

## Assignment II

### Database Design and ER Modeling

The overall purpose of the lab is to practice the process of modeling and designing a relational database given a certain scenario. The lab involves extending a given ER diagram, and then translating that extension to the relational model. The student should become familiar with how to create tables in SQL, define primary and foreign keys, and insert and update data into tables.

After the lab, the student should be able to model real world scenarios in terms of EER model and translate an EER diagram into a relational database implementation.

#### 1 Preparations

If needed install Mimer and then set up the Johnson Brothers database. Instructions and scripts can be found at the lab course webpage.

#### 2 Background reading

Read through this material, and also chapter 3, chapter 4, and chapter 8 in the course book (Elmasri & Navathe).

#### 3 The scenario - the company database

The Jonson Brothers is a retail company with department stores in many major US cities. The company has a large number of employees and sells a varied line of products. To manage all information about the company structure and products, a database system is used. The company consists of a number of stores that contain a number of departments. The company has a number of employees, who (among other things) sell items at the different stores. Sales are registered in the sale and debit tables. The sale and debit tables may be a bit tricky to understand. You can view a row in the debit table as representing the receipt you get when you pay for your items, while a row in the sale table represents a row on such a receipt.

The company has contracts with various suppliers, who supply items for sale and also parts for the company's computer equipment. Deliveries of computer parts are registered in the supply table. The current state of the company database can be seen in the ER diagram given in Appendix A and the table definitions and contents in the appendixes B and C.

The business is expanding and the database is continuously being extended with new information. The management of Jonson Brothers has hired you to help them extend their database. The work requires extensions to support a bonus system where managers can be given an extra bonus (e.g. if their departments have met their sale predictions) added to their salary. The management also wants to tie up customers to shop more by creating a credit card that users can use when paying for items that they buy.

#### 4 Exercises

**IMPORTANT NOTICE:** Please be aware that Assignment 3 will be based on the results of these exercises. Good solutions and understanding of them is therefore highly recommended.

- 1) Start by analyzing the ER diagram in Appendix A, and the relational database in Appendix B and Appendix C. Based on the structure of the relational database denote on the diagram

cardinalities ratios of the relationships, such as one-to-one, one-to-many, and many-to-many.

- 2) Extend the ER diagram with an entity type MANAGER that is a sub-class of employee. A manager is an employee that is a head of a department, or manager of other employees, or both. Add support for a manager bonus that is added to the salary, by giving the manager entity a bonus attribute. Draw your extensions to the ER diagram in the appendix A, translate the extension to the relational model, and implement it in the company database.
- 3) Now that you have changed the schema, also change the data, so that all managers are managers! That is, if you have made a manager table, you should insert data in it. You also have to change the database implementation to ensure that only managers manage employees and departments.
- 4) All departments showed good sales figures last year! Give all current department managers 10000 in bonus. Note that not all managers are department managers.
- 5) In the existing database, your customers can buy things and pay for them, as reflected by the sale and debit tables. Now, you want to create support for a customer card, with possible credit. The customers will have accounts, where they can deposit and withdraw money, and pay for the purchases. Add the following:
  - Information must be stored about customers such as name, street address, city, and state.
  - Information about accounts such as account number, balance, and allowed credit.
  - Information about account deposits/withdrawals such as transaction number, account number, date and time of deposit/withdrawal, amount, and the employee responsible for the transaction (that is, the employee that registers the transaction, not the customer that owns the account). Replace the entity type DEBIT by a more general entity type, called for example TRANSACT. This entity type represents not only sales, but also deposits and withdrawals. You may want to drop the table debit, and create a new table for the new information.
  - Customers and accounts should be defined with customer and account numbers (integers) that can be automatically generated.

Extend the EER diagram with your new entities, relationships, and attributes. Implement your extension in your Mimer database. Ensure that all new relations are in BCNF. Add primary keys and any foreign keys to your table definitions.

