Boeing Plane Maintenance System
Team DBuggers

Ainsly DSouza   Jaidev Shriram   Tanvi Kamble
2018101060   2018101012   2018114004

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Abstract

With the ever increasing number of planes in service today, it is important for every aircraft manufacturer to regularly monitor the safety standards of each airplane to prevent major loss of life and property. Our database aims to do this along with added service of checking profitability in production of the various models of airplanes.

Summary

1 About

As an example, we have selected Boeing as an airplane manufacturer. The primary purpose of this database is to ensure the safety of passengers and also to maintain profitability for the manufacturer. On a side note, the database also stores information about all each airplane sold, its maintenance records, its buyer, its inspecting officer.

1.1 Purpose

1.1.1 Safety

Safety of Passengers is of paramount importance for any airplane manufacturer. Along with massive loss of life and property, any airplane crash could do extensive damage to a manufacturer's reputation in the market as well as their reputation in the passengers' eyes. Hence our database stores comprehensive, information about the maintenance of each plane, along with their crash reports, if any. So if any of the crash reports suggest an error on the manufacturers part such as constantly failing parts or improper maintenance, all airplane using that part can be immediately stopped from flying until the replacement of faulty parts or the maintenance officer could be put under review respectively in order to prevent any further crashes.

1.1.2 Profitability

Whenever an airplane manufacturer signs a production contract, it does so in terms of x planes in years along with maintenance for z years for some amount of money. Our database stores the number of times an airline has requested service, along with cost of parts replaced. Hence Net Profit is calculated as: Payment received per plane - Cost of production per plane - Cost of part * Number of times replaced (for all parts). Hence if an airline requests an unfair number of maintenance checks, the manufacturer tries to negotiate a higher price from that airline in order to maintain profitability by accounting for the losses incurred. Also if there is any part that keeps requiring maintenance, our database can alert the manufacturer to search for an alternative part.

1.2 Document Disclaimer

All attributes listed unless specified are expected to be NOT NULL type and have to be filled. The attributes at this time only contain essential information but more data may be added later, but this will not affect the

usage of data or the relations between entities but rather refine the goals of this application.

1.3 Users

There will be only two kinds of users:

1. View Access: Those will view access will only be able to view the data in the table. This could be relevant for an accountant/maintenance engineer. Details such as sales will be protected and only accessible to the concerning department.

2. Administrative Access: Only those that are company executives will have access to modify data in the database. This is intentional and necessary as sensitive data such as maintenance records must be protected from sabotage.

2 Database Requirements

The purpose of this application is to make data management easier. Since the complexities of airplanes are significant, and given the sheer number of planes in use, an efficient way for Boeing to keep track of maintenance records among other details like purchase details is crucial.

The following section will detail all the strong entities required for this application. These entities must not be deleted without removing mentions of the same in other weak entities (detailed in section 2.2).

2.1 Strong Entities

2.1.1 Plane Model

This entity conveys information regarding the plane models that the company produces. This will be an exhaustive list that includes planes that were in production but are no longer continued. Revisions of a plane will be considered as new entries in the table. The attributes that this entity will have are:

1. **ID**: This is a unique numeric identifier for the plane model

2. **Name** (String type): This refers to the name of the plane model, such as the Boeing 777.

3. **Reference Code** (String type): This is the serial number used in internal documents to refer to the plane.

4. **Date of Release** (Date type): cannot be updated

5. **Classification** : Multi-valued datatype that classifies the plane into categories such as : Propeller, Jet Engine, Supersonic, Passenger, General Purpose, Cargo, Military

6. **Age** (Number) : Derived datatype, derived from the date of release

7. **Wingspan Dimensions** (Number) : Corresponds to the wingspan dimensions in meter

8. **Nose-Tail Dimensions** (Number) : Corresponds to the length of the plane vertically

2.1.2 Purchaser/Group

This entity conveys information regarding the buyer of a plane model. This list will have the names of all airlines/companies/persons that have purchased a Boeing airplane. For the remainder of this document, the terms buyer, airline company, and purchaser have been used interchangeably. The attributes that this entity will have are:

1. **ID** (Number): This is a unique identifier for the company

2. **Name** (String Type): Name of the company as listed in official documents

2.1.3 Contractor/Company

This entity contains the list of all contractors/companies that Boeing will be in touch with to built it's plane. This for instance, would include Rolls Royce as they make engines for Boeing.

1. **ID** (Number): This is a unique identifier for the part

2. **Name** (String Type): Name of the contractor

2.1.4 Inspection/Audit Agency

This entity contains information on the organization that approves/goes through the maintenance records. This is a crucial part of any process since flight safety standards are high and all operations done on them must pass each and every check. Having a list of agencies that did maintenance is a good way to check who is accountable in the event of failure. The attributes relevant are:

1. **ID** (Number): This is a unique identifier for the agency

2. **Name** (String): Name of the agency

The next section contains the bulk of meaningful data for the database, ie, data that the application will use mainly.

2.2 Weak Entities

2.2.1 Sale

This entity contains the sale information for every transaction concerning a plane. This table is relevant since planes are sent on a slow roll out and if parts for a model are upgraded midway, information on planes left in the pipeline will be useful in ensuring that they follow the updated procedure along with a new plane model ID for these models.

