CST3504 PROJECT 1 (Exam 2) – Fall 2017

Project Requirements – Analysis & Design Phase for Car Rental System

Project Exam Problem Statement

Overview & Business Objectives

- You are hired as a consultant by **NYCTech Car Rental Inc**., (Represented by Prof. Rodriguez) to design & implement the **database tier** for a **Car Rental System Three-Tiered Web Application** named ***EZRentalCar.com***.
  - This **Car Rental System** is designed to allow customers both private and corporate to reserve cars for renting, similar to existing online car rental systems such as Avis, Hertz, Budget, etc.
  - The application is to be designed to support dozens of major cities around the world. In addition, provide a great user experience in reserving and renting vehicles with the best pricing available in the market. The company currently have rental agency branches in US, Canada, Mexico, UK, Japan & Australia and looking to expand further in the future.

- This application will be divided into several projects (PROJECT 1, PROJECT 2(Final Project in CST3504) etc.) based on project management principles by dividing the project into phases.
  - In this PROJECT 1, you will create the ***ER/EER model***, in addition to the ***Normalized Logical Model***.
  - Future PROJECT(S) will include Physical Model Diagram and Implementation.

Car Rental System Detailed Business Requirements

Business Requirements

- A Business Analyst was hired by Mr. Rodriguez to compile the list or requirements based on the results of interviews and conversations with the various business stakeholders.
- Below are the requirements captured by the Business Analyst:

EZ-Car Rental is a car rental company that rents vehicles to customers in several countries. They have rental agency branch locations in US, Canada, Mexico, UK, Japan & Australia. The rental agencies are in cities throughout each country and there can be more than one rental agency in a city, for example New York City has 2 rental agencies or branches in Manhattan one in Brooklyn and two in Queens near each airport. Because there are multiple rental agencies, a customer can pick up a vehicle in one location and drop it off at another.
A rental agency or branch is identified by a rental agency ID, address which is composed of street address, city, state, country & zip code. In addition, phone number.

EZ-Car Rental offer their services to two types of customers, corporate customers & consumers. The application should store the following information about all types of customers: a customer ID which is their driver license number, driver license expiration date, customer name which is composed of first name, last name, address which is composed of street number & name, city, state, zip code. In addition, date of birth, mobile number, email, and credit card which is composed of credit card number, name & expiration date. A customer can have many credit cards they can use to pay for rental transaction. In addition, the credit card used by a customer can be co-owned by many individuals such a family member or corporate entity the customer works for.
For corporate customers we must store the company name, company ID (we store an ID for each company), Company contact composed of contact name & phone number and finally corporate rate. For our private consumer customers, any discount code and discount description. In addition, for our private customers, we offer a frequent rental program called **EZPlus** where they earn points every time they rent a car and can leverage these points to pay for their next rental. Therefore, we need to capture their EZPlus number and EZPlus earned points.

In our business, we only have consumer or corporate customers. No other type of customer exists. If a private consumer wishes to rent and also works for a company that also rents from us, each of these transactions must be separate customer accounts. you can only be a consumer or corporate customer not both.

A vehicle must first be reserved before it can be rented, therefore there is a distinction between a reservation and a rental. A reservation guarantees a vehicle will be ready for you to pick-up and rent. A rental means a customer complied with the reservation and picked up the vehicle.

A reservation is not made for a specific vehicle, but for a vehicle rental category at a rental agency location. We have the following vehicle rental categories: Car (economy, intermediate, full size, luxury), SUV, or Van. Each of these categories have a different price range. Therefore, a vehicle rental category has a rental category ID that identifies the category of the vehicle being reserved, rental category name (ex. for car (economy, intermediate, full size, luxury), SUV, or Van) and finally rental category rate. Note that a vehicle rental category can have one, none or many vehicles available to rent, nevertheless, a vehicle can only belong to one vehicle rental category.

The reservation process involves a customer reserving a vehicle rental category to be pick-up/drop-off at a rental agency. Therefore, the reservation process requires the customer, vehicle rental category & rental agency of pick-up & drop-off. For a reservation we wish to capture a unique confirmation number to be used to track the reservation. In our business, for a reservation, we must adhere to the following rules:

- Each reservation has a pick-up rental agency. A reservation can only have one pick-up rental agency location, but a rental agency can have many reservation pick-ups happening.
- Each reservation has a drop-off rental agency (may be different than pick-up rental agency). A reservation can only have one drop-off rental agency location, but a rental agency can have many reservation drop-offs happening

Based on these two rules, the reservation process must capture the pick-up rental agency ID in addition the target drop-off rental agency ID. In addition, the reservation must capture the rental date, return date, rental time, return time of the reservation to provide estimated cost of the rental. In addition, we must capture the reservation status (e.g. confirmed, cancelled, completed), reservation status ID for each reservation status. Finally estimated cost, which is derived from the rental & returned date & time. A vehicle rental category can be reserved from zero or many rental locations, and many or no customers.

