

Parking Garage Automation: Reserve Your Spot!

Software Engineering – 14:332:452

Group #3:

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URL(s):

www.reserve-your-spot.com (Actual Website)

www.sites.google.com/site/ece452parkinggarage (Project Tracking Site)

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Effort Breakdown

All team members contributed equally

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Customer Statement of Requirements

Goals

The objective is to design a sophisticated system which will seek to maximize occupancy and profit while allowing the customer quick and easy access to his vehicle.

Problem Statement

At the moment, the garage is not equipped with any computerized system. Additionally, the current system involves the employees to walk around inspecting the occupancy of parking spots. Due to the lack of a computerized system, congestion inside the garage is rampant. The current system is not well designed; during peak times the garage could have free spots but would have no way of checking instantly, this would discourage customers from wanting to park in the garage thereby robbing the garage of additional income. The management has taken note of the situation and has requested the designing and implementation of software that would increase their efficiency, thereby increasing their profit.

Proposed Solution

In order to fix the mentioned problems, the management has requested us to design a system that would make their garage more efficient thereby increasing its occupancy and profit.

The new system will include a website or mobile application that will allow customer to place online reservations. The reservation would include date, time and duration of stay and will also allow the customer to choose their preferred parking spot. Each customer will be required to register on the website; at registration time, the customer is not compelled to enter in a license plate number for their vehicle, this is allowed so that customers are not tied down to one vehicle. The system allows for customers to be able to park even with rented or borrowed vehicles, it does this by creating a temporary association to the new license plate to the customer. This was done so that the garage is accessible by more customers, which would bring in more income to the garage.

The garage is also being remodeled such that the parking decks above ground level will be accessible only by an elevator that will lift vehicles to different decks. One of the major problems of the garage before the implementation of the new software was rampant congestion caused by drivers searching for parking spots. To alleviate this problem, the management has devised one-way entering and exiting systems. As we have already discussed, the elevator is the only way for vehicles entering the garage to get to their parking spaces; but in addition to that, the management has also constructed a ramp that connects all the floors to the ground floor. The customers will use this ramp to exit the parking garage; as there is no two-way traffic on the ramp, there is a very little chance of accidents and such there is no way congestion can form while customers enter and leave the garage.

The proposed system will not depend on employees to check if spots are available; instead, the garage relies on camera based license plate recognition software to track vehicles as they enter and exit the garage. Additionally, the garage also employs sensors on the parking spots to recognize which spots have been taken and which are open. This capability reduces the chance of mistakes by the employees there by making the garage more efficient in assigning parking spots to customers. Each time a vehicle enters the garage, the tracking software quickly takes reads the license plate and refers to the database.

If the software cannot recall the necessary information or if the license plate recognition software is not able to read the license plate, the elevator will not function and the software would prompt the customer to manually input their membership number at the terminal next to the vehicle elevator for it to proceed. The system is designed to account all possibilities, such that if the vehicle does not have a front license plate, the software would alert the customer to do the same thing. As we have mentioned earlier, if the software cannot recall a certain license plate then the customer can register that license plate to his account as well.

If a registered customer forgets to make a reservation and decides to use the garage then he may be allowed to take a walk-in parking spot without a registration if there are any available spots. These types of customers are known as registered walk-ins. If the software recognizes the vehicle registration number but cannot find an existing reservation to the customer who owns the vehicle, then the customer will have to specify the expected duration and time of departure using the terminal at the vehicle elevator. If the vehicle registration number is not recognized then the software will prompt the customer to type in their membership number and their estimated parking duration.

If a customer fails to show up after reserving a spot, the spot will be held reserved for a 30-minute grace period, during which the customer can park on his reserved spot and be billed for the full reserved period. If the customer does not show up to claim his spot during the grace period then the parking spot will be marked unreserved. A customer who does shows up after their grace period can extend their reservation if there are any vacant and unreserved spots. The customer will then be billed for their initial reserved time, their grace period and the new reserved time.

If a customer decides to leave before their time expires then he or she will still be billed for the full reserved period. The spot is then marked vacant and be open to other customers. On the other hand if a customer doesn't leave when their reserved period expires, the rate he will have to pay will increase along with the duration of the overstay. If a customer arrives and his spot is still occupied by a previous customer who overstayed then the garage will direct him to another parking spot, however if there are no vacant parking spots, then the customer is given a rain check.

The payment system is fully electronic, customers are emailed a bill once a month that they will have to pay, and otherwise they will not be able to park again. The bill will include the base rate as well as all parking fees or penalty fees, if any. Customers are billed according to number of times they use the garage, if the garage recognizes that a vehicle is registered to with a customer, and then he or she will receive a bill at the end of the month for garage usage. If the system detects that a car is associated with more than one customer, then it will bill the customer with the current temporal association, which is created at the terminal in the vehicle elevator or created when the customer wanted a parking reservation.

With so many machines working at the same time, there can be cases where things can go wrong. One of the most important machines in the garage is the camera based license-plate recognition software. Without the software, the elevator would not function and the garage would not know if a customer has exited. The importance of the cameras are so great that there are several fail-safe's built into the system; firstly the camera is designed to work under all conditions and it is able to read the license plates despite its condition. Also, if the system does not recognize a license plate, the software prompts the customer to enter their member number; if the software doesn't recognize that as well, then it does not allow the customer to enter the garage.

One of the main advantages of this new system was that employees no longer had to manually check parking spots to see if they were occupied; to assist them, floor sensors were installed in all the parking spots. These sensors are triggered when a vehicle parks in the parking spot, at this time, the sensor automatically alerts the garage's system that the spot has been occupied. The other function these sensors have is that they also alert the system whenever the vehicle leaves the parking spot and the system marks that spot as vacant. To prevent malfunction, the sensor was designed such that it doesn't trigger unless a car occupies the spot or leaves the spot.

