someone else's broken code, avoiding time wasted on parts of the application that is not allocated to that developer.
- In case of a rollback, the repository will always be in a good state, which helps to avoid further rollbacks.

Some of the constraints that we have in place are:

- Developers will only commit code that has the associated unit tests created and those unit tests must pass.
- Developers must never commit broken code that could impede the efficiency of other developers, if a commit is required a new branch should be created.
- If there are known bugs, developers must log these within the GitHub Issues to ensure that other developers know that it is known/being worked on in case they come across it.

Our group is confident that these constraints will allow us to develop the application with fewer interruptions and ensure that only high quality, tested code is being pushed to the repository.

## User Manual

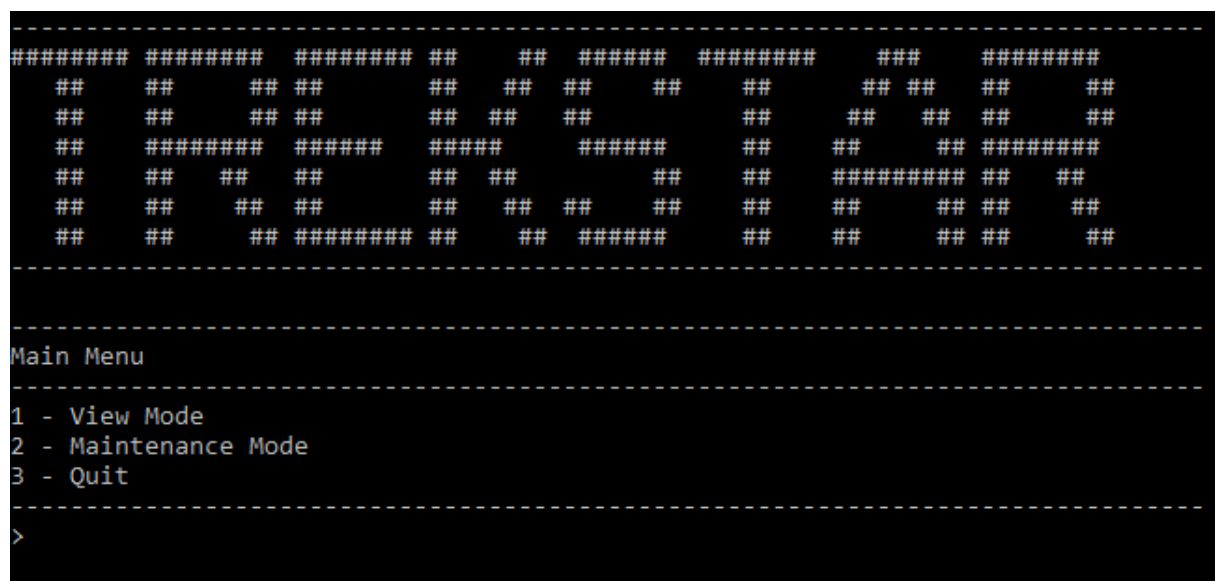
### Software Introduction

The Trekstar project management application has been developed for TrekStar Pictures and allows them to create and manage Projects along with their associated product materials and metadata. This guide will cover how to use the core features of the application, which includes:

- Using the main menu
- Using view mode
- Using maintenance mode

### Using the Main Menu

To use the Main Menu, open the application and you will be presented with the following screen



```
#####  
##  ##  ##  ##  ##  ##  ##  ##  ##  ##  ##  ##  ##  
##  ##  ##  ##  ##  ##  ##  ##  ##  ##  ##  ##  ##  
##  #####  #####  #####  #####  ##  ##  ##  #####  
##  ##  ##  ##  ##  ##  ##  ##  #####  ##  ##  
##  ##  ##  ##  ##  ##  ##  ##  ##  ##  ##  ##  
##  ##  ##  #####  ##  ##  #####  ##  ##  ##  ##  
-----  
Main Menu  
-----  
1 - View Mode  
2 - Maintenance Mode  
3 - Quit  
-----  
>
```

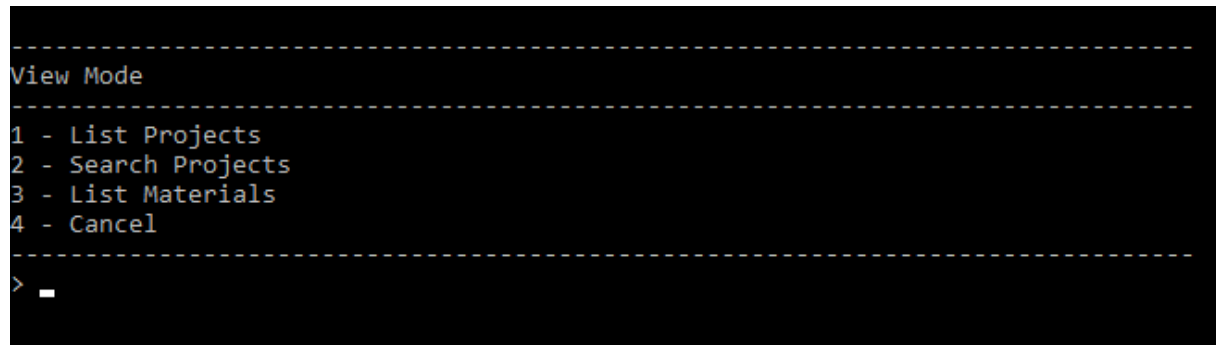
**Figure 50:** Visual representation of the Main Menu

Once on this screen, you can use the following keyboard inputs to navigate around the application, to find out more about each feature, click the associated information link.

Input Value	Command Action	Information Link
1	Inputting this value will cause the application to enter View Mode	Using View Mode
2	Inputting this value will cause the application to enter Maintenance Mode	Using Maintenance Mode
3	Inputting this value will cause the application to safely exit	Not required

## Using View Mode

Once you have reached the View Mode page you will be presented with the following screen

A screenshot of a terminal window with a black background and light blue text. The text displays a menu titled 'View Mode' followed by four numbered options: '1 - List Projects', '2 - Search Projects', '3 - List Materials', and '4 - Cancel'. The menu is enclosed in dashed lines. Below the menu, there is a prompt character '>' followed by a small white cursor bar.

```
View Mode
-----
1 - List Projects
2 - Search Projects
3 - List Materials
4 - Cancel
-----
> _
```

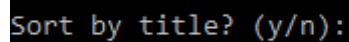
**Figure 51:** Visual representation of View Mode

Once on this screen, you can use the following keyboard inputs to navigate around view mode, to find out more about each feature, click the associated information link.

Input Value	Command Action	Information Link
1	Inputting this value will cause the application to list projects	<a href="#">Listing Projects</a>
2	Inputting this value will cause the application to enter search mode for projects	<a href="#">Using Search Projects</a>
3	Inputting this value will cause the application to navigate back to the main menu	<a href="#">Main Menu</a>

## Using List Projects

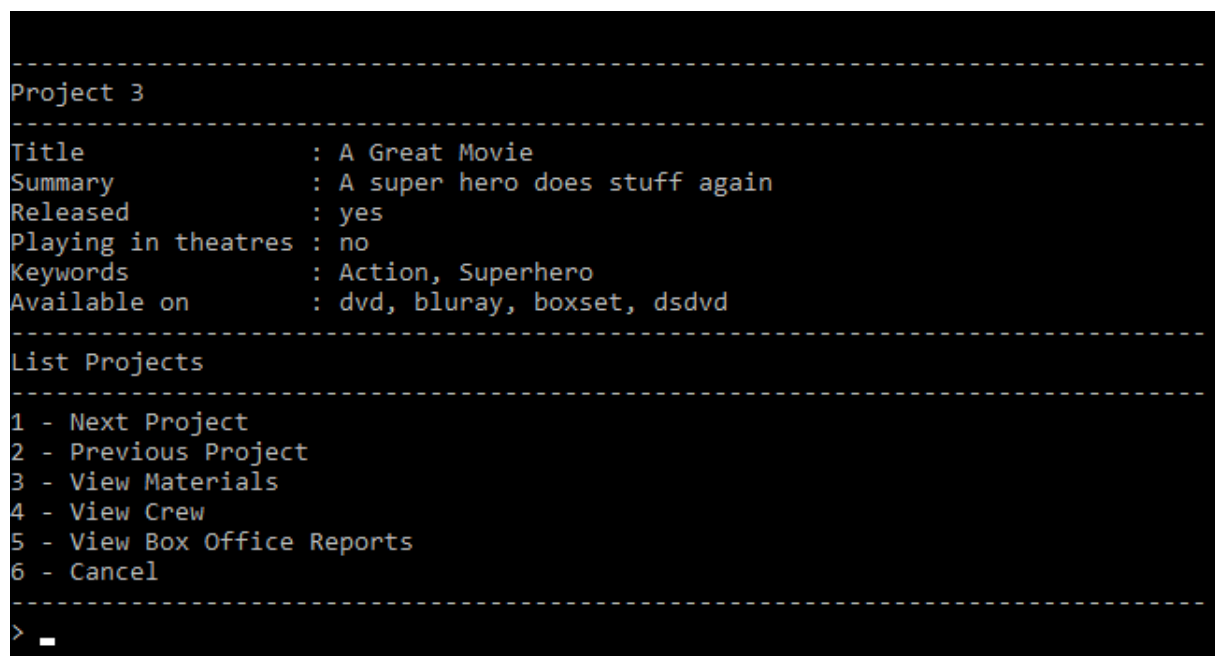
Once you have entered the List Projects functionality you will be asked if you wish to sort all of the projects by their title, you can enter *y* to confirm that you wish for the projects to be order by their titles and *n* to decline.



```
Sort by title? (y/n):
```

**Figure 52:** Visual representation of the application asking if you wish to sort by title

You will now see the projects that are held within your applications database, you can see an example of this below.



```
-----
Project 3
-----
Title           : A Great Movie
Summary         : A super hero does stuff again
Released        : yes
Playing in theatres : no
Keywords        : Action, Superhero
Available on     : dvd, bluray, boxset, dsdvd
-----
List Projects
-----
1 - Next Project
2 - Previous Project
3 - View Materials
4 - View Crew
5 - View Box Office Reports
6 - Cancel
-----
> _
```

**Figure 53:** Visual representation of project listings

As you can see in the figure above, there are more options available to you, these options allow you to navigate through the projects. You can see the associated input actions below.

Input		
Value	Command Action	Information Link
1	This will cause the application to move onto the next project in the database	Not Required

Input Value	Command Action	Information Link
2	This will cause the application to move onto the previous project in the database	Not Required
3	This will cause the application to enter the view materials functionality	View Materials
4	This will cause the application to enter the view crew functionality	View Crew
5	This will cause the application to enter the view box office reports functionality	View Box Office Reports
6	This will cause the application to navigate back to view mode	View Mode

## Using View Materials

Once you have reached the View Materials page you will be presented with the following screen

```
-----  
Material 0  
-----  
Additional Language Track 1 : FRA  
Additional Language Track 2 : GER  
Additional Subtitle Track 1 : FRA  
Additional Subtitle Track 2 : GER  
Audio Format : Dolby  
Bonus Features 1 : Director's Comments  
Content : big big movie  
Format : bluray  
Frame Aspect : 16:9  
Language : ENG  
Packaging : Plastic  
Retail Price : 13.990000  
Run Time : 655  
Subtitles : ENG  
-----  
List Materials  
-----  
1 - Next Material  
2 - Previous Material  
3 - Cancel  
-----  
> _
```

**Figure 54:** Visual representation of View Materials

Once on this screen, you can use the following keyboard inputs to navigate around view materials, to find out more about each feature, click the associated information link.

Input Value	Command Action
1	This will cause the application to move onto the next material in the database
2	This will cause the application to move onto the previous material in the database
3	This will cause the application to navigate back to List Projects



## Using View Crew

Once you have reached the View Crew page you will be presented with the following screen

```
Name      : Matt
Job Title : Director
-----
List Crew
-----
1 - Next Crew
2 - Previous Crew
3 - Cancel
-----
>
```

**Figure 55:** Visual representation of View Crew

Once on this screen, you can use the following keyboard inputs to navigate around view crew, to find out more about each feature, click the associated information link.

