Module 2 - Design Report

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Contents

1 Introduction

Last year, we were asked by the Barchester City Council to design a new car parking system. This system controls all daily happenings in relation to the car parks. They are still unsatisfied with their current design and wanted us to improve it.

2 Last Years Interviews

Issues elicited by most groups

All groups wanted to know what features the new car parking system would need to have. The car park requires management functionality. Everyone also asked about the SLA contract of the security company and about the attendants duties. Each group also asked about data storage with respect to seasonal ticket holders and about renewing the ticket.

Most groups asked about what extra information the Barchester City Council would like the obtain. A response was for example sales figures. They are a for profit enterprise and thus revenue and net profit are of grave importance.

Issues elicited by one or two groups

Most groups did not ask about possible damages in the car park.
Some groups did not ask about possible fines for ordinary customers that park in designated seasonal ticket holders spots.
Some groups also did not ask about the tariff change of a ticket which takes place at 6pm.
A few groups elicited what happens when your ticket is lost or damaged. The solution is to call the attendant.
Some groups also asked about the 5 second time limit constraint in which a ticket must be printed.

As taken from and stated in last years interviews here is the complete list of management information items desired by the City:

- For short and long term stay at the car park the rates are based on how relatively popular a certain car park is.
- The five second constraint in which a ticket must be printed is a guideline and not a strict must. However, if this 5 second target is not met consistently one will notify the maintenance company that is responsible for breakdowns and maintenance. There will always be an attendant at the office in the car park, who can be contacted via the intercom.
- For every park the system should store certain data. Namely, the amount of tickets sold, how many cars are in the car park and at what hours the car park is most busy, ie. peak hours.

- In the case of a seasonal ticket holders the system should store certain data: name, address, phone number, amount of time spent in park and expiration date. Three weeks before the seasonal ticket expires the individual will be sent an email to inform them how to renew or cancel their season ticket.
- When the security guards enters and exit the parking lot, the date and time will be recorded. In this way one can see if the security are completing the expected number of visits per day.
- If one is not happy as the expected number of visits are not completed the Council will be notified that the security company did not respect the terms of the contract.
- The Barchester City Council has an SLA contract (Service level agreement) with the security company. This agreement defines how long and how often a security guard ought to be present at the car park. The attendance of the security guard should automatically be checked by the system. This includes the time of arrival, time of departure and thus we can calculate the duration of the visit.
- We must store information about the car park as a whole. For example information regarding sales figures. This is vital information for a for profit company.

3 Glossary

Attendant	The attendant is a person that works for the car park. He helps people who are having problems with entering/paying/leaving at the car park.
Bar code	This is machine-readable code in the form of numbers and a pattern of parallel lines of varying widths that stores information about the ordinary ticket customer. One must insert the ticket into the control pillar and it will read the ticket and let you exit if all conditions are met.
Barrier	A gate at the entrance of the car park. Prevents entry of car when lowered. Is raised when a car is allowed to enter and once more lowered once a car passes. It is for security purposes to prevent people who don't have a right to enter from doing so.

Car park	Place or building with a bunch of parking spaces where people park their cars.
Card reader	Device used by security guards to check in and out.
Control pillar	A pillar at the entrance of the car park. A customer can press buttons on the control pillar, insert tickets and take tickets from it. The control pillar also raises and lowers the barrier. It checks if season tickets are valid and records data about the customer such as entry time . It prints ordinary customer tickets as well .
Intercom	Electrical device that facilitates communication betwixt thes customer and the attendant.
Invalid coins	Coins not accepted by the pay station.
LCD display	Small screen at the control pillar and pay station which displays instructions for the customers.
Office	Place to go when someone has problems with anything and an attendant will help you.
Ordinary ticket	Ticket printed when you press the button at the control pillar.It shows the date and time that it was printed alongside a bar code so you know how much to pay when exiting. .
Pay station	Machine that scans tickets and determines the amount of money that has to be paid.
Receipt	Shows when one paid and how much one paid for the ticket. .
Return tray	Bin where customers can collect change or invalid coins.
Season ticket	Season tickets can be bought for three, six or twelve months for a specific car park. Season tickets are only valid for weekdays. They allow one to enter the car park on weekdays for free once you have purchased such a ticket for said period of time.
Security card	Card for the security guard to check into the car park and checkout when they arrive and leave.
Security guards	People from an external third party company hired by the city council to check if cars are parked correctly and keep the car park safe.

Sensor	Device which detects whether a car is present in front of control pillar.
Spaces	A spot or slot where you can place your car in the car park. When there is a lot of spaces there are not many parked cars. No more than 10% of the spaces in a car park are allocated to season ticket holders.