A major problem in the old garage was that customers generally spent a long time looking for parking spots which resulted in congestion within the garage, the new system is designed such that if the customers spot is still occupied by a previous customer then he or she will be assigned a new parking spot. To help customers, the vehicle elevator was designed such that it will always lift the vehicle to the appropriate deck and never stop at a wrong deck; this is quite important because, it will prevent customers from searching for their spot. It will also reduce the chance that a customer will accidentally park in another spot instead of the one that was assigned to them.

The website will be used to allow customers to place online reservations as well as provide the parking garage staff with basic customer information and statistics. The goal is to design a friendly user interface in order to allow the customer to use the website on a computer and possibly a mobile device. Any mobile device app will be presented in our demo's using a phone

emulator on our computers. It will have a fundamental structure so anyone using the site can do so while on the go or multitasking. The home page will take the user to a login page where unregistered users can easily create an account with basic information. As changes are made, the database will be adjusted through this website as customers will enter their account information, register their vehicles, and place reservations.

Glossary of Terms

Camera – A device for recording or reading visual images in the form of photographs and video, used to read license plates and send information to garage system.

Cancelled Reservation – A customer who cancelled his reservation before the reservation period.

Confirmed Reservation – A customer who requested a reservation for a parking spot.

Customer – A person who wishes to use the garage's services.

Database – Entity that stores all the client information.

Extension – Extending or requesting more time for a reservation.

Elevator – A platform used to raise vehicle to different floors.

Elevator Terminal – A console or screen inside the elevator where the customer can enter in necessary information.

Grace Period – An amount of time for a late customer to claim his spot before the reservation is removed.

License-Plate Recognition Software – A camera based system that reads the license plates of vehicles and checks the information against the database.

Member Number – A unique number that is given to customers who have registered on the site.

No-show – When a customer fails to show within the grace period.

Overbooking – Accept more reservation for parking spots than there is room for.

Overstay – When a customer doesn't leave the garage at the end of his reservation period.

Rain Check – A ticket given to a customer who wants to park but there are not vacancies.

Registered Customer – A customer who has registered an account on the garage's website prior to showing up to the garage.

Reservation – The act of reserving a parking spot.

Reservation Confirmation Number – A number that is given to the customer as a confirmation of his reserving a parking spot.

Sensors – A device that is placed on the floor of every parking spot that detects if that spot is occupied or vacant.

Under Stay – The act of leaving a parking spot before the reservation period is over.

Vehicle – A thing that is used to transport people (I.E: car).

Walk-In – When a customer requests an immediate parking spot without prior reservation.

Website – An interface that the customer can use to register, and reserve parking spots.

System Requirements

Enumerated Functional Requirements

Identifier	Priority	Requirement
Plate_to_Read	5	The system shall read the plate
Car_to_Customer	5	The system shall identify the customer based on the license plate
Spot_Sensor	3	The system should detect which spots are vacant/occupied
Vacancy_Display	2	The system should display vacant spots
Elevator_Display	2	The system should display information to customer on the elevator
Elevator_Bad_Read	4	The system shall notify the user on the elevator that their plate was not in the system allowing a confirmation number input
Internet_Site	5	The system shall be linked to the internet
App	1	The system should be linked with an app
Elevator	5	The system should take the car to the right level
Rain_Check	4	The system shall give rain checks to customers who have been overbooked
Exit_Gate	2	The system should have a gate at the exit

Enumerated Nonfunctional Requirements

FURPS (Priority Five)	
Functionality	<ul style="list-style-type: none"> • Features floor sensors that detect when a parking spot is occupied or vacant. • Includes a camera-based system that detects when a vehicle is entering or exiting the garage. • Contains a terminal-based system that allows the customer to enter in member information.
Usability	<ul style="list-style-type: none"> • There is a help dialog box on every page to provide the user with an idea of the steps they need to take for certain actions. <ul style="list-style-type: none"> ○ For example, the reservation page has a text box on the right hand side that instructs the user what to do after they place the reservation. • There is consistency as all the web pages follow the same template. • To keep it simple, the site was kept to roughly five pages. • To accomplish simplicity, each page has a navigation bar to access the individual pages
Reliability	<ul style="list-style-type: none"> • System is designed with fail-safes to decrease the chance of failure. • System uses sensors and cameras to check if customers have parked properly. • Additional parking spots will be available if customer's spot is occupied by another vehicle. • System is designed to accept last minute parking requests depending on availability and existing reservations. • Database is stored on site to decrease the chance of data loss.
Performance	<ul style="list-style-type: none"> • In order to be efficient, parking spots for the ground level will be assigned as customers enter the lot as opposed to having them choose their own. <ul style="list-style-type: none"> ○ The same method is applied to reservations that are placed online. • Throughput is increased as a result of the online reservation process. <ul style="list-style-type: none"> ○ By eliminating this step from the procedure done at the garage, it decreases the change of traffic congestion due payment transactions.
Supportability	<ul style="list-style-type: none"> • This design is very adaptable as far as the garage size is concerned. <ul style="list-style-type: none"> ○ If there are ever future plans to expand the garage additional floors or any other renovation, the adjustment would be as simple as making an update in the database table. • Maintainability is also fairly straightforward as there isn't too much customer information to deal with. <ul style="list-style-type: none"> ○ If there was ever a need to remove or update a customer from the database, the action would be carried out to their credit card, vehicle, and reservation information automatically.

On-Screen Appearance Requirements

This section is not relevant to the project so it does not apply.