### Hints:

Foreign keys are added either when defining a table (after the attribute definitions), or by altering it:

```
ALTER TABLE tablename1
ADD FOREIGN KEY (columnname1, columnname2, ...)
REFERENCES tablename2 (columnname1, columnname2, ...);
```

You can use sequences for automatic generation of unique numbers:

```
CREATE UNIQUE SEQUENCE seqname
INITIAL_VALUE = init_value INCREMENT = increment;
```

The generated sequence of numbers can be used as a default value for a column in the table definition:

```
... DEFAULT NEXT_VALUE OF seqname ...
```

See the MIMER SQL Language Reference for details. Also look in the files that you loaded the original database from.

## 5 Handing in solutions

Hand in your modifications to the database schema by extending and modifying the ER diagram given in Appendix A (possibly by hand) and by adding new tables to the ones in Appendix B. Hand in:

- Your new EER diagram;
- SQL commands modifying the database schema and data: table definitions including primary and foreign key definitions, inserts, and updates. Include the replies from the database server when the commands are run;
- Motivate why your relations are in BCNF by specifying all functional dependencies.

## 6 Appendices

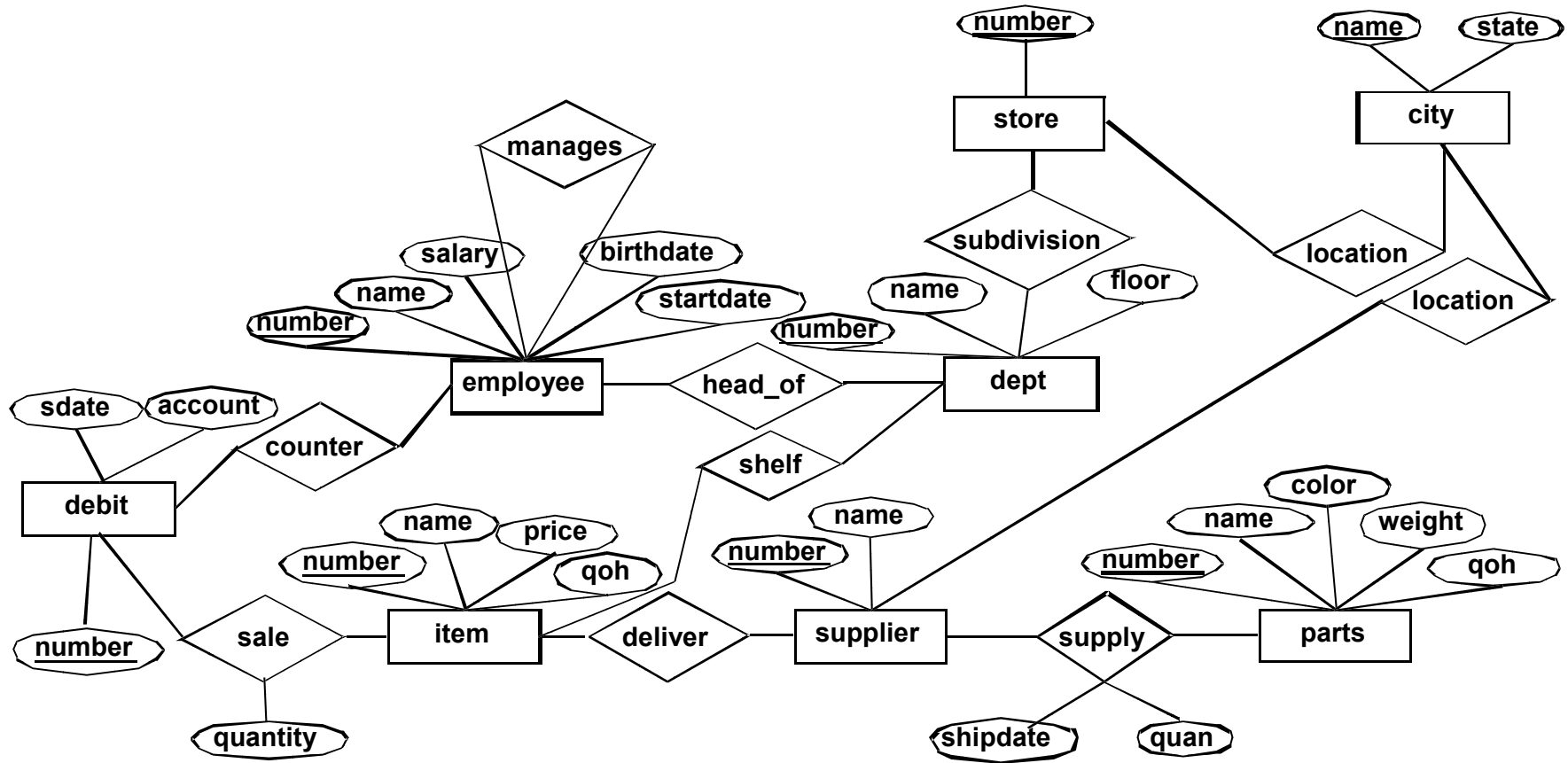
Appendix A: An ER diagram of the existing Jonson Brothers company database