1. **ID** (Number): This is a unique identifier for the sale

2. **Plane Model ID** (Number): Foreign Key corresponding to the plane model purchased

3. **Company ID** (Number): Foreign Key corresponding to the company that placed the order

4. **Quantity** (Number): The number of planes that have been placed

5. **Progress** (Number): Measure of how many planes were shipped to date

2.2.2 Parts

Refers to all the parts that Boeing has and uses in its inventory. This entity acts like a class and has multiple instances. Each company will produce multiple parts, and if the type of the part is not mentioned in the sub classes, the data may continue to exist without classification. The list of attributes common to all sub classes are:

1. **ID** (Number): This is a unique identifier for the part

2. **Company ID** (Number): Foreign Key for the company that provided this part

3. **Cost** (Number): Cost of the part

The sub classes that derive from this are:

1. **Engine**: Refers to the engine maker of the plane model

    (a) **Name** (String) Name/Model of the engine
    (b) **Type** (String): Jet Engine/Supersonic/Propeller/other

(c) **Power** (String): Power of the engine

2. **Software**: Refers to the software used on board

   (a) **Name** (String): Name of software used on board

3. **Black box**: Refers to the black box that is used on board

   (a) **Capacity** (Number): How much data it can store without requiring replacement/data erasure

   (b) **Water Tolerance** (Number): Maximum amount of water pressure it can withstand

Since one contractor may producer multiple parts, note that multiple parts may be linked to the same company. The company ID is crucial to this table as a foreign key and establishes a one-many relationship between the contractor and the parts produced by it.

2.2.3 List of Planes

This is the crucial part of the database which has the list of all planes ever sold by Boeing. This entity will have unique for entries every plane with internal ID's to reference the plane in question. Since maintenance, and other operations are done on individual models, this table is critical. Since the data in Plane Model and company may repeat, this forms a one-many relationship with them. The attributes of this table are:

1. **ID** (Number): Unique identifier for the plane

2. **Plane Model ID** (Number): Foreign key corresponding to the plane model

3. **Airline ID** (Number): Foreign key corresponding to the company that owns the plane

4. **Date of Purchase** (Date): The date the plane was shipped for use

5. **Decommission date** (Date): The date the plane was officially grounded

6. **Sale ID** (Number): Foreign key corresponding to the sale in which this plane was sold to the company

7. **Age** (Number): Derived data type from the date of purchase

2.2.4 Maintenance Reports

Each entry in this table needn't be on different dates or on different planes. Rather, this approach permits closer inspection on parts instantly. There could be multiple reports per plane, and hence this forms a one-many relationship with the planes as well as the inspectors. This table has the following attributes:

1. **ID** (Number): Unique identifier for each maintenance record

2. **Inspector/Auditor ID** (Number): Foreign Key corresponding to the inspection agency/agent that requested and approved of the maintenance. Valuable for holding people accountable in the event of catastrophe

3. **Plane ID** (Number): Foreign key corresponding to the plane on which servicing was done

4. **Maintenance Date** (Date): Date on which said maintenance was done

5. **Cost** (Number): Total service cost + material cost of maintenance. This is the cost Boeing bears.

2.2.5 Crash Reports

Crash reports are essential to the database and provide information crucial to the Boeing team regarding it's entire fleet of planes. The table has the following attributes:

1. **ID** (Number): Unique identifier for the plane

2. **Plane Model ID** (Number): Foreign key corresponding to the plane

3. **Date of Purchase** (Number): The date the plane was shipped for use

4. **Date of Incident** (Date): The date of the crash

5. **Date of Last Maintenance check** (String): The date the last check was conducted

6. **Reason For Crash** (String): Major cause of failure of airplane. Mostly a link to the internal file report.

7. **Investigating Agency** (ID): Foreign key of the agency generating the crash report

3 Functional Requirements

This database helps the airplane making company handle the orders placed by different Airlines for different models, their maintenance, the cost of production and the profit/loss. In addition to this, it permits a ton of analysis on the efficiency of planes as a result of links between maintenance records and the plane models across different companies.

3.1 Adding New Planes, Maintenance Report

Since this is a dynamic application which must be updated in real time to reflect new purchases, data in the sales tables, maintenance reports etc can be added.

3.2 Update Cost

As times change, the cost of parts change, the application must be able to update the cost.

3.3 Update Airline

Since we are using ID's to link our database, we support re-branding of companies.

3.4 Deleting sales that fail to go through

Our application supports the removal of sales data if a purchase was cancelled at a later point. Other data do not support deletion as all data is crucial for archival purposes. Just because a plane is no longer in service, does not warrant deletion of data.

3.5 Admin: Add attributes

Using the admin privelege, executives will be able to add columns to the table and thereby attributes.

3.6 Maintenance Trends

Data on what parts are getting maintained/replaced the most in a plane will offer valuable insight into the life of a part, and if the part model itself must be switched out.

3.7 Error Detection

Following a crash, Boeing will be able to alert all those plane companies who have/had planes with a certain part to ground the flight. Instant access to this data would save tremendous time.

3.8 Regular Maintenance Check

Since airplanes require frequent maintenance, if Boeing detects that a plane has not been reevaluated after a certain time span, it can send alerts to the concerned company. Boeing is concerned about such situations since it is the Boeing stock price that dips after a plane crash, regardless of what caused the crash.

3.9 Sales and Production Line

This feature enables the user to determine the total planes that are pending to be made based on the model and quantity requirements of each Airline company.

3.10 Manufacturing and Production Line

Depending on the result provided by function 4, the user can then query the number of plane parts that need to be ordered from various manufacturers.

3.11 Sale Negotiation

The user can query the database to find the budget to build a particular plane model that is dependent on the price negotiation by the corresponding airline, and the parts that need to be ordered from external manufacturers. This along with the average maintenance cost of planes will be a good measure that is now instantly available.

3.12 Is making the plane profitable?

The system allows the user to query the frequency of replacements made per part for the different plane models distributed to respective airlines over the past five years and total profit/loss made by the company due to replacements and view the resulting profits.