Software Requirements Specification (SRS)

Quality Defect Analysis Automation

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Customer: GM Plant / Dr. Daly (Our Client)

Instructor: Dr J. Daly

1 Introduction

This document will provide a source for information needed to understand the Quality Defect Analysis Automation system. The purpose for this document is described and a list of abbreviations and definitions is provided. This section gives a scope description and overview of everything included in this SRS document.

1.1 Purpose

The purpose of this document is to describe the technical requirements for the automation of the paint defect analysis documents and eliminate the use of paper diagrams. It presents a means for added convenience for client analysis while checking the vehicle model for defects as well as better organization of defects and their severities. This document is written for the software developers, practitioners, documentation writers, and users involved in the GM domain.

1.2 Scope

The final product is a web service application that generates electronic defect reports for analysis. The main application will be made up of HTML, PHP, Javascript, with the use of MySQL/NoSQL. These will allow us to generate the necessary form information and fields for the client analysis to fill in and save the appropriate defect details. The purpose is to eliminate the need for paper forms being used for defect analysis. It will be able to allow enough fields and options to thoroughly describe what the defect is and the severity as well as how the defect will be handled. The application requires an internet connection to save and display results, and all defect information is maintained in a database. Images of the vehicle will be generated with defect areas highlighted.
1.3 Definitions, acronyms, and abbreviations

1) Acronyms
   a) GM - General Motors
   b) DPU - Defects Per Unit
   c) VSI - Not needed, ignore this
   d) Sev - severity
   e) HTML - Hypertext markup language
   f) JS - Javascript
   g) PHP - Personal home page

2) Abbreviations
   a) ACD; TRV; ACD; ENC; TRV; TRV; ENC; ACD; ACD; ENC - different car types, diagrams will be labeled as which type of car it is. The actual name is irrelevant
   b) Letter(s) + Number (A3, C1, LA2, etc..) - location on car model
   c) XR, RY, SC, W7, VG, DM - car colors
   d) CHG - the car model we will be using

3) Definitions
   a) Defect - A defect in the scope of our project is an incorrect paint marking on a vehicle

1.4 Organization

The rest of our SRS will give a more indepth overview of our product. It will explain the technicals specifications with modeling, give example use cases, explain how to use our product, explain limitations of our product, give any requirements needed to use our product, and finally explain what will be delivered in the v1 and v2 prototype.

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2 Overall Description
This section will give an overview of the data input and report production system. It will describe certain constraints that we will encounter with our current system. It will also explain the overall process that we expect our system should take, both in use as well as behind the scenes. In addition, it includes requirements and features that will be postponed until further notice.

2.1 Product Perspective
The product is a web-based interface and database designed for paint defect analysis at various GM plants. The goal is to streamline the input, collection, and analysis of paint defect data points. The secondary advantage to creating this product is the reduction of paper waste inherent in the previous system. The web application will be the entirety of our system. There will be no inter-system communication required.

The product will require only a computer with internet access and a web browser for use. The entire system will be accessed via a web page. However, the user will require an MSU account to access the product itself. The user interface will consist of a webpage with horizontal rows of textboxes and dropdown boxes for user input. The input boxes will allow user input of location, severity, and quantity. The interface will allow for the creation of additional defects as well as additional car units.

As we will be needing a database to hold previous data entries, the web page must allow for reliable storage of data over a long period of time. Specific groups of data must be able to be pulled out of the database for cross-sectional data analysis (weekly reports).
2.2 Product Functions

The system aims to automate reports analyzing any defects, and their severity, detected on assembly line vehicles in the contracted GM plants for the client. Firstly, the system will allow the input of data regarding the defect detected, the severity of the defect, the quantity of the defect, and the total of times this defect appears on the vehicle. Secondly, the system will use the entered data to create any desired report summarizing the findings. The system will also generate reports of data entered over time.

The diagram above represents the high-level goals of the system development. The first goal will be the ability to accept data that is entered into the system. After this is accomplished the system should be able to generate specific reports desired for the input given at that time and also be able to store the entered data to be observed at any given time. Then, allowing for the storage of data, the system should generate reports for data over certain periods of time to show trends to be analyzed by the user.

2.3 User Characteristics

This system is targeted towards experienced analysts. The user should have sufficient background knowledge regarding the models of the vehicles, the types of defects, and the scale with which the severity of the defects are determined by. This user should also be familiar with the general naming conventions of the vehicles and defects, as the system will adhere to these guidelines and address the vehicles and defects accordingly.
2.4 Constraints
A possible constraint to the system is inconsistency of data and operation. To perform properly, all relevant data should be provided to the system. Without this, the system will be unable to accurately assess data to generate reports, both for single entry reports and long-term data reports. The lack of, incorrectness, or inconsistency of any data will result in incorrect reports. This includes any lack of guidelines, by the analyst, for correctly identifying the severity of the defects. If multiple users of one system are not following the same guidelines, the results will be incorrect due to inconsistency. This system does not have any safety-critical properties.