Appendix B: The DDL statements creating the Jonson Brothers company database schema

Appendix C: The contents of the existing company Jonson Brothers database

### Appendix A:

E/R diagram of the existing company database:



## Appendix B:

### The schema for the existing company database

```
CREATE TABLE employee
(number INTEGER CONSTRAINT pk_employee PRIMARY KEY,
 name VARCHAR(20),
 salary INTEGER,
 manager INTEGER,
 birthyear INTEGER,
 startyear INTEGER);

CREATE TABLE dept
(number INTEGER CONSTRAINT pk_dept PRIMARY KEY,
 name VARCHAR(20),
 store INTEGER NOT NULL,
 floor INTEGER,
 manager INTEGER);

CREATE TABLE item
(number INTEGER CONSTRAINT pk_item PRIMARY KEY,
 name VARCHAR(20),
 dept INTEGER NOT NULL,
 price INTEGER,
 qoh INTEGER CONSTRAINT ck_item_qoh CHECK (qoh >= 0),
 supplier INTEGER NOT NULL);

CREATE TABLE parts
(number INTEGER CONSTRAINT pk_parts PRIMARY KEY,
 name VARCHAR(20),
 color VARCHAR(8),
 weight INTEGER,
 qoh INTEGER);

CREATE TABLE supply
(supplier INTEGER NOT NULL,
 part INTEGER NOT NULL,
 shipdate DATE NOT NULL,
 quan INTEGER,
 CONSTRAINT pk_supply PRIMARY KEY (supplier, part, shipdate));

CREATE TABLE sale
(debit INTEGER NOT NULL,
 item INTEGER NOT NULL,
 quantity INTEGER,
 CONSTRAINT pk_sale PRIMARY KEY (debit, item));

CREATE TABLE debit
(number INTEGER CONSTRAINT pk_debit PRIMARY KEY,
 sdate DATE DEFAULT CURRENT_DATE NOT NULL,
 employee INTEGER NOT NULL,
 account INTEGER NOT NULL);

CREATE TABLE city
(name VARCHAR(15) CONSTRAINT pk_city PRIMARY KEY,
 state VARCHAR(6));

CREATE TABLE store
(number INTEGER CONSTRAINT pk_store PRIMARY KEY,
 city VARCHAR(15) NOT NULL);

CREATE TABLE supplier
(number INTEGER CONSTRAINT pk_supplier PRIMARY KEY,
 name VARCHAR(20),
 city VARCHAR(15) NOT NULL);

-- Add foreign keys

ALTER TABLE dept
ADD CONSTRAINT fk_dept_store FOREIGN KEY (store) REFERENCES store (number);
ALTER TABLE dept
ADD CONSTRAINT fk_dept_employee FOREIGN KEY (manager) REFERENCES employee (number)
ON DELETE SET NULL;

ALTER TABLE item
ADD CONSTRAINT fk_item_dept FOREIGN KEY (dept) REFERENCES dept (number);
```

