

# ***Natural Language to AI Face Generation Using Machine Learning***

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# **I Project Description**

## **1 Project Overview**

The threat of crime is a certainty that comes with living in a modern society, and especially when living in the city. Even with the resources allocated to remedy and prevent crime, it still isn't enough to completely eradicate it. This Natural Language to AI Face Generation tool will allow both federal and local law enforcement agencies to create a better representation of a possible culprit to a crime.

This will happen in three main parts. First, there is the need for input. The way this software works is that it will process common language descriptors for features of a human face. It will also accept an already created sketch done by hand to provide a base model to work on. Second, will be the creation of the image and/or strengthening of a sketch. Local governments will allow the use of camera/ video surveillance equipment already available to create a database of images from various angles of a person's head to aid the software in facial recognition and the design of a face. Finally, an output of a 3-D model of a human face will be created. This output will be able to be matched against the faces of those in a lineup or a digital image to scan for similarities and give a percentage of how similar they are.

## **2 The Purpose of the Project**

### **2a The User Business or Background of the Project Effort**

Local and federal law enforcement, even today, still employ the old timey concept of taking eye witness reports to create a physical composite of the face of a criminal at large. Even though many aspects of these agencies have been modernized with the use of computers to get more accurate results, there are still legacy systems that need help getting to the standard of today. The use of AI and software to provide an easier to use and more effective tool will pave the way for allowing these agencies to provide a safer world for all to live in.

### **2b Goals of the Project**

The goal of this project is to aid judicial bodies in creating a better portrayal of suspects. This software will enhance the systems already in use (sketch artists) with a more refined implementation. Since the software uses an AI to learn, it can keep learning and get better over time on how to portray specific descriptors to a face. The ease of just typing in, and even utilizing an already created sketch to provide a base model will make it that much more efficient to get a working model of a criminal that can be used to help victims or eyewitnesses identify them.

## **2c Measurement**

The main way to gauge how effective this software is, starts by asking the agencies on their internal reports and metrics. First, we ask them how high the rate of identification of a criminal is before giving them the software to establish a baseline. Then, we ask them after one year how their rates have changed since the introduction of the software. If there is at least a 20% increase in identification of suspects, then we consider the software a success. The AI of this software will get better over time as it learns patterns of recognition, meaning a substantial amount of time must be spent using it to accurately assess how well it works, making a 20% increase within the first year a realistic goal.

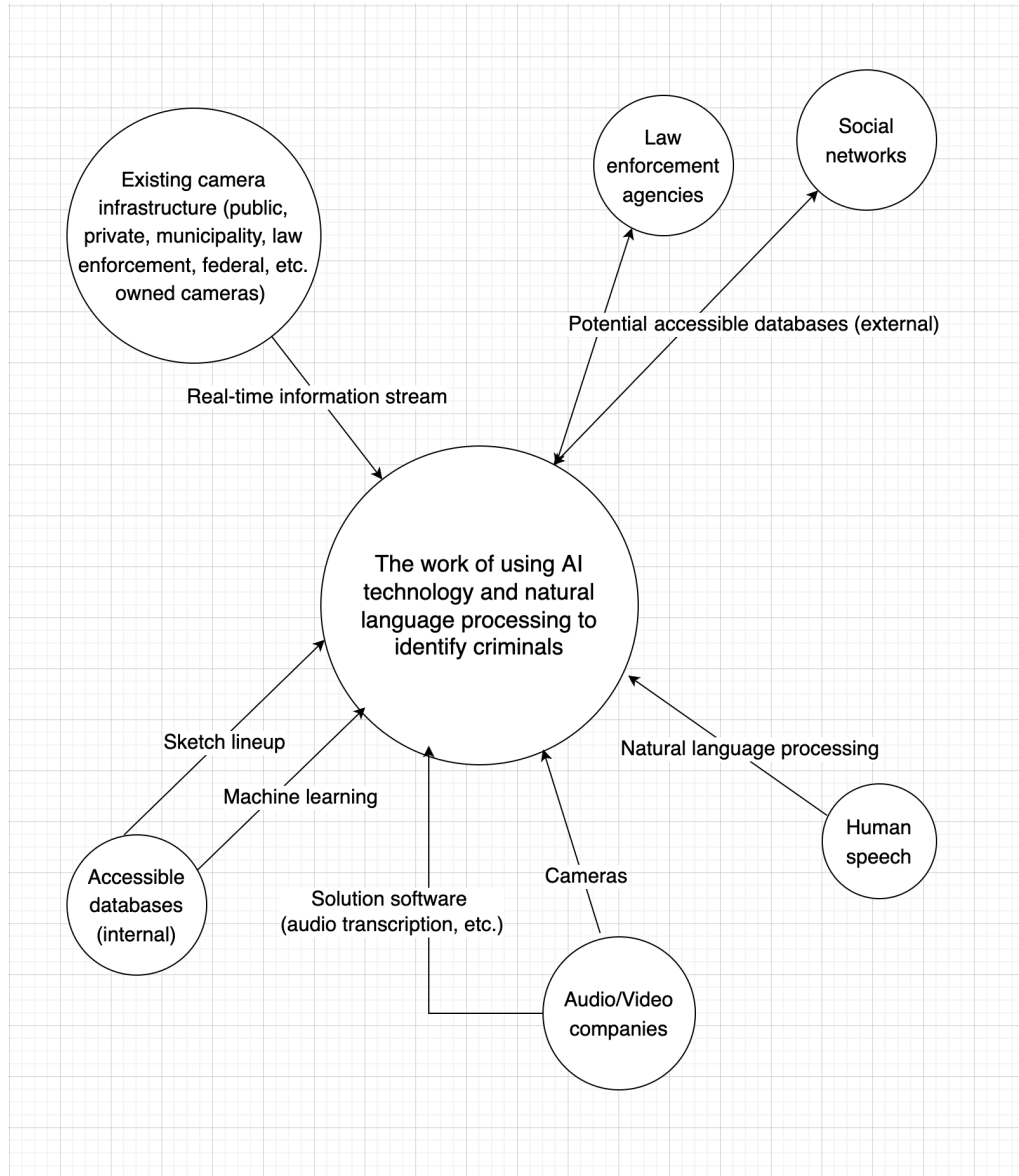
## **3 The Scope of the Work**

The scope of the work addressed is the utilization of AI technology in combination with natural language processing to identify criminals; the scope of the work is a part of a larger whole, known as the business, in which we can establish as part of this project to refer to the criminal justice system and law enforcement agencies. The scope will include implementing redesigned methods using current technologies and infrastructure in order to meet the demands of our modern needs and capabilities.