Input Value	Command Action
1	This will cause the application to move onto the next crew member in the database
2	This will cause the application to move onto the previous member in the database
3	This will cause the application to navigate back to List Projects

### Using View Box Office Reports

Once you have reached the View Box Office Reports page you will be presented with the following screen

```
-----
Box Office Report for Week Number 2
-----
Revenue           : 1000
Tickets Sold      : 100
-----
List Box Office Reports
-----
1 - Next Box Office Report
2 - Previous Box Office Report
3 - Cancel
-----
>
```

**Figure 56:** Visual representation of View Box Office Reports

Once on this screen, you can use the following keyboard inputs to navigate around view box office reports, to find out more about each feature, click the associated information link.

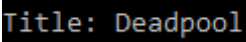
Input Value	Command Action
1	This will cause the application to move onto the next box office report in the database
2	This will cause the application to move onto the previous box office report in the database
3	This will cause the application to navigate back to List Projects

### Using Search Projects

Once you have entered the Search Projects functionality you will be asked to select what search type you would like to use, the following options will be provided:

Input Value	Command Action	Information Link
1	This will cause the application to enter the search by title functionality	Search By Title
2	This will cause the application to enter the search by actor functionality	View Crew
3	This will cause the application to navigate back to view mode	View Mode

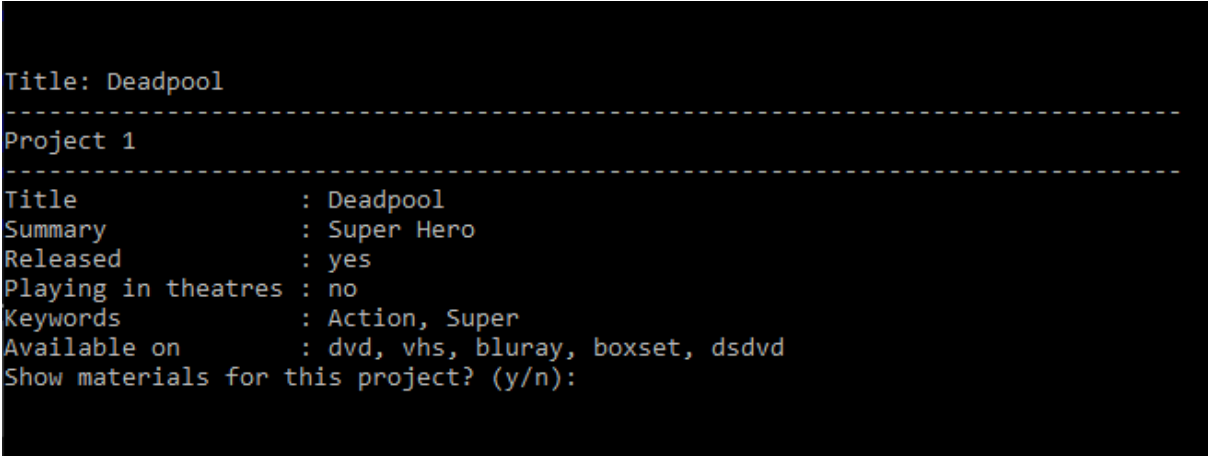
### Using Search By Title



```
Title: Deadpool
```

**Figure 57:** Visual representation of the application asking for a search query

You will now see the associated projects that matched to your search query, you can see an example of this below.



```
Title: Deadpool
-----
Project 1
-----
Title           : Deadpool
Summary         : Super Hero
Released        : yes
Playing in theatres : no
Keywords        : Action, Super
Available on     : dvd, vhs, bluray, boxset, dsdvd
Show materials for this project? (y/n):
```

**Figure 58:** Visual representation of a project being discovered from a search query

As you can see in the figure above, there is the option to display the associated materials for this project, you can enter *y* to confirm that you wish to view the materials for the associated project, which will bring up the following information:

```
-----  
Material 0  
-----  
Additional Language Track 1 : FRA  
Additional Language Track 2 : GER  
Additional Subtitle Track 1 : FRA  
Additional Subtitle Track 2 : GER  
Audio Format : Dolby  
Bonus Features 1 : Director's Comments  
Content : big big movie  
Format : bluray  
Frame Aspect : 16:9  
Language : ENG  
Packaging : Plastic  
Retail Price : 13.990000  
Run Time : 655  
Subtitles : ENG  
-----  
List Materials  
-----  
1 - Next Material  
2 - Previous Material  
3 - Cancel  
-----  
> _
```

**Figure 59:** Visual representation of a projects materials being displayed

As you can see in `CHANGEFIGUREVALUE`, there are more options available, you can find what each command does below

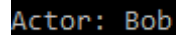
You can also enter *n* to confirm that you do not want to view the materials for the associated project, which will bring up the following information:

```
Title: Deadpool
-----
Project 1
-----
Title           : Deadpool
Summary         : Super Hero
Released        : yes
Playing in theatres : no
Keywords        : Action, Super
Available on    : dvd, vhs, bluray, boxset, dsdvd
Show materials for this project? (y/n): n
-----
View Mode
-----
1 - List Projects
2 - Search Projects
3 - Cancel
-----
> _
```

**Figure 60:** Visual representation of a projects materials not being displayed

As you can see in CHANGEFigureValue, there are more options available to you, these are the options associated with View Mode, therefore you can find more information by reading the View Mode section of this user guide.

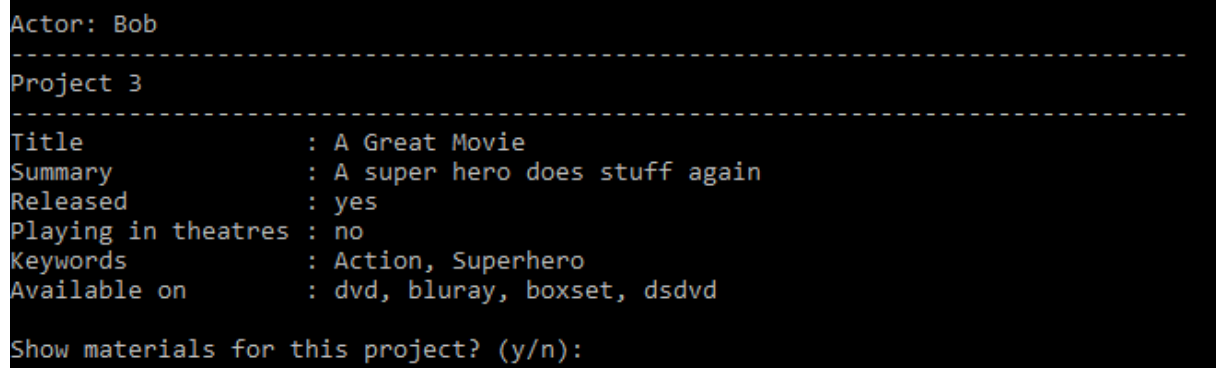
## Using Search By Actor



```
Actor: Bob
```

**Figure 61:** Visual representation of the application asking for a search query

You will now see the associated projects that matched to your search query, you can see an example of this below.



```
Actor: Bob
-----
Project 3
-----
Title           : A Great Movie
Summary         : A super hero does stuff again
Released        : yes
Playing in theatres : no
Keywords        : Action, Superhero
Available on    : dvd, bluray, boxset, dsdvd
Show materials for this project? (y/n):
```

**Figure 62:** Visual representation of a project being discovered from a search query

As you can see in the figure above, there is the option to display the associated materials for this project, you can enter *y* to confirm that you wish to view the materials for the associated project, which will bring up the following information:

```
-----
Material 0
-----
Additional Language Track 1 : FRA
Additional Language Track 2 : GER
Additional Subtitle Track 1 : FRA
Additional Subtitle Track 2 : GER
Audio Format : Dolby
Bonus Features 1 : Director's Comments
Content : big big movie
Format : bluray
Frame Aspect : 16:9
Language : ENG
Packaging : Plastic
Retail Price : 13.990000
Run Time : 655
Subtitles : ENG
-----
List Materials
-----
1 - Next Material
2 - Previous Material
3 - Cancel
-----
> _
```

**Figure 63:** Visual representation of a projects materials being displayed

As you can see in `CHANGEFIGUREVALUE`, there are more options available, you can find what each command does below

Input Value	Command Action
1	This will cause the application to move onto the next material in the database
2	This will cause the application to move onto the previous material in the database
3	This will cause the application to navigate back to View Mode

You can also enter *n* to confirm that you do not want to view the materials for the associated project, which will bring up the following information:



```
Actor: Bob
-----
Project 3
-----
Title           : A Great Movie
Summary         : A super hero does stuff again
Released        : yes
Playing in theatres : no
Keywords        : Action, Superhero
Available on    : dvd, bluray, boxset, dsdvd

Show materials for this project? (y/n): n
-----
View Mode
-----
1 - List Projects
2 - Search Projects
3 - Cancel
-----
>
```

**Figure 64:** Visual representation of a projects materials not being displayed

As you can see in `CHANGEFIGUREVALUE`, there are more options available to you, these are the options associated with View Mode, therefore you can find more information by reading the View Mode section of this user guide.

### Using List Materials

Once you have entered the List Materials functionality you will be asked to input a Project ID, this must be a numeric value, you can find the accepted Project IDs above the input location, select an ID from this list.

```
-----  
ID: 3, Title: A Great Movie  
ID: 4, Title: Back To The Future  
ID: 1, Title: Deadpool  
ID: 2, Title: Superheroes  
-----  
Project ID: 3_
```

**Figure 65:** Visual representation of selecting a Project ID to list materials for

You will now see the materials linked to the requested project that are held within your applications database, you can see an example of this below.

```
-----  
Material 0  
-----  
Additional Language Track 1 : FRA  
Additional Language Track 2 : GER  
Additional Subtitle Track 1 : FRA  
Additional Subtitle Track 2 : GER  
Audio Format : Dolby  
Bonus Features 1 : Director's Comments  
Content : big movie  
Format : dvd  
Frame Aspect : 16:9  
Language : ENG  
Packaging :  
Retail Price : 9.990000  
Run Time : 120  
Subtitles : ENG  
-----  
List Materials  
-----  
1 - Next Material  
2 - Previous Material  
3 - Cancel  
-----  
>
```

**Figure 66:** Visual representation of material listings

As you can see in Figure 10, there are more options available to you, these options allow you to navigate through the materials. You can see the associated input actions below.

---

Input Value	Command Action
1	This will cause the application to move onto the next material in the database
2	This will cause the application to move onto the previous material in the database
3	This will cause the application to navigate back to View Mode

---

## Using Maintenance Mode

Once you have reached the Maintenance Mode page you will be presented with the following screen

```
-----
Maintenance Mode
-----
1 - Add Project
2 - Update Project
3 - Remove Project
4 - Add Project Materials
5 - Update Project Materials
6 - Remove Project Materials
7 - Add Project Crew
8 - Update Project Crew
9 - Remove Project Crew
10 - Add Box Office Report
11 - Remove Box Office Report
12 - Cancel
-----
>
```

**Figure 67:** Visual representation of Maintenance Mode

Once on this screen, you can use the following keyboard inputs to navigate around maintenance mode, to find out more about each feature, click the associated information link.