The rental process means the customer complied with the reservation and is actually renting the reserved vehicle. The rental process includes the customer, the actual vehicle & rental agency of pick-up & drop-off. The rental process requires a rental agreement number to uniquely identify the rental. Note that in our business, a rental must adhere to the following rules:

- Each rental has a pick-up rental agency. A rental can only have one pick-up rental agency location, but a rental agency can have many rental pick-ups happening.
- Each rental has a drop-off rental agency (may be different than pick-up rental agency). A rental can only have one drop-off rental agency location, but a rental agency can have many rental drop-offs happening

Because a customer can pick up and drop off a vehicle at different location, for each rental, the system must capture the pick-up rental agency ID in addition, drop off Agency ID (can be different than pick-up). In addition, the rental must capture the pick-up date, drop-off date, pick-up time, drop-off time of the rental to provide the actual cost of the rental. Also, the pick-up odometer value & drop-off odometer value to determine the number of miles of the rental. Another attribute is rental cost, which is derived from the pick-up, drop-off dates/times. In addition, a rental process needs to capture the fuel options provided to customers, we need the fuel option ID that identifies each fuel option & fuel option description (e.g. pay-in-advance return with empty tank at no additional cost, pay-for-used fuel only, self-service). Finally, insurance cost must be captured. Note that at this time, all our customers must pay for insurance and we will calculate this cost automatically for full coverage of our vehicles and passengers with no options to opt-out. A customer must pay insurance when renting. Note that a vehicle can be rented from zero or many rental locations, and many or no customers.

Note that we decided to capture the pick-up & drop-off location, date, time & cost when doing both a reservation and rental because a customer may reserve for a location, date & cost, but totally change their mind when picking up the vehicle etc., and any of these are subject to change via reservation or in the agency location, and we need to capture the history of all these transactions.

EZ-Car Rental has a system to manage their vehicles for renting, maintenance, selling, etc., by classifying them into three vehicle classes: cars, minivans/SUVs, and Vans. All these types of vehicles share the following common characteristics:

- Each vehicle is identified by the vehicle id or VIN number, the name of the vehicle composed of make, model & year. The vehicle rental category ID from the vehicle rental categories (ex. car (for car is economy, intermediate, full size, luxury), SUV, or Van). Additional attributes of vehicle are: color, plate number, mileage, transmission type (ex. manual or automatic), seat capacity, daily rental cost, vehicle status (ex. reserved, rented, available, maintenance, off-duty), Vehicle Status ID which is the ID number assigned to each of the status (ex. reserved, rented, available, maintenance, off-duty), ID of the rental agency vehicle belongs to or assigned to & finally the current agency location ID where vehicle is currently located since vehicle can be drop-off at any location within a country. Note that for transmission type, and vehicle status we are only interested in the value of these types, no further details about the types are required.
- Cars are vehicles that have a trunk capacity in volume, for example a luxury Mercedes E class car has a trunk capacity of 18 cubic ft.
- Minivans & SUVs are vehicles with a towing capacity in pounds and additional attribute of these vehicle types is the indication if they are all wheel drive (AWD) which is a yes or no value.
- Finally, Vans, are vehicles with a cargo capacity in volume & maximum payload in pounds.

Note that there are other types of vehicles of interest that we may want to store data on other than cars, minivans, SUVs and vans. In addition, a vehicle can only be classified as a car, minivan/SUV or van or other. Not any combination of these, for example, a car is not a van or SUV etc., or the other way around.

In a future upgrade of this application, we wish to also provide insurance options to our customers, in addition to login features so each customer has access to their accounts etc., and finally providing a more efficient way to process invoices for payments.