Our glossary defines terms with a brief explanation in alphabetical order. There was not much to change from last year. Thus this glossary hinges heavily on last years glossaries.

4 Actors List

Table 2: Actors list

Actors	Description
Customer	An ordinary customer, who has to buy a ticket every time he/she enters the car park.
Season ticket holder	A customer, who pays an amount upfront for a season ticket. He can use this for a certain amount of time and can enter or leave the car park as much as needed as long as the ticket is valid.
Office Attendant	An employee of the car parks owner who helps the customers out in case there are any problems with their tickets or the system.
Security guard	Someone who monitors the car park to ensure that no one is breaking the rules.
Control pillar	The main interaction tool for the customer to enter and leave the car park. A customer can insert tickets or press buttons to interact with it. The control pillar also prints the ticket and checks them for validity.

5 Requirements List

Nr.	Requirements	Use Case(s)
1	As a seasonal ticket holder I want to be able to enter the car park at weekdays.	Enter car park
2	As an ordinary customer I want to be able to get a ticket and enter the car park.	Enter car park.
3	As a security guard I want to be able to enter the car park with a pass card.	Enter car park.
4	As an ordinary ticket holder I want to be able to go to the pay machine to pay my ticket fee.	Pay the ticket.
5	As a customer I want to be able to view if there is a free spot in the car park.	View empty spot.
6	As a security guard i want to be able to scan my pass at the scanner in the office.	Scan pass.
7	As a customer I want to be able to insert my card at the control pillar.	Insert card.
8	As a customer I want to be able to receive change when I pay at the paying machine.	Receive change.
9	As a customer I want to be able to take a ticket when pressing the button on the control pillar.	Take ticket.
10	As an office attendant I want to be able to help customers that have problems with their tickets.	Help Customers

6 Use Case Descriptions (Brief)

Table 4: Use Case Descriptions

Begin of Table	
Press button on control pillar.	A normal customer can press the button on the control pillar when entering the garage to receive a ticket.
Insert season ticket.	A season ticket holder can insert his or her ticket instead of having to press the button to receive a ticket.
Raise barrier.	If a ticket has been given out or a season ticket has been checked by the control pillar the barrier will be raised when a customer wants to enter. If a ticket is accepted at departure of a customer, the barrier will be raised as well. The office attendant can manually override the system to raise the barrier as well.
Lower barrier	The barrier is lowered after the sensors confirmed the car is past the barrier.

Continuation of Use Case descriptions **??**	
Print ticket.	If a normal customer presses the button at the control pillar upon entry, the control pillar will print out a ticket with which the customer can be identified.
Check season ticket.	Upon either entry or departure, the control pillar checks the season ticket for validity and sends the time of arrival and the time of departure information to the car park system.
Press receipt button.	If the customer has paid for his or her ticket, the pay machine will ask the customer if he or she wants a receipt with which the customer can respond by pressing this specific button.
Eject ticket.	If the customer has paid for the ticket the pay machine will eject the ticket which the customer needs to leave the car park.
Eject receipt.	If the customer presses the receipt button, the pay machine will eject the receipt for the customer with the ticket info.
Calculate car park charge.	The pay machine will calculate how much the customer must pay when a ticket is inserted.
Calculate change.	If there is change available in the pay machine and the customer overpays, the machine will calculate how much money it needs to eject to compensate the overpaying.
Perform payment process.	If the ticket is not accepted by the pay machine, the customer is instructed to go to the office attendant who can manually calculate the price the customer has to pay and validate the ticket as paid for.
Buy season ticket.	A customer can buy a season ticket at the car park which will turn the customer into a season ticket holder.
Insert ticket.	A normal customer must insert his or her paid for ticket into the control pillar when departing.
Record time.	Upon arrival or departure, the control pillar sends the timestamp of the season ticket holder to the car park system.
View status of system.	At any given point in time, the office attendant can open the status of the system which will be refreshed every ten seconds if the software is active.
Walk to the office.	A security guard can walk to the office instead of going through the barrier with a car.
Scan card using the card reader.	If the security guard arrived at the office without entering the car park by car, he or she must scan his or her card at the office.