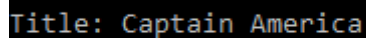
Input Value	Command Action	Information Link
1	Inputting this value will cause the application to enter add project	<a href="#">Adding Projects</a>
2	Inputting this value will cause the application to enter update project	<a href="#">Updating Projects</a>
3	Inputting this value will cause the application to enter remove project	<a href="#">Removing Projects</a>
4	Inputting this value will cause the application to enter update project materials	<a href="#">Add Project Materials</a>
4	Inputting this value will cause the application to enter update project materials	<a href="#">Updating Project Materials</a>
5	Inputting this value will cause the application to enter remove project materials	<a href="#">Removing Project Materials</a>

Input Value	Command Action	Information Link
4	Inputting this value will cause the application to enter update project materials	Add Project Crew
4	Inputting this value will cause the application to enter update project materials	Updating Project Crew
5	Inputting this value will cause the application to enter remove project materials	Removing Project Crew
4	Inputting this value will cause the application to enter update project materials	Add Box Office Report
4	Inputting this value will cause the application to enter update project materials	Updating Box Office Report
6	Inputting this value will cause the application to navigate back to the main menu	Main Menu

### Using Add Project

Once you have entered the Add Project functionality you will be asked to enter the following information:

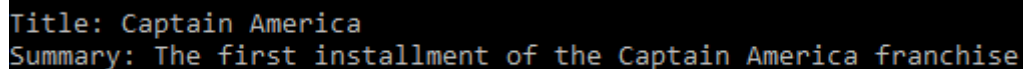
Firstly, you need to enter the Project Title, this is the name that you want your project to be called. Any value is accepted.



```
Title: Captain America
```

**Figure 68:** Visual representation of the application asking for a Project Title

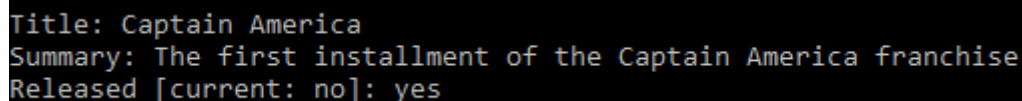
Next, you will be asked for a project summary. Any value is accepted.



```
Title: Captain America  
Summary: The first installment of the Captain America franchise
```

**Figure 69:** Visual representation of the application asking for Project Summary

Next, you will be asked if the project has been released. Only the values *y* and *n* are accepted. With *y* confirming that the project has been released and *n* confirming that the project has not been released.



```
Title: Captain America  
Summary: The first installment of the Captain America franchise  
Released [current: no]: yes
```

**Figure 70:** Visual representation of the application asking if the project has been released

Next, you will be asked if the project will be playing in theaters. Only the values *y* and *n* are accepted. With *y* confirming that the project will be playing in theatres and *n* confirming that the project will not be playing in theatres.

```
Title: Captain America
Summary: The first installment of the Captain America franchise
Released [current: no]: yes
Playing In Theatres [current: no]: yes
```

**Figure 71:** Visual representation of the application asking if the project will be playing in theatres

Next, you will be asked how many keywords you would like associating with the project. Any numeric value is accepted.

```
Title: Deadpool 3
Summary: Deadpool
Released [current: no]: y
Playing In Theatres [current: no]: y
Number of Keywords: 1_
```

**Figure 72:** Visual representation of the application asking how many keywords should be associated with the project

Finally, you will be asked what keywords you would like associated with the project, the amount of keyword requests depends on the previously entered numeric value. Any value is accepted.

```
Title: Deadpool 3
Summary: Deadpool
Released [current: no]: y
Playing In Theatres [current: no]: y
Number of Keywords: 1
Keyword: Marvel
```

**Figure 73:** Visual representation of the application asking for a keyword

As you can see in CHANGEFigureValue, there are more options available to you, these are the options associated with Maintenance Mode, therefore you can find more information by reading the Maintenance Mode section of this user guide.

## Using Update Project

Once you have entered the Update Project functionality you will be asked to enter the following information:

Firstly, you need to enter a Project ID, this must be a numeric value, you can find the accepted Project IDs above the input location, select an ID from this list.

```
-----  
[1]: Title: A Great Movie  
[2]: Title: Deadpool  
-----  
Project ID [1 - 2]: 1_
```

**Figure 74:** Visual representation of selecting a Project ID to update the project for

Next, you will be presented with multiple options, you can use the following keyboard inputs to update certain aspects of the project, to find out more about each update, click the associated information link.

Input Value	Command Action	Information Link
1	Inputting this value will cause the application to enter edit title	Edit Title
2	Inputting this value will cause the application to enter edit summary	Edit Summary
3	Inputting this value will cause the application to enter edit released	Edit Released
4	Inputting this value will cause the application to enter edit playing in theatres	Edit Playing In Theatres
4	Inputting this value will cause the application to enter edit existing keywords	Edit Existing Keywords
5	Inputting this value will cause the application to enter edit existing keywords	Edit Crew
6	Inputting this value will cause the application to navigate back to the maintenance mode menu	Maintenance Mode Menu



## Edit Title

Once you have entered the Edit Title functionality you will be asked to enter the following information:

You need to enter the new Project Title, this is the new name that you want your project to be called. Any value is accepted.

```
Title [current: A Great Movie]: An even greater movie
-----
Maintenance Mode
-----
1 - Add Project
2 - Update Project
3 - Update Project Materials
4 - Cancel
-----
> _
```

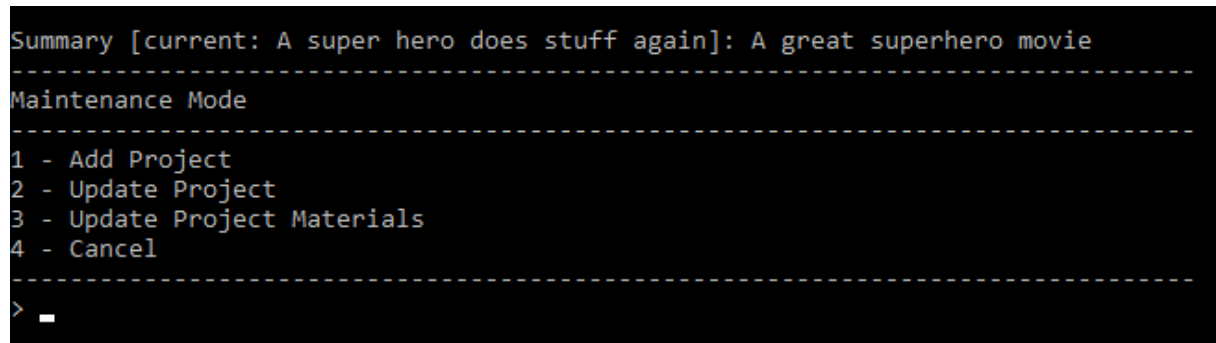
**Figure 75:** Visual representation of the application asking for a new Project Title

As you can see in the figure above, there are more options available to you, these are the options associated with Maintenance Mode, therefore you can find more information by reading the Maintenance Mode section of this user guide.

## Edit Summary

Once you have entered the Edit Summary functionality you will be asked to enter the following information:

You need to enter the new Project Summary, this is the new summary that you want your project to have. Any value is accepted.



```
Summary [current: A super hero does stuff again]: A great superhero movie
-----
Maintenance Mode
-----
1 - Add Project
2 - Update Project
3 - Update Project Materials
4 - Cancel
-----
> _
```

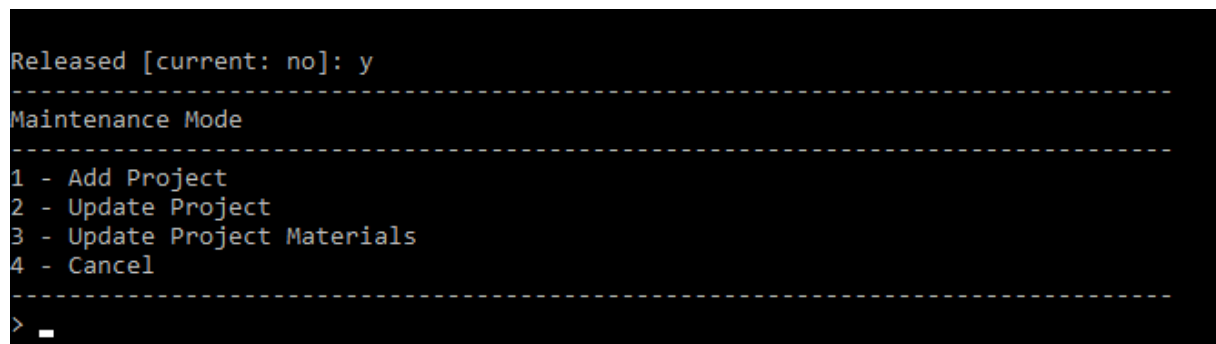
**Figure 76:** Visual representation of the application asking for a new Project Summary

As you can see in the figure above, there are more options available to you, these are the options associated with Maintenance Mode, therefore you can find more information by reading the Maintenance Mode section of this user guide.

## Edit Released

Once you have entered the Edit Released functionality you will be asked to enter the following information:

You need to enter the new Released value, this is the new released state that you want your project to have. Only the values *y* and *n* are accepted. With *y* confirming that the project is released and *n* confirming that the project is not released.



```
Released [current: no]: y
-----
Maintenance Mode
-----
1 - Add Project
2 - Update Project
3 - Update Project Materials
4 - Cancel
-----
> _
```

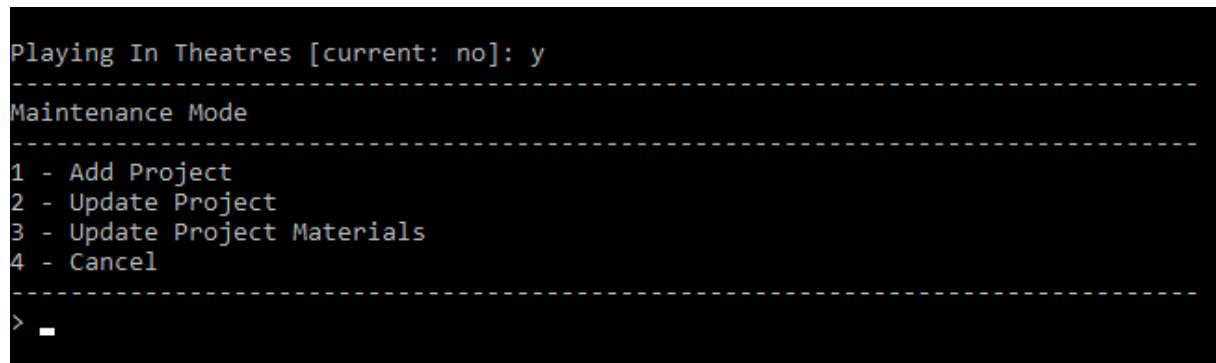
**Figure 77:** Visual representation of the application asking for a new Released value

As you can see in the figure above, there are more options available to you, these are the options associated with Maintenance Mode, therefore you can find more information by reading the Maintenance Mode section of this user guide.

### Edit Playing In Theaters

Once you have entered the Edit Playing In Theaters functionality you will be asked to enter the following information:

You need to enter the new playing in theatres value, this is the new playing in theaters state that you want your project to have. Only the values *y* and *n* are accepted. With *y* confirming that the project will be playing in theatres and *n* confirming that the project will not be playing in theatres.



```
Playing In Theatres [current: no]: y
-----
Maintenance Mode
-----
1 - Add Project
2 - Update Project
3 - Update Project Materials
4 - Cancel
-----
> _
```

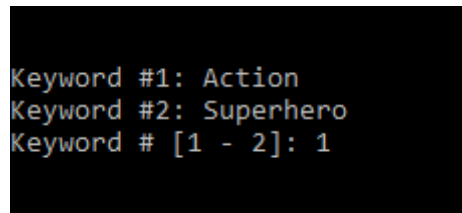
**Figure 78:** Visual representation of the application asking for a new Project Title

As you can see in the figure above, there are more options available to you, these are the options associated with Maintenance Mode, therefore you can find more information by reading the Maintenance Mode section of this user guide.