### **3a The Current Situation**

Creating a sketch of a criminal has gotten down to a finely tuned methodology. The current way of generating a composite image is by gathering clues from eye witnesses about how the perpetrator looks. Of the whole process, this is the hardest part. The accuracy of a bystanders' recollection of how a criminal looks when they are fleeing from the crime scene poses the biggest challenge in terms of modeling a detailed and incriminating image. The participants mainly start with the largest portions of the face (hair, skin color). However, the smallest, seemingly insignificant, details are the parts that matter the most when creating the composite. The challenge is to find and identify criminals based on some set of descriptors, with varying accuracy and reach.

### 3b The Context of the Work



**Figure 1 - Context of the Work Diagram**

### 3c Work Partitioning

**Table 1 - Business Event List**

<b>Event Name</b>	<b>Input and Output</b>	<b>Summary</b>
Infrastructure upgrade	Better stream of info (in)	When technology improves, AI must adapt.
Change in social media	Changing database (in) New ways to match (out)	AI must also be able to adapt with software/DB.
Accent detected in speech	Understood meaning (in)	AI understands accents.
Criminal match found	Alert to agencies (out)	Send an alert for a match
New company structure	Permissions change (in)	Secure software for owner

### 3d Competing Products

Some existing products which the client could use instead, are the applications developed by Clearview AI: Clearview AI Software and Clearview AI Search Engine. As stated on their Wikipedia page, “Clearview AI is an American facial recognition company, providing software to companies, law enforcement, universities, and individuals. The company’s algorithm matches faces to a database of more than three billion images indexed from the internet, including social media applications.” As stated on the Clearview website, “Clearview AI is a privately-owned, U.S. based company, dedicated to innovating and providing the most cutting-edge technology to law enforcement to investigate crimes, enhance public safety, and provide justice to victims.” The Clearview product line aids law enforcement by matching an input image against its internal database of web scraped publicly available images, however it does not include the ability to utilize natural language processing to conduct its work. Additionally, it relies on having an already taken image to use as input meaning it can only work if the perpetrator has an online/ digital persona.

There is also Identi-Kit which is a very advanced image manipulation tool. It allows the control of every facial feature, even including accessories that may have been worn. It gives the options to resize, adjust transparency, alter styles of hair, etc, to create a composite much as how it's already done by hand. The main issue regarding this software is that it necessitates the knowledge and expertise of someone who knows how to operate graphic design tools, meaning it is somewhat cumbersome to use. It also creates a 2-D sketch of an individual rather than a 3-D model, as our software proposes.

## 4 The Scope of the Product

The scope of this product entails a software application packaged with the ability to input common facial descriptors, receiving an image, or strengthening of a sketch, and outputting a 3-D human facial model, all out of the box. The product will also have the capability to connect with the databases of currently existing infrastructure that gather real-time information via cloud (such as street cameras) databases of publicly accessible social network profiles, and other solution software which will help aid in the process. The product will be solely the software application; no physical peripherals will be included, and mileage may vary with full product capability depending on the available resources the client has at hand.

### 4a Scenario Diagram(s)

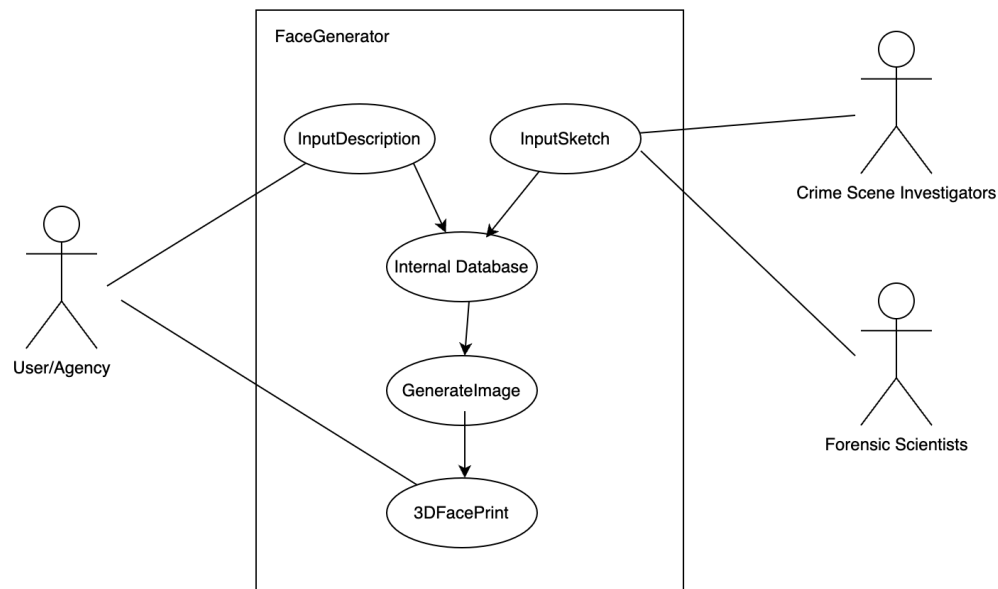


Figure 2 - Scenario Diagram

### 4b Product Scenario List

Table 2 - Product Scenario List

Scenario Name	External Actors Involved	Other Relevant Info
Input Description	User/Agency	Can be skipped if input sketch is chosen.

Input Sketch	Crime Scene Investigators, Forensic Scientists	Can be skipped if input description is chosen.
Update Internal Database	N/A, info gathered above*	*Cameras also actors.
Generate Image	N/A, info gathered above	Image generated from either description or sketch.
3-D Facial Printing	User/Agency	N/A

#### 4c Individual Product Scenarios

1. **Input Description:** For the input description, the end user (which should be a private agency - this product will not be marketed or sold to the general public) can choose to provide the FaceGenerator with an input description of a suspect based on their findings. Alternatively, this step can be bypassed if Scenario 2 is chosen as the route of the investigation. Biometrics should be included if possible. The end user will be able to verbally describe to the FaceGenerator a description of the suspect, which will then send that information to the internal database and create a profile for the suspect, and continue on to for further processing.
2. **Input Sketch:** For the input sketch, the end user will hand off this step to external actors (such as crime scene investigators or forensic scientists) who will then provide sketches based on their description of a suspect. This step should only be taken if Scenario 1 is not chosen as the route of the investigation. The input sketch should also include any biometrics if available. The external actors will be able to provide a sketch, in which the software will create a profile for the suspect based upon said sketch, and will then continue along to the next steps for further processing.
3. **Update Internal Database:** In this scenario, information gathered from earlier scenarios (either an input description from 1 or an input sketch from 2) will be provided to the software's internal database. The database will create a profile for the suspect and any relevant information will be stored here, such as a possible name, date of birth, physical features, etc, as well as any possible biometric information. The end user will be able to update this suspect profile as more information arrives, and once ready, ship the user profile to be processed in the following scenario.
4. **Generate Image:** In the Generate Image scenario, the software will receive a suspect profile from the previous scenario and generate an image

based on all of the information from this suspect's profile. If the chosen route was to give information from an input description, the software will create this generated image from scratch, using machine learning and artificial intelligence technologies to recreate this description to the best of its capabilities. If the chosen route was to give information from an input sketch, the software will instead strengthen the details of the sketch to the best of its abilities based on the data it has gathered over time.