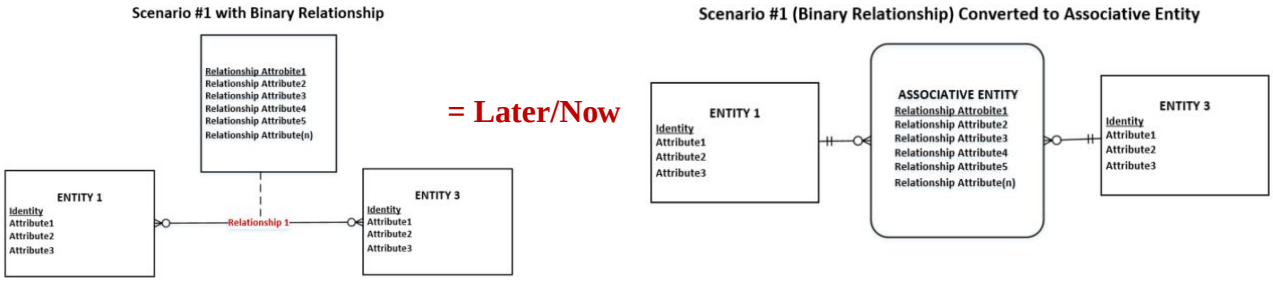
Hint & Special Comment About Business Requirements

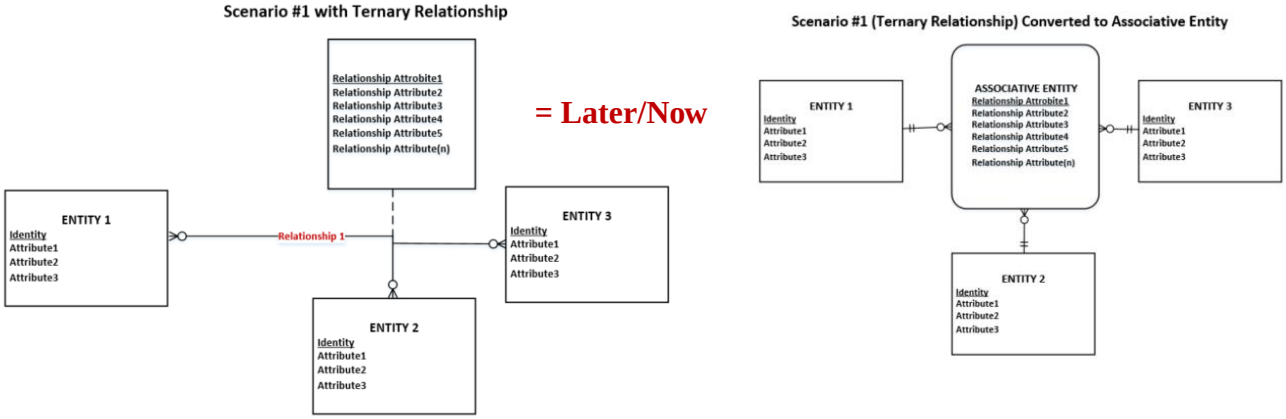
In these business requirements there are two situation that we have not encounter before:

- **Scenario #1** – You have a scenario where you identify a ***many-to-may*** relationship (whether unary, binary or ternary) that has ***relationship attributes*** which can or does not include an ***identifier***.

  - **Under normal circumstances you have the following options:**

    1. Continue to model using the relationship attribute notation until the end of the model. After the model is completed, you can decide to convert to an Associative Entity if you like.
    2. You can also immediately convert to an Associative Entity once you suspect that is the case and then continue modeling until you complete the model.





Hint & Special Comment About Business Requirements (Cont)

In these business requirements there are two situation that we have not encounter before:

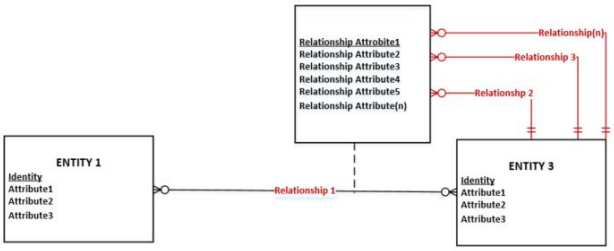
- **Scenario #2** – Same as scenario #1, where you identify a ***many-to-may*** relationship (whether unary, binary or ternary) that has ***relationship attributes*** which can or does not include an ***identifier***, but this time, the business requirements identify other ***relationships*** that seem to be between the ***relationship attributes*** and one of the **ENTITIES** of the ***many-to-may*** relationship.

