

# Database Design and Conceptual Model

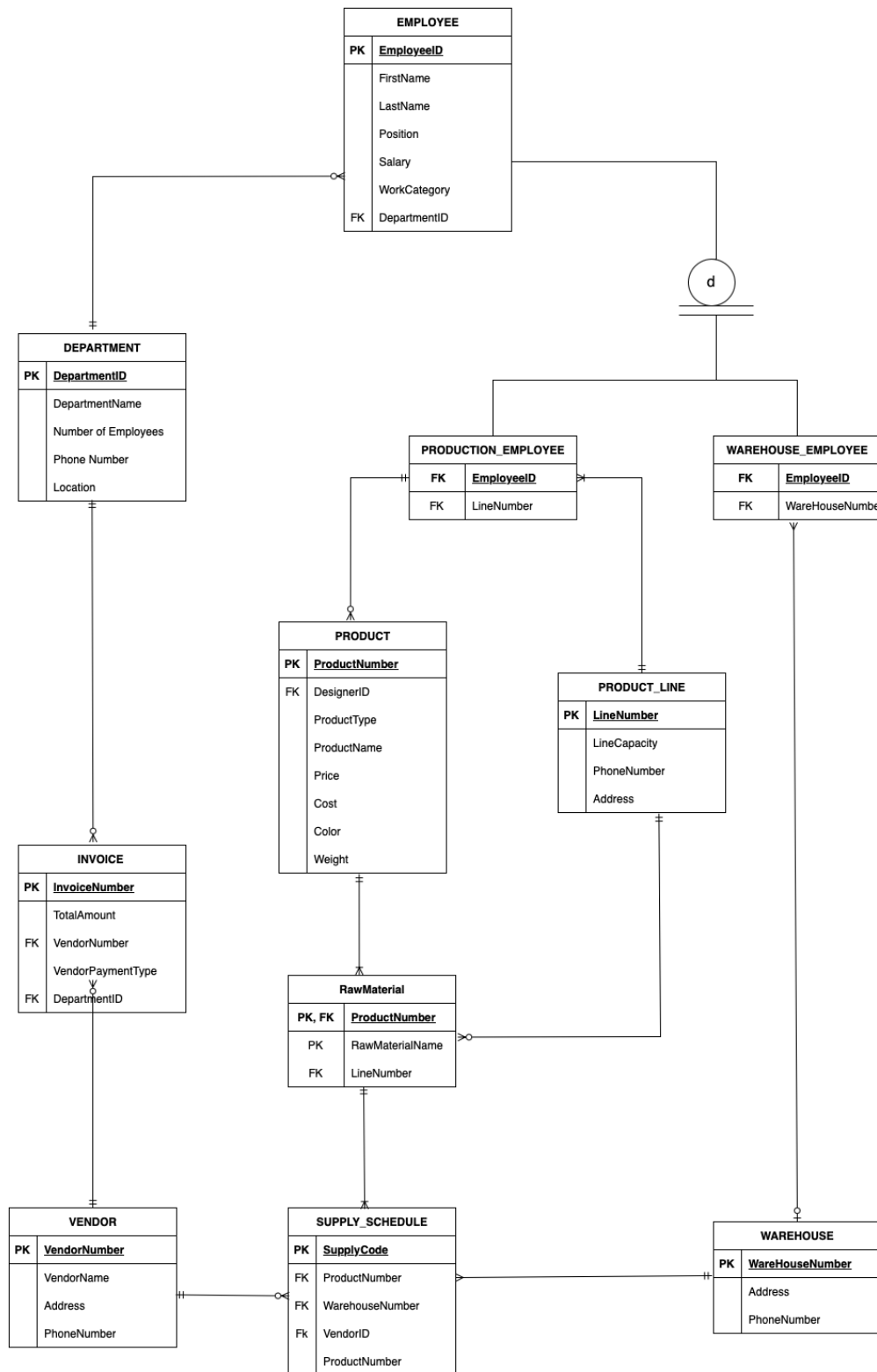
## Entities and Attributes

Entity	Attributes
Employee	EmployeeID, FirstName, LastName, Position, Salary, WorkCategory, DepartmentID
Department	DepartmentID, DepartmentName, Location, NumberOfEmployees, PhoneNumber, Manager
Product	ProductNumber, ProductName, ProductType, DesignerID, Price, Cost, Color, Weight (lbs)
Raw Material	ProductNumber, RawMaterialName, LineNumber
Production Line	LineNumber, LineCapacity (items/hour), PhoneNumber, Address
Vendor	VendorNumber, VendorName, Address, PhoneNumber
Warehouse	WarehouseNumber, Address, PhoneNumber
Invoice	InvoiceNumber, TotalAmount, VendorNumber, VendorPaymentType, DepartmentID
Warehouse_Employee	EmployeeID, WarehouseNumber
Production_Employee	EmployeeID, LineNumber