5. **3-D Facial Printing:** In the final scenario state, the software will then take the image generated from the previous scenario and apply the necessary transformations to create an accurate 3-D rendering of a suspect's face. This 3-D facial printing will be stored within the software's internal database and connected to the suspect's profile. If the end user has the opportunity to connect the software to external databases, such as any cloud services which are connected to physical cameras, or social media databases, the software will keep a tab on this stream of real-time information and alert the end user if a close enough match has been found.

## 5 Stakeholders

### 5a The Client

The primary client for this project is expected to be the U.S. federal government and/or security companies providing service to the government. The use cases are specifically tailored for use by government law enforcement agencies, and as such should work closely with them so as to ensure the best possible synergy with their needs and existing systems.

### 5b The Customer

Law enforcement agencies: All levels of law enforcement including federal, state, local and international agencies are expected to get use out of this product. It can significantly aid in efforts to find missing persons and identifying and tracking down criminals when identifiable images of the person of interest may not exist.

Colleges and universities: The software can be used to make the jobs of professors and TAs taking attendance and preventing cheating during exams and similar situations easier. The software could also find effective use in preventing school shootings, as it could monitor suspicious and/or high risk individuals based on reports. This functionality does overlap with law enforcement.

Marketing and advertising industry: As the program can scan for specific traits and descriptions of people, it can also be useful for marketers looking to target specific groups and audiences for their campaigns.



## **5c Hands-On Users of the Product**

In law enforcement contexts, the program would be used by police officers, detectives and forensic investigators. Any victims or witnesses who can give physical descriptions of the person(s) of interest would naturally also be involved in the use of the program.

In an educational/anti-cheating context, the primary hands-on users would be instructors and examiners. TAs may or may not be involved in the use of the program depending on the schools policies and discretion of individual instructors. Campus security would also find use of the program as other law enforcement officers would.

In advertising contexts, the program could be used by marketing coordinators, market researchers and managers, as well as campaign directors and researchers for political and advertisement campaigns.

## **5d Maintenance Users and Service Technicians**

Software developers who will continue to update software past launch and respond to any bugs or issues. Service technicians to provide live support. System administrators, network administrators, database administrators, devops teams. Security administrators and a security team to keep sensitive user data safe.

## **5e Other Stakeholders**

Facial recognition technology is controversial so we may run into objections for this project's development and implementation for use by law enforcement or otherwise. There are groups concerned with privacy and the possibility of misuse of this kind of software whose interests the project might go against.

Forensic artists may be negatively impacted by the widespread implementation of this technology as it might shift their existing duties to be more digital and involved with software than it previously did, or might eliminate their jobs altogether.

Individuals with access to this technology could certainly use it outside of its intended purpose, such as for stalking or tracking down people outside against their will and outside of the context of law enforcement and this is a negative consequence we must be vigilant against for victims of such misuse.

## **5f User Participation**

We need groups to take part in research to develop the facial recognition AI for this project. The research group will be involved in describing different faces to allow the algorithm to learn from their responses and improve itself accordingly.

Forensic artists, who have been tasked with similar job descriptions as this program, should also be involved in the research and development of this project as their expertise and knowledge is valuable.

User data will be collected and utilized to further develop the capabilities of the software and provide a larger pool of data for it to draw upon.

## **5g Priorities Assigned to Users**

Key users are law enforcement using the software to identify and track down persons of interest in criminal cases. Forensic artists in particular may find good use of the product; however, as mentioned in 5e, it is also possible that forensic artists may object to the tool being developed as it might lead to lower overall demand for forensic artists. However, our aim is for our product to be used by and in conjunction with forensic artists, not to replace them.

Schools and advertising agencies are lower on the target user priorities but we still expect the program to be of use and interest to them.

## **6 Mandated Constraints**

### **6a Solution Constraints**

Description: The product shall include a natural-language processor for a natural and ‘easy-to-use’ feel.

Rationale: The product is to be marketed towards crime investigation agencies and should simplify the methods of face-generation that already exist.

Fit criterion: The product should be as close to human interaction as possible.

Description: The product should utilize scanned photos from security cameras in order to update face-generation knowledge.

Rationale: In order for the face-generation aspect to be as accurate as possible, new information should be constantly added so that the machine can learn.

Fit criterion: Drawing skills should become better over time, and the AI should have a method of bettering itself.

### **6b Implementation Environment of the Current System**

The product shall be available on mainstream desktop operating systems: Windows, MacOS, and Linux

### **6c Partner or Collaborative Applications**

The product shall utilize public security camera database systems around the country.

## **6d Off-the-Shelf Software**

The software will be offered directly to crime investigators/agencies. The software will not be offered publicly, nor will it be available for anonymous download on the internet. Implementation specialists will directly assist companies/organizations in the setup of the product.

## **6e Anticipated Workplace Environment**

- The product should be usable in any crime-agency office.
- The product should be used by crime investigation specialists.
- The computing process will require certain computing ability from the computer's CPU.

## **6f Schedule Constraints**

Access to public security camera information must be accomplished first. Once done, the face-generation AI can be developed, followed by the learning aspect of the AI by increasing its database with images coming in from the security camera systems.

Each aspect of the software will require significant reliance on the other, so the order of things must be precise and strategic.

## **6g Budget Constraints**

Implementation of dynamic AI face generation with natural language processing will take a great deal of time and expertise to create. An estimated 20 engineers will be required over the course of 5 years to achieve. While the overarching time-frame of the project is possibly unpredictable, it will take an estimated \$15 million.

# **7 Naming Conventions and Definitions**

## **7a Definitions of Key Terms**

- Natural language descriptors: Everyday language, which are used to describe features of a face (e.g.: large nose, small eyes, etc).

## **7b UML and Other Notation Used in This Document**

Documentation of figures, tables, and diagrams follows Martin Fowler's "UML Distilled" [3].