Functional Requirements Specification

Stakeholders

- ❖ Parking Garages
- ❖ High End Restaurants
- ❖ Theme Parks
- ❖ Camera and Sensor Companies
- ❖ Hotels
- ❖ Scanning Device Programmers

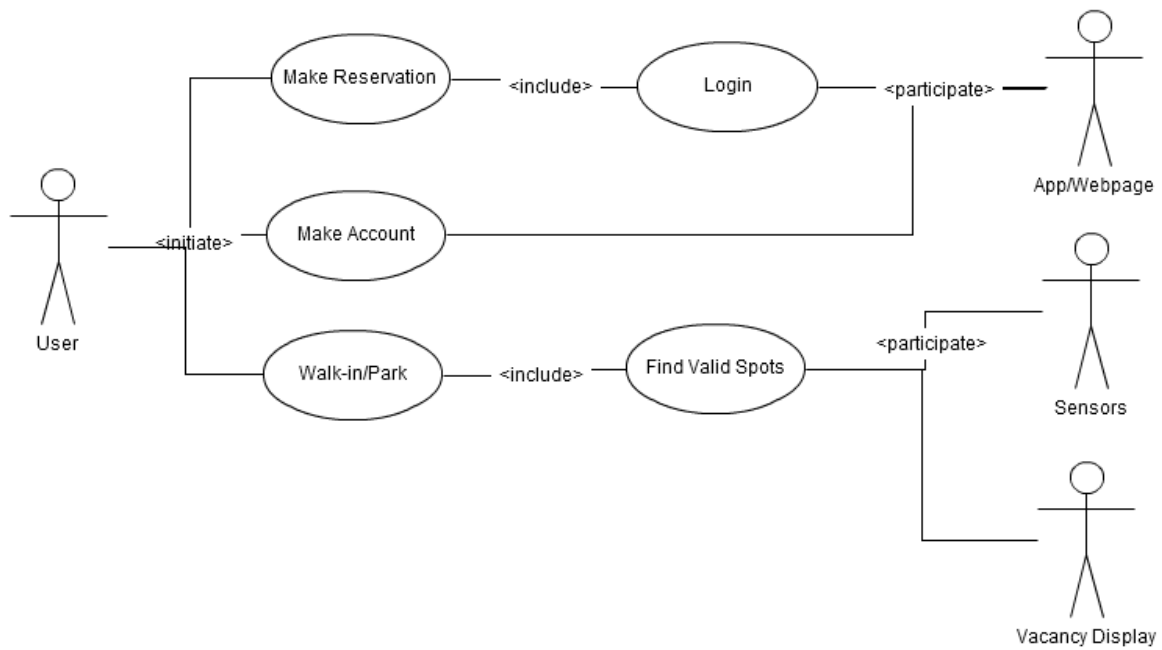
Actors and Goals

Actors:	Goals:
Car	To be shown to the correct level to park
Management	To set the parking prices and have maximum efficiency
Worker	To set up the reservations or to know that an invalid customer is trying to access the garage
Customer	To park at their parking spot
Cameras	To Identify the car to the customer
Sensors	To find out if there are vacant spots in the lot
Vacancy Display	To show what spots are vacant or occupied
Database	To store all of the customer information
Internet Site	To allow customers to make their reservations
Phone	To allow the customer to use the app
App	To allow the user to make a reservation on the go
Servers	To allow the internet to run
Elevator	To allow the customer to access the correct level
Elevator Keypad	To allow customers to input reservation numbers if they're not identified by their license plate
Elevator Display	To update an identified user with information about their parking or to notify a non-identified user that they were not identified and to enter their reservation number

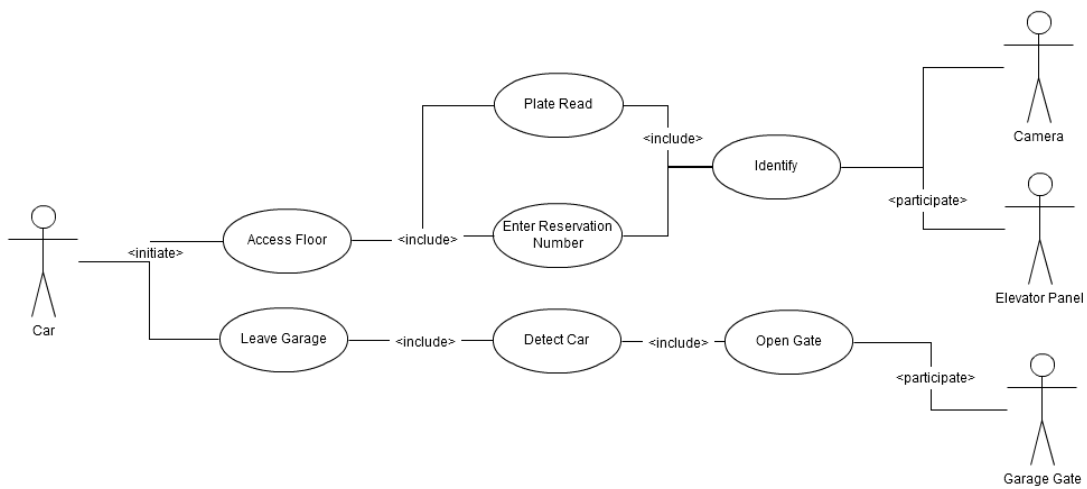
Casual Description

Use Case	Name	Description	Requirement
UC-1	Leave the Garage	To exit the garage via the exit gate	Exit_Gate
UC-2	Look for Vacant Spots	To see if there are vacant spots to park in (walk in)	Spot_Sensor, Vacancy_Display
UC-3	Access floor	To access the correct parking floor via the plate read or a reservation number entry	Elevator, Plate_Read, Car_To_Customer, Elevator Display
UC-4	Make Reservation	To make a reservation to park	Internet_Site, App
UC-5	Walk In/Park	To get parking without a reservation	Spot_Sensor
UC-6	Get a Rain Check	To get a rain check if overbooking happens	Rain_Check
UC-7	Change Information	To change your contact information	Internet_Site
UC-8	Make Contract	To make a contract for guaranteed parking	Internet_Site
UC-9	Set Price	To set the price for parking in the garage	