### Edit Existing Keywords

Once you have entered the Edit Existing Keywords functionality you will be asked to enter the following information:

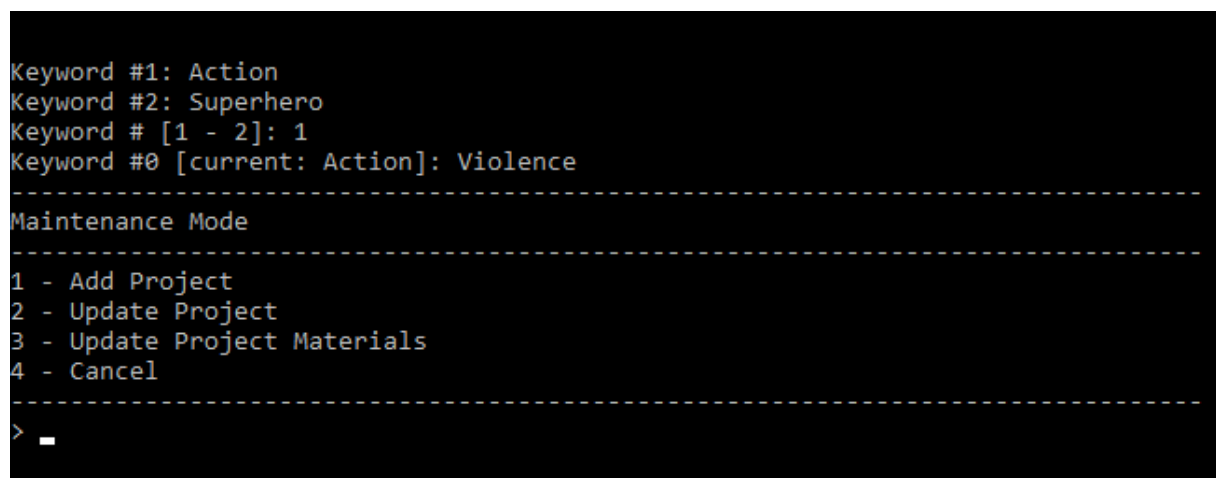
You need to enter the keyword identifier you wish to update, you can find the identifier in the provided list, an example of this can be seen below:



```
Keyword #1: Action
Keyword #2: Superhero
Keyword # [1 - 2]: 1
```

**Figure 79:** Visual representation of the application showing the current Keyword identifiers

Once you have inputted a valid keyword identifier you will be asked to enter your new Keyword, any value is accepted.



```
Keyword #1: Action
Keyword #2: Superhero
Keyword # [1 - 2]: 1
Keyword #0 [current: Action]: Violence
-----
Maintenance Mode
-----
1 - Add Project
2 - Update Project
3 - Update Project Materials
4 - Cancel
-----
> _
```

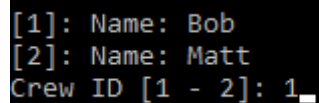
**Figure 80:** Visual representation of the application asking for a new keyword

As you can see in the figure above, there are more options available to you, these are the options associated with Maintenance Mode, therefore you can find more information by reading the Maintenance Mode section of this user guide.

## Edit Crew

Once you have entered the Edit Crew functionality you will be asked to enter the following information:

You need to enter the crew identifier you wish to update, you can find the identifier in the provided list, an example of this can be seen below:



```
[1]: Name: Bob  
[2]: Name: Matt  
Crew ID [1 - 2]: 1_
```

**Figure 81:** Visual representation of the application showing the current Crew identifiers

Once you have inputted a valid keyword identifier you will be asked to enter the type of data you would like to update, you can find the associated values below, to find out more about each function, click the associated information link.

Input Value	Command Action	Information Link
1	Inputting this value will cause the application to enter update crew name	<a href="#">Edit Name</a>
2	Inputting this value will cause the application to enter update crew job title	<a href="#">Edit Job Title</a>
3	Inputting this value will cause the application to navigate back to the maintenance mode menu	<a href="#">Maintenance Mode Menu</a>

### Edit Crew Name

Once you have entered the Edit Crew Name functionality you will be asked to enter the following information:

You need to enter the new Crew Name, this is the new name for the crew member that you selected. Any value is accepted.

```
Name [current: Tim]: Jones
-----
Maintenance Mode
-----
1 - Add Project
2 - Update Project
3 - Remove Project
4 - Add Project Materials
5 - Update Project Materials
6 - Remove Project Materials
7 - Add Project Crew
8 - Update Project Crew
9 - Remove Project Crew
10 - Add Box Office Report
11 - Remove Box Office Report
12 - Cancel
-----
> _
```

**Figure 82:** Visual representation of the application asking for a new Crew Name

As you can see in the figure above, there are more options available to you, these are the options associated with Maintenance Mode, therefore you can find more information by reading the Maintenance Mode section of this user guide.

### Edit Crew Job Title

Once you have entered the Edit Crew Job Title functionality you will be asked to enter the following information:

You need to enter the new Crew Job Title, this is the new job title for the crew member that you selected. Any value is accepted.

```
Job Title [current: Actor]: Producer
-----
Maintenance Mode
-----
1 - Add Project
2 - Update Project
3 - Remove Project
4 - Add Project Materials
5 - Update Project Materials
6 - Remove Project Materials
7 - Add Project Crew
8 - Update Project Crew
9 - Remove Project Crew
10 - Add Box Office Report
11 - Remove Box Office Report
12 - Cancel
-----
>
```

**Figure 83:** Visual representation of the application asking for a new Crew Name

As you can see in the figure above, there are more options available to you, these are the options associated with Maintenance Mode, therefore you can find more information by reading the Maintenance Mode section of this user guide.

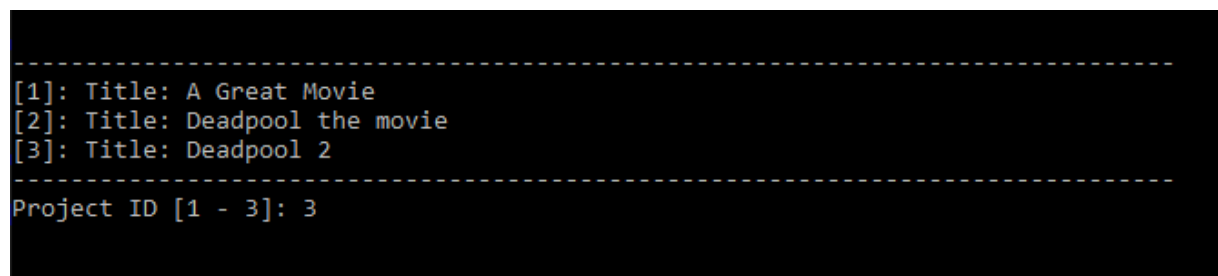


### Using Remove Project

Once you have entered the Remove Project functionality you will be asked to enter the following information:

You only need to enter a Project ID, this must be a numeric value, you can find the accepted Project IDs above the input location, select an ID from this list.

Once you submit this Project ID it will be removed from the database.



```
-----  
[1]: Title: A Great Movie  
[2]: Title: Deadpool the movie  
[3]: Title: Deadpool 2  
-----  
Project ID [1 - 3]: 3
```

**Figure 84:** Visual representation of selecting a Project ID to update the project for

As you can see in the figure above, there are more options available to you, these are the options associated with Maintenance Mode, therefore you can find more information by reading the Maintenance Mode section of this user guide.

### Using Add Project Materials

Once you have entered the Add Project Materials functionality you will be asked to enter the following information:

Firstly, you need to enter a Project ID, this must be a numeric value, you can find the accepted Project IDs above the input location, select an ID from this list.

```
-----  
[1]: Title: A Great Movie  
[2]: Title: Deadpool  
-----  
Project ID [1 - 2]: 1_
```

**Figure 85:** Visual representation of selecting a Project ID to proceed with selecting a project to add a material to

Next, you will be asked to enter the material format identifier you wish to add within the previously selected project, you can find the identifier in the provided list, an example of this can be found below:

```
-----  
Material Format:  
-----  
1 - DVD  
2 - Double Sided DVD  
3 - Bluray  
4 - VHS  
5 - Box Set  
-----  
> 1
```

**Figure 86:** Visual representation of selecting a Material Format ID to add to the project

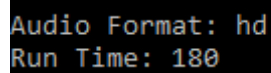
Once you have selected a Material Format ID you will be asked to enter the following information:

Next, you need to enter the Audio Format, this is the audio format that you want your material to have. Any value is accepted.

```
Audio Format: hd
```

**Figure 87:** Visual representation of the application asking for a Project Title

Next, you will be asked for the material run time. Any numeric value is accepted.

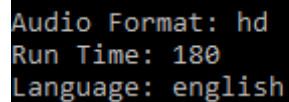


```
Audio Format: hd
Run Time: 180
```

A terminal window with a black background and green text. It displays two lines of text: "Audio Format: hd" and "Run Time: 180".

**Figure 88:** Visual representation of the application asking for the material Run Time

Next, you will be asked for the material language. Any value is accepted.

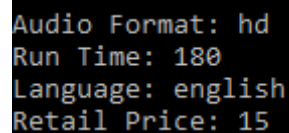


```
Audio Format: hd
Run Time: 180
Language: english
```

A terminal window with a black background and green text. It displays three lines of text: "Audio Format: hd", "Run Time: 180", and "Language: english".

**Figure 89:** Visual representation of the application asking for the material Language

Next, you will be asked for the material retail price. Any numeric value is accepted.

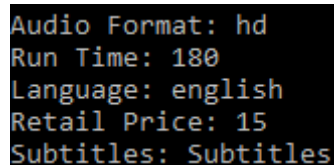


```
Audio Format: hd
Run Time: 180
Language: english
Retail Price: 15
```

A terminal window with a black background and green text. It displays four lines of text: "Audio Format: hd", "Run Time: 180", "Language: english", and "Retail Price: 15".

**Figure 90:** Visual representation of the application asking for the material Retail Price

Next, you will be asked for the material subtitles. Any value is accepted.



```
Audio Format: hd
Run Time: 180
Language: english
Retail Price: 15
Subtitles: Subtitles
```

A terminal window with a black background and green text. It displays five lines of text: "Audio Format: hd", "Run Time: 180", "Language: english", "Retail Price: 15", and "Subtitles: Subtitles".

**Figure 91:** Visual representation of the application asking for the material Subtitles

Next, you will be asked for the material frame aspect. Any value is accepted.

```
Audio Format: hd
Run Time: 180
Language: english
Retail Price: 15
Subtitles: Subtitles
Frame Aspect: 16:9
```

**Figure 92:** Visual representation of the application asking for the material Frame Aspect

Next, you will be asked for the material content. Any value is accepted.

```
Audio Format: hd
Run Time: 180
Language: english
Retail Price: 15
Subtitles: Subtitles
Frame Aspect: 16:9
Content: Content
```

**Figure 93:** Visual representation of the application asking for the material Content

Next, you will be asked if the material has any additional language tracks. Any value is accepted, if you enter anything other than 0 you will be asked for the Additional Language track otherwise you can move onto the next input.

```
Audio Format: hd
Run Time: 180
Language: english
Retail Price: 15
Subtitles: Subtitles
Frame Aspect: 16:9
Content: Content
Number of Additional Language Tracks: 1
```

**Figure 94:** Visual representation of the application asking if the material has any additional language tracks

If you entered more than 0 the application will ask you to enter the following information for the amount of language tracks added.

```
Audio Format: hd
Run Time: 180
Language: english
Retail Price: 15
Subtitles: Subtitles
Frame Aspect: 16:9
Content: Content
Number of Additional Language Tracks: 1
Additional Language Track #1: french_
```

**Figure 95:** Visual representation of the application asking for material additional language track information

Next, you will be asked if the material has any additional subtitle tracks. Any value is accepted, if you enter anything other than 0 you will be asked for the Additional Subtitle track otherwise you can move onto the next input.

```
Audio Format: hd
Run Time: 180
Language: english
Retail Price: 15
Subtitles: Subtitles
Frame Aspect: 16:9
Content: Content
Number of Additional Language Tracks: 1
Additional Language Track #1: french
Number of Additional Subtitle Tracks: 1
```

**Figure 96:** Visual representation of the application asking if the material has any additional subtitle tracks

If you entered more than 0 the application will ask you to enter the following information for the amount of subtitle tracks added.

```
Audio Format: hd
Run Time: 180
Language: english
Retail Price: 15
Subtitles: Subtitles
Frame Aspect: 16:9
Content: Content
Number of Additional Language Tracks: 1
Additional Language Track #1: french
Number of Additional Subtitle Tracks: 1
Additional Subtitle Track #1: spanish
```

**Figure 97:** Visual representation of the application asking for material additional subtitle track information

Finally, you will be asked if the material has any additional bonus features. Any value is accepted, if you enter anything other than 0 you will be asked for the Bonus Feature otherwise you can move onto the next input.

```
Audio Format: hd
Run Time: 180
Language: english
Retail Price: 15
Subtitles: Subtitles
Frame Aspect: 16:9
Content: Content
Number of Additional Language Tracks: 1
Additional Language Track #1: french
Number of Additional Subtitle Tracks: 1
Additional Subtitle Track #1: spanish
Number of Bonus Features: 1
```

**Figure 98:** Visual representation of the application asking if the material has any bonus features

If you entered more than 0 the application will ask you to enter the following information for the amount of bonus features added.

```
Audio Format: hd
Run Time: 180
Language: english
Retail Price: 15
Subtitles: Subtitles
Frame Aspect: 16:9
Content: Content
Number of Additional Language Tracks: 1
Additional Language Track #1: french
Number of Additional Subtitle Tracks: 1
Additional Subtitle Track #1: spanish
Number of Bonus Features: 1
Bonus Feature #1: behind the scenes
-----
Maintenance Mode
-----
1 - Add Project
2 - Update Project
3 - Remove Project
4 - Add Project Materials
5 - Update Project Materials
6 - Remove Project Materials
7 - Add Project Crew
8 - Update Project Crew
9 - Remove Project Crew
10 - Add Box Office Report
11 - Remove Box Office Report
12 - Cancel
-----
> _
```

**Figure 99:** Visual representation of the application asking for material bonus feature information

As you can see in `CHANGEFIGUREVALUE`, there are more options available to you, these are the options associated with Maintenance Mode, therefore you can find more information by reading the Maintenance Mode section of this user guide.