## **7c Data Dictionary for Any Included Models**

Input sketches and database images are of a typical image file format (png, jpg, etc) for maximum compatibility.

## 8 Relevant Facts and Assumptions

### 8a Facts

- The Natural-Language processing aspect will only support certain languages, most likely languages commonly used by crime investigators in the U.S.
- At product setup time, software will immediately scan all known images in the database, initializing AI knowledge. AI will periodically scan for new images in the database.

### 8b Assumptions

- User's computer will have line/internet access to the image database(s).
- User's computer is powerful enough to handle machine learning and AI generation aspects.
- User speaks one of the languages included in the natural language processing aspect.
- Direct access to image and video surveillance infrastructure.

## II Requirements

*SV: Sections 9 and 10 deal with functional requirements. Sections 11 to 20 are a very thorough list of possible non-functional requirements, not all of which apply to every project. You should think carefully about each of these, form requirements if applicable, or write "Not Applicable" otherwise. See section 10 for the format of individual requirements. Section 21 documents the acceptance tests planned to verify the requirements – See that section for further details, and be aware that every requirement needs at least one verifying acceptance test ( though some tests may verify more than one requirement. )*

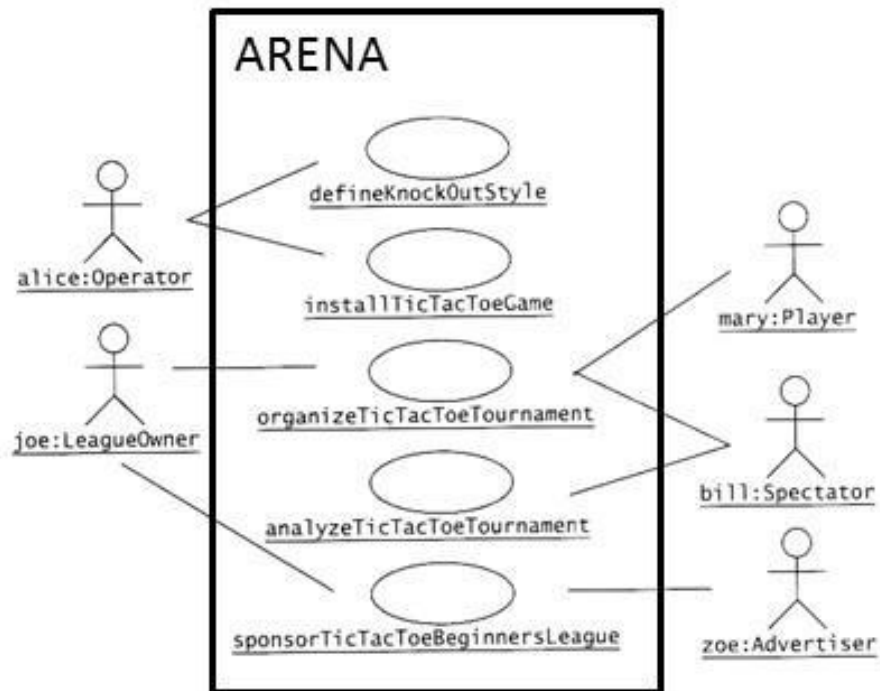
### 1 Product Use Cases

*SV: Product Use Cases are very similar to Product Scenarios, but in more formal detail. They serve as a first step towards developing functional requirements, and can aid in organizing requirements according to the use case(s) from which they were developed. See the CS 440 web site for a sample use-case form, with instructions.*

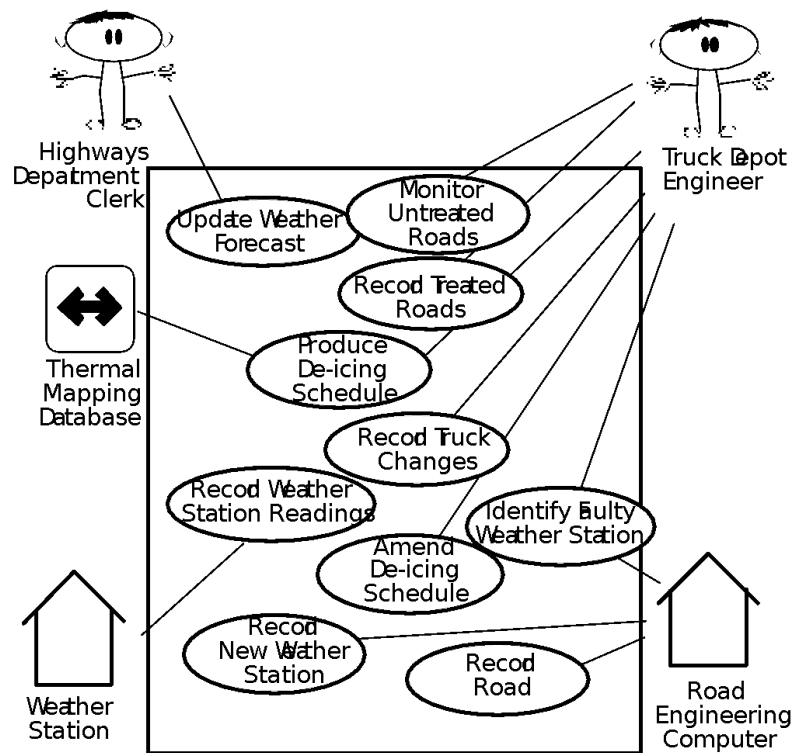
#### 1a Use Case Diagrams

*SV: Use case diagrams list the use cases developed for a system, mark the boundary of what is internal or external to the system to be developed, and indicate which external entities ( actors ) are associated with each use case.*

*Examples*



**Figure 1 - Sample Use Case Diagram from Bruegge & DuToit ( modified )**



**Figure 2 - Sample Use Case Diagram from Robertson and Robertson**

### **1b Product Use Case List**

*SV: A list ( table ) of use cases is an alternative to the use case diagram, particularly when there are many use cases. There may be additional information in the table not found in the diagram, such as cross referencing to other sections or materials.*

### **1c Individual Product Use Cases**

*SV: The following example was copied from “useCaseFormWithInstructions.docx”, available on the CS 440 web site. ( There is also a blank version available. )*

Use case ID: _____ Name: _____ pre-conditions: _____ post-conditions: _____ Initiated by: _____ Triggering Event: _____ Additional Actors: _____
Sequence of Events: <ol style="list-style-type: none"> <li>1. Initiating event or action should be step 1, taken by initiating actor.</li> <li>2. System response follows, indented right.</li> <li>3. All external action steps are aligned with step 1. ( "stimulus" style )</li> <li>4. All system responses are indented right, aligned with step 2. ( "response" style )</li> <li>5. All steps should be expressed in the active voice, clearly indicating <b><u>who</u></b> performs each action</li> <li>6. The sequence of events should show a back-and-forth stimulus-response relationship.</li> </ol>
Alternatives: These would be normal and expected variations from the base case. Exceptions: These would be unusual variations from the base case, often caused by problems.