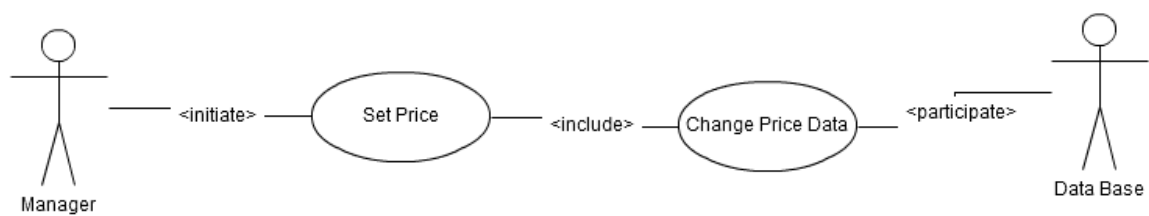
Customer Use Case Diagram



Car Use Case Diagram

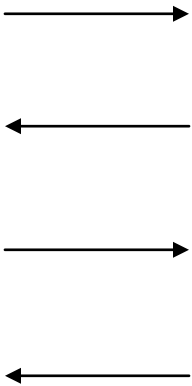


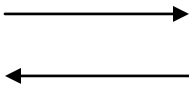
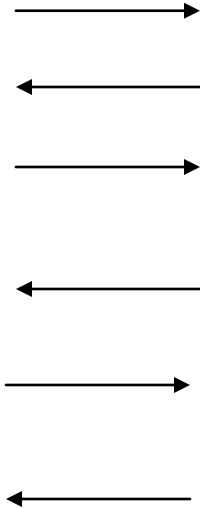
Manager Use Case Diagram



Fully-Dressed Description

Use Case (UC-4)	Reservation
Requirements	Internet site; App
Initiating Actors	Any customers; Workers
Actor's Goal	To reserve a parking spot
Participating Actors	Internet site; Phone; Servers
Precondition	The customer logged into the internet site; The user registered their information
Post condition	The user logs out
Main Success Scenario <div> <div>→</div> <div>←</div> <div>→</div> <div>←</div> </div>	1. The user chooses whether they want a long term parking situation or just for a day 2a. If customer chose one day they are asked to put in from what time they will be there 2b. If customer chose long-term the system asks what floor the customer wants 3a. Customer puts in times 3b. Customer chooses level 4a. If spots available output information, otherwise outputs no spot available 4b. If spots available on that level for long term, output information otherwise ask for another level

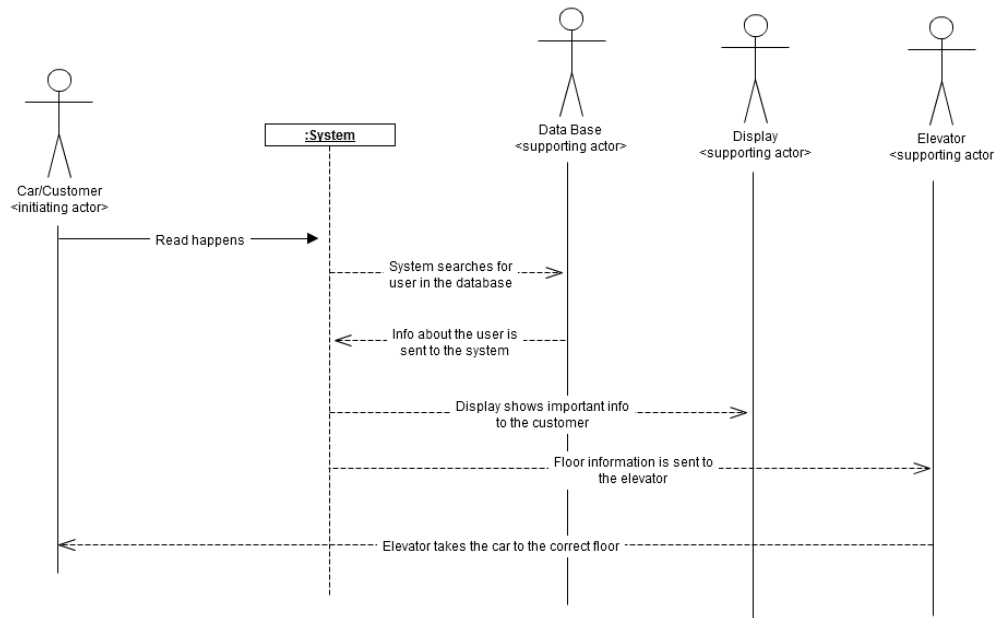
Use Case (UC-5)	Walk In
Requirements	Spot_Sensor; Vacancy_Display
Initiating Actors	Customers
Actor's Goal	To get a parking spot without a reservation
Participating Actors	Display system; Sensors; Data-base
Precondition	The system is ready to receive the customers input
Post conditions	The system marks the spot the customer has taken (if any) The system gets ready for another customer's input
Main Success Scenario 	1. The customer puts in the times that they want to hold a spot 2a. The system displays that a spot is open during the requested reservation time and requests a credit card number 2b. The system displays that no spot is open and then gets ready to receive more input 3a. The customer puts in credit card information 3b. The customer cancels 4a. The system confirms that the information entered is correct and then adds the customer information to the database 4b. The system is ready for another customer

Use Case (UC-6)	Access_floor
Related Requirements	Plate_Read, Car_To_Customer, Elevator, Elevator_Bad_Read
Initiating Actors	Any of: Car, Customers
Actor's Goal	To access the correct parking level floor
Participating Actors	Elevator, Elevator panel, Database
Precondition	-The customer has tried to be identified by the system
Post conditions	-The Elevator returned to ground floor and ready for another customer
Main Success Scenario 	Car enters elevator as Identify gives parking level info to the system The system takes the customer to designated floor
Alternate Scenarios 	1) Car enters elevator as Identify returns bad read to the system 2) elevator display prompts user for reservation input 3) i) customer puts in correct reservation number ii) customer puts in incorrect reservation number 4) i) customer is taken to the correct level ii) wrong input counter goes up 5) ii) a) wrong input counter != max ii) b) wrong input counter == max 6) ii) a) loops back to reservation prompt ii) b) Elevator display asks customer to leave, security is notified