### Using Update Project Materials

Once you have entered the Update Project Materials functionality you will be asked to enter the following information:

Firstly, you need to enter a Project ID, this must be a numeric value, you can find the accepted Project IDs above the input location, select an ID from this list.

```
-----  
[1]: Title: A Great Movie  
[2]: Title: Deadpool  
-----  
Project ID [1 - 2]: 1_
```

**Figure 100:** Visual representation of selecting a Project ID to proceed with selecting a material to update

Next, you will be asked to enter the material identifier you wish to update within the previously selected project, you can find the identifier in the provided list, an example of this can be found below:

```
[1]: Format: dvd  
[2]: Format: bluray  
[3]: Format: boxset  
[4]: Format: dsdvd  
[5]: Format: dvd  
[6]: Format: dvd  
Material ID [1 - 6]: 1
```

**Figure 101:** Visual representation of selecting a Material ID to update the material for

Next, you will be presented with multiple options, you can use the following keyboard inputs to update certain aspects of the material, to find out more about each update, click the associated information link.

Input Value	Command Action	Information Link
1	Inputting this value will cause the application to enter edit audio format	<a href="#">Edit Audio Format</a>
2	Inputting this value will cause the application to enter edit run time	<a href="#">Edit Run Time</a>



Input Value	Command Action	Information Link
3	Inputting this value will cause the application to enter edit language	Edit Language
4	Inputting this value will cause the application to enter edit retail price	Edit Retail Price
5	Inputting this value will cause the application to enter edit subtitles	Edit Subtitles
6	Inputting this value will cause the application to enter edit frame aspect	Edit Frame Aspect
7	Inputting this value will cause the application to enter edit content	Edit Content
8	Inputting this value will cause the application to enter edit additional language tracks	Edit Additional Language Tracks
9	Inputting this value will cause the application to enter edit additional subtitle tracks	Edit Additional Subtitle Tracks
10	Inputting this value will cause the application to enter edit bonus features	Edit Bonus Features
11	Inputting this value will cause the application to navigate back to the maintenance mode menu	Maintenance Mode Menu

If you selected VHS, you will see the following options.

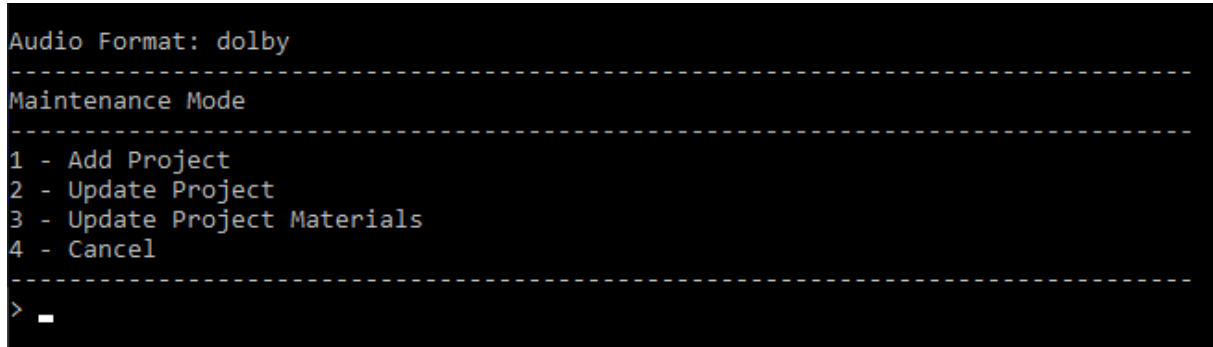
Input Value	Command Action	Information Link
1	Inputting this value will cause the application to enter edit audio format	Edit Audio Format
2	Inputting this value will cause the application to enter edit run time	Edit Run Time
3	Inputting this value will cause the application to enter edit language	Edit Language
4	Inputting this value will cause the application to enter edit retail price	Edit Retail Price

Input Value	Command Action	Information Link
5	Inputting this value will cause the application to enter edit subtitles	Edit Subtitles
6	Inputting this value will cause the application to enter edit frame aspect	Edit Frame Aspect
7	Inputting this value will cause the application to enter edit packaging	Edit Packaging
8	Inputting this value will cause the application to enter edit audio track	Edit Audio Track
9	Inputting this value will cause the application to navigate back to the maintenance mode menu	Maintenance Mode Menu

### Edit Audio Format

Once you have entered the Audio Format functionality you will be asked to enter the following information:

You need to enter the new Audio Format, this is the new audio format that you want your material to have. Any value is accepted.

A terminal window with a black background and green text. The first line shows 'Audio Format: dolby'. Below it is a dashed line. The next line is 'Maintenance Mode', followed by another dashed line. Then a list of four options: '1 - Add Project', '2 - Update Project', '3 - Update Project Materials', and '4 - Cancel'. This is followed by a third dashed line. The final line shows a prompt character '>' followed by a cursor bar.

```
Audio Format: dolby
-----
Maintenance Mode
-----
1 - Add Project
2 - Update Project
3 - Update Project Materials
4 - Cancel
-----
> _
```

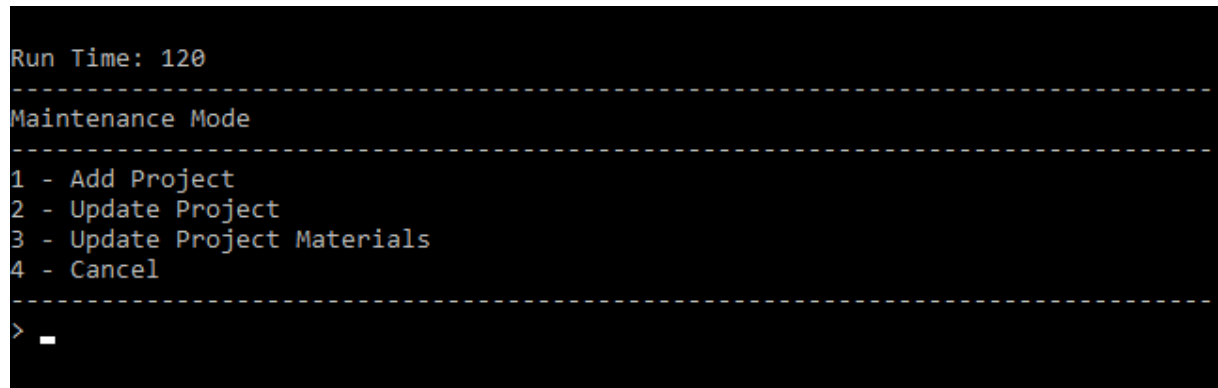
**Figure 102:** Visual representation of the application asking for a new Audio Format

As you can see in the figure above, there are more options available to you, these are the options associated with Maintenance Mode, therefore you can find more information by reading the Maintenance Mode section of this user guide.

### Edit Run Time

Once you have entered the Edit Run Time functionality you will be asked to enter the following information:

You need to enter the new Run Time, this is the new run time that you want your material to have. Any numeric value is accepted.



```
Run Time: 120
-----
Maintenance Mode
-----
1 - Add Project
2 - Update Project
3 - Update Project Materials
4 - Cancel
-----
> _
```

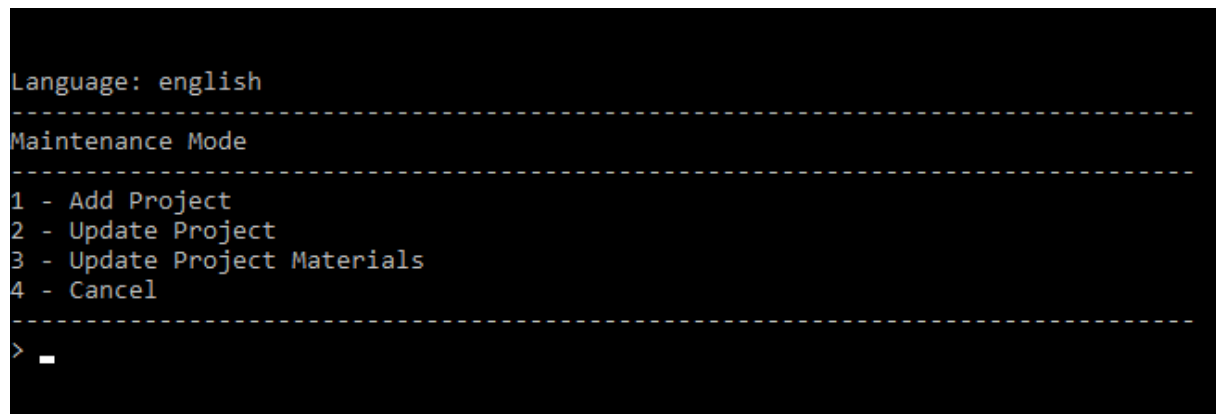
**Figure 103:** Visual representation of the application asking for a new Run Time

As you can see in the figure above, there are more options available to you, these are the options associated with Maintenance Mode, therefore you can find more information by reading the Maintenance Mode section of this user guide.

## Edit Language

Once you have entered the Edit Language functionality you will be asked to enter the following information:

You need to enter the new Language, this is the new language that you want your material to have. Any value is accepted.



```
Language: english
-----
Maintenance Mode
-----
1 - Add Project
2 - Update Project
3 - Update Project Materials
4 - Cancel
-----
> _
```

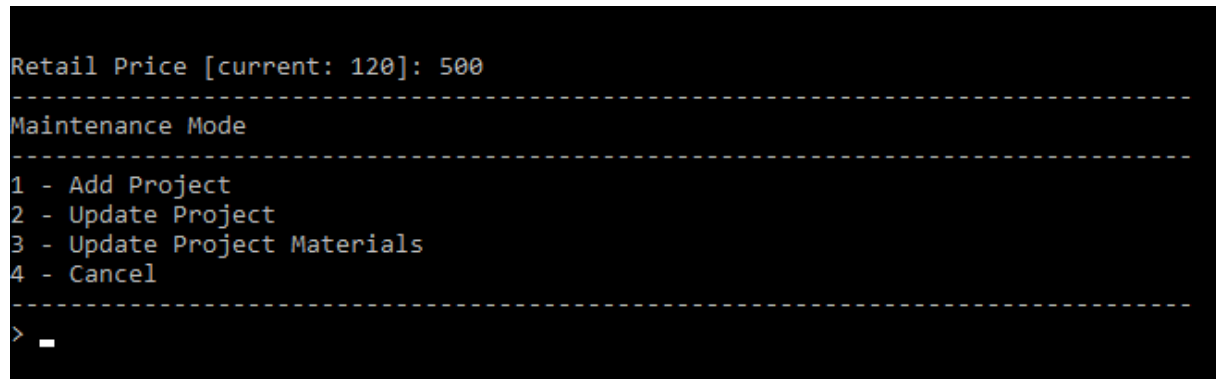
**Figure 104:** Visual representation of the application asking for a new Language

As you can see in the figure above, there are more options available to you, these are the options associated with Maintenance Mode, therefore you can find more information by reading the Maintenance Mode section of this user guide.