2.5 Assumptions and Dependencies
It will be assumed that this system is being used in a place with adequate access to the internet. The user should have a computer present with them at the various checkpoints of the assembly line.

It will also be assumed that the user is entering correct and consistent data into the system. This system is not responsible for checking the integrity of the data inputted. It also requires that the identification and naming of the defects is kept consistent as long-term data may become askewed as it will not link an association between the differing defect names

2.6 Apportioning of Requirements
While the long-term collection of entries into a database is expected and planned upon, the addition of a database to our system will be slightly postponed until we provide a working data-entry and report production system.

In addition, the inclusion of an interactive car diagram that displays colorized markings has been deemed temporarily unnecessary. When the functioning parts of the system are complete, this detail can be pursued.

3 Specific Requirements
1. User Interface
   1.1. Add Cars
      1.1.1. Input for analyst name and date
      1.1.2. Text boxes and drop-down boxes for model name, defect name, severity, and location
1.1.3. “Additional defect” button to allow for multiple defects per vehicle and “additional car” button to allow for multiple vehicles
1.1.4. “Done” button which stores all inputted data into database

1.2. Generate Reports
1.2.1. Drop-down box for report type and calendar for dates.
1.2.2. Optional parameters:
   1.2.2.1. Analyst name
   1.2.2.2. Location(s)
1.2.3. “Done” button

2. Defect Analysis Report
2.1. Must be able to handle multiple data entries from subsequent days to generate reports.
2.2. Provides a complete list of all defects in the same format as the entry format.
2.3. Provides lists of defects by type and location. Includes data point of # of defects per unit.
2.4. Provides a summary including:
   2.4.1. Legend
   2.4.2. Total defects in report
   2.4.3. Total units in report
   2.4.4. # of defects per unit
2.5. A legend for the report, displaying each type of defect and a corresponding color.
2.6. A table for a severity overview, displaying how many of each Sev 1, Sev 5, and Special defects are present out of a total number of defects.
2.7. Tables showing number of Sev 1, Sev 5, Special, and total defects for each region of a car:
   2.7.1. Right Vertical
   2.7.2. Roof
   2.7.3. Left Vertical
   2.7.4. Hood
   2.7.5. Deck
   2.7.6. Left Side
   2.7.7. Right Side
2.8. A pie chart showing the number of each defect type.

3. Database of individual input forms
3.1. Must, at least, hold a week of daily input forms.

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4 Modeling Requirements

4.1 Use Case Diagram

Use Case: Add Car
Actors: Analyst (initiator)
Type: Primary and essential
Description: The Analyst opens the application. They may insert a car with an identifying model name.

Use Case: Add Car with Defects
Actors: Analyst (initiator)
Type: Primary and essential
Description: The Analyst opens the application.

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Perform **Add Car**. Perform **Add Defect** for each defect present.

**Cross Ref.:** Requirements 1.1  
**Use-Cases:** Add Car, Add Defect.

**Use Case:** Add Defect  
**Actors:** Analyst (initiator)  
**Type:** Secondary and essential  
**Description:** The analyst adds a defect to an existing car. Inserting a defect requires information about the location, the severity, and the name of the defect.  
**Cross Ref.:** Requirements 1.1  
**Use-Cases:** None

**Use Case:** Generate Report  
**Actors:** Analyst (initiator)  
**Type:** Primary and essential  
**Description:** The Analyst generates a report.  
**Perform Parameterize Defects.** A report is generated by the application with data from a given range of defects. **Make Legend.**  
**Make Pie Chart.** **Make Tables.**  
**Cross Ref.:** Requirements 2.1-2.7  
**Use-Cases:** Parameterize Defects, Make Legend, Make Pie Chart, Make Tables

**Use Case:** Parameterize Defects  
**Actors:** Analyst (initiator)  
**Type:** Secondary and essential  
**Description:** Select which range of defects are to be used for a report. Defects may be selected based on location, severity, or date of entry.  
**Cross Ref.:** Requirements 1.2  
**Use-Cases:** None

**Use Case:** Make Legend  
**Actors:** System (initiator)  
**Type:** Secondary and essential  
**Description:** Generate and return a legend for the defects in a given report. Each defect in the report is mapped to a unique color.  
**Cross Ref.:** Requirements 2.5  
**Use-Cases:** None

**Use Case:** Make Pie Chart  
**Actors:** System (initiator)  
**Type:** Secondary and essential  
**Description:** Generate and return a pie chart for the defects in a given report.