  - As you know we have not seen a situation where a ***relationship*** is established between the ***relationship attribute*** symbol and an **ENTITY**. I don't know if this is even allowed
  - **Under this special circumstance you only have ONE option:**

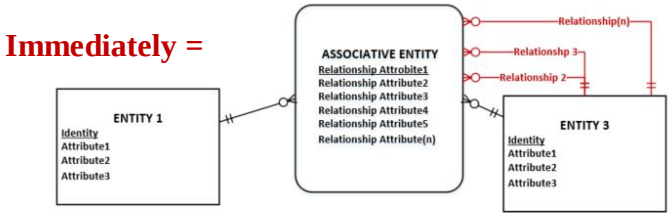
    1. **Immediately** convert to an Associative Entity once you suspect that is the case and then continue modeling until you complete the model. This scenario can only be modeled when the relationship between the entities (whether unary, binary or ternary) if the relationship is modeled as an **ENTITY** not a ***relationship***.

  - This action is not new since the rules of Associative Entity says that if there are relationship attributes is best to be converted to an associative entity.
  - Most important, remember the definition of an ENTITY = Objects or nouns, also events. Events is the key here, there are relationships that are actually events that we need to capture its data and these events are best model as an ENTITY not a relationship.

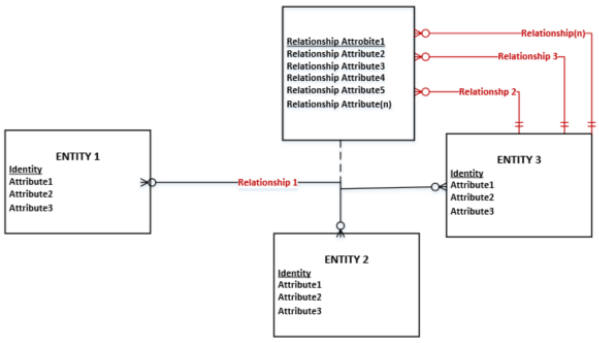
Scenario #2 with Binary Relationship with multiple relationships to Relationship Attributes



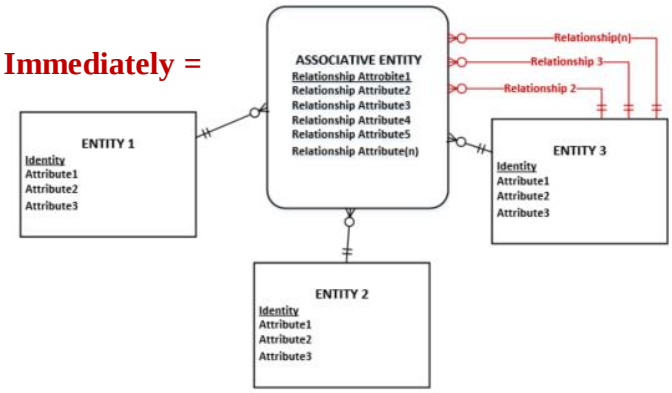
Scenario #2 Binary Relationship with additional relationships Converted Immediately to Associative Entity



Scenario #2 with Ternary Relationship Relationship with multiple relationships to Relationship Attributes



Scenario #2 Ternary Relationship with additional relationships Converted Immediately to Associative Entity



- We are modifying the rules to Associative Entity – If reading the business requirements, you come across all the requirements that satisfy an associative entity and in addition there are multiple relationship between what looks like the associative entity and one of the entities part of the Associative Entity relationship, then **CONVERT TO ASSOCIATIVE ENTITY IMMEDIATELY!**
- Keep a look-out for this scenario in these business requirements since it appears in two situations. See if you can spot it and immediately use an Associative Entity and don't continue to model using the standard **relationship attribute symbol**.