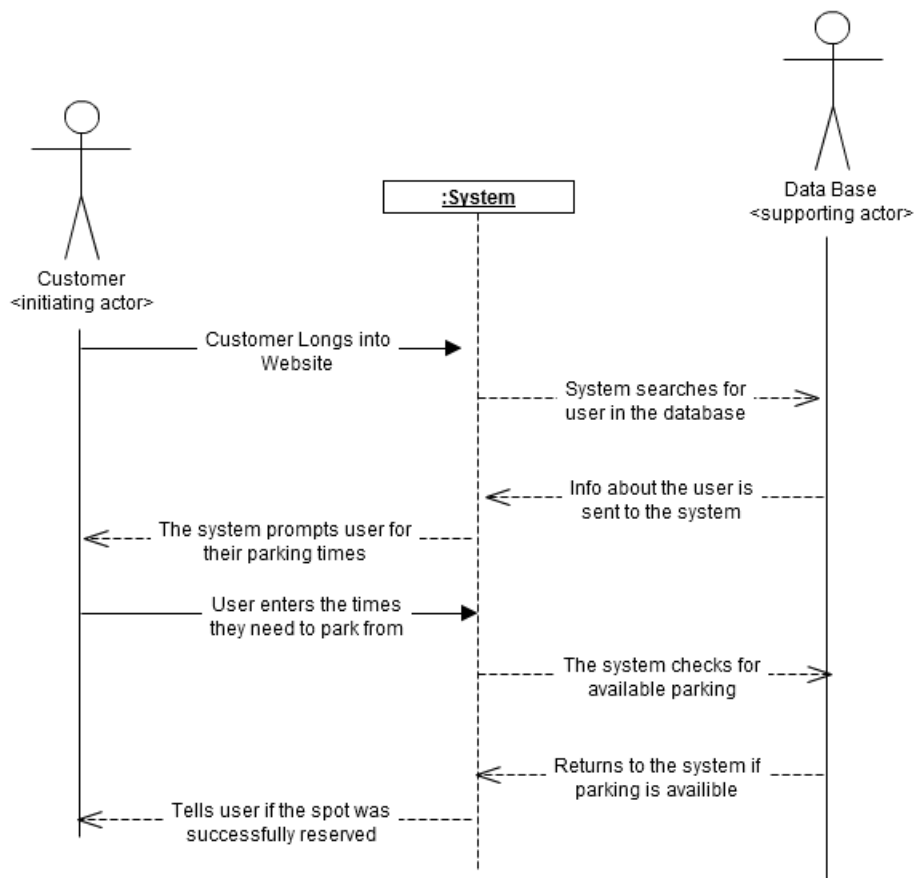
Traceability Matrix

	UC-1	UC-2	UC-3	UC-4	UC-5	UC-6	UC-7	UC-8	UC-9
Plate_to_Read			X						
Car_to_Customer			X						
Spot_Sensor		X			X				
Vacancy_Display		X			X				
Elevator_Display			X						
Elevator_Bad_Read			X						
Internet_Site				X			X	X	X
App				X			X	X	
Elevator			X						
Rain_Check						X			
Exit_Gate	X								
Total PW	2	5	21	6	5	4	6	6	5

Access_Floor System Sequence Diagram



Reservation System Sequence Diagram



User Interface Design

The figures below show the general layout for the system's website though not fully implemented. Nonetheless, its design is meant to minimize the effort required for the user to navigate and use the website. Preliminary Design and User Effort Estimation are described in the sections. A simple sleek interface prevents clutter and confusion to enhance user experience. The screen mock-ups are accessible at www.reserve-your-spot.com

Home Page


With an online website, customers can create an account where they can check out the system. A customer can navigate the website via the six links on top of the home page which are "Home," "About Us," "My Account," "Place A Reservation," "View The Garage," and "References." The home page also has a "Welcome Note" to greet customers!

RESERVE YOUR SPOT!

Note: This website is being used for educational purposes only!

HOME	ABOUT US	MY ACCOUNT	PLACE A RESERVATION	VIEW THE GARAGE	
------	----------	------------	---------------------	-----------------	--

REFERENCES



Place Reservations, ONLINE!

WELCOME NOTE

Welcome to Reserve Your Spot! Looking to make a reservation? No problem! Login in on the right hand side of the page to access your account. Don't have an account? No problem! Creating one is easy and only requires your basic information. If you don't need a reservation and are just stopping by, feel free to navigate our website to learn more about what we do and how we can help you.

LOG IN!

Email:

Password:

[Forgot Password?](#)

Don't have an account? [Register Here](#)

Home | About Us | My Account | Place a Reservation | View The Garage | References

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Typical Input Sequence: It requires one mouse click to navigate to each link.

Log In

The log in is located on the bottom right of the homepage. It requires an email address and password to log in. A customer's email and password can range from thirty to fifty keystrokes. No mouse clicks are necessary to login since the cursor automatically starts in the email entry field. If a customer does not have an account, he or she may create an account with one mouse click on the "Register Here" link colored in red beneath the Login button. User Registration is presented below. Also, if customers forget their password, they can click on "Forgot Password" below the Password entry to redeem their password.

LOG IN!

Email:

Password:

[Forgot Password?](#)

Don't have an account? [Register Here](#)

Typical Input Sequence

1. Email: exampleuser@rutgers.eden.edu	Type in email address (20 – 35 keystrokes), press tab
2. Password: *****	Type in password (~10 keystrokes), press Enter to login (1 keystroke)

User Registration

A customer can register for an account by entering six fields of information. They are the customer's first name, last name, email, date of birth, gender and password. This takes an estimated sixty keystrokes and six mouse clicks. To expedite the process, a customer does not need to enter a credit card number or a vehicle's license plate number.