### Edit Retail Price

Once you have entered the Edit Retail Price functionality you will be asked to enter the following information:

You need to enter the new Retail Price, this is the new retail price that you want your material to have. Any numeric value is accepted.



```
Retail Price [current: 120]: 500
-----
Maintenance Mode
-----
1 - Add Project
2 - Update Project
3 - Update Project Materials
4 - Cancel
-----
> _
```

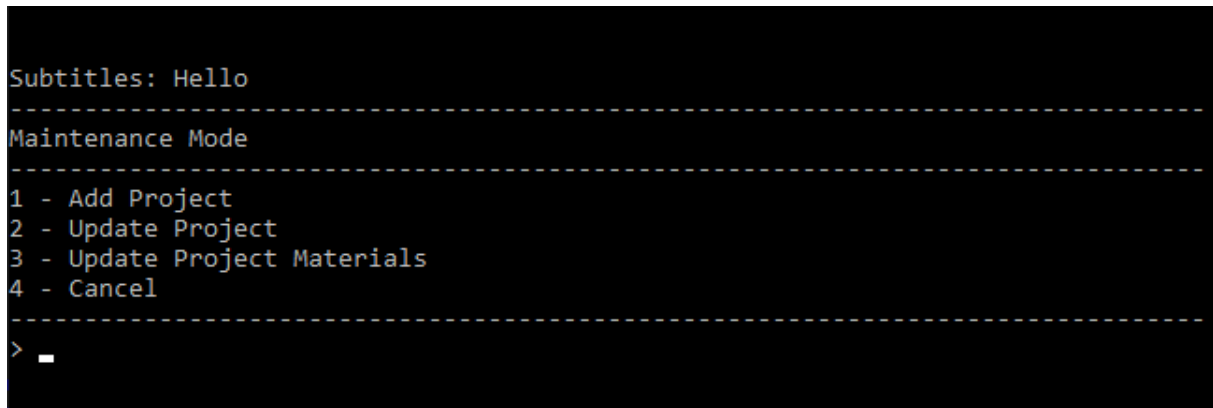
**Figure 105:** Visual representation of the application asking for a new Retail Price

As you can see in the figure above, there are more options available to you, these are the options associated with Maintenance Mode, therefore you can find more information by reading the Maintenance Mode section of this user guide.

## Edit Subtitles

Once you have entered the Edit Subtitles functionality you will be asked to enter the following information:

You need to enter the new Subtitles, this is the new subtitles that you want your material to have. Any value is accepted.



```
Subtitles: Hello
-----
Maintenance Mode
-----
1 - Add Project
2 - Update Project
3 - Update Project Materials
4 - Cancel
-----
> _
```

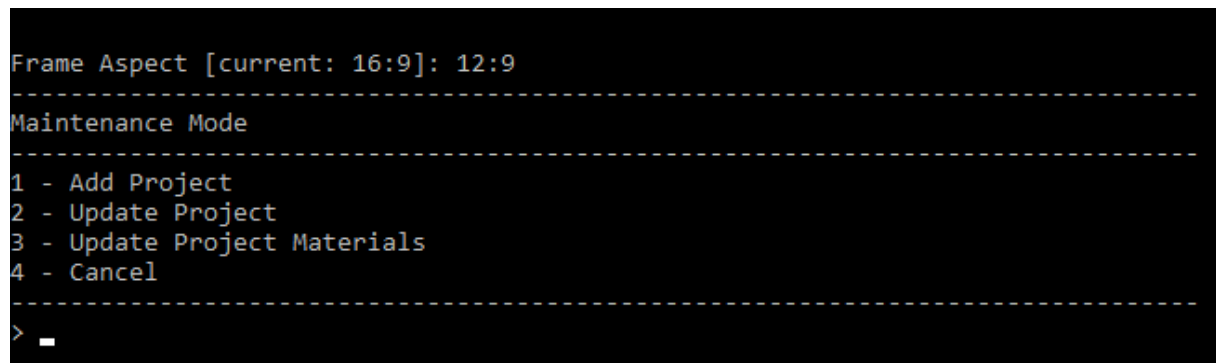
**Figure 106:** Visual representation of the application asking for new Subtitles

As you can see in the figure above, there are more options available to you, these are the options associated with Maintenance Mode, therefore you can find more information by reading the Maintenance Mode section of this user guide.

### Edit Frame Aspect

Once you have entered the Edit Frame Aspect functionality you will be asked to enter the following information:

You need to enter the new Frame Aspect, this is the new frame aspect that you want your material to have. Any value is accepted.



```
Frame Aspect [current: 16:9]: 12:9
-----
Maintenance Mode
-----
1 - Add Project
2 - Update Project
3 - Update Project Materials
4 - Cancel
-----
> _
```

**Figure 107:** Visual representation of the application asking for a new Frame Aspect

As you can see in the figure above, there are more options available to you, these are the options associated with Maintenance Mode, therefore you can find more information by reading the Maintenance Mode section of this user guide.



## Edit Packaging

Once you have entered the Edit Packaging functionality you will be asked to enter the following information:

You need to select from the list of packaging types, this is the new packaging type that you want your material to have. Any value from 1-2 is accepted.

```
[1] : Plastic
[2] : Cardboard
Packaging [1 - 2]: 1
-----
Maintenance Mode
-----
1 - Add Project
2 - Update Project
3 - Remove Project
4 - Add Project Materials
5 - Update Project Materials
6 - Remove Project Materials
7 - Add Project Crew
8 - Update Project Crew
9 - Remove Project Crew
10 - Add Box Office Report
11 - Remove Box Office Report
12 - Cancel
-----
> _
```

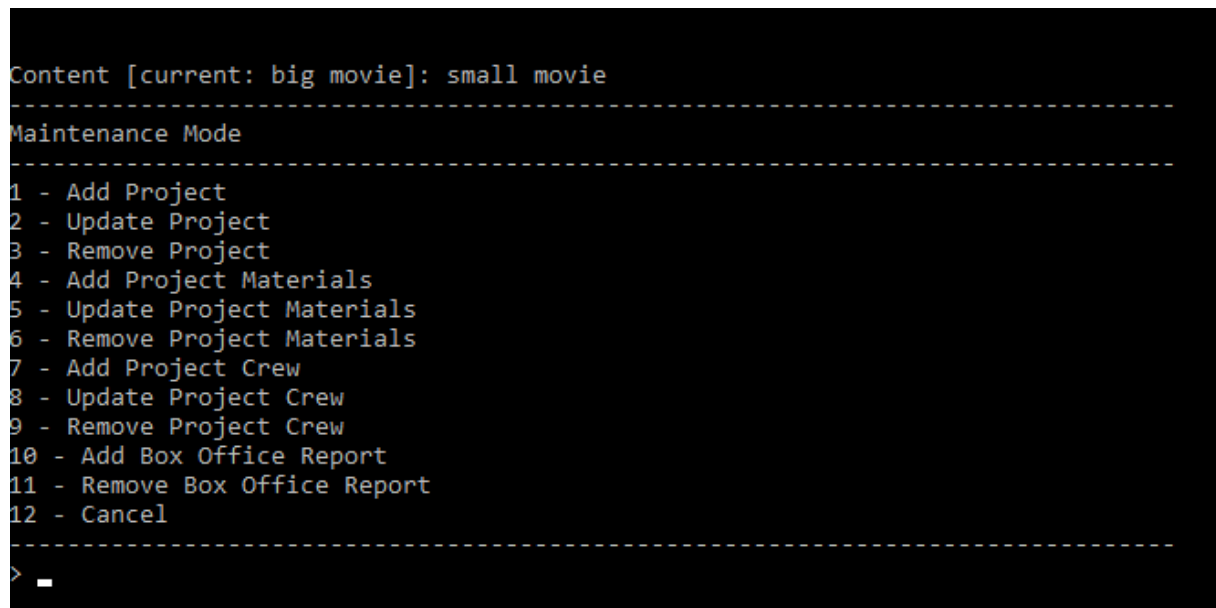
**Figure 108:** Visual representation of the application asking for new Packaging information

As you can see in the figure above, there are more options available to you, these are the options associated with Maintenance Mode, therefore you can find more information by reading the Maintenance Mode section of this user guide.

## Edit Content

Once you have entered the Edit Content functionality you will be asked to enter the following information:

You need to enter the new Content details, this is the new content information that you want your material to have. Any value is accepted.



```
Content [current: big movie]: small movie
-----
Maintenance Mode
-----
1 - Add Project
2 - Update Project
3 - Remove Project
4 - Add Project Materials
5 - Update Project Materials
6 - Remove Project Materials
7 - Add Project Crew
8 - Update Project Crew
9 - Remove Project Crew
10 - Add Box Office Report
11 - Remove Box Office Report
12 - Cancel
-----
> _
```

**Figure 109:** Visual representation of the application asking for new Content information

As you can see in the figure above, there are more options available to you, these are the options associated with Maintenance Mode, therefore you can find more information by reading the Maintenance Mode section of this user guide.

### Edit Additional Language Tracks

Once you have entered the Edit Additional Language Tracks functionality you will be asked to enter the following information

You need to enter the Additional Language Track identifier you wish to update, you can find the identifier in the provided list, an example of this can be seen below:

```
Language Track #1: FRA
Language Track #2: GER
Additional Language Track [1 - 2]:
```

**Figure 110:** Visual representation of the application showing the current Additional Language Track identifiers

You need to enter the new Additional Language Tracks details, this is the new additional language tracks information that you want your material to have. Any value is accepted.

```
Language Track #1: FRA
Language Track #2: GER
Additional Language Track [1 - 2]: 2
Additional Language Track #2 [current: GER]: ENG
```

#### Maintenance Mode

- 1 - Add Project
- 2 - Update Project
- 3 - Remove Project
- 4 - Add Project Materials
- 5 - Update Project Materials
- 6 - Remove Project Materials
- 7 - Add Project Crew
- 8 - Update Project Crew
- 9 - Remove Project Crew
- 10 - Add Box Office Report
- 11 - Remove Box Office Report
- 12 - Cancel

```
> _
```

**Figure 111:** Visual representation of the application asking for new Additional Language Tracks information

As you can see in the figure above, there are more options available to you, these are the options associated with Maintenance Mode, therefore you can find more information by reading the Maintenance Mode section of this user guide.

### Edit Additional Subtitle Tracks

Once you have entered the Edit Subtitle Language Tracks functionality you will be asked to enter the following information

You need to enter the Subtitle Language Track identifier you wish to update, you can find the identifier in the provided list, an example of this can be seen below:

```
Subtitle Track #1: FRA
Subtitle Track #2: GER
Additional Subtitle Track [1 - 2]: 1
```

**Figure 112:** Visual representation of the application showing the current Additional Subtitle Track identifiers

You need to enter the new Additional Subtitle Tracks details, this is the new additional subtitle tracks information that you want your material to have. Any value is accepted.

```
Subtitle Track #1: FRA
Subtitle Track #2: GER
Additional Subtitle Track [1 - 2]: 1
Additional Subtitle Track #1 [current: FRA]: ENG
-----
Maintenance Mode
-----
1 - Add Project
2 - Update Project
3 - Remove Project
4 - Add Project Materials
5 - Update Project Materials
6 - Remove Project Materials
7 - Add Project Crew
8 - Update Project Crew
9 - Remove Project Crew
10 - Add Box Office Report
11 - Remove Box Office Report
12 - Cancel
-----
> _
```

**Figure 113:** Visual representation of the application asking for new Additional Subtitle Tracks information

As you can see in the figure above, there are more options available to you, these are the options asso-

ciated with Maintenance Mode, therefore you can find more information by reading the Maintenance Mode section of this user guide.

