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Database Design and Development

Topic 3:
Enhancing Design (2)

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Enhancing Design (2) Topic 3 - 3.2

Scope and Coverage

This topic will cover:

- Deriving a set of relations from a conceptual data model
- Validating relations using normalisation
- Integrity constraints on tables

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Learning Outcomes

By the end of this topic students will be able to:


- List the steps in logical design
- Give an account of the main activities that make up logical design
- Check the integrity constraints on their data model

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Logical Design


- **Step One:** Create and check ER model
- **Step Two:** Map ER Model to tables

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Iterative


- Discussed as a series of steps but...
- Iterative
- Step-wise refinement
- Revisiting steps
- User involvement

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Logical Design Step One - 1

- **Step One:** Create and check ER mode
 - 1.1 Identify entities
 - 1.2 Identify relationships
 - 1.3 Identify and associate attributes with entities
 - 1.4 Determine attribute domains
 - 1.5 Determine candidate, primary and alternative key attributes

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Logical Design Step One - 2

- **Step One:** Create and check ER mode
 - 1.6 Specialise/Generalise entities (optional step, not covered here)
 - 1.7 Check model for redundancy
 - 1.8 Check model supports user transactions
 - 1.9 Review model with user


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Identifying Entities

- Examine user requirements
- Look for nouns
- Look for objects that exist in their own right e.g. Customers, staff,
- Be aware of synonyms and homonyms


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Art Suppliers Example Revisited - 1

- From an interview with the manager:
- “We get our goods from various suppliers. Generally we have one supplier for each item. Customers order from us. They usually order in bulk and we fill in an order form. We usually group orders in the same are into a delivery. We have three delivery vans.”

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Art Suppliers Example Revisited - 2

- From an interview with the **manager**.
- “We get our **goods** from various **suppliers**. Generally we have one supplier for each **item**. **Customers order** from us. They usually order in bulk and we fill in an **order form**. We usually group orders in the same are into a **delivery**. We have three delivery **vans**.”

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Art Suppliers – Some Possible Entities

- Manager
- Goods
- Suppliers
- Item
- Customers
- Order
- Order form
- Delivery
- Vans

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Examining Entities more Closely

- Manager – one of a number of types of Staff
- Suppliers – yes probably an entity
- Item aka Goods
- Customers - yes
- Order – yes so we don't need a separate entity for order form
- Delivery - yes
- Vans – yes in order to allocate to a delivery


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Step 1.2 Identify Relationships

- Look for verbs e.g. Items are supplied by Suppliers
- Draw up a table with relationships between entities.

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Cross Reference Entities for Relationships


Entity	Relationship	Entity
Items	Have	Suppliers
Orders	Contain	Items

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Add Multiplicity


Entity	Multiplicity	Relationship	Multiplicity	Entity
Items	1	Have	0...*	Suppliers
Orders	1...*	Contain	0...*	Items

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Step 1.3 Identify Attributes

- Ask the question ‘what information are we to hold about that particular entity?’
- Are they simple or composite attributes.
- Activity: What attributes do we need for a ‘Customer’?


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Step 1.4 Determine Attribute Domains

- What are the possible values of an attribute?

Attribute	Description	Data type	Domain
CustomerID	Unique ID for customer	Char	First character will be letter ‘C’ followed by a sequential number
CustomerSurname	Customer’s surname	Char	
CustomerType	Specifies if customer is private or a company	Char	Will be letter ‘P’ for Private or ‘C’ for company
CustomerSex	Customer’s sex	Char	Will be ‘M’ or ‘F’

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Step 1.5 Determine Candidate, Primary and Alternate Keys

- Candidate key is an attribute or group of attributes capable of uniquely identifying a row.

CustomerID	OrderItemNo	Date	Time
1	1	13/01/11	9.55
1	2	13/01/11	9.56
3	1	13/01/11	10.01

Possible candidate keys?

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- Candidate key is an attribute or group of attributes capable of uniquely identifying a row.

CustomerID	OrderItemNo	Date	Time
1	1	13/01/11	9.55
1	2	13/01/11	9.56
3	1	13/01/11	10.01

Possible candidate keys?

1. CustomerID, OrderItemNo, Date, Time
2. CustomerID, OrderItemNo, Date
3. CustomerID, OrderItemNo, Time

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Chose the Primary Key by Choosing

- The candidate key with the minimal set of attributes
- The candidate key that is less likely to have its values changed
- The candidate key that is less likely to lose uniqueness over time
- The candidate key with fewest characters or numbers
- The candidate key that is easiest to use for users

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- Candidate key is an attribute or group of attributes capable of uniquely identifying a row.

CustomerID	OrderItemNo	Date	Time
1	1	13/01/11	9.55
1	2	13/01/11	9.56
3	1	13/01/11	10.01

Possible candidate keys?

1. CustomerID, OrderItemNo, Date, Time
2. CustomerID, OrderItemNo, Date
3. CustomerID, OrderItemNo, Time


Candidate 2 is best choice

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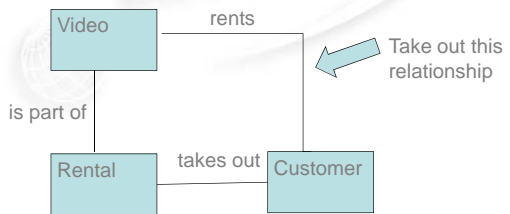
Step 1.7 Check Model for Redundancy

- Re-examine one-to-one relationships
- Remove redundant relationships
- Consider time dimension when assessing redundancy


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Remove Redundant Relationships




```
graph TD; Video[Video] ---|is part of| Rental[Rental]; Rental ---|takes out| Customer[Customer]; Video ---|rents| Customer[Customer];
```

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Step 1.8 Check Model Supports User Transactions

- Describe and document transactions
- Example
 1. Create, update and delete a customers details
 2. Create and update an order
 3. Retrieve details for customers and the orders they make

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Documenting Transactions

Transaction/Table	Customer	Order
1	C U D	
2		C U
3	R	R

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Step 1.9 Review Model with User

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Step 2.1 Create Tables

- Move from entities to tables.
- Most entities will have a one-to-one mapping of entity to table.
- Document in a data dictionary

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Entities to Tables - 1

- Decompose any 'many to many' relationships

```
graph TD; Order --- Item; Order --- OrderItem; OrderItem --- Item;
```

An order is for many items and an item might be on many orders

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Entities to Tables - 2

- Some domains will become separate tables
- If a 'type' attributes has many values and these are dynamic then a look-up table to support the domain should be added.
- Product_Type, Student_Type

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Step 2.2 Check Table Structure using Normalisation


- Use the normalisation techniques discussed in the previous lecture to check the tables
- Do the tables you have from the top-down method match those from the bottom-up (normalisation) method?

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Step 2.3 Check Tables Support user Transactions

- As the CRUD matrix checked that the ER supported the transactions a similar check should now be made for the tables.


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Step 2.4 Check Business Rules

- This begins the process of check integrity rules and other constraints.
 - Check required data
 - Column domain constraints
 - Entity integrity
 - Multiplicity
 - Referential integrity

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Step 2.5 Review Logical Design with Users

 *This is vital!*

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Learning Outcomes

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References

- Connolly, T. and Begg, C. (2004). *Database Systems: A Practical Approach to Design, Implementation, and Management*, 4th Edition. Addison Wesley – **Chapters 9 and 10**


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Any Questions?

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