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Each defect will be shown as a piece on a pie chart with a unique color and name, represented in width as a percentage of number of occurrences within the sample size report.

Cross Ref.: Requirements 2.8
Use-Cases: None

Use Case: Make Tables
Actors: System (initiator)
Type: Secondary and essential
Description: Generate and return tables for the defects in a given report. Each table will have columns titled Severity, Total, and DPU. There will be 4 rows: “Sev 1,” “Sev 5,” “Special,” and “Overall.”

Cross Ref.: Requirements 2.6, 2.7
Use-Cases: None

4.2 System Class Diagram
The class diagram is represented in UML with the following notation: a class is represented by a box; the name is written above the attributes. An attribute is represented as “attribute : type,” with lines to represent relationships between the classes.
An analyst will generate a report by giving a selection of defects for the report. They must provide a name for the report and their own name - the rest of the data can be generated automatically. A report will need to handle generating tables based on a list of defects, generating a legend based on a list of defects, and generating a pie chart based on a list of defects. A defect has a name, severity, location, and date associated with it. A table may have a location on a car or indicate that it is for all defects in the report, severity numbers for each of the three types, and dpu for each of the three types. It will also display overall values of numbers and dpu as a final row.

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### Data Dictionary:

**ReportGenerator**

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Data type</th>
<th>Rel to</th>
<th>Rel type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>cars</td>
<td>relation</td>
<td>Car</td>
<td>1 to *</td>
<td>cars to submit to database</td>
</tr>
<tr>
<td>report</td>
<td>relation</td>
<td>Report</td>
<td>1 to *</td>
<td>reports created</td>
</tr>
</tbody>
</table>

**Report**

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Data type</th>
<th>Rel to</th>
<th>Rel type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>name</td>
<td>string</td>
<td></td>
<td></td>
<td>a name for the report</td>
</tr>
<tr>
<td>date</td>
<td>dateTime</td>
<td></td>
<td></td>
<td>the date of the report</td>
</tr>
<tr>
<td>analyst</td>
<td>string</td>
<td></td>
<td></td>
<td>the analyst the report is for</td>
</tr>
<tr>
<td>totalDefects</td>
<td>float</td>
<td></td>
<td></td>
<td>number of defects found</td>
</tr>
<tr>
<td>dpu</td>
<td>float</td>
<td></td>
<td></td>
<td>defects per unit (totalDefects / totalUnits)</td>
</tr>
<tr>
<td>totalUnits</td>
<td>float</td>
<td></td>
<td></td>
<td>number of cars analyzed for the report</td>
</tr>
<tr>
<td>startDate</td>
<td>dateTime</td>
<td></td>
<td></td>
<td>the start range for car data</td>
</tr>
<tr>
<td>endDate</td>
<td>dateTime</td>
<td></td>
<td></td>
<td>the end range for car data</td>
</tr>
<tr>
<td>legend</td>
<td>relation</td>
<td>Legend</td>
<td>1 to 1</td>
<td>legend generated by the report</td>
</tr>
<tr>
<td>pieChart</td>
<td>relation</td>
<td>PieChart</td>
<td>1 to 1</td>
<td>pie chart generated by the report</td>
</tr>
<tr>
<td>tables</td>
<td>relation</td>
<td>Table</td>
<td>1 to *</td>
<td>tables generated by the report</td>
</tr>
<tr>
<td>cars</td>
<td>relation</td>
<td>Car</td>
<td>1 to *</td>
<td>cars used to generate report</td>
</tr>
</tbody>
</table>

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### Table

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Data type</th>
<th>Rel to</th>
<th>Rel type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>location</td>
<td>string</td>
<td></td>
<td></td>
<td>the location this table is for</td>
</tr>
<tr>
<td>numSev1</td>
<td>int</td>
<td></td>
<td></td>
<td>number of severity 1 defects</td>
</tr>
<tr>
<td>numSev5</td>
<td>int</td>
<td></td>
<td></td>
<td>number of severity 5 defects</td>
</tr>
<tr>
<td>numSpecial</td>
<td>int</td>
<td></td>
<td></td>
<td>number of special defects</td>
</tr>
<tr>
<td>numOverall</td>
<td>int</td>
<td></td>
<td></td>
<td>number of defects</td>
</tr>
<tr>
<td>dpuSev1</td>
<td>float</td>
<td></td>
<td></td>
<td>defects per unit for severity 1</td>
</tr>
<tr>
<td>dpuSev5</td>
<td>float</td>
<td></td>
<td></td>
<td>defects per unit for severity 5</td>
</tr>
<tr>
<td>dpuSpecial</td>
<td>float</td>
<td></td>
<td></td>
<td>defects per unit for special</td>
</tr>
<tr>
<td>dpuOverall</td>
<td>float</td>
<td></td>
<td></td>
<td>total defects per unit</td>
</tr>
<tr>
<td>cars</td>
<td>relation</td>
<td>Car</td>
<td>* to *</td>
<td>cars used to generate table</td>
</tr>
</tbody>
</table>