- *For all of the above, list as NA if not applicable.*
- *The following may be added if relevant, or omitted otherwise:*
  - *related use cases or scenarios*
  - *associated tests, systems, classes, etc.*
  - *revision history*
  - *references to other documents*

- *author(s) / originator( s )*
- *notes*
- *Alternatives and Exceptions may be listed either as separate use cases or as notes to a base case, depending on their significance and similarity.*
- *For regularly occurring periodic events, "time" can be listed as the initiating actor.*

## 2 Functional Requirements

*SV: Each requirement listed needs to have a unique identifier, a short name, a one- or two-sentence description, a rationale, a fit criteria, and reference to one or more acceptance tests to be used to confirm the completion of this particular requirement. The acceptance tests themselves are documented in section 0- See that section for further details. It is recommended to number the requirements according to their type, such as F-4 for the fourth functional requirement or U-2 for the second usability requirement. Functional requirements specifically deal with the functionality the system must have, and are generally derived directly from the steps the system takes during use cases.*

### ID# - Name

**Description:** Your description here . . .

**Rationale:** Your rationale here . . .

**Fit Criterion:** Your fit criteria here . . .

**Acceptance Tests:** List ID# and/or names here . . .

## 3 Data Requirements

*SV: Data requirements deal with requirements that are somehow related to data, such as the definition of what is included in a "student record" or the acceptable form of an e-mail address or allowable range of certain data items.*

### ID# - Name

**Description:** Your description here . . .

**Rationale:** Your rationale here . . .

**Fit Criterion:** Your fit criteria here . . .

**Acceptance Tests:** List ID# and/or names here . . .



## 4 Performance Requirements

### 4a Speed and Latency Requirements

*SV: Requirements specifying how fast ( or slow ) the product must operate or how much lag is allowable between stimulus and either initial response or task completion. Other timing-related requirements could go in this section.*

#### ID# - Name

**Description:** Your description here . . .

**Rationale:** Your rationale here . . .

**Fit Criterion:** Your fit criteria here . . .

**Acceptance Tests:** List ID# and/or names here . . .

### 4b Precision or Accuracy Requirements

*SV: Self-explanatory. How accurate or precise must the system be.*

#### ID# - Name

**Description:** Your description here . . .

**Rationale:** Your rationale here . . .

**Fit Criterion:** Your fit criteria here . . .

**Acceptance Tests:** List ID# and/or names here . . .

### 4c Capacity Requirements

*SV: Requirements regarding the largest “thing” the system must be able to handle, or perhaps how many things it can handle ( at once. ) Note: Requirements regarding how many things it can handle in a given time period would be a speed requirement, covered in section 12a above.*

#### ID# - Name

**Description:** Your description here . . .

**Rationale:** Your rationale here . . .

**Fit Criterion:** Your fit criteria here . . .

**Acceptance Tests:** List ID# and/or names here . . .

## 5 Dependability Requirements

### 5a Reliability Requirements

*SV: Reliability relates to how frequently the system fails, ( either by shutting down or by delivering erroneous results ), and the consequences of those failures. These requirements may also address the conditions under which it is allowed to fail ( or not. ), See also availability and robustness in the following sections.*

#### ID# - Name

**Description:** Your description here . . .

**Rationale:** Your rationale here . . .

**Fit Criterion:** Your fit criteria here . . .

**Acceptance Tests:** List ID# and/or names here . . .

### 5b Availability Requirements

*SV: Availability addresses the amount of time the system is running and available for use. It is affected by how often the system goes down ( reliability ), but also by the time required to bring the system back up again, the availability lost due to regularly scheduled maintenance down times, and the ability of the system to offer at least partial functionality in the face of failures or resource shortages. See also reliability and robustness.*

#### ID# - Name

**Description:** Your description here . . .

**Rationale:** Your rationale here . . .

**Fit Criterion:** Your fit criteria here . . .

**Acceptance Tests:** List ID# and/or names here . . .

### 5c Robustness or Fault-Tolerance Requirements

*SV: This section deals with the system's ability to provide at least partial functionality in the face of failures or resource shortages, such as operating in offline mode when network connectivity is unavailable. See also reliability and availability.*

#### ID# - Name

**Description:** Your description here . . .

**Rationale:** Your rationale here . . .

**Fit Criterion:** Your fit criteria here . . .

**Acceptance Tests:** List ID# and/or names here . . .

## 5d Safety-Critical Requirements

*SV: These requirements address potential harm to health, safety, or property, and may refer to relevant standards such as OSHA compliance.*

### ID# - Name

**Description:** Your description here . . .

**Rationale:** Your rationale here . . .

**Fit Criterion:** Your fit criteria here . . .

**Acceptance Tests:** List ID# and/or names here . . .

## 6 Maintainability and Supportability Requirements

### 6a Maintenance Requirements

*SV: This section deals with the ease with which the system can be maintained, and possibly who will perform system maintenance and under what conditions. The ease of evolving the system into future versions may also be addressed here, or in a separate section ( not included in this template ) if that is a major concern.*

### ID# - Name

**Description:** Your description here . . .

**Rationale:** Your rationale here . . .

**Fit Criterion:** Your fit criteria here . . .

**Acceptance Tests:** List ID# and/or names here . . .

### 6b Supportability Requirements

*SV: What ongoing support is to be provided, e.g. through a help desk. See also training requirements in section 16g below.*

### ID# - Name

**Description:** Your description here . . .

**Rationale:** Your rationale here . . .

**Fit Criterion:** Your fit criteria here . . .

**Acceptance Tests:** List ID# and/or names here . . .

## **6c Adaptability Requirements**

*SV: Description of other platforms or environments to which the product must be ported.*

### **ID# - Name**

**Description:** Your description here . . .

**Rationale:** Your rationale here . . .

**Fit Criterion:** Your fit criteria here . . .

**Acceptance Tests:** List ID# and/or names here . . .

## **6d Scalability or Extensibility Requirements**

*SV: The ease of expanding the system to a larger capacity as the business grows.*