## Edit Bonus Features

Once you have entered the Edit Bonus Features Tracks functionality you will be asked to enter the following information

You need to enter the Bonus Features identifier you wish to update, you can find the identifier in the provided list, an example of this can be seen below:

```
Bonus Feature #1: Director's Comments
Bonus Feature [1 - 2]: _
```

**Figure 114:** Visual representation of the application showing the current Bonus Features identifiers

You need to enter the new Bonus Features details, this is the new bonus feature information that you want your material to have. Any value is accepted.

```
Bonus Feature #1: Director's Comments
Bonus Feature [1 - 2]: 1
Bonus Feature #1 [current: Director's Comments]: Directors Cut
-----
Maintenance Mode
-----
1 - Add Project
2 - Update Project
3 - Remove Project
4 - Add Project Materials
5 - Update Project Materials
6 - Remove Project Materials
7 - Add Project Crew
8 - Update Project Crew
9 - Remove Project Crew
10 - Add Box Office Report
11 - Remove Box Office Report
12 - Cancel
-----
> _
```

**Figure 115:** Visual representation of the application asking for new Bonus Features information

As you can see in the figure above, there are more options available to you, these are the options associated with Maintenance Mode, therefore you can find more information by reading the Maintenance Mode section of this user guide.

## Edit Audio Track

Once you have entered the Edit Audio Track functionality you will be asked to enter the following information:

You need to enter the new Audio Track details, this is the new audio track that you want your material to have. Any value is accepted.

```
Audio Track [current: udio]: audio
-----
Maintenance Mode
-----
1 - Add Project
2 - Update Project
3 - Remove Project
4 - Add Project Materials
5 - Update Project Materials
6 - Remove Project Materials
7 - Add Project Crew
8 - Update Project Crew
9 - Remove Project Crew
10 - Add Box Office Report
11 - Remove Box Office Report
12 - Cancel
-----
> _
```

**Figure 116:** Visual representation of the application asking for new Audio Track information

As you can see in the figure above, there are more options available to you, these are the options associated with Maintenance Mode, therefore you can find more information by reading the Maintenance Mode section of this user guide.



### Using Remove Project Materials

Once you have entered the Remove Project functionality you will be asked to enter the following information:

Firstly, you need to enter a Project ID, this must be a numeric value, you can find the accepted Project IDs above the input location, select an ID from this list.

```
-----  
[1]: Title: A Great Movie  
[2]: Title: Deadpool the movie  
[3]: Title: Deadpool 2  
-----  
Project ID [1 - 3]: 3
```

**Figure 117:** Visual representation of selecting a Project ID to remove Materials for

Once you have selected a Project ID you will be presented with the associated Material IDs, you need to now select a Material ID from this list and it must be a numeric value.

```
[1]: Format: dvd  
[2]: Format: bluray  
[3]: Format: boxset  
[4]: Format: dsdvd  
Material ID [1 - 4]: 4  
-----  
Main Menu  
-----  
1 - View Mode  
2 - Maintenance Mode  
3 - Quit  
-----  
> _
```

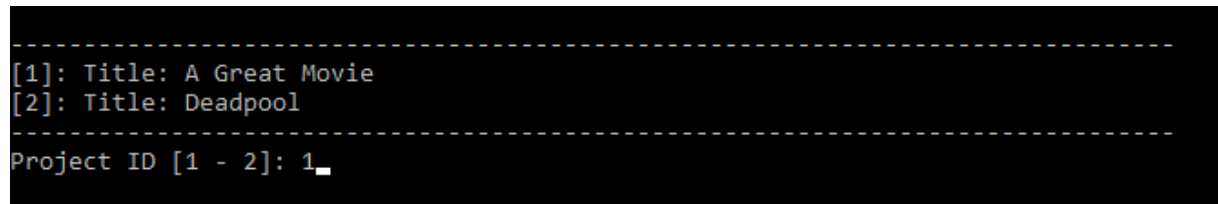
**Figure 118:** Visual representation of selecting a MaterialID to delete

As you can see in the figure above, there are more options available to you, these are the options associated with Maintenance Mode, therefore you can find more information by reading the Maintenance Mode section of this user guide.

### Using Add Crew

Once you have entered the Add Crew functionality you will be asked to enter the following information:

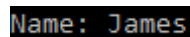
Firstly, you need to enter a Project ID, this must be a numeric value, you can find the accepted Project IDs above the input location, select an ID from this list.

A terminal window with a black background and light green text. It displays a list of project titles: '[1]: Title: A Great Movie' and '[2]: Title: Deadpool'. Below this, it prompts 'Project ID [1 - 2]:' followed by the number '1' and a cursor. The list is enclosed in dashed lines.

```
-----  
[1]: Title: A Great Movie  
[2]: Title: Deadpool  
-----  
Project ID [1 - 2]: 1_
```

**Figure 119:** Visual representation of selecting a Project ID to proceed with selecting a project to add crew to

Next, you need to enter the Name of the crew member. Any value is accepted.

A terminal window with a black background and light green text. It displays the prompt 'Name: James' followed by a cursor.

```
Name: James_
```

**Figure 120:** Visual representation of the application asking for a Crew members name

Next, you need to enter the Job Title of the crew member. Any value is accepted.

```
Name: James
Job Title: Director
-----
Maintenance Mode
-----
1 - Add Project
2 - Update Project
3 - Remove Project
4 - Add Project Materials
5 - Update Project Materials
6 - Remove Project Materials
7 - Add Project Crew
8 - Update Project Crew
9 - Remove Project Crew
10 - Add Box Office Report
11 - Remove Box Office Report
12 - Cancel
-----
>
```

**Figure 121:** Visual representation of the application asking for a Crew members job title

As you can see in `CHANGEFIGUREVALUE`, there are more options available to you, these are the options associated with Maintenance Mode, therefore you can find more information by reading the Maintenance Mode section of this user guide.

### Using Update Crew

Once you have entered the Update Crew functionality you will be asked to enter the following information:

Firstly, you need to enter a Project ID, this must be a numeric value, you can find the accepted Project IDs above the input location, select an ID from this list.

```
-----
[1]: Title: A Great Movie
[2]: Title: Deadpool
-----
Project ID [1 - 2]: 1_
```

**Figure 122:** Visual representation of selecting a Project ID to proceed with selecting a crew member to update

Next, you will be asked to enter the crew identifier you wish to update within the previously selected

project, you can find the identifier in the provided list, an example of this can be found below:

```
[1]: Name: Bob  
[2]: Name: Matt  
[3]: Name: James  
Crew ID [1 - 3]: 1
```

**Figure 123:** Visual representation of selecting a Crew ID to update the information for

Next, you will be presented with multiple options, you can use the following keyboard inputs to update certain aspects of the material, to find out more about each update, click the associated information link.

Input Value	Command Action	Information Link
1	Inputting this value will cause the application to enter edit crew name	<a href="#">Edit Crew Name</a>
2	Inputting this value will cause the application to enter edit crew job title	<a href="#">Edit Crew Job Title</a>
3	Inputting this value will cause the application to navigate back to the maintenance mode menu	<a href="#">Maintenance Mode Menu</a>

### Edit Crew Name

Once you have entered the Edit Crew Name functionality you will be asked to enter the following information:

You need to enter the new Crew Name, this is the new name that you want your crew member to have. Any value is accepted.

```
Name [current: Tim]: Jones
-----
Maintenance Mode
-----
1 - Add Project
2 - Update Project
3 - Remove Project
4 - Add Project Materials
5 - Update Project Materials
6 - Remove Project Materials
7 - Add Project Crew
8 - Update Project Crew
9 - Remove Project Crew
10 - Add Box Office Report
11 - Remove Box Office Report
12 - Cancel
-----
> _
```

**Figure 124:** Visual representation of the application asking for a new Crew Name

As you can see in the figure above, there are more options available to you, these are the options associated with Maintenance Mode, therefore you can find more information by reading the Maintenance Mode section of this user guide.

### Edit Crew Job Title

Once you have entered the Edit Crew Job Title functionality you will be asked to enter the following information:

You need to enter the new Crew Job Title, this is the new job title that you want your crew member to have. Any value is accepted.

```
Job Title [current: Actor]: Producer
-----
Maintenance Mode
-----
1 - Add Project
2 - Update Project
3 - Remove Project
4 - Add Project Materials
5 - Update Project Materials
6 - Remove Project Materials
7 - Add Project Crew
8 - Update Project Crew
9 - Remove Project Crew
10 - Add Box Office Report
11 - Remove Box Office Report
12 - Cancel
-----
>
```

**Figure 125:** Visual representation of the application asking for a new Crew Job Title

As you can see in the figure above, there are more options available to you, these are the options associated with Maintenance Mode, therefore you can find more information by reading the Maintenance Mode section of this user guide.

### Using Remove Crew

Once you have entered the Remove Crew functionality you will be asked to enter the following information:

Firstly, you need to enter a Project ID, this must be a numeric value, you can find the accepted Project IDs above the input location, select an ID from this list.

```
-----  
[1]: Title: A Great Movie  
[2]: Title: Deadpool  
-----  
Project ID [1 - 2]: 1_
```

**Figure 126:** Visual representation of selecting a Project ID to proceed with deleting a crew member

Once you submit this Project ID you will need to select the Crew Member to select from the list of IDs above the input location, select an ID from this list.

```
[1]: Name: Tim  
[2]: Name: Matt  
[3]: Name: James  
Crew ID [1 - 3]: 3  
-----  
Maintenance Mode  
-----  
1 - Add Project  
2 - Update Project  
3 - Remove Project  
4 - Add Project Materials  
5 - Update Project Materials  
6 - Remove Project Materials  
7 - Add Project Crew  
8 - Update Project Crew  
9 - Remove Project Crew  
10 - Add Box Office Report  
11 - Remove Box Office Report  
12 - Cancel  
-----  
>
```

**Figure 127:** Visual representation of selecting a Project ID to update the project for

As you can see in the figure above, there are more options available to you, these are the options associated with Maintenance Mode, therefore you can find more information by reading the Maintenance

Mode section of this user guide.



### Using Add Box Office Report

Once you have entered the Add Box Office Report functionality you will be asked to enter the following information:

Firstly, you need to enter a Project ID, this must be a numeric value, you can find the accepted Project IDs above the input location, select an ID from this list.

```
-----  
[1]: Title: A Great Movie  
[2]: Title: Deadpool  
-----  
Project ID [1 - 2]: 1_
```

**Figure 128:** Visual representation of selecting a Project ID to proceed with selecting a crew member to update

Once you have selected a Project ID you will be asked to enter the following information:

Next, you need to enter the Week Number, this is the week number that you want your box office report to relate to. Any numeric value is accepted.

```
Week Number: 2
```

**Figure 129:** Visual representation of the application asking for a Week Number

Next, you need to enter the Revenue, this is how much money was made during the entered week. Any numeric value is accepted.

```
Week Number: 2  
Revenue: 100
```

**Figure 130:** Visual representation of the application asking for a Revenue value

Next, you need to enter the Tickets Sold, this is the amount of tickets sold in the entered week. Any numeric value is accepted.

```
Week Number: 2
Revenue: 100
Tickets Sold: 10
-----
Maintenance Mode
-----
1 - Add Project
2 - Update Project
3 - Remove Project
4 - Add Project Materials
5 - Update Project Materials
6 - Remove Project Materials
7 - Add Project Crew
8 - Update Project Crew
9 - Remove Project Crew
10 - Add Box Office Report
11 - Remove Box Office Report
12 - Cancel
-----
> _
```

**Figure 131:** Visual representation of the application asking for a Tickets Sold value

As you can see in the figure above, there are more options available to you, these are the options associated with Maintenance Mode, therefore you can find more information by reading the Maintenance Mode section of this user guide.