7 Extended use case description

7.1 Leaving Extended use case

Leaving	
Actors action	**System response**
1 Drive to barrier	2 Sensor detects car presence
4 Insert ticket	3 Display: “Insert ticket”
7 Leave car park	5 Check if 15 minutes have passed since payment
	6 Raise barrier
	8 Lower barrier

Alternatives
5 Skip step if the ticket is a season ticket and instead record time of departure
6 Activate intercom on control pillar if check fails instead of raising the barrier
8 Lower the barrier only if the sensors have confirmed that the car is through entirely

7.2 Payment Extended use case

Paying ticket	
Actors action	**System response**
1 insert ticket	2 scan ticket
5 insert notes/coins	3 calculate car park charge
9 press “receipt” button	4 display message
	6 validate ticket
	7 add time/date
	8 calculate change
	10 eject receipt
	11 eject ticket

Alternatives
1 buy season ticket
2 attendant performs payment process if ticket can not be scanned
5 repeat until the desired amount is reached 9, 10 optional

7.3 Entry Extended use case

Entry	
Actors actions	**System response**
1 Drive to barrier	2 Sensor detects a cars presence
4 Presses Button	3 Display: "Insert ticket or Press button"
6 Takes ticket	5 Prints ticket
	7 Raise barrier
	8 Detect cars passing
	9 Lower barrier

Alternatives
3 If the car park is full display "Full"
3-8 skip the rest of the steps if car park is full
4-6 If the customer is a seasonal ticket holder insert season ticket
skip the steps four to six in this case.
Instead use alternative step 5.1 (system response) - Check season ticket
7-9 Do not execute step nine if the car did not pass the barrier and enter.

7.4 Security Extended use case

Security	
Actors actions	**System response**
1 Insert card.	2 Checks bar-code and saves time and date of entrance.
4 Take the pass card.	3 Eject ticket and display "You can (not) enter.".
6 Drive in the car park.	5 Raise the pillar.
8 Insert the ticket.	7 Lower the pillar.
11 Drive away.	9 Eject ticket check bar-code and save time and date.
	10 Display "You can leave" and raise the pillar.
	12 Lower the pillar.

Alternatives
1-6. In case the Security guard enters the car park on foot he/she scans the card at the office.
8-12. In case the Security guard leaves the car park on foot he/she scans the card at the office and then leaves the car park.

8 Class Diagram

For the class diagram last year's diagrams where analysed and are used to create, what is believed a better class diagram. In this section we will analyse what has been adapted removed or improved into the new diagram.

Starting with the Car Park all teams included a class for it but there where differences at the variables. Some really smart ideas where found so it was believed that it would be nice to include them. This fact is also present at some other classes.

The most interesting thing found was that the ticket's layout differed within the teams. Some teams included both seasonal tickets as well as the daily tickets while others missed one of the two. In our case we believed including both of them and connecting them with the appropriate people who make use of them was a better way to go with.

In our case there are three different types of people generalized by the main class Person the seasonal ticket holder, the attendant and the security guard.

The ordinary ticket holders are not generalized by the Person class because it is believed that data such as name, address and phone number is unknown to the system.

As mentioned above people are connected to a certain ticket or a pass for the guard. Tickets are also generalized by a Ticket which holds information for both an ordinary ticket and a seasonal ticket. However ordinary tickets hold some more information such as time that was paid and if it is paid or not. This also applies to seasonal tickets where the expiration date is also saved. Some teams included an issuing machine and a control pillar in our case we believed that these, add on the functionality of the car park system but do not save any important data so they where excluded.

Finally it is mentioned that a city council has a contract with a security company this is modeled by almost all the teams and it is a very good point so it was applied on our version as well. A security guard works for a security company and is able to enter the car park via a security card. Also the city council has multiple car parks in a city so that is also modeled.

9 Entry Process Analysis

9.1 Entry–Activity Diagram

I used one of the diagrams from last year as the basis of this activity diagram. I also availed of two other diagrams as a reference source to improve upon the basis.

As stated in the lecture slides for each branch there need not be an equivalent merge unless both activities need to finish before the next activity can occur. In this diagram I believe that for each fork a merge node was required. There is one activity that is an exception in customer called withdraw season ticket where I did not merge and simply ended. I argue that a merge is not required as the activity Raise_Barrier can occur before one withdraws their ticket in the case of check successful. In the case of check failed I believe a merge is also not necessary.

9.2 Entry–Use Case Diagram

For this diagram I referenced all three of last years use case diagrams but I didn't have any basis. This is an amalgamation of all three diagrams with some of my own minor additions. Both types of customers are generalised to the customer actor. This was done as both kinds of customer have this one activity in common. I read in last years lectures that one activity can only have one actor and thus I found it necessary to generalise the seasonal ticket customer and the ordinary customer actors.

The Reason why raise barrier is an extension of detect car's presence is that:

1. For ordinary customer there may be a case where a party accidentally or maliciously presses the button whilst walking by and does not have a

vehicle.