## Business Rules

- **B1:** Each product must be produced by one specific production line.
- **B2:** Production line can produce multiple products.
- **B3:** For repair purposes, production lines may produce no products.
- **B4:** Each vendor can supply many raw materials to any number of warehouses.
- **B5:** Raw materials are supplied by any number of warehouses, which are supplied by any number of vendors.
- **B6:** Each warehouse can be supplied with any number of raw materials from more than one vendor, but each warehouse must be supplied with at least one raw material.
- **B7:** Raw materials may also be directly supplied by vendors.
- **B8:** The company has departments, warehouses, and production lines.
- **B9:** The company designs and produces products.
- **B10:** Each department, warehouse, and production line has multiple employees.
- **B11:** Each employee works in only one department, warehouse, or production line.
- **B12:** Only Employees within the design department designs products. Each designer can design multiple products.
- **B13:** Different departments must not work on the same product.
- **B14:** Vendors submit invoices if they supply any raw materials.
- **B15:** Vendors submit invoices if they receive any orders.
- **B16:** Invoices must be processed by the accounting department.

# ERD



## Business Problems Addressed

The database is designed to address the following business problems:

- Inefficient tracking of production processes and inventory.
- Inadequate management of raw materials from multiple vendors.
- Difficulties in coordinating multiple departments, warehouses, and production lines.
- Challenges in maintaining the relationship between products, their designers, and production lines.
- The need for an automated system to process invoices from vendors.

## Entities and Relationships

### EMPLOYEE

- Description: Represents individuals working in different departments, warehouses, or production lines.
- Key Relationships: Linked to DEPARTMENT, PRODUCTION\_EMPLOYEE, and WAREHOUSE\_EMPLOYEE based on their role.

### DEPARTMENT

- Description: Represents various departments within the company.
- Key Relationships: Has multiple EMPLOYEES and is related to INVOICE for processing invoices.

### PRODUCTION\_EMPLOYEE

- Description: Represents employees specifically assigned to production lines.
- Key Relationships: Tied to EMPLOYEE and PRODUCT\_LINE to reflect their specific role in production.

### WAREHOUSE\_EMPLOYEE

- Description: Represents employees working in warehouses.
- Key Relationships: Connected to EMPLOYEE and WAREHOUSE to denote their specific location of work.

### PRODUCT

- Description: Represents the products designed and produced by the company.
- Key Relationships: Linked to PRODUCT\_LINE as per B1 and B2, and to EMPLOYEE through DESIGNER\_ID for B12.

### PRODUCT\_LINE

- Description: Represents the production lines in the factory.
- Key Relationships: Produces one type of PRODUCT (B2, B3), and uses RAW\_MATERIAL (B1).

### INVOICE

- Description: Represents financial documents submitted by vendors.
- Key Relationships: Linked to VENDOR and DEPARTMENT for processing (B14, B15, B16).

### VENDOR

- Description: Represents suppliers of raw materials.
- Key Relationships: Supplies RAW\_MATERIAL to WAREHOUSES and issues INVOICES.

### RAW\_MATERIAL

- Description: Represents materials used in production.
- Key Relationships: Supplied by VENDOR to WAREHOUSE (B4, B5, B6) and used by PRODUCT\_LINE.

### SUPPLY\_SCHEDULE

- Description: Represents the schedule for supplying raw materials.
- Key Relationships: Connects VENDOR, WAREHOUSE, and PRODUCT for supply chain management.

### WAREHOUSE

- Description: Represents storage facilities for raw materials and finished products.
- Key Relationships: Stores RAW\_MATERIAL and employs WAREHOUSE\_EMPLOYEES.

## Key Design Decisions

- **Normalization:** The database is normalized to the third normal form (3NF) to eliminate data redundancy while ensuring data integrity.

- **Data Integrity and Constraints:** Foreign key constraints are used to maintain the relationships between entities. Check constraints ensure that business rules (like B6) are enforced.

- **Indexing Strategy:** Indexes are applied to frequently accessed fields such as EmployeeID, ProductNumber, and VendorNumber to improve query performance.

- **Scalability and Performance:** The database is designed to handle scaling up as the company grows. Performance metrics will be monitored to make necessary adjustments.

- **Super-type and Sub-type:** The given 'Employee' table structure, while functional can benefit from refinement to ensure clarity and maintainability. By using the supertype-subtype model, we eliminated the occurrence of NULL values in the table, ensuring that each employee record clearly indicates their role and associated department, warehouse, or production

## Changes for final ERD

- Created Department Employee Entity to separate the relationship between set of employees and the Department Entity
- Further Normalized the Raw Material and Production Line Entity.
- Modified few attributes in entities characterizing the entities better.

## In Business rules

B2 is changed to - Production Line can produce multiple products

## Final ERD