### **ID# - Name**

**Description:** Your description here . . .

**Rationale:** Your rationale here . . .

**Fit Criterion:** Your fit criteria here . . .

**Acceptance Tests:** List ID# and/or names here . . .

## **6e Longevity Requirements**

*SV: This specifies the expected lifetime of the product.*

### **ID# - Name**

**Description:** Your description here . . .

**Rationale:** Your rationale here . . .

**Fit Criterion:** Your fit criteria here . . .

**Acceptance Tests:** List ID# and/or names here . . .

## 7 Security Requirements

*SV: Security requirements address who is allowed what type of access to the system, and what areas require special protection or diligence. In practice security requirements must often be written by security experts, and may refer to standards.*

### 7a Access Requirements

*SV: These requirements address who has access to what ( data or functionality ) and under what conditions or restrictions.*

#### ID# - Name

**Description:** Your description here . . .

**Rationale:** Your rationale here . . .

**Fit Criterion:** Your fit criteria here . . .

**Acceptance Tests:** List ID# and/or names here . . .

### 7b Integrity Requirements

*SV: These requirements address the protection of data(bases) from intentional or accidental corruption, loss, or theft.*

#### ID# - Name

**Description:** Your description here . . .

**Rationale:** Your rationale here . . .

**Fit Criterion:** Your fit criteria here . . .

**Acceptance Tests:** List ID# and/or names here . . .

### 7c Privacy Requirements

*SV: These requirements address data that must remain confidential, such as medical records or other personally identifiable data. Laws often apply. (See also section 20.)*

#### ID# - Name

**Description:** Your description here . . .

**Rationale:** Your rationale here . . .

**Fit Criterion:** Your fit criteria here . . .

**Acceptance Tests:** List ID# and/or names here . . .

## **7d Audit Requirements**

*SV: This section applies when a system must provide support for transaction auditing, such as some financial or medical systems.*

### **ID# - Name**

**Description:** Your description here . . .

**Rationale:** Your rationale here . . .

**Fit Criterion:** Your fit criteria here . . .

**Acceptance Tests:** List ID# and/or names here . . .

## **7e Immunity Requirements**

*SV: This section addresses the system's ability to resist viruses, worms, Trojan Horses, etc.*

### **ID# - Name**

**Description:** Your description here . . .

**Rationale:** Your rationale here . . .

**Fit Criterion:** Your fit criteria here . . .

**Acceptance Tests:** List ID# and/or names here . . .

## **8 Usability and Humanity Requirements**

*SV: This section is concerned with requirements that make the product usable and ergonomically acceptable to its hands-on users.*

### **8a Ease of Use Requirements**

*SV: This section addresses the ease with which the intended audience can use the system properly, and conversely the difficulty with which they can use it improperly.*

### **ID# - Name**

**Description:** Your description here . . .

**Rationale:** Your rationale here . . .

**Fit Criterion:** Your fit criteria here . . .

**Acceptance Tests:** List ID# and/or names here . . .

## **8b Personalization and Internationalization Requirements**

*SV: This section addresses the ease with which the system can be configured for personal preferences, and for things such as language, currency, units, symbols, etc.*

### **ID# - Name**

**Description:** Your description here . . .

**Rationale:** Your rationale here . . .

**Fit Criterion:** Your fit criteria here . . .

**Acceptance Tests:** List ID# and/or names here . . .

## **8c Learning Requirements**

*SV: Requirements related to how easy it is for the intended audience to learn to use the product.*

### **ID# - Name**

**Description:** Your description here . . .

**Rationale:** Your rationale here . . .

**Fit Criterion:** Your fit criteria here . . .

**Acceptance Tests:** List ID# and/or names here . . .

## **8d Understandability and Politeness Requirements**

*SV: These requirements relate to how intuitively the intended audience understands what the program does, what its messages mean, and how to use it. Definitely related to ease of use, ( section 16a ), but more specifically addressing comprehension of the program output, instructions, and other messages.*

### **ID# - Name**

**Description:** Your description here . . .

**Rationale:** Your rationale here . . .

**Fit Criterion:** Your fit criteria here . . .

**Acceptance Tests:** List ID# and/or names here . . .

## 8e Accessibility Requirements

*SV: Requirements related to use of the product by individuals with disabilities.*

### ID# - Name

**Description:** Your description here . . .

**Rationale:** Your rationale here . . .

**Fit Criterion:** Your fit criteria here . . .

**Acceptance Tests:** List ID# and/or names here . . .

## 8f User Documentation Requirements

*SV: List of the user documentation to be supplied as part of the product.*

### ID# - Name

**Description:** Your description here . . .

**Rationale:** Your rationale here . . .

**Fit Criterion:** Your fit criteria here . . .

**Acceptance Tests:** List ID# and/or names here . . .

## 8g Training Requirements

*SV: A description of the training needed by users of the product.*

### ID# - Name

**Description:** Your description here . . .

**Rationale:** Your rationale here . . .

**Fit Criterion:** Your fit criteria here . . .

**Acceptance Tests:** List ID# and/or names here . . .

## 9 Look and Feel Requirements

### 9a Appearance Requirements

*SV: These requirements address things such as the colors, fonts, and logos used, often to reflect corporate branding or similarity to related products. See also style in the next section.*



**ID# - Name**

**Description:** Your description here . . .

**Rationale:** Your rationale here . . .

**Fit Criterion:** Your fit criteria here . . .

**Acceptance Tests:** List ID# and/or names here . . .

**9b Style Requirements**

*SV: Style requirements address the impression the product makes upon users, such as professionalism for a tax accounting package, friendliness for a children's game, or how "cool" it is for a teenage audience. Product packaging may also be addressed here, and/or appearance in the previous section.*

**ID# - Name**

**Description:** Your description here . . .

**Rationale:** Your rationale here . . .

**Fit Criterion:** Your fit criteria here . . .

**Acceptance Tests:** List ID# and/or names here . . .

**10 Operational and Environmental Requirements**

**10a Expected Physical Environment**

*SV: These requirements relate to the physical environment in which the product will operate.*

**ID# - Name**

**Description:** Your description here . . .

**Rationale:** Your rationale here . . .

**Fit Criterion:** Your fit criteria here . . .

**Acceptance Tests:** List ID# and/or names here . . .

**10b Requirements for Interfacing with Adjacent Systems**

*SV: This section describes the requirements to interface with partner applications and/or devices that the product needs to successfully operate.*

**ID# - Name**

**Description:** Your description here . . .

**Rationale:** Your rationale here . . .

**Fit Criterion:** Your fit criteria here . . .

**Acceptance Tests:** List ID# and/or names here . . .

**10c Productization Requirements**

*SV: Requirements related to the distribution and/or installation of the product.*

