

12 Farm Management

Problem Description

John's family owned and operated a 640-acre farm for several generations. John, a recent graduate of the Industrial and Systems Engineering Department, is now in charge of the family business. John has to decide about what type of livestock and how many of each type they should keep in the farm as well as what type of crops and how much they should plant the next year. The amount produced for each crop depends on the weather conditions. Help John to build a database that will assist him in managing the business.

Database Design

We present the main entity types of this database. For each entity type, we provide some of the corresponding attributes. Use this information in order to: (a) Build an Enhanced E-R diagram; (b) Transform the Enhanced E-R diagram to a relational database. Identify the primary key(s) and the foreign key(s) for each relation. Draw the relational integrity constraints; (c) For each of the relations created, indicate its normal form. If the relation is not in the 3NF, decompose it into 3NF relations.

1. *Livestock*: The main attributes are identification number, name, type, breed, age, description, etc.
2. *Crop*: The main attributes are identification number, name, type, breed, description, average yield, etc.
3. *Livestock transactions*: The main attributes are transaction number, transaction date, selling price per head, number of livestock sold, total amount of money earned from sales, etc.
4. *Crop transactions*: The main attributes are transaction number, transaction date, crop name, amount sold, price per unit, amount of money earned, etc.
5. *Labor*: The main attributes are date, amount of person-hours used, amount of money paid per hour, total amount paid, job description, etc.
6. *Weather*: The main attributes are date, temperature, amount of rain, description, etc.
7. *Customer*: The main attributes are identification number, name, address, telephone number, fax number, etc.
8. *Supplier*: The main attributes are identification number, name, address, telephone number, fax number, etc.

Access Application Development

The following are some of the queries, forms, and reports one can create in order to increase the functionality of the database:

Queries:

1. Create the following search queries:
 - a. This query prompts for the name of a customer and returns a list of the purchases made by this customer. For each purchase include the following information: purchase date, quantity purchased, shipping date, amount paid, payment date, etc.
 - b. This query prompts for the name of a supplier and returns a list of its outstanding orders (orders not yet received). For each order include the following information: order release date, order delivery date, description of the products included in the order, quantity ordered, amount to be paid, payment date, etc.
 - c. This query prompts for the name of a crop and returns a list of customers who have purchased this particular crop. This list is used by the management to inform customers about price changes, special deals, etc. For each customer, include the address and the telephone number.
 - d. This query prompts for the type of a livestock and returns the following information: selling price per head per year during the last ten years, number of livestock at the end of the year during the last ten years, number of livestock sold in a year during the last ten years, total amount of money earned from sales per year during the last ten years, etc.
 - e. This query prompts for the name of an item (livestock or crop) and return a list of the suppliers that provide this item. For each supplier display the address and telephone number.
2. The following queries help the management to understand which crops/livestock are selling more/less. This information will be used to reallocate the investment funds for the coming year.
 - a. List the five crops that have generated the highest income in the last year.
 - b. List the five livestock that have generated the highest income in the last year.
 - c. Find the crop that has generated the lowest income in the last year.
 - d. Find the livestock that has generated the lowest income in the last year.
3. John wants to establish long-term relationships with some of his most qualified customers and suppliers. The following queries will help him to identify the potential customers/suppliers.
 - a. Find the five customers that have purchased the most (had the highest yearly spending) during the last year.
 - b. Find the five customers that have purchased the most (had the highest average yearly expenses) during the last five years.
 - c. Find the five suppliers from whom the company has purchased the most (had the highest yearly spending) during the last year.
 - d. Find the five suppliers from whom the company has purchased the most (had the highest average yearly spending) during the last five years.
 - e. List the suppliers that never sent a late shipment during the last year.
4. Create a query that presents the total amount of money generated from livestock and crops per year during the last ten years. Sort the information by the total income

generated from both livestock and crops. In the same query include a description about the weather conditions in each year. This query will help John to (a) understand the impact of the weather conditions on crop yield and (b) decide whether crops or livestock should be the main stream of the business.

5. Create a query that presents the total amount of money spent and the total amount of money earned per year during the last five years.

Forms:

1. Create a user sign-in form together with a registration form for new users.
2. Create the following data entry forms that are used for database administrative functions: crops, livestock, crop transactions, weather, etc. These forms allow the user to add, update, and delete information about crops, livestock, crop transactions, weather, etc.
3. Create a “Search” form. This form consists of five command buttons. When a particular command button is clicked on, one of the five search queries that we have already built will run and the corresponding results will be presented.
4. Create a form that browses through the information about crops. The form presents the following information for each crop: identification number, name, type, breed, average yearly yield, etc. Create a subform that for the selected crop presents the yield, price, and total earnings per year during the last ten years. Create a command button that, when clicked on, prompts the user for a date and returns the weather conditions on that date. Create another command button that, when clicked on, prompts the user for a year and returns the name and identification number of the crop that sold the most in that particular year.
5. Create a query that browses through the information about livestock. The form presents the following for each livestock: identification number, name, type, breed, etc. Create a subform that for the selected livestock presents the average selling price per head, number of livestock at the end of the year, number of livestock sold, and total amount of money earned from sales per year during the last ten years. Create a command button that, when clicked on, prompts the user for a year and returns the name and identification number of the livestock that sold the most in that particular year.
6. Create a form that allows the user to choose a customer from, say, a combo box. Create a subform that for the selected customer presents a list of backorders (orders not yet delivered). For each backorder present the following: order date, quantity ordered, description of the products ordered, etc. Create a command button that, when clicked on, prompts an order number and returns the number of days that a particular order is late or the number of days left until delivery date.
7. Create a form that allows the user to choose a supplier from, say, a list box. Create a subform that for the selected supplier presents a list of outstanding orders (orders not yet received). For each outstanding order present the following: order date, quantity ordered, description of the products ordered, etc. Create a command button that, when clicked on, prompts an order number and returns the number of days that a particular order is late or the number of days left until delivery date.