Database Technology, 2005  
Assignment II: Database Design and E/R Modeling

```
ALTER TABLE item
  ADD CONSTRAINT fk_item_supplier FOREIGN KEY (supplier) REFERENCES supplier (number);

ALTER TABLE supply
  ADD CONSTRAINT fk_supply_supplier FOREIGN KEY (supplier) REFERENCES supplier (number);
ALTER TABLE supply
  ADD CONSTRAINT fk_supply_parts FOREIGN KEY (part) REFERENCES parts (number);

ALTER TABLE sale
  ADD CONSTRAINT fk_sale_item FOREIGN KEY (item) REFERENCES item (number);
ALTER TABLE sale
  ADD CONSTRAINT fk_sale_debit FOREIGN KEY (debit) REFERENCES debit(number);
-- implies that a debit/transaction must be created before a sale record.

ALTER TABLE debit
  ADD CONSTRAINT fk_debit_employee FOREIGN KEY (employee) REFERENCES employee (number);

ALTER TABLE store
  ADD CONSTRAINT fk_store_city FOREIGN KEY (city) REFERENCES city (name);

ALTER TABLE supplier
  ADD CONSTRAINT fk_supplier_city FOREIGN KEY (city) REFERENCES city (name);

-- Create the view that has to be modified in lab 2, question 17

CREATE VIEW sale_supply(supplier, item, quantity) as
  SELECT supplier.name, item.name, sale.quantity
  FROM supplier, item, sale
  WHERE  supplier.number = item.supplier AND
         sale.item = item.number;
```

## Appendix C:

The contents of the existing company database:

```
SELECT * FROM employee;
=====
NUMBER NAME                SALARY    MANAGER    BIRTHYEAR  STARTYEAR
=====
10 Ross, Stanley           15908      199        1927        1945
11 Ross, Stuart            12067      -          1931        1932
13 Edwards, Peter          9000       199        1928        1958
26 Thompson, Bob           13000      199        1930        1970
32 Smythe, Carol           9050       199        1929        1967
33 Hayes, Evelyn           10100      199        1931        1963
35 Evans, Michael          5000       32         1952        1974
37 Raveen, Lemont          11985      26         1950        1974
55 James, Mary             12000      199        1920        1969
98 Williams, Judy          9000       199        1935        1969
129 Thomas, Tom            10000      199        1941        1962
157 Jones, Tim             12000      199        1940        1960
199 Bullock, J.D.          27000      -          1920        1920
215 Collins, Joanne        7000       10         1950        1971
430 Brunet, Paul C.        17674      129        1938        1959
843 Schmidt, Herman        11204      26         1936        1956
994 Iwano, Masahiro        15641      129        1944        1970
1110 Smith, Paul           6000       33         1952        1973
1330 Onstad, Richard        8779       13         1952        1971
1523 Zugnoni, Arthur A.    19868      129        1928        1949
1639 Choy, Wanda           11160      55         1947        1970
2398 Wallace, Maggie J.    7880       26         1940        1959
4901 Bailey, Chas M.       8377       32         1956        1975
5119 Bono, Sonny           13621      55         1939        1963
5219 Schwarz, Jason B.     13374      33         1944        1959
```

25 rows found

```
SELECT * FROM dept;
=====
NUMBER NAME                STORE     FLOOR     MANAGER
=====
1 Bargain                   5         0         37
10 Candy                    5         1         13
14 Jewelry                  8         1         33
19 Furniture                 7         4         26
20 Major Appliances         7         4         26
26 Linens                    7         3         157
28 Women's                  8         2         32
34 Stationary               5         1         33
35 Book                      5         1         55
43 Children's               8         2         32
47 Junior Miss              7         2         129
49 Toys                     8         2         35
58 Men's                    7         2         129
60 Sportswear               5         1         10
63 Women's                  7         3         32
65 Junior's                 7         3         37
70 Women's                  5         1         10
73 Children's               5         1         10
99 Giftwrap                 5         1         98
```

19 rows found

```
SELECT * FROM store;
=====
NUMBER CITY
=====
5 San Francisco
7 Oakland
8 El Cerrito
```