Salary & Compensation (Grade) Requirements

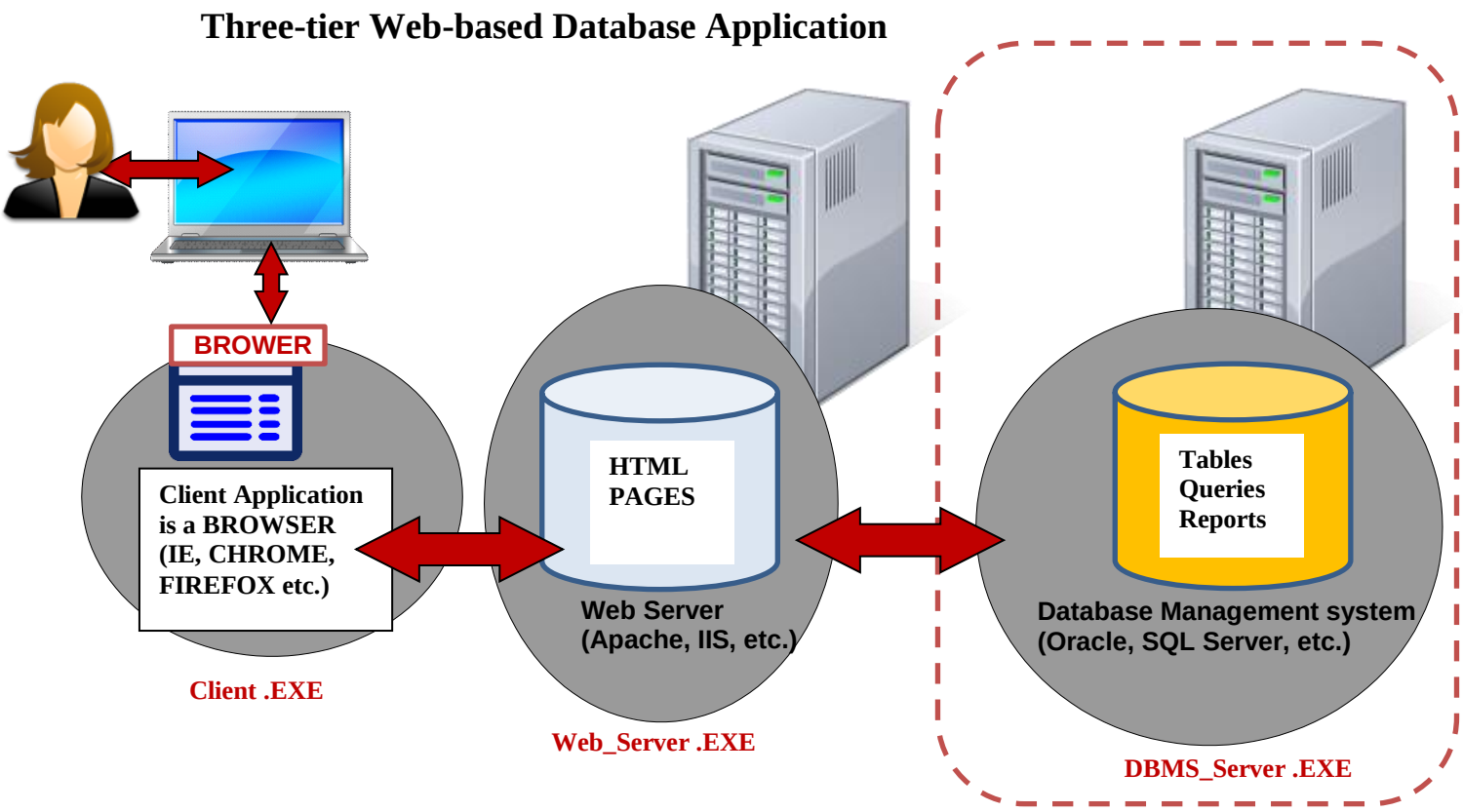
- The *client* (Prof. Rodriguez) has the right to **fire you** (Fail you) at any time or reduce the amount of payment (Low Grade) during the development of the system based on the following:

  - If the system is not design properly.
  - Falls behind schedule (submitted late)
  - You are caught copying other consultants work or giving your work to other consultants! You should be working on your own to implement this system.
  - **IMPORTANT** – Most important, **NOT** following the program ***REQUIREMENTS***. **Warning! NOT following the requirements can quickly lead to the unemployment line!**

Car Rental System Detailed Techanical Requirements

Technical Objectives

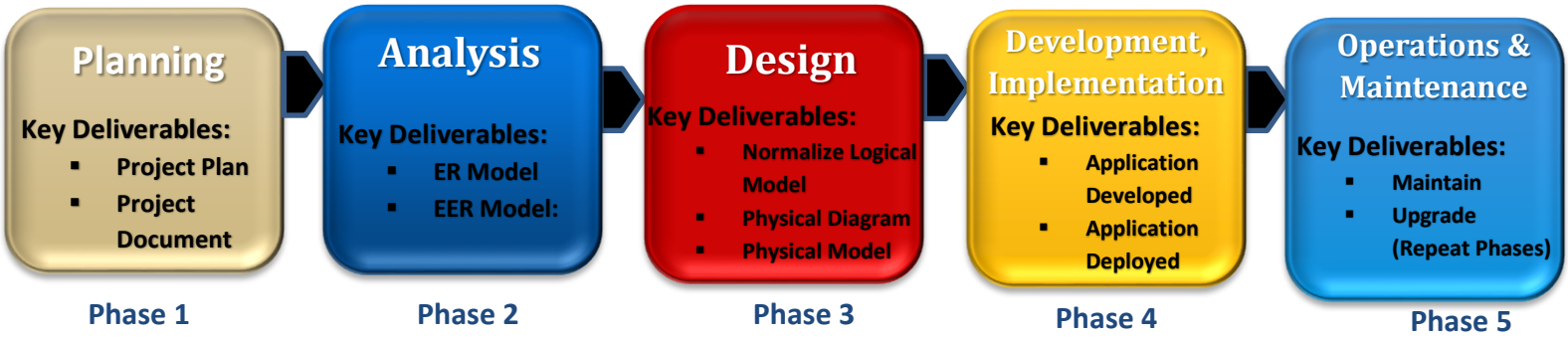
- The system is a typical **Three-Tiered Web Database Application** with a web-based front-end for the user, Web Server for processing and a database backend to store the data:



- This project will focus only on the DBMS or backend design and implementation using **Oracle DBMS** and NOT on the front-end or client application hosted in the Web Server.

Project Management & Implementation Objectives

- We will use our project management database lifecycle methodology for the project by implementing the **Planning Phase**, **Analysis Phase**, and part of the **Design Phase** for the **Car Rental System**.
- Below are the 5 PHASES & their main deliverables:



Final Requirements for this Project

- Implementation & technical requirements are out of scope of this project. Future projects will address this section.
- In this PROJECT 1, our goals for this EZ Rental Car system is as follows:
  - Model the business requirements using a conceptual model (ER/EER)
  - Transform the conceptual model to a normalized logical model that targets a Relational Database Management System.
- In the next pages, we outline the details for the phases in scope of this project.

- Below are the requirements and activities of the **Planning Phase** & **Analysis Phase**:

Phases	Description
Phase 1: Planning & Discovery 	▪ ***Purpose:*** - *Develop the plan, understand the business and discover existing information systems.* - *Interview, discover, etc.* ▪ ***Database Professional Role:*** - *Database/Systems Analyst* - *Business Analyst* ▪ ***Deliverables:*** 1. ***Primary Database Deliverable –*** *Project Document* **Main deliverables in this phase for this PROJECT!**
Phase 2: Analysis 	▪ ***Purpose:*** *1. Analyze/derive detailed user requirements for data & develop data model to represent requirements.* 1. *Identify the **Business Rules**, use correct **Naming convention** guidelines etc.* *2. Create a detailed **ER Conceptual Data Model** **(Entity-Relational Model - ER Diagram)*** *3. Create a detailed **EER Conceptual Data Model** **(Enhanced Entity-Relational Model - EER Diagram)*** ▪ ***Database Professional Role:*** - *Database/Systems Analyst* ▪ ***Deliverables:*** 1. ***Primary Database Deliverable – Detailed Conceptual Data Model:*** ○ *E-R Diagram* ○ *Enhanced E-R Diagram* 2. ***Updated Project Document*** **Main deliverables in this phase for this PROJECT!**

- Below are the requirements and activities of the **Design Phase** and which deliverable are expected in this project:

Phase 3: *Design*

Design

- ***Purpose:***
  - *Develop a detailed design of database Information System based on all specifications and requirements.*
  - *Create a **Normalized Logical Data Model (Logical Schema)***
  - *Create a **Data Dictionary***
  - *Create a **Physical Data Model Schema Diagram***
  - *Implement **Technical Specification for Performance/Efficiency, Data integrity, Security, Backup/Disaster Recovery, etc.***
- ***Database Professional Role:***
  - ***Database Analyst** – Logical Data Model*
  - ***Database Administrator & Analyst** – Physical Data Model*
  - ***All Roles may be involved***
- ***Activities include:***
  1. *Create detailed **Logical Data Model (Logical Schema)** as follows:*
     - ***TRANSFORM** – **Convert ER/EER Diagram** to **Logical Model Diagram***
     - ***NORMALIZATION** – Process of breaking down tables with abnormalities to produce smaller, well-structure tables to reduce redundancy and inconsistencies.*
  2. *Create detailed **Physical Data Model (Physical Schema)** as follows:*
     - ***PHYSICAL SCHEMA DIAGRAM** – Convert Normalized Logical Model to the Physical Schema Diagram based on **DBMS** to be used.*
     - ***PHYSICAL TECHNICAL SPECIFICATIONS** – Technical specifications for performance, storage & hardware requirements, security, backup & disaster recovery, compliance, etc.*
- ***Project Management Activities:***
  - *PM Activities – Create Design Document, Update Plan etc.*
- ***Deliverables:***
  1. ***Primary Database Deliverable – Normalized Logical Data Model (Logical Schema)***
  2. ***Primary Database Deliverable – Data Dictionary***
  3. ***Primary Database Deliverable – Physical Schema Diagram***
  4. ***Primary Database Deliverable – Physical Technical Specifications***
  5. *Other project related documents such as Project Plan etc.*
- ***Timeline/duration:***
  - *TBD based on timelines & project requirements.*

Main deliverables in this phase!