**ID# - Name**

**Description:** Your description here . . .

**Rationale:** Your rationale here . . .

**Fit Criterion:** Your fit criteria here . . .

**Acceptance Tests:** List ID# and/or names here . . .

**10d Release Requirements**

*SV: Specification of the intended release cycle for the product and the form that the release shall take.*

**ID# - Name**

**Description:** Your description here . . .

**Rationale:** Your rationale here . . .

**Fit Criterion:** Your fit criteria here . . .

**Acceptance Tests:** List ID# and/or names here . . .

**11 Cultural and Political Requirements**

**11a Cultural Requirements**

*SV: This section contains requirements that are specific to the sociological factors that affect the acceptability of the product. If you are developing a product for foreign markets, then these requirements are particularly relevant. Bear in mind that “cultural groups” may also apply to population subgroups such as teenagers, the elderly, or ironworkers.*

**ID# - Name**

**Description:** Your description here . . .

**Rationale:** Your rationale here . . .

**Fit Criterion:** Your fit criteria here . . .

**Acceptance Tests:** List ID# and/or names here . . .

**11b Political Requirements**

*SV: Requirements included strictly to make “the boss” happy, either internally to the development company, or internally to the client company, or possibly an external third party.*

**ID# - Name**

**Description:** Your description here . . .

**Rationale:** Your rationale here . . .

**Fit Criterion:** Your fit criteria here . . .

**Acceptance Tests:** List ID# and/or names here . . .

**12 Legal Requirements**

**12a Compliance Requirements**

*SV: A statement specifying the legal requirements for this system, often referring to relevant laws and/or requiring approval by the legal department.*

**ID# - Name**

**Description:** Your description here . . .

**Rationale:** Your rationale here . . .

**Fit Criterion:** Your fit criteria here . . .

**Acceptance Tests:** List ID# and/or names here . . .

**12b Standards Requirements**

*SV: These requirements specify documented standards to which the product must conform, as opposed to legal regulations.*

**ID# - Name**

**Description:** Your description here . . .

**Rationale:** Your rationale here . . .

**Fit Criterion:** Your fit criteria here . . .

**Acceptance Tests:** List ID# and/or names here . . .

## 13 Requirements Acceptance Tests

*SV: Every requirement must have one or more acceptance tests associated with it, to confirm that the requirement has been met. At this point these tests are not yet completely specified – A one- or two-sentence description of each test will suffice. Note that some tests may verify more than one requirement, and that some requirements may require multiple tests for their confirmation.*

### 13a Requirements – Test Correspondence Summary

*SV: The following sample table is available from the CS 440 web site as “Sample Requirement Test Correspondence Table.xlsx” It is recommended that you work with the table in Excel, and then drag it into the document when it is completed. Depending on the number of requirements and/or tests included, it may be necessary to use multiple tables, and/or use landscape mode. Every row and every column of the table should include at least one X. Below the table list the ID #, name, and short description of each individual acceptance test.*

Test	Requirements																			
	Req 1	Req 2	Req 3	Req 4	Req 5	Req 6	Req 7	Req 8	Req 9	Req 10	Req 11	Req 12	Req 13	Req 14	Req 15	Req 16	Req 17	Req 18	Req 19	Req 20
Test 1	X																			
Test 2		X				X														
Test 3			X	X																
Test 4					X	X														
Test 5																				
Test 6																				
Test 7																				
Test 8																				
Test 9																				
Test 10																				
Test 11																				
Test 12																				
Test 13																				
Test 14																				
Test 15																				

**Table 1 - Requirements - Acceptance Tests Correspondence**

### 13b Acceptance Test Descriptions

*SV: Provide a brief description of each acceptance test. Detailed test specifications will appear in a separate document, which may be referenced here when available.*

#### **ID # - Name**

**Description:** Your description here . . .

## III Design

### 1 Design Goals

*SV: Identify the important design goals that are to be optimized in the proposed design.*

Your text goes here . . .

### 2 Current System Design

*SV: **IF** the proposed new system is to replace an existing system, then the current system should be described here. Otherwise insert a brief statement that there is no pre-existing system.*

Your text goes here . . .

### **3 Proposed System Design**

*This section will make heavy use of class diagrams, and also sequence and deployment diagrams where noted. However don't overlook finite state, activity, communication, or other diagram types as needed for effective communication.*

#### **3a Initial System Analysis and Class Identification**

*SV: Perform grammatical and similar analyses to identify the most important and obviously needed classes, and to organize them into an initial class structure. An initial class diagram is appropriate, containing few if any internal details.*

Your text goes here . . .

#### **3b Dynamic Modelling of Use-Cases**

*SV: Insert sequence diagrams of ( at least the most important ) use-cases, as a means of identifying other needed classes.*

Your text goes here . . .

#### **3c Proposed System Architecture**

*SV: Identify the Software Architecture to be applied to this project, such as Client-Server, Repository, MVC, etc., along with justification for the choice.*

Your text goes here . . .

#### **3d Initial Subsystem Decomposition**

*SV: A slightly more detailed class diagram, showing the classes identified in sections 24a, 24b, and 0 above, partitioned into subsystems. For each subsystem provide a brief description of the subsystem, including its key responsibilities. There should still be few if any internal details.*

Your text goes here . . .

### **4 Additional Design Considerations**

*SV: The sections listed here do not need to be presented in the order given, and may not all be relevant for any particular project. Those that are relevant can help identify additional classes that are needed as a result.*

#### 4a Hardware / Software Mapping

*SV: This is particularly important for distributed systems, such as those employing a client-server architecture. Use a deployment diagram to indicate which subsystems are mapped onto which piece(s) of hardware, and what communication subsystems need to be added to the system as a result.*

Your text goes here . . .

#### 4b Persistent Data Management

*SV: Document the classes and perhaps subsystems necessary to store persistent data when the system shuts down, and to restore that data when the system starts back up again.*

*Reiterate key data structures and information as necessary for the understanding of this design phase. Refer the reader back to the data dictionary in section **Error! Reference source not found.** to avoid undue repetition, while reviewing only the most relevant items here.*

Your text goes here . . .

#### 4c Access Control and Security

*SV: Identify the access control and security concerns for this system, and the new classes and/or subsystems that must be added to handle those concerns.*

Your text goes here . . .

#### 4d Global Software Control

*SV: Identify the global software control concerns for this system, and the new classes and/or subsystems that must be added to handle those concerns.*

Your text goes here . . .

#### 4e Boundary Conditions

*SV: Identify the boundary condition concerns for this system, and the new classes and/or subsystems that must be added to handle those concerns. In particular consider startup, shutdown ( normal or abnormal ), and the creation and/or maintenance of any configuration files, databases, or similar supporting data files.*

Your text goes here . . .

