Tutorial 4 – Conceptual Design

Remember we can classify an ERDs at one of three levels:

1. Conceptual ERD - an ERD drawing which makes no assumptions about the Data Model which the system will be implemented in

2. Logical ERD (also called a Data Structure Diagram) - an ERD created from the Conceptual ERD which is redrawn in terms of a selected Data Model eg. Relational. The major issues at this stage, if a Relational Data Model is selected, are:
   - relationships are represented by FK’s
   - M:N relationships are replaced by 1:M relationships

3. Physical ERD (also represented by a schema file) - an ERD created from the Logical ERD which is redrawn in terms of a selected DBMS eg. Oracle. Most of the issues at this stage of translation will relate to Oracle data types and the Oracle create table/index syntax. Conceptual and Logical ERDs are drawn in terms of a portable (‘idealised’) data type, now you must translate these types to those supported by your selected DBMS software.

For DBMS you may draw ERDs using any of the following (or any combination of the following):

(i) using a general drawing package - **hand drawn submissions are not acceptable**, however you may make use of any standard drawing package to create your diagrams. This approach will support all three ERD levels, you will need to manually make the appropriate translations.

(ii) Microsoft VISIO - VISIO is available in the on-campus labs and also available for you (as a Monash student) to install at home. If you wish to install VISIO at home please speak to your lecturer who will explain the local arrangements. VISIO does not fully support Conceptual ERD design, it has excellent support for logical ERD design (Crows Foot) and some support for Physical ERD modelling (a button to select physical types). VISIO Professional does not support schema generation, you will need to manually make the translation from the logical ERD to the schema file. The enterprise version of VISIO (which Monash is not licensed for) enables the user to generate database scripts from the ERD.

If you decide to use VISIO, support material is available on the [text books web site](#) under the Online Companion link (you will need to create an account to login).

(iii) Gershwin

Gershwin - is a modelling tool which was written within Monash University several years ago. Gershwin runs under MS Windows and is available for download as:

- **Gershwin Version 3.04**

To use Gershwin, download, install the software and run C:\Program Files\Monash\Gershwin304\gershwin.exe

Gershwin supports Conceptual ERD modelling (CHEN), Logical ERD modelling via the Data Structure Diagram and limited Physical modelling (no schema generation for Oracle is available). For Oracle you will will need to manually make the translation from the logical ERD to the schema file.

Whichever approach you decide to use for assignments, it is really important that you understand the translation process Conceptual ERD to Logical ERD (or Data Structure Diagram) and Logical ERD to Physical ERD (or schema).

**Task A: Manual ERD**

Given a scenario represented by the following entities and attributes:

CUSTOMER - customer number (99999), name (C20), address (C20), phone number (C10)

ORDERS - order number (99999), order date (Date), customer number and for each product ordered the quantity ordered (99) and the total line price (999999.99)
PRODUCTS - product number (99999), product description (C20) and product unit price (999.99)

- **Manually** prepare a Conceptual Entity Relationship Diagram (CHEN Notation) using **paper and pen**, be sure to show connectivity, cardinality and all attributes (including underlining the PK)
- Convert this ERD **manually** into a Logical Entity Relationship Diagram

**Task B: Using a CASE or diagramming tool**

Create a Conceptual ERD (Chen) for the above scenario, using your solution to task A as a guide, with Gershwin.

Create a Logical ERD (Crows Foot) for the above scenario, using your solution to task A as a guide, with MS Visio.

**Task C:**

**Theory**


**Review Questions:**

1. What two conditions must be met before an entity can be classified as a weak entity? Give an example of a weak entity.
2. What is a strong (or identifying) relationship, and how is it depicted in a Crow’s Foot ERD?
3. Given the business rule “an employee may have many degrees,” discuss its effect on attributes, entities, and relationships. (*Hint: Remember what a multivalued attribute is and how it might be implemented.*)
4. What is a composite entity, and when is it used?
5. Suppose you are working within the framework of the conceptual model in Figure Q4.5.