RESERVE YOUR SPOT!

Note: This website is being used for educational purposes only!

[HOME](#)[ABOUT US](#)[MY ACCOUNT](#)[VIEW THE GARAGE](#)[SITE REFERENCES](#)

REGISTRATION

First Name:

Last Name:

Email:

Re-Enter Email:

Date of Birth:

Day

Month

Year

Gender:

Select

Password:

Register

Cancel

[Home](#)[About Us](#)[My Account](#)[View The Garage](#)[Site References](#)

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Typical Input Sequence

1. First Name: example	~ 6 keystrokes, press tab
2. Last Name: user	~6 keystrokes, press tab
3. Email: exampleuser@rutgers.eden.edu	20 -30 keystrokes, press tab
4. Re-Enter Email: exampleuser@rutgers.eden.edu	20-30 keystrokes
5. Date of Birth: Day/Month/Year	3 mouse clicks
6. Gender: Male/Female/Unspecified	1 mouse click
7. Password: *****	~10 keystrokes, press enter to register

My Account

With one mouse click on the “My Account” link, a customer can view his or her account. There are several entries that need to be filled. To complete these entries, it takes approximately sixty keystrokes and about eight mouse clicks. “Vehicle Information” is not complete, but it will ask for the customer’s license plate number and state.

RESERVE YOUR SPOT!

Note: This website is being used for educational purposes only!

LOGOUT	ABOUT US	MY ACCOUNT	PLACE A RESERVATION	VIEW GARAGE	REFERENCES
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BASIC INFORMATION

First Name:

Last Name:

Date of Birth:

Gender:

CREDIT CARD INFORMATION

Credit Card #:

Name on Card:

Type:

VEHICLE INFORMATION

[Home](#) | [About Us](#) | [My Account](#) | [Place a Reservation](#) | [View The Garage](#) | [References](#)

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Typical Input Sequence

Basic Information

1. First Name: example	~6 keystrokes, press tab
2. Last Name: user	~6 keystrokes, press tab
3. Date of Birth: Month/Day/Year	~20 keystrokes
4. Gender: Male/Female/Unspecified	1 mouse click, press enter to save changes

Credit Card Information

1. Credit Card Number: XXXX-XXXX-XXXX-XXXX	16 keystrokes, press tab
2. Name on Card: Example User	10 – 20 keystrokes
3. Type: Visa/MasterCard/American Express	1 mouse click, press enter to save changes

Place A Reservation

A customer can reserve a parking spot by clicking on the “Place A Reservation” button. With one mouse click, the customer can navigate to the window below. It requires nine mouse clicks to make a reservation. To the right of the screen is a “What To Do Next” section. It describes what customers should do when they reach the parking garage. Also, there is a red link labeled “Click to View the Garage” at the bottom right where customers can view the garage.

RESERVE YOUR SPOT!

Note: This website is being used for educational purposes only!

LOGOUT	ABOUT US	MY ACCOUNT	PLACE A RESERVATION	VIEW GARAGE	REFERENCES
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RESERVE THAT SPOT!

From

Date:

Time:

Till

Date:

Time:

WHAT TO DO NEXT

Once you have placed a reservation, all that's left to do is go to the garage. When you arrive, drive into the elevator platform that will take you to the appropriate level. Pay attention to the display panel in the elevator as it will inform you of your spot number.

Find how much room is still available by taking a closer look at the garage. Click the link below.

[Click to View the Garage!](#)

Home | About Us | My Account | Place a Reservation | View The Garage | References

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Typical Input Sequence: One mouse click is necessary for each field totaling eight mouse clicks plus another mouse click for “Reserve!” to place a reservation.

View Garage, About Us and References

These three web pages are not fully developed. They are a work in progress and will be available in the near future. “View Garage” will display which parking spots are available or reserved. “About Us” is a personal statement about the system and its purpose. It will have contact information where viewers can raise questions and concerns. Lastly, “References” is a bibliography page.

Domain Analysis

Domain Model

Domain Model for UC-3:Access Floor

Concept Definition

Responsibility Description	Type	Concept name
Container that stores all client information (including license plate, name and credit card)	K	Database
Takes in plate numbers and accesses Database to find which client it is associated with	D	Identifier
Read the plate number	D	Plate_reader
Displays useful information regarding system status to the user	D	Elevator displays

Association definition

Concept Pair	Associated Description	Association Name
Plate_reader ↔ Identifier	Plate_reader passes the license play number to Identifier	Provides data
DataBase ↔ Identifier	Identifier accesses the database and links plate to the right client	Provides data
Identifier ↔ Elevator Display	Identifier passes the reservation confirmation and floor number to Elevator Display	Provides data
Identifier ↔ Elevator	Identifier passes the right floor number to Elevator	Conveys request

Attribute definition

Concept	Attributes	Attribute Description
Database	client identity client license plate client credit card	Used to determine right reservation Used to link a car to the right client Used to pay for parking
Identifier	client search license plate search	Used to search the database for right client Used to search database for license plate associated with client
Elevator Display	user prompt	Used to prompt user to enter customer number or have license plate scanned
Elevator	floor select	Used to select right floor to go to

UC-4 Make Reservation

Concept Definition

Responsibility Description	Type	Concept name
Container that stores all client information (including license plate, name and credit card)	K	DataBase
Field in which user is prompted to login	D	Login
Field in which user is prompted to register	D	Register
Knows where there is an empty spot	K	Spot checker
Logs reservation into database	D	Logger

Association Definition

Concept Pair	Associated Description	Association Name
Login ↔ Database	Login uses databases to find right client	Conveys requests
Register ↔ Database	Register sends the client info to the database	Provides data
Logger ↔ Database	Logger accepts the reservation sends to database	Conveys requests