Car Rental System Database Analysis & Design Detailed Requirements

Requirement #1 (Planning Phase) – Create an MS Word Design & Implementation Document

- Create a Microsoft Word document with the following requirements:

❖ Requirement #1a – Create MS Word Document:

1. Create a Microsoft Word document to store all your plan, analysis & design phases information of **this PROJECT EXAM!**
2. This document is to contains the requirements for the ***EZRentalCar.com*** **Car Rental System** and an explanation of what you are going to do etc.
3. Is important for you to understand that this document is where all the results of this **this PROJECT EXAM** will be stored and will be submitted to the professor.
4. **Every section of the document should be clearly labeled and professionally created**. Don't just paste information without explanation of each section. Have an introduction section explaining the objectives or requirements of the project etc.
5. For each section, you are going to describe, keep your explanations short. I am not asking for an essay or report, but a well-documented information, that is easy to read and makes sense to the reader.
6. Your goal is to make it easy for the reader to understand from a high-level what you have done.
7. **The information from the next sets of requirements in this documents are to be entered in this document**.
8. **THIS DOCUMENT IS YOUR DELIVERABLE and you will be PAID/GRADED on what is in it**.

❖ Requirement #1b – Read and analyzed the requirements

1. This document is to contains the requirements for the ***EZRentalCar.com*** **Car Rental System** and an explanation of what you are going to do etc.
2. Read carefully the requirements listed in the Problem Statement, Business & Technical Requirements section of this document.
3. If you need to go back to the business analyst (Prof. Rodriguez) for questions or clarification of the requirements do so.

Requirement #2 (Analysis Phase) – Create the ER or EER Conceptual Model for the Car Rental System based on the Business Requirements:

- Based on the requirements listed in the Business & Technical Requirements section, create the ER/EER conceptual model as follows:

❖ Requirement #2a – Read and analyzed the requirements

1. Thoroughly read and analyzed the business requirements for the ***EZRentalCar.com*** **Car Rental System**.
2. Write mind-map or just write down your thoughts of what you understand you are being asked to do.

❖ Requirement #2b – Create the ER/EER Conceptual Model:

1. Using a ***DRAWING TOOL***, create the ER or EER diagram for the ***EZRentalCar.com*** **Car Rental System** based on the business requirements.
2. Use a ***DRAWING TOOL*** that allows you to use the symbols used in your book and in class. Don't use a tool that restricts or uses different symbols. No hand-written diagrams will be accepted.
3. PASTE the ER.

❖ Requirement #2c – PASTE the ER/EER Conceptual Model in your Project Document:

1. Once you created the ER/EER conceptual model, PASTE it to the Project Document you created in **requirement #1**.
2. Label the section accordingly.
3. Also include any assumptions made and explanations for these assumptions.

Go Fishing!
Theory & Examples on this TOPIC can be found:

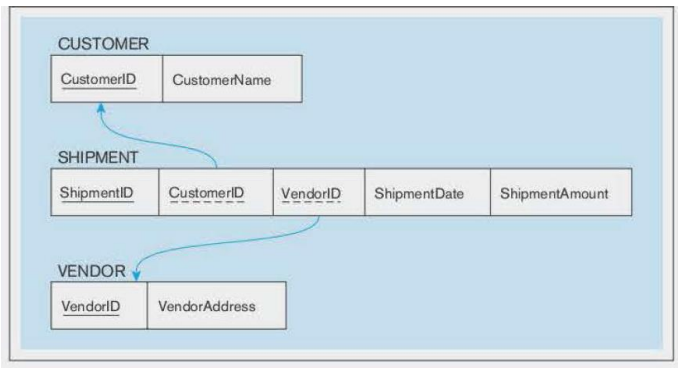
- **My Lectures:**
  - **Lecture 2 - CST3504 Data Modeling**
  - **HW 2 & 3**
  - **Lecture 3 - CST3504 Enhanced ER Model**
  - **HW 4**
- **Book: Modern Database Management (Chapter 2 & 3)**

Requirement #3 (Design Phase) – – Transform the ER/EER Conceptual Model of Requirements #2 to a Logical Model (Before Normalization)

- Using the ER/EER Model from **Requirements #2**, do the following:

❖ Requirement #3a – Transform the ER/EER Model to the Logical Model (Before Normalization)

1. CONVERT the **ER/EER Conceptual Model** of **requirement #2** to a **Logical Model**.
2. Follow the transformation steps in the lecture notes & book to perform your transformation.
3. Use a ***DRAWING TOOL*** that allows you to use the symbols used in your book and in class for the logical model. Don't use a tool that restricts or uses different symbols. No hand-written diagrams will be accepted.
4. At the end of the transformation, you should have a Logical model showing the **RELATIONS or TABLES** with **Primary-keys**, **Foreign-keys** & **RELATIONSHIP LINES** like the example from your book shown below



❖ Requirement #3b – PASTE the Non-normalized Logical Model in your Project Document:

1. Once you created the ER/EER conceptual model, PASTE it to the Project Document you created in **requirement #1**.
2. Label the section accordingly & explain what you have done.

Go Fishing!

Theory & Examples on this TOPIC can be found:

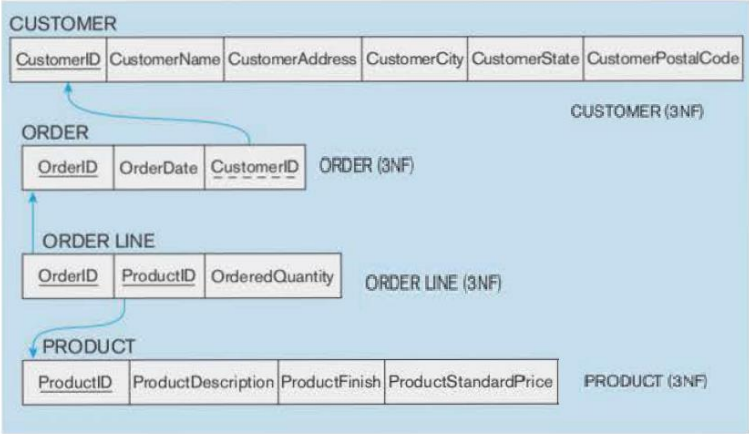
- **Lecture 4 - CST3504 Logical DB Design (see conversion rules & Examples at the end of the lecture)**
- **Database Management (Chapter 4)**

Requirement #4 – NORMALIZE the Logical Model Diagrams from Requirements #3

- Using the LOGICAL Model created in **Requirement #3** do the following:

❖ Requirement #4a – NORMALIZE the Logical Model of Requirement #3 to 3NF (Third-Normal-Form)

1. Apply the rules of **normalization** to the **Logical Diagram** created in **Requirement #3** to **3NF**.
2. Follow the ***NORMALIZATION*** steps in the lecture notes & book to remove any redundancy, inconsistencies or table abnormalities.
3. Use the same ***DRAWING TOOL*** in **Requirement #3** allows you to use the symbols used in your book and in class. No hand-written diagrams will be accepted.
4. At the end of the ***NORMALIZATION***, you should have a Logical model showing the **NORMALIZED RELATIONS or TABLES** with **Primary-keys**, **Foreign-keys** & **RELATIONSHIP LINES** like the example from your book shown below



❖ Requirement #4b – PASTE the NORMALIZED Logical Model in your Project Document:

1. Once you created the Logical Model has been NORMALIZED, PASTE it to the Project Document you created in **requirement #1**.
2. Label the section accordingly & explain what you have done.

Go Fishing!

Theory & Examples on this TOPIC can be found:

- **Lecture 4 - CST3504 Logical DB Design (see conversion rules & Examples at the end of the lecture)**
- **Database Management (Chapter 4)**

Project Exam Expected Deliverables

Project Deliverables

Submit the following based on requirements:

1. **DOCUMENT/FILE #1 (From Requirement #1)** – **PDF version** of the **Project Word Document** which includes the information:
   - **a)** Includes all **requirements 1 through 4** executed.
   - **b)** ***CONVERT*** this Word document to a **PDF file**
   - **c)** ***SUBMIT*** the **PDF file**

2. **IMPORTANT!!!** CONVERT this Word document to a **PDF file **********
3. ***SUBMIT*** the **PDF file**
4. Email the **PDF file** to **arod1212@outlook.com** (**DO NOT cc arod@microsoft.com**)
5. Email subject line should have the following syntax: **CST3504-YOUR FULL NAME-PROJECT1**

Project Due Date

- Due date **Monday Dec 18th, 2017**

  - **DON'T WAIT TO START THIS PROJECT ON THE WEEKEND THAT IS DUE! START IMMEDIATELY**