Figure Q4.5 The Conceptual Model for Question 5

- Write the business rules that are reflected in it.
- Identify all the cardinalities.
- Explain how you would modify the design to remove the M:N relationship between MAINTENANCE and PART. (6th Edition)
6. When might you want to use entity supertypes and subtypes and what must be the relationship between them? Give an example. (6th Edition)
7. How would you (graphically) identify each of the following ER model components?
   - an entity
   - the cardinality (0,N)
   - a weak relationship, and
   - a strong relationship
8. Discuss the difference between a composite key and a composite attribute. How would each be indicated in
9. What two courses of action are available to a designer when he or she encounters a multivalued attribute?
10. What is a derived attribute? Give an example.
11. How is a relationship between entities indicated in an ERD? Give an example, using the Crow’s Foot notation.
12. Discuss two ways in which the 1:M relationship between COURSE and CLASS can be implemented. (Hint: Think about relationship strength.)
13. How is a composite entity represented in an ERD, and what is its function? Illustrate the Crow’s Foot model.
14. What three (often conflicting) database requirements must be addressed in database design?
15. Briefly, but precisely, explain the difference between single-valued attributes and simple attributes. Give an example of each.
16. What are multivalued attributes, and how can they be handled within the database design?
17. Write the ten cardinalities that are appropriate for this ERD.

18. Write the business rules reflected in this ERD.
19. What two attributes must be contained in the composite entity between STORE and PRODUCT? Use proper terminology in your answer.
20. Describe precisely the composition of the DEPENDENT weak entity’s primary key. Use proper terminology in your answer.

Practical Issues

The answers to the following problems should be attempted using appropriate drawing/CASE/modelling software

The first three problems are based on the following Chen ER model.

Figure P3.1. ERD for Problems 1-3
1. Use the following business rules to create a conceptual ERD (Chen model), include all appropriate connectivities:
   - A department employs many employees, but each employee is employed by one department.
   - Some employees, known as "rovers," are not assigned to any department.
   - A division operates many departments, but each department is operated by one division.
   - An employee may be assigned to many projects, and a project may have many employees assigned to it.
   - A project must have at least one employee assigned to it.
   - One of the employees manages each department, and each department is managed by one employee.
   - One of the employees runs each division, and each division is run by one employee.

2. Add all cardinalities onto the model.

3. Make a copy of the ERD and modify it by splitting the M:N relationship into two 1:M relationships that are connected through a composite entity. Then rewrite the connectivities and cardinalities to match the changes you have made.

4. Convert the Chen model you have developed in problems 1-3 to a Crow’s Foot model. Include at least the minimum number of attributes required to implement the model.

5. Given the following information, produce an ERD - based on the Crow’s Foot model - that can be implemented. Make sure you include all appropriate entities, relationships, connectivities, and cardinalities.
   - EverFail company is in the quick oil change and lube business. Although customers bring in their cars for what is described as "quick oil changes," EverFail also replaces windshield wipers, oil filters, and air filters, subject to customer approval. The invoice contains the charges for the oil used and all parts used, and a standard labor charge. When the invoice is presented, customers pay cash, use a credit card, or write a check. EverFail does not extend credit. EverFail’s database is to be designed to keep track of all components in all transactions.
   - Given the high parts usage of the business operations, EverFail must maintain careful control of its parts (oil, wipers, oil filters, air filters) inventory. Therefore, if parts reach their minimum on-hand quantity, the parts in low supply must be reordered from an appropriate vendor. EverFail maintains a vendor list, which contains both the vendors actually used and the potential vendors.
   - Periodically, EverFail mails updates to customers, based on the date of the car’s service. EverFail also tracks each customer’s car mileage.

6. Prepare an Entity Relationship Diagram (ERD) for the following description of a Property Rental System - you may select to create a Chen or Crows Foot model. Below are some statements about a Real Estate Agency:
   - Properties are rented by tenants. Each tenant is assigned a unique number by the Agency. Data held about tenants include family name, given name, property rented, contact address - street, city, state, postcode & telephone number. A tenant may rent more than one property and many tenants may rent parts of the same property (eg. a large shopping complex).
   - Properties are owned by owners. Each property is assigned a unique building number. The agency only recognises a single owner for any of the properties it handles. The owner, address, and value are recorded for each property. In addition the lease period and bond are recorded for each property or sub property rented. An owner may own several properties.
   - Properties are subject to damage and the agency records all instance of damage to its properties - property, date, type of damage and repair cost are recorded. Repair costs are charged directly to tenants.
   - Normal property maintenance is also noted - property, date, type of maintenance and cost are recorded. Maintenance costs are charged to the property owner.
   - Tenants pay accounts to the Agency - these consist of weekly rental payments, bond payments (for new properties) and damage bills. The date of payment, tenant, property, type of account (Rental, Bond, Damage) and amount are recorded.