3 rows found

Database Technology, 2005  
 Assignment II: Database Design and E/R Modeling

```
SELECT * FROM item;
  NUMBER NAME                DEPT    PRICE    QOH    SUPPLIER
=====
   11 Wash Cloth              1         75     575     213
   19 Bellbottoms            43        450     600     33
   21 ABC Blocks              1         198     405     125
   23 1 lb Box                 10        215     100     42
   25 2 lb Box, Mix           10        450     75      42
   26 Earrings                 14       1000     20     199
   43 Maze                     49        325     200     89
   52 Jacket                   60       3295     300     15
  101 Slacks                   63       1600     325     15
  106 Clock Book               49        198     150     125
  107 The 'Feel' Book         35        225     225     89
  115 Gold Ring                14       4995     10     199
  118 Towels, Bath             26        250    1000     213
  119 Squeeze Ball            49        250     400     89
  120 Twin Sheet               26        800     750     213
  121 Queen Sheet              26       1375     600     213
  127 Ski Jumpsuit            65       4350     125     15
  165 Jean                     65        825     500     33
  258 Shirt                    58        650    1200     33
  301 Boy's Jean Suit          43       1250     500     33
```

20 rows found

```
SELECT * FROM parts;
  NUMBER NAME                COLOR    WEIGHT    QOH
=====
   1 central processor        pink         10         1
   2 memory                    gray         20        32
   3 disk drive                black        685         2
   4 tape drive                 black        450         4
   5 tapes                      gray          1       250
   6 line printer               yellow       578         3
   7 l-p paper                   white         15        95
   8 terminals                   blue          19        15
   9 terminal paper              white         2       350
  10 byte-soap                   clear         0       143
  11 card reader                 gray        327         0
  12 card punch                  gray        427         0
  13 paper tape reader           black        107         0
  14 paper tape punch            black        147         0
```

14 rows found

```
SELECT * FROM sale;
  DEBIT    ITEM    QUANTITY
=====
  100581    118         5
  100581    120         1
  100582     26         1
  100586    106         2
  100586    127         3
  100592    258         1
  100593     23         2
  100594     52         1
```

8 rows found

```
SELECT * FROM debit;
  NUMBER SDATE                EMPLOYEE    ACCOUNT
=====
  100581 1995-01-15                 157    10000000
  100582 1995-01-15                 1110   14356540
  100586 1995-01-16                  35    14096831
  100592 1995-01-17                 129    10000000
  100593 1995-01-18                  13    11652133
  100594 1995-01-18                 215    12591815
```

6 rows found



Database Technology, 2005  
 Assignment II: Database Design and E/R Modeling

```
SELECT * FROM city;
NAME          STATE
=====
Amherst      Mass
Atlanta      Ga
Boston       Mass
Dallas       Tex
Denver       Colo
El Cerrito   Calif
Hickville    Okla
Los Angeles  Calif
Madison      Wisc
New York     NY
Oakland      Calif
Paxton       Ill
Salt Lake City Utah
San Diego    Calif
San Francisco Calif
Seattle      Wash
White Plains Neb
```

17 rows found

```
SELECT * FROM supply;
SUPPLIER      PART  SHIPDATE          QUAN
=====
5             4  1994-11-15         3
5             4  1995-01-22         6
20            5  1995-01-10        20
20            5  1995-01-11        75
62            3  1994-06-18         3
67            4  1995-07-01         1
89            3  1995-07-04       1000
89            4  1995-07-04       1000
122           7  1995-02-01        144
122           7  1995-02-02         48
122           9  1995-02-01        144
241           1  1995-06-01         1
241           2  1995-06-01        32
241           3  1995-06-01         1
241           4  1993-12-31         1
241           8  1995-07-01         1
241           9  1995-07-01       144
440           6  1994-10-10         2
475           1  1993-12-31         1
475           1  1994-07-01         1
475           2  1993-12-31        32
475           2  1994-05-31        32
475           3  1993-12-31         2
475           4  1994-05-31         1
999           10 1996-01-01       144
```

25 rows found

```
SELECT * FROM supplier;
NUMBER NAME          CITY
=====
5 Amdahl             San Diego
15 White Stag       White Plains
20 Wormley          Hickville
33 Levi-Strauss     San Francisco
42 Whitman's        Denver
62 Data General     Atlanta
67 Edger            Salt Lake City
89 Fisher-Price     Boston
122 White Paper     Seattle
125 Playskool       Dallas
199 Koret           Los Angeles
213 Cannon          Atlanta
241 IBM             New York
440 Spooly          Paxton
475 DEC             Amherst
999 A E Neumann     Madison
```

16 rows found