### Car

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Data type</th>
<th>Rel to</th>
<th>Rel type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>model</td>
<td>string</td>
<td></td>
<td></td>
<td>The car model</td>
</tr>
<tr>
<td>date</td>
<td>dateTim</td>
<td></td>
<td></td>
<td>The date the car was added</td>
</tr>
<tr>
<td>report</td>
<td>relation</td>
<td>Report</td>
<td>* to 1</td>
<td>the reports this car is in</td>
</tr>
<tr>
<td>defects</td>
<td>relation</td>
<td>Defect</td>
<td>* to *</td>
<td>defects present on the car</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Defect</th>
<th>Attribute</th>
<th>Data type</th>
<th>Rel to</th>
<th>Rel type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>name</td>
<td>string</td>
<td></td>
<td></td>
<td></td>
<td>a name for the defect</td>
</tr>
<tr>
<td>severity</td>
<td>enum</td>
<td></td>
<td></td>
<td></td>
<td>the severity type for the defect</td>
</tr>
<tr>
<td>location</td>
<td>enum</td>
<td></td>
<td></td>
<td></td>
<td>the location on the car this was found</td>
</tr>
<tr>
<td>car</td>
<td>relation</td>
<td>Car</td>
<td>* to 1</td>
<td></td>
<td>car this defect is on</td>
</tr>
<tr>
<td>tables</td>
<td>relation</td>
<td>Table</td>
<td>* to *</td>
<td></td>
<td>tables this defect is used in</td>
</tr>
<tr>
<td>legend</td>
<td>relation</td>
<td>Legend</td>
<td>* to *</td>
<td></td>
<td>legends this defect is in</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Legend</th>
<th>Attribute</th>
<th>Data type</th>
<th>Rel to</th>
<th>Rel type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>legendEntries</td>
<td>map</td>
<td></td>
<td></td>
<td></td>
<td>A mapping of a color (string) to a defect (Defect)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PieChart</th>
<th>Attribute</th>
<th>Data type</th>
<th>Rel to</th>
<th>Rel type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>name</td>
<td>string</td>
<td></td>
<td></td>
<td></td>
<td>a name for the pie chart</td>
</tr>
<tr>
<td>legend</td>
<td>relation</td>
<td>Legend</td>
<td>1 to 1</td>
<td></td>
<td>the entries and colors for the pie chart</td>
</tr>
</tbody>
</table>

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4.3 Representative Scenario

4.3.1 Analyst Adds a Car

1. Analyst opens the application
2. Analyst navigates to “Add Cars” page
3. Analyst presses “Add Car” and inputs name on web form
4. Analyst presses “Submit”
5. System opens connection with the database
6. System runs a query to the database to save the car
7. Database returns success or failure message
8. Analyst closes the application
4.3.2 Analyst Adds Car with 2 Defects

1. Analyst opens the application
2. Analyst navigates to “Add Cars” page
3. Analyst presses “Add Car” and inputs the name
4. Analyst presses “Add Defect” under the created car and inputs information
5. Analyst presses “Add Defect” under the created car and inputs information for a second defect
6. Analyst presses “Submit”
7. System opens connection with the database
8. System runs a query to the database to save the car
9. Database returns success or failure message
10. Analyst closes the application

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4.3.3 Analyst Generates a Report (11/27-11/31)

1. Analyst opens the application
2. Analyst navigates to “Generate Report” page
3. Analyst inputs needed information on the web form
4. Analyst presses “Submit”
5. The system creates a report
6. The report opens a connection to the database
7. The report uses Analyst Input to run a Select query on the database
8. The database returns the cars
9. The report generates a Legend

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10. The report generates a Pie Chart
11. The report generates Tables
12. The report returns the generated Report
13. Analyst closes the application

4.4 State Diagram

The application will have a default page which will allow the choice of adding cars or creating a report. Upon selection of one of the two options, it will ask for additional information. The “add cars” page will require information on any number of cars which may have any number of defects. On submission, the system will submit to the database. On completion, the user will be redirected to the default page. The “generate reports” page will require information about the date range of the report, a name for the report, and an optional field to select a location on the car. On submission, the system will generate a report. On completion, the user will be redirected to a page which displays the report. On any of the 3 pages, the user may hit “back” or “return” to be redirected to the default page.