2. For seasonal ticket customer their may be a case where the check failed and they do not have the authority to enter.

9.3 Entry Sequence Diagram

Here I used a diagram from last year as a basis. It was quite near complete in my opinion so I did not perform many alterations. I used the other two diagrams as reference as combined them in to one.

The main things done were creating more alt fragments to encapsulate all possible interactions betwixt lifelines.

9.4 Entry–State Machine Diagram

Here I used one of last years diagrams as a basis and attempted to simplify the possible states. There are a few states for the control pillar. When the pillar is idle it is in a "sensing" state where the sensor on the pillar can detect a cars presence. There is an active state where it check if there is room in the car park. There are also three display states. These states are informative states. They tell the customer what action to perform via an LCD screen. The LCD screen displays one of "Car park Full" , "Press button to get ticket and enter the car park" or "take ticket".These three states are mutually exclusive. Finally there is a barrier raised or lowered state.

10 Security Process Analysis

10.1 Use Case Diagram

Only one team was able to create a use case diagram about the security visit, so a baseline of Group's 14 is used to create the new diagram.

A very nice touch was that the group divided correctly the actors, present actors are the security guard and the card reader. We believed adding a control pillar also will make the system a little bit more complete. Once a security guard enters the car park he or she can scan the pass with a card reader found in the office but he/she can also insert the pass on the car park entrance and drive in with a car and vise versa for exiting the car park.

10.2 Sequence Diagram

None of the teams included a sequence diagram about the security process, so we came up with some ideas and represented them.

The whole diagrams is divided between entering the car park as well as leaving it. When entering a security guard either enters the card in the control pillar or scans it at the office found inside. This functionalities are also divided by a alternate "box". Once a ticket is scanned or inserted the bar-code data is

sent back to the system where a check is made to make sure the security guard is assigned at this car park and sends an appropriate message to the control pillar or the scanner. The same process is being made to exit the car park.

10.3 Activity Diagram

As far as the activity diagram goes only group 14 has completed one so we had to work with it as a baseline.

Group 14 starts the diagram with the use of a control pillar when entering the car park to make it more complete we also added the scanner in the office. Once the card is inserted or scanned the clocking terminal checks the bar-code data and decides whether to allow the security guard to enter with the appropriate messages. The data is then sent to the park system where the date and time of arrival is stored. The baseline is used when the guard is exiting the car park.

An extra feature included by group 14 is that the guard can leave the office at any time and continue his/her services later on. However this made the initial diagram to be incomplete and wrongly formatted therefore since it is not even mentioned at the module guide we decided to skip it.

10.4 State Machine Diagram

None of the groups have created a state machine diagram so a new one was created out of scratch.

The first state is when the security guard arrives at the entrance of the car park and weather he/she wants to enter via a vehicle or enter on foot, he/she will insert the card or scan the ticket at the office. The information is checked and the guard is or is not allowed to enter the car park. When he/she is not allowed to enter, the state machine diagram shows that the security guard leaves the car park and the process ends. When the security guard is allowed in he/she can insert the card again to exit the car park. This process can repeat as many times as necessary for a security guard to re-enter the car park when he/she is taking a break and will continue his/her duty later. Otherwise, when the security guards finishes his/her duty the state machine diagram ends.

11 Payment Process Analysis

All diagrams have last years diagrams as a basis and have been modified in order to improve them. In some cases the changes are very minimal because we could not find many errors in the design of the diagram.

11.1 Use Case Diagram

The diagram has changed only very slightly in comparison to Group 11 old diagram. The only notable change that has been made was that the payment process performed by the office attendant is now included in ejecting the ticket.

We have done this because the ticket can not be given back to the customer by the office attendant without performing the payment process.

11.2 Sequence Diagram

The sequence diagram has also stayed largely unchanged apart from a few splits and changes in what kind of message/response is being used. After the first part of the alt loop ends a new sequence is started since the first one ends with the customer having to go to the office. The realization that a form of payment is invalid has also been changed from a message from the pay station to a response from the pay machine, since the machine is the one analyzing the money. The optional loop for the chase there being change has been changed into an alt loop for 1:there is no change and 2:there is change.

11.3 Activity Diagram

The diagram describes the steps the customer has to go through in order to pay for a ticket. It largely follows the same narrative and order the old diagrams did with a few notable differences. Namely, the "there is no change" part has been split up. Instead of having one block, we decided to have the machine tell the customer that there is no change in the beginning and give no change out in the end. If we would have left it in the other way, the customer would not have known that there is no change in the machine until he/she already paid, which could result in the customer massively overpaying and not getting the change back. For example paying a 5.50 charge with a 10 note.