Attribute Definition

Concept	Attributes	Attribute Description
Database	client identity client license plate client credit card	Used to determine right reservation Used to link a car to the right client Used to pay for parking
Register	Field Checker Data passer	Used to make sure all required fields are filled in Used to record client in database
Login	Field Checker Client Search Password Checker	Used to make sure all the required fields are filled in Used to search database for entered client Used to check for the correct password
Logger	Data passer Field Checker	Used to record the reservation into database Used to make sure all required fields are filled in

UC-5 Walkin/Park

Concept Definition

Responsibility Description	Type	Concept name
Container that stores all client information (including license plate, name and credit card)	K	Database
Checks for open spots	D	Spot checker
Checks database to see if client is registered with parking garage	D	Identifier
Inform user if there is a spot available or not	D	Vacancy display
Confirm that user parked in right spot	K	Spot sensor

Association Definition

Concept Pair	Associated Description	Association Name
Login ↔ Database	Login	Provides data
DataBase ↔ Identifier	Identifier accesses the database and links plate to the right client	Provides data
Identifier ↔ Vacancy Display	If there is no match the Identifier requests to prompt user to register	Conveys requests
Spot Checker ↔ Vacancy Display	Spot Checkers uses Vacancy Display to show results of its actions	Provides data

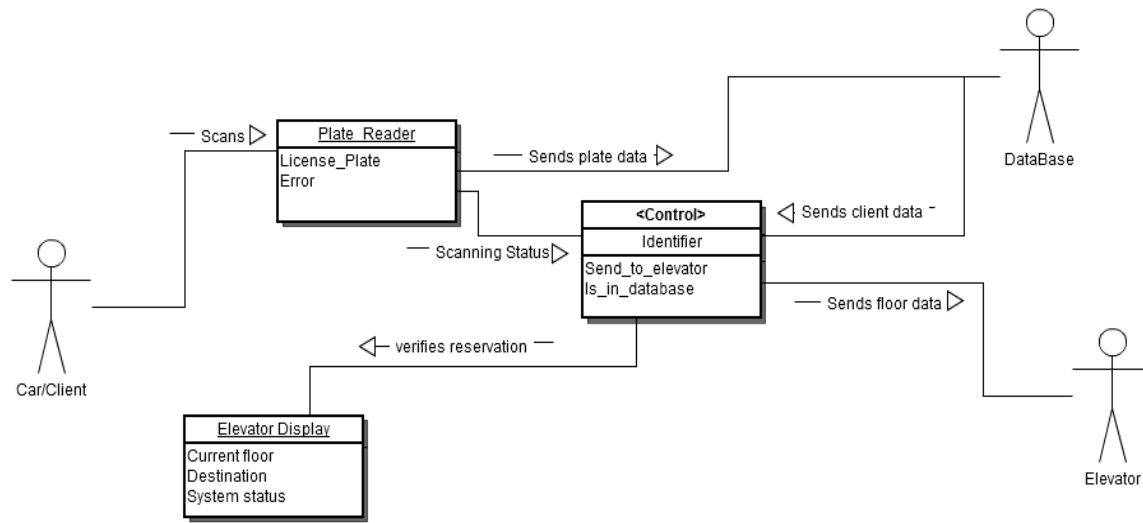
Attribute Definition

Concept	Attributes	Attribute Description
Database	client identity client license plate client credit card	Used to determine right reservation Used to link a car to the right client Used to pay for parking
Identifier	Client Search License plate search	Used to search the database for right client Used to search database for license plate associated with client
Vacancy Display	User Prompt	Used to prompt user to enter walking information
Spot Checker	Spot Sensors	Uses spot sensors to check for empty spots

Traceability Matrix

Domain Concepts										
PW		DataBase	Login	Register	Spot Checker	Elevator Display	Elevator	Identifier	Plate Reader	Vacancy Display
2	UC-1	X			X					
5	UC-2	X			X					X
21	UC-3	X				X	X	X	X	
6	UC-4	X	X	X						
5	UC-5	X	X							X
4	UC-6	X	X							X
6	UC-7	X	X	X						
6	UC-8				X	X	X	X	X	
5	UC-9	X								

Domain Model



System Operational Contracts

Operation	Access Floor
Preconditions	Elevator checks for reservation by that customer and allows entry if it finds a reservation.
Postconditions	Comes back to ground floor waits for new customer.

Operation	Walk In/Park
Preconditions	If there are vacancies in the parking garage, the system allows walk in's to choose a spot and park; changes to occupied once the user selects a spot on the ground floor because, only the ground floor is available for walk in's. Spot_Sensor= "vacant"
Postconditions	Spot_Sensor= "vacant"

Operation	Reservation
Preconditions	Checks to see if spots are vacant. Allows user to register for a spot, prompts user to enter in member information and time of duration. Vacancy_Dis = Parking Spots – Reserved Spots; Reserved Spots =Reserved Spots + 1;
Postconditions	Shows the new number of available spots. Vacancy_Dis = Parking Spots – Reserved Spots;

Operation	Rain Check
Preconditions	If a customer’s reserved parking spot is still occupied by the previous occupant and there are no vacant parking spots, the customer is given a Rain_Check for future reservations.
Postconditions	Customer uses Rain_Check when new parking spot is available.

Mathematical Models

The system that is being developed will be based on the practice of overbooking that is currently being used in many hotels around the world. This is being used to achieve the goal of having 100 percent occupancy and thus optimizing revenue. Customers will be split into five different categories in the mathematical model.

These categories are as follows:

Walk-ins: These are customers that are registered within the database system but do not have a reservation. They show up at the time they would like to park and will be either accepted or denied based on if there is extra space in the garage.

Understays: These are customers that arrive on time to park but leave before the time they registered for expires.