5 Prototype
In the prototype v1, we will be demonstrating our user interface. It will have all of the web pages complete, entering data page, running report page, and but with no functionality. In the prototype v2, the user will have the ability to enter data,

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which will then be stored on the sql server, then run reports on a specified data set and have tables and car images with the location of the defects generated.

5.1 How to Run Prototype
The user will need no specific requirements to access our program. It will work with any browser, OS, and has no hardware requirements on their computer. For the prototype v1, we will have a web server hosting our HTML web pages. For the prototype v2, we will have a web server hosting our HTML and Php backend and we will have a sql database storing the defects. The only networking requirement is a low-end internet connection to be able to load our web pages and send and receive requests (which is a miniscule amount of data). There are no needed plugins, we will only be using basic HTML tables and displaying basic images. Our prototype will be accessible from cse.msu.edu/~gagnona1/cse435/prototype.

5.2 Sample Scenarios
Here, we have a scenario where various defects have been discovered by the client analysis and it’s time to put them in the system to be reviewed and taken care of. The user runs the Quality Defect Analysis Application and a form is generated. The user inputs all the various defects along with their location on the vehicle, severity of defect, and the DPU. Then images are generated that reflect the information the user specified in the form.
Figure 1: Images generated by information given by the user with defects highlighted and color coated for differentiation.
Figure 2-3: Specific information on defects given by user input.

Table 2 - Severity Overview

<table>
<thead>
<tr>
<th>Severity</th>
<th>Total</th>
<th>DPU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sev 1</td>
<td>25</td>
<td>0.83</td>
</tr>
<tr>
<td>Sev 5</td>
<td>61</td>
<td>2.03</td>
</tr>
<tr>
<td>Special</td>
<td>19</td>
<td>0.63</td>
</tr>
<tr>
<td>Overall</td>
<td>105</td>
<td>3.50</td>
</tr>
</tbody>
</table>

Table 3 - Right Vertical

<table>
<thead>
<tr>
<th>Severity</th>
<th>Total</th>
<th>DPU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sev 1</td>
<td>1</td>
<td>0.03</td>
</tr>
<tr>
<td>Sev 5</td>
<td>4</td>
<td>0.13</td>
</tr>
<tr>
<td>Special</td>
<td>3</td>
<td>0.1</td>
</tr>
<tr>
<td>Overall</td>
<td>8</td>
<td>0.27</td>
</tr>
</tbody>
</table>

Table 4 - Roof

<table>
<thead>
<tr>
<th>Severity</th>
<th>Total</th>
<th>DPU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sev 1</td>
<td>2</td>
<td>0.07</td>
</tr>
<tr>
<td>Sev 5</td>
<td>11</td>
<td>0.37</td>
</tr>
<tr>
<td>Special</td>
<td>4</td>
<td>0.13</td>
</tr>
<tr>
<td>Overall</td>
<td>17</td>
<td>0.57</td>
</tr>
</tbody>
</table>

Table 5 - Left Vertical

<table>
<thead>
<tr>
<th>Severity</th>
<th>Total</th>
<th>DPU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sev 5</td>
<td>6</td>
<td>0.2</td>
</tr>
<tr>
<td>Special</td>
<td>2</td>
<td>0.07</td>
</tr>
<tr>
<td>Overall</td>
<td>8</td>
<td>0.27</td>
</tr>
</tbody>
</table>

Table 6 - Hood

<table>
<thead>
<tr>
<th>Severity</th>
<th>Total</th>
<th>DPU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sev 1</td>
<td>17</td>
<td>0.57</td>
</tr>
<tr>
<td>Sev 5</td>
<td>31</td>
<td>1.03</td>
</tr>
<tr>
<td>Special</td>
<td>5</td>
<td>0.17</td>
</tr>
<tr>
<td>Overall</td>
<td>53</td>
<td>1.77</td>
</tr>
</tbody>
</table>

Figure 2

Template based on IEEE Std 830-1998 for SRS. Modifications (content and ordering of information) have been made by Betty H.C. Cheng, Michigan State University (chengb at chengb.cse.msu.edu)
Figure 3

Template based on IEEE Std 830-1998 for SRS. Modifications (content and ordering of information) have been made by Betty H.C. Cheng, Michigan State University (chengb at chengb.cse.msu.edu)
Figure 4: Pie chart of data on the amount of defects and how many were present.

6 References