11.4 State Machine Diagram

The new diagram has been modeled closely to Group 14s diagram. In comparison to the other Payment state machine diagrams there is now only one end node since the main line has been modified into a loop, so that the machine goes back into standby mode in comparison to group 11s diagram. Another notable change is the actual payment part of the diagram. It has been simplified and a receipt part has been added to the diagram, so the customer can receive a receipt. The diagram has also been cleaned up to make the diagram more readable and easier to understand.

12 Departure Process Analysis

12.1 Use Case Diagram

The most common similarity between the projects of last year was that the use case diagrams had too many actors since in the other diagrams part of the system can be involved. In use case diagrams the only actors are the people interacting with the whole system instead of specific parts and how those specific parts interact with each other. Use case diagrams show specifically

how to interact with the system itself. This means that there are only three actors involved when a customer wants to leave the car park. Of course the customer him-/herself is involved with a distinction between normal customers and season ticket holders. If a ticket is not accepted when the customer wants to leave, an attendant employed by the local government can step in to help the customer. The customers only interaction with the system by inserting a ticket into the control pillar (the system) except for when the ticket is invalidated by the system. In that case the system will activate the intercom on the control pillar to give the customer a way to communicate with the hired employee. The employee is able to see the current situation within the car park and check the ticket of a customer when he needs help. If the employee deems the reasoning of the customer valid, the employee is able to raise the barrier manually to let the customer through.

12.2 Sequence Diagram

A sequence diagram shows the chronological order of the communication between the customer and the system that is in place. This also includes the communication between parts of the system, for example the customer talking to the employed attendant or the software commanding the barrier to be raised and lowered. The first distinction to be made is between valid and invalid tickets. Valid tickets, either season tickets or normal tickets all result in the car park system self raising and lowering the barrier. The optional message is sent to the database if it was a season ticket, with the data of that ticket. Invalid tickets result in the intercom being activated by the system which gives the customer the option to talk with the office attendant. The office attendant then is able to control the raising of the barrier himself to let the customer through, after which the system takes over again to lower the barrier when the customer has left. Else the office attendant instructs the customer to repay for the ticket since he has been parking longer than has been indicated by the customer. After the customer has left, the system will send a message to the database to decrement the total number of cars within the car park by one and optionally, the database will send a reply message to the car park system if the car park was full, which results in the display outside of the parking garage now showing that there are free spaces in the garage again. And a message is displayed on the control pillar to waiting customers after the system has checked there are customers waiting to enter the parking garage.

12.3 Activity Diagram

The activity diagrams of last year projects had the fewest errors which meant that some changes are only to make the diagram easier to read. A prominent mistake was that the time symbol which is used in activity diagrams was used as a condition that had to be met to declare valid. The aforementioned symbol is used to show that it needs to be past a specific time before the action will be taken. In the case of leaving the car park, the only action that has a time

constraint is that the intercom of the control pillar is activated if between being paid for the ticket and scanning it at the control pillar has elapsed fifteen minutes. This cannot be used to show that if there have not been fifteen minutes since the ticket was paid for, the ticket is validated.

12.4 State Machine Diagram

The hard part of making a clear state machine diagram is the tendency to switch from thinking in transitions to states within the process. Another problem that arose was that there was no definitive answer to be found in last year projects if the parking garage would be operating twenty-four hours a day, seven days a week. Some groups made the assumption this would be the case which in turn results in the state machine diagram having no definitive endpoint. This is the choice that was made to insert into the state machine diagram of this project. This means that the process will either loop back to the control pillar being on standby if there is no new customer who wants to exit the car park after the customer in the process that just took place left or the first state for the next loop of the process will be that the customer is at the pillar since there is another customer that wants to leave the car park.

13 Appendix

13.1 Group Members Contributions

13.1.1 Project Report

All group members contributed diligently with respect to writing up the project report.

13.1.2 Diagrams

Kevin Singpurwala–S2205858

- Entry - State machine diagram
- Entry - use case diagram
- Entry - Activity diagram
- Entry - Sequence diagram

Stelios Gavriel–S1975412

- Security - State machine diagram
- Security - use case diagram
- Class diagram
- Security - Activity diagram
- Security - Sequence diagram

Tim Goudswaard–S1921088

- Leaving - State machine diagram
- Leaving - Activity diagram
- Leaving - use case diagram
- Leaving - Sequence diagram

David Lütke-Sunderhaus–S2184389

- Payment - State machine diagram
- Payment - Activity diagram
- Payment - use case diagram
- Payment - Sequence diagram