### Using Remove Box Office Report

Once you have entered the Remove Box Office Report functionality you will be asked to enter the following information:

Firstly, you need to enter a Project ID, this must be a numeric value, you can find the accepted Project IDs above the input location, select an ID from this list.

```
-----  
[1]: Title: A Great Movie  
[2]: Title: Deadpool the movie  
[3]: Title: Deadpool 2  
-----  
Project ID [1 - 3]: 3
```

**Figure 132:** Visual representation of selecting a Project ID to remove a Box Office Report for

Once you have selected a Project ID you will be presented with the associated Week IDs, you need to now select a Week ID from this list and it must be a numeric value.

```
[1]: Week Number: 1  
[2]: Week Number: 2  
Crew ID [1 - 2]: 1  
-----  
Maintenance Mode  
-----  
1 - Add Project  
2 - Update Project  
3 - Remove Project  
4 - Add Project Materials  
5 - Update Project Materials  
6 - Remove Project Materials  
7 - Add Project Crew  
8 - Update Project Crew  
9 - Remove Project Crew  
10 - Add Box Office Report  
11 - Remove Box Office Report  
12 - Cancel  
-----  
>
```

**Figure 133:** Visual representation of selecting a Box Office Report to delete

As you can see in the figure above, there are more options available to you, these are the options associated with Maintenance Mode, therefore you can find more information by reading the Maintenance

Mode section of this user guide.

## Conclusion

### Testing Approach

The unit tests written using Google Test allowed us to perform continuous testing as we added new functionality to the application. Should any new code cause the tests to fail, we were able to immediately backtrack and fix the bug. This prevented bugs “snowballing” in to larger issues that could have caused unnecessary delays and stress later in development.

### Computational Efficiency

When deciding which algorithm to use to search for a project based on its title, it was decided that a linear search would be far too inefficient. Linear search has an average time complexity of  $O(n)$ ; while this would be suitable for smaller datasets, its inefficiency would become more apparent as more projects are added. As a result, it was decided that a binary search should be used, accompanied by a merge sort in order to satisfy the pre-requisites of the binary search.

The binary search has an average time complexity of  $O(\log n)$  and the merge sort has an average time complexity of  $O(n \log n)$ . As a result, despite performing two operations, the overall average time complexity remains logarithmic and therefore scales well when the dataset containing projects grows.

### Reliability

The reliability of the application was deemed to be good due to the extensive set of unit tests and comprehensive test plan. It was understood that user’s actions can not always be predicted and therefore, large amounts of destructive testing proved that the application would not fail due to user input.

### Security

When working on the project there were multiple considerations around the security of the application, you can see some of the considerations below, however, due to time restrictions it was not feasible to implement the features:

- As a major feature implementation it was a consideration to add User Roles to the application, this would allow an organisation to control who has access to what information or functionality, for example, an organisation could create the reader and writer roles. The writer role would

allow assigned users to add projects, project materials, crew, etc and read data. Whereas the reader role would only allow users to view what data has been inputted into the system. We see this addition as an important inclusion into the application as it will help to protect the security/integrity of the data.

- As a more minor implementation, it was a consideration to add integrity validation to the JSON file to ensure that the database has not been tampered with, this would be achieved by creating a SHA256 hash of the JSON content when the application is gracefully closed and then verifying the hash is the same upon opening the application. This would allow the application to verify that the content has not been tampered with while it was closed, protecting the security and integrity of the application data.

### **Portability**

The application makes use of mostly standard library components that are part of C++. Any additional libraries used for the main application are header-only libraries that can be included alongside the source code and, again, make use of standard library components. This means that building the application will be successful on any platform capable of running a C++ compiler build for the C++11 standard.

It must be noted that Google Test must be installed should user wish to compile and run the tests. However, it was deemed that this would only be performed by further maintainers of the software and therefore its portability was not as crucial.

### **Maintainability**

The modular design of the application allows new methods to be added to the models, view and controllers without changing the behaviour of existing components. This means that future maintainers of the application would be able to extend its functionality easily.

The code is well documented and commented and the provided diagrams of the system are a good reflection of its design and implementation. This would allow further maintainers to quickly understand the architecture of the code and be able to make changes easily.

### **Scalability**

When developing the application scalability was considered and the design of the applications database will allow for organisations to release the application via a Group Policy Object (on Windows machines) and report back to the central database that will provide the information to the applications. This means that it is possible to scale the application across all employees.

## Appendix

### Managing group work

Whilst working on this project our group used a multitude of methods to ensure that we were collaborating efficiently and getting the most amount of work completed as possible, these methods included, but are not limited to:

- Using Facebook Messenger to converse with other group members about certain aspects of the program or documentation, this allowed us to keep in touch and ensure we were on track with the workload.
- Using GitHub to its full potential, this includes the use of GitHub Issues and Pull Requests in conjunction with code reviews for each major feature. Whenever a bug or issue was discovered the group member that uncovered the issue would create a GitHub issue. If the bug was within another group members individual work then that member would be added as a participant so that they could fix the issue. Once large features were added to the program, pull requests were used with each group member being requested to review the code before merging into the master branch.

Overall, our experience of working as a group has been productive and enjoyable, being able to distribute the workload across group members was an important aspect to the project and allowed us to complete it efficiently. We have all taken learning points from this experience that could be applied to the workplace, or even in our upcoming placements. For example:

- The use of GitHub's features (such as pull requests, issues and code reviewing) will be an excellent skill to have within the workplace, as more often than not, organisations will have some sort of code review system/Quality Assurance (QA) procedure in place and being able to understand how this all works without training will show that you are a competent employee.
- The use of a messaging platform was also important, sometimes organisations have employees working across the globe and having the ability to efficiently collaborate on messaging systems (such as Slack) is an important skill to have.

### Meeting Minutes

During group meetings a member was nominated to write minutes, these minutes were an important factor during the development of the application as they allowed us to go back and check what work we have all be allocated. On the following pages you can find the minutes for the aforementioned meetings.

## SDI Strand Group Meeting 1 | MINUTES

---

Meeting date | time 4<sup>th</sup> February | 11:00am | Meeting location Pavilion

Type of meeting	Introduction	Callum Axon (CA)
		Callum Carney (CC)
		Matthew Robinson (MR)

### AGENDA TOPICS

---

Time allotted | 10 minutes | Agenda topic SDI Introduction & Setup |

It has been agreed by members that Software Design & Implementation Meetings are going to take place before the lecture which takes place on Mondays between 13:00pm and 14:00pm. These meetings are likely to last up to an hour.

CA to create the GitHub repository that will hold all of the code for the project and documentation.

MR to create the project and commit the basic files to GitHub in which CA & CC can then clone the repo.

---

Time allotted | 5 minutes | Agenda topic Documentation formatting |

CA brings up the point of using LaTeX instead of Microsoft Word for creating the documentation, CC & MR agree with CA.

CC brings up the possibility of using Pandoc with a LaTeX template that will allow us to easily display code and documentation content easily as Markdown is supported.

CA and MR agree, CC to create the base documentation files and commit to git.

Action items	Person responsible	Deadline
Create GitHub Repository	CA	ASAP
Create project and commit basic files	MR	ASAP
Create LaTeX documentation files	CC	ASAP

Meeting closed at 11:15 am.

**Figure 134:** Meeting 1 - Minutes



## SDI Strand Group Meeting 2 | MINUTES

---

Meeting date | time 18<sup>th</sup> February | 11:00am | Meeting location Pavilion

Type of meeting	Progress Check	Callum Axon (CA)
		Callum Carney (CC)
		Matthew Robinson (MR)

### AGENDA TOPICS

---

Time allotted | 15 minutes | Agenda topic Progress of previous meetings action items |

CA confirms that the GitHub repository has been created and our accounts have been added as collaborators.

MR confirms that the project files have been created and committed to git. MR shows CA & CC the structure of the project files.

CC confirms that the LaTeX files have been created and points CA & MR to a guide created by CC on how to setup LaTeX on their local machine in order to edit the documentation.

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Time allotted | 5 minutes | Agenda topic Member allocations |

CA states that we need to allocate member letters in accordance with the Spec.

CA agrees to be Member A, CC agrees to be Member C, MR agrees to be Member B

All members agree that we should start working on our individual tasks.

CC states that he will create a Facebook Messenger group chat in order for us to collaborate more efficiently.

Action items	Person responsible	Deadline
Create Facebook Messenger group	CC	ASAP
Work on associated individual tasks	All	ASAP

Meeting closed at 11:20 am.

**Figure 135:** Meeting 2 - Minutes

## SDI Strand Group Meeting 3 | MINUTES

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Meeting date | time 4<sup>th</sup> March | 11:00am | Meeting location Pavilion

Type of meeting	Progress Check	Callum Axon (CA)
		Callum Carney (CC)
		Matthew Robinson (MR)

### AGENDA TOPICS

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Time allotted | 10 minutes | Agenda topic Checkup |

CC created the group chat and all group members have been collaborating.

MR shows the progress on his individual tasks, so do CA & CC.

All group members are happy with the current progress.

Action items	Person responsible	Deadline
Work on associated individual tasks	All	ASAP

Meeting closed at 11:10 am.

**Figure 136:** Meeting 3 - Minutes

## SDI Strand Group Meeting 4 | MINUTES

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Meeting date | time 18<sup>th</sup> March | 11:00am | Meeting location Pavilion

Type of meeting	Progress Check	Callum Axon (CA)
		Callum Carney (CC)
		Matthew Robinson (MR)

### AGENDA TOPICS

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Time allotted | 10 minutes | Agenda topic Checkup |

CA shows the progress on his individual tasks, so do CC & MR.

All group members are still happy with the current progress and no interventions need to be made.

MR thinks that the group no longer needs to convene, unless the rate of progression decreases. CA & CC agree. Group meetings will no longer occur on Mondays.

Action items	Person responsible	Deadline
Work on associated individual tasks	All	ASAP

Meeting closed at 11:10 am.

**Figure 137:** Meeting 4 - Minutes

## SDI Strand Group Meeting 5 | MINUTES

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Meeting date | time 8<sup>th</sup> April | 14:00pm | Meeting location Skype

Type of meeting Discussion

Callum Axon (CA)  
Callum Carney (CC)  
Matthew Robinson (MR)

### AGENDA TOPICS

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Time allotted | 45 minutes | Agenda topic GUI discussion |

The group felt it necessary to convene in order to discuss the point of having a GUI versus a Command Line Interface.

The group discusses the possibility of using Qt for the GUI, amongst other potential GUI libraries.

MR brings up the point of the GUI being an optional point and that we should focus on other tasks before considering the implementation of a GUI.

CA & CC agree, CC brings up that the Specification states that for a first the application must have an "Detailed user interface and its instruction", this does not state Graphical User Interface. Therefore the group can still achieve a first without the implementation of a GUI.

All group members agree that a GUI should be held off and reconsidered later.

Action items	Person responsible	Deadline
Work on associated individual tasks	All	ASAP

Meeting closed at 14:45 pm.

**Figure 138:** Meeting 5 - Minutes

## SDI Strand Group Meeting 6 | MINUTES

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Meeting date | time 23<sup>rd</sup> April | 10:00am | Meeting location Skype

Type of meeting	Quality Assurance	Callum Axon (CA)
		Callum Carney (CC)
		Matthew Robinson (MR)

### AGENDA TOPICS

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Time allotted | 7 hours 32 minutes | Agenda topic Quality Assurance |

The group felt it necessary to convene in order to perform the final checks on the completed Application and Documentation.

During this time some bugs were discovered and resolved and the final aspects of the documentation were put together and proofread by group members.

Action items	Person responsible	Deadline
N/A	N/A	N/A

Meeting closed at 5:32 pm.

**Figure 139:** Meeting 6 - Minutes

## References

(“Top 6 Most Important Benefits of Mvc Architecture for Web Application Development Process” 2017)  
(Wayner 2019)

“Top 6 Most Important Benefits of Mvc Architecture for Web Application Development Process.” 2017. *Siya Infotech*. <http://siyainfo.com/2017/01/16/top-6-important-benefits-mvc-architecture-web-application-development-process/>.

Wayner, Peter. 2019. “How to Choose the Right Software Architecture: The Top 5 Patterns.” *TechBeacon*. TechBeacon. <https://techbeacon.com/app-dev-testing/top-5-software-architecture-patterns-how-make-right-choice>.