#### **4f User Interface**

*SV: Include a preliminary user interface design here, possibly as a rough sketch or other mockup, in order to identify additional classes needed to implement the interface.*

Your text goes here . . .

#### **4g Application of Design Patterns**

*SV: Any design patterns applied as a result of previous sections should have been addressed there, and identified as such at the time. Use this section to document only the additional design patterns that were not previously covered elsewhere. ( If any. )*

Your text goes here . . .

### **5 Final System Design**

*SV: Include here the final version of the overall system design, incorporating all the subsystems and classes added as a result of additional design considerations. Multiple diagrams may be needed, possibly starting with an overall package diagram showing all the different subsystems and the ( important ) classes contained within each one. Still not a lot of internal details.*

Your text goes here . . .

## **6 Object Design**

*This section documents the internal details of each class, to the extent that they can be designed at this time. Included should be the class interfaces ( public method signatures and responsibilities ) and constraints. It is probably best to break this section up into subsections corresponding to subsystems as documented above, and/or by ( Java ) packages if those are designed. It may also be appropriate to address additional design pattern considerations here, but not to the point of being redundant of previous documentation.*

*Certain methods, such as simple getters, setters, and constructors are not always documented, unless there is something special about them such as in the Singleton or Factory Method design patterns.*

#### **6a Packages**

*SV: If the design involves assigning classes to packages ( .e.g Java packages ), then the packages to be created should be documented here.*

Your text goes here . . .



## **6b Subsystem I**

Your text goes here . . .

## **6c Subsystem II**

Your text goes here . . .

## **6d etc.**

Your text goes here . . .

# **IV Project Issues**

## **1 Open Issues**

*SV: Issues that have been raised and do not yet have a conclusion.*

Your text goes here . . .

## **2 Off-the-Shelf Solutions**

*SV: Discussion of products or components currently available that could either be incorporated into the new solution or simply used instead of developing ( parts of ) the new solution. The distinction between sections 35 a, b, and c is subtle, and not very important.*

Your text goes here . . .

### **2a Ready-Made Products**

*SV: Products available for purchase that could be used either as part of a solution or instead of ( a part of ) a solution.*

Your text goes here . . .

### **2b Reusable Components**

*SV: Similar to 35a, but for components such as libraries or toolkits instead of fully blown products.*

Your text goes here . . .

### **2c Products That Can Be Copied**

*SV: Products that could legally be copied would typically be past projects developed by the same development group, provided there were no restrictions that would prevent their reuse.*

Your text goes here . . .

### **3 New Problems**

*SV: The proposed new system certainly has its benefits, but it could also raise new problems. It is a good idea to identify any such potential problems early on, rather than being surprised by them later.*

#### **3a Effects on the Current Environment**

*SV: Could the new system have any adverse effects on the working environment, e.g. the way people do their jobs?*

Your text goes here . . .

#### **3b Effects on the Installed Systems**

*SV: Could the new system have any adverse effects on other hardware or software systems?*

Your text goes here . . .

#### **3c Potential User Problems**

*SV: Could the new system have any adverse effects on the users of the software? Could users possibly have a negative response to the new system?*

Your text goes here . . .

#### **3d Limitations in the Anticipated Implementation Environment That May Inhibit the New Product**

*SV: Are there any ( physical ) limitations in the expected environment that could inhibit the proposed product? ( e.g. weather, electrical interference, radiation, lack of reliable power, etc. )*

Your text goes here . . .

#### **3e Follow-Up Problems**

*SV: Basically any other possible problems that could occur.*

Your text goes here . . .

### **4 Migration to the New Product**

*SV: This section only applies when there is an existing system that is being replaced by a new system, particularly when data must be preserved and possibly translated /*

*reformatted. Otherwise just write "Not Applicable" under section 38 and remove sections 38a and 38b.*

#### **4a Requirements for Migration to the New Product**

*SV: These are a list of requirements relevant to the migration procedures. For example a requirement that the two systems be run in parallel for a time until the client is satisfied with the new system and the users know how to use it.*

Your text goes here . . .

#### **4b Data That Has to Be Modified or Translated for the New System**

*SV: This section specifically addresses data that must be preserved and/or translated / reformatted during the migration process.*

Your text goes here . . .

### **5 Risks**

*SV: Consideration of the potential risks that could cause the project to fail / underperform.*

Your text goes here . . .

### **6 Costs**

*SV: An estimate of what it will cost to complete this project. Think not only in terms of dollars, but also time, resources, lost opportunities, etc.*

Your text goes here . . .

### **7 Waiting Room**

*SV: This is a place to record ideas or wishes that will not be included in the current release of the product, but which might be worth reconsidering at a later date.*

Your text goes here . . .

### **8 Ideas for Solutions**

*SV: When developing requirements only, it is not the role of the business analyst to dictate the implementation of the solution. However they can pass along any ideas they have here as suggestions to the developers. For CS 440 this report includes system and object design, so this section would make suggestions for implementation and testing that would come after design, such as the use of a particular language, IDE, library, or other tools.*

Your text goes here . . .

## 9 Project Retrospective

*SV: At the conclusion of the ( CS 440 ) project, reflect back on what worked well and what didn't, and how the process could be improved in the future.*

Your text goes here . . .

## V Glossary

*SV: The glossary is a more complete and inclusive dictionary of defined terms than that found in section I.7.a, the latter of which only covered the most important key terms needed to understand the report.*

Your text goes here . . .

## VI References / Bibliography

*This section describes the documents and other sources from which information was gathered. This sample bibliography was generated using the “Insert Citation” and “Bibliography” buttons in the “Citations & Bibliography” section under the “References” tab of MS Word. Creating new citations will not update this list unless you click on it and select “Update Field”. You may need to reset the style for this paragraph to “normal” after updating.*

[1] Robertson and Robertson, Mastering the Requirements Process.

[2] A. Silberschatz, P. B. Galvin and G. Gagne, Operating System Concepts, Ninth ed., Wiley, 2013.

[3] M. Fowler, UML Distilled, Third Edition, Boston: Pearson Education, 2004.

## VII Index

*This section provides an index to the report. The sample below was generated using the “Mark Entry” and “Insert Index” items from the “Index” section on the “References” tab, and can be automatically updated by right clicking on the table below and selecting “Update Field”. To remove marked entries from the document, toggle the display of hidden paragraph marks ( the paragraph button on the “Home” tab ), and remove the tags shown with XE in { curly braces. }*

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