Design a logo for this database. The logo may contain the picture of a crop, livestock, a farm, etc. Insert this logo in the forms created above as well as on the reports that you will be creating next. Include the following in the forms created: record navigation command

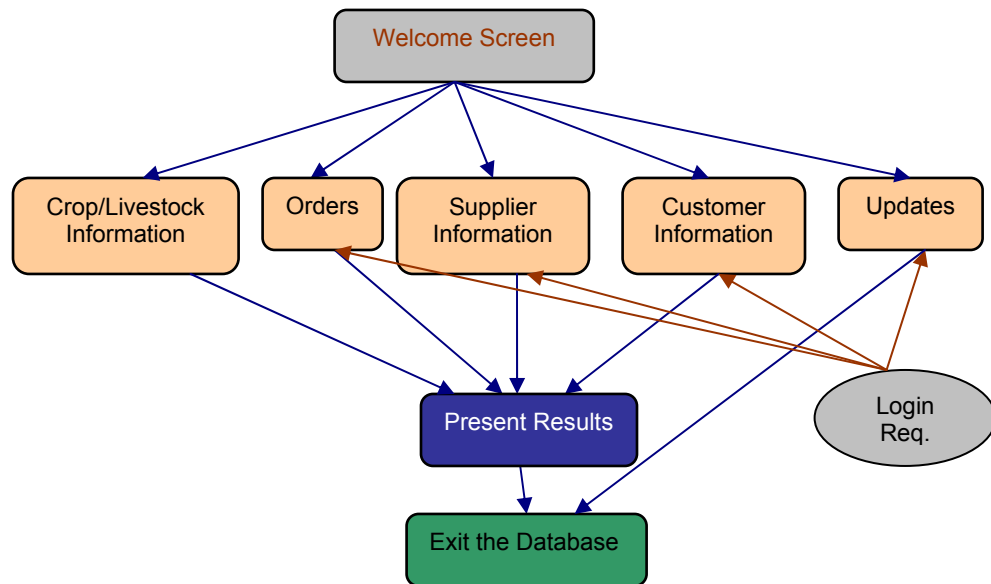
buttons, record operations command buttons, and form operations command buttons as needed.

Reports

1. Create a report that presents all the buy/sell transactions performed in the current month. Include in this report the transaction identification number, transaction date, description, name and address of the supplier/customer, amount of money paid/received, and payment date.
2. Create a report that is used at the end of the year to present the total amount earned from sales, the total amount of money spent, the amount of credit (e.g., sales for which a payment is not received yet) and debt (e.g., purchases for which a payment is not made yet), the amount of crops in the inventory expected to be sold, and the value of livestock owned.
3. Create a report that lists all the customers with whom the farm did business in the past year. For each customer, present the name and a list of orders submitted. For each order, present the quantity ordered, order description, amount paid (or to be paid), and payment date. Group this information by customer. Sort the customers by last name and by order date.
4. Create a report that lists all the suppliers with whom the farm did business in the past year. For each supplier, present the name and a list of orders submitted. For each order, present the quantity ordered, order description, amount paid (or to be paid), and payment date. Group this information by supplier. Sort the suppliers by last name and by order date.
5. Create a report that presents for each crop planted in the farm the following information: name, type, breed, yield in the current year, and unit price.
6. Create a report that presents for each livestock the following information: name, type, breed, selling price per head, total number of livestock, number of livestock sold during the current year, and total amount of money earned from sales.
7. Use the chart wizard to present the following information:
 - a. Annual yield per crop type during the last ten years.
 - b. Annual yield per livestock type during the last ten years.
 - c. Total earnings from crop sales per year during the last ten years.
 - d. Total earnings from livestock per year during the last ten years.
 - e. Total amount of working hours on the farm per year during the last ten years.
8. Use the label wizard to create labels with the address of each customer and each supplier.

Visual Basic.NET Application Development

This database application can be used by managers, suppliers, customers, and the database manager. In the following figure we present a tentative layout of the system.



In the welcome screen, the user can choose one of the five options presented. We give details about the forms or set of forms to be included in each option; however, you are encouraged to add other forms you find important.

Crop/Livestock Information: The user can browse the database to retrieve information about crops and livestock. We suggest that the queries and forms about crops and livestock that we have already described in the Access Application Development section be included in here.

Orders: The user can place an order for a product or check the status of an order. In order to access this information, a login name and password are required.

Suppliers Information: The user can browse the database to learn more about suppliers. Only the farm manager and database administrator have access to this information.

Customer Information: The user can browse the database to learn more about customers. Only the farm manager and database administrator have access to this information.

Update: The update form requires an administrator login name and password. This form allows the user to add/delete/update the information kept in this database about crops, livestock, customers, suppliers, etc.

Web Extension

The users of this database are the customers, the suppliers, the farm managers, and the database administrator. A user may access this database from personal computers at home or in the office. A user should be able to search for crops, livestock, yield information, etc. Customers and suppliers, however, should not be allowed to update/delete information about customers, suppliers, crops, etc. Only the database administrator can have access to the update forms. Only the database administrator and farm managers can access the information about the customers and suppliers.

Develop an ASP.NET web application that will enable the users to access the database and perform the activities described above. Your application will have forms similar to the ones described in the VB.NET Application section.

Reference

W.L. Winston, "Operations Research: Applications and Algorithms," *Duxbury Press*, 3rd Edition, 1993.