Overstays: These are customers that arrive on time and wish to park longer than they registered for. (An extra fee will be applied for these customers)

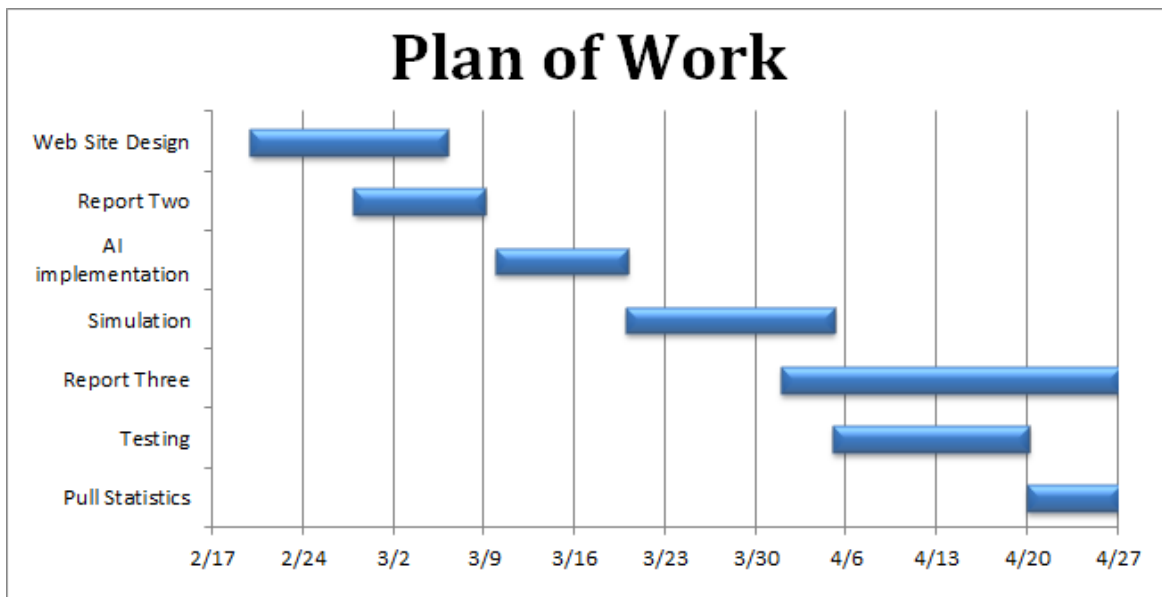
Guaranteed reservations: these are daily customers who have signed a contract to park in the parking garage every day. Since they pay ahead of time for the right to park each day for a certain period of time their spot will be guaranteed.

Confirmed reservations: These are customers who make a reservation in advance. These reservations will expire within a certain time period. The garage system will use expired reservations to fit walk-ins into the garage.

Using all of the above five categories the following equation was outlined in Hotel Front Office Management by James A. Bardi:

Total number of parking spots available – confirmed reservations * no show factor based on history – guaranteed reservations * no show factor based on history – predicted overstays + predicted understays – predicted walk-ins = number of additional parking spots needed to achieve full garage.

Plan of Work



- ❖ Web Site Design
 - For the most part, the basic layout of the entire site has been created and even implements basic database queries. The remainder of the work that needs to be done contains additional database implementations and cosmetic fixes for the design itself.
- ❖ Report Two
 - The second report will be a continuation of this one and will provide an exact explanation of how the website will look and function. It will also be more specific with how the artificial intelligence will be implemented.
- ❖ AI Implementation
 - In order to get a better feel as to how the site will function as a large quantity of users interact with it, artificial intelligence will be implemented to demonstrate. Once activated, the threads will pull all the available spots in the garage from the database and then place random reservations.
- ❖ Simulation
 - The simulation aspect of this project will be a hidden page. It will be strictly used to demonstrate how the artificial intelligence will interact with regular user actions. Its purpose is to activate the artificial intelligence and demonstrate how the 'View Garage' portion of the website will update itself to change the status of the individual spots.
- ❖ Report Three
 - As the final report, report three will have an exact explanation of how the final product will work and function. It will specify any changes made going back to the original proposal. It will demonstrate how the user will interact with the site, what's going on in the background, and what the management staff can do with it behind the scenes.

- ❖ Testing
 - Predicted testing methods will primarily include unit testing. Since the user will interact with the website for their needs, the plan is to work on each page individually in order to find any faults in the design and functionality. It will first begin with testing the site alone and then performing the same testing methods as the artificial intelligence is running in the background.
- ❖ Pulling Statistics
 - If time allows, this will be an additional page on the website. As of now, plans are to keep this strictly for the use of the parking garage management staff. It'll be a simple run down of how many clients over stay their reservation, have a credit card on file, park in the garage on a day-to-day basis, and much more. The purpose of this is to give the staff a better idea as to what type of people they are dealing with on a consistent basis and how to predict future ideas/improvements to the garage based on these numbers.

Breakdown of Responsibilities

- ❖ Bartosz Agas
 - Worked on Report 1, Web Site Design, Database Structuring, Report 2, Coding and Implementation, Simulation, Report 3
- ❖ Christopher Tran
 - Worked on Report 1, Web Site Design, Database Structuring, Report 2, Coding and Implementation, Simulation, Report 3
- ❖ Marvin Germar
 - Worked on Report 1, Web Site Design, Database Structuring, Report 2, Coding and Implementation, Simulation, Report 3
- ❖ Michael Van Genderen
 - Worked on Report 1, Web Site Design, Report 2, Coding and Implementation, Simulation, Report 3, Testing
- ❖ Justin Levatino
 - Worked on Report 1, Web Site Design, Report 2, Coding and Implementation, Simulation, Report 3, Testing
- ❖ Tarun Katikaneni
 - Worked on Report 1, Web Site Design, Report 2, Coding and Implementation, Simulation, Report 3, Testing

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