System Analysis and Design

Data Flow Diagram(DFD)

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UAP

What is a Data Flow Diagram?

- A data flow diagram (DFD) is a graphical representation of the movement of data between external entities, processes and data stores within a system.
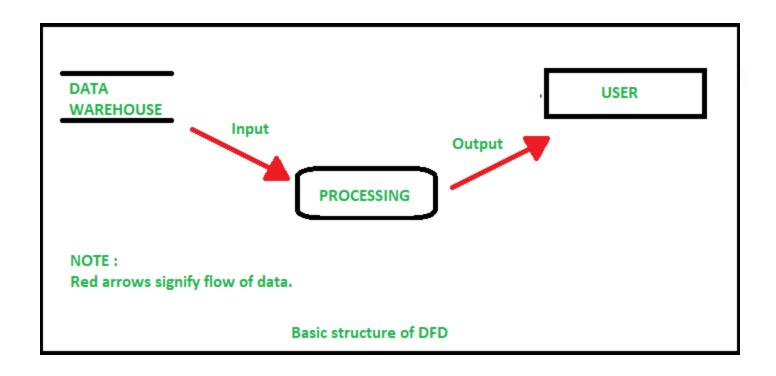
- Simply put, DFD's show how data moves through an information system.

The Flow Model/Basic Structure

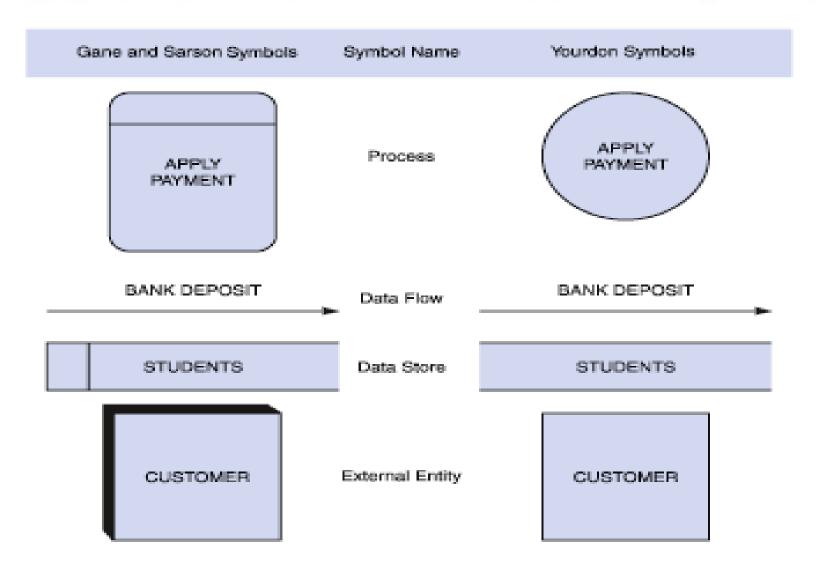Every computer-based system is an information transform ....

The Flow Model/Basic Structure

DATA WAREHOUSE

Input

PROCESSING

Output

USER

NOTE :
Red arrows signify flow of data.
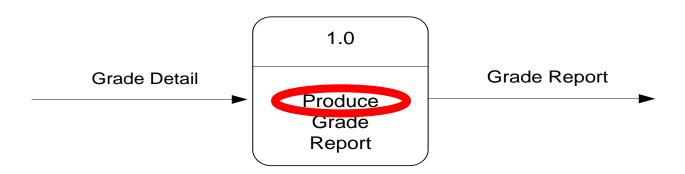
Basic structure of DFD

Definitions and Symbols

- **Process**: work or actions performed on data (inside the system) (circle/bubble chart)

- **Data store**: data at rest (inside the system) (open rectangle)

- **Source/sink**: external entity that is the origin or destination of data (outside the system) (square box)

- **Data flow**: arrows depicting movement of data (arrow/line)

Gane and Sarson VS DeMarco and Yourdon symbols

Gane and Sarson Symbols	Symbol Name	Yourdon Symbols
APPLY PAYMENT	Process	APPLY PAYMENT
BANK DEPOSIT →	Data Flow	BANK DEPOSIT →
STUDENTS	Data Store	STUDENTS
CUSTOMER	External Entity	CUSTOMER

Process

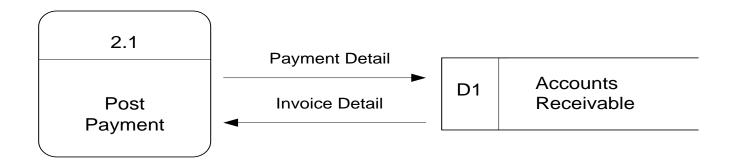- The work or actions performed on data so that they are transformed, stored, or distributed.

- Process labels should be **verb phrases!**

Process example

Examples: *compute taxes, determine area, format report, display graph*

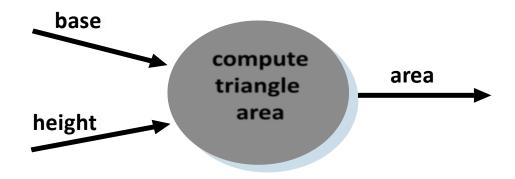*Data must always be processed in some way to achieve system function*

Data Flow

```
┌─────────────┐
│    2.1      │         Payment Detail        ┌──────────────────────────┐
│─────────────│    ──────────────────────▶    │     │                    │
│             │                               │ D1  │   Accounts         │
│   Post      │         Invoice Detail        │     │   Receivable       │
│   Payment   │    ◀──────────────────────    │     │                    │
└─────────────┘                               └──────────────────────────┘
```

- – A path for data to move from one part of the system to another.
- – Data in motion!
  - Arrows depict the movement of data.
- – **NO VERBS**

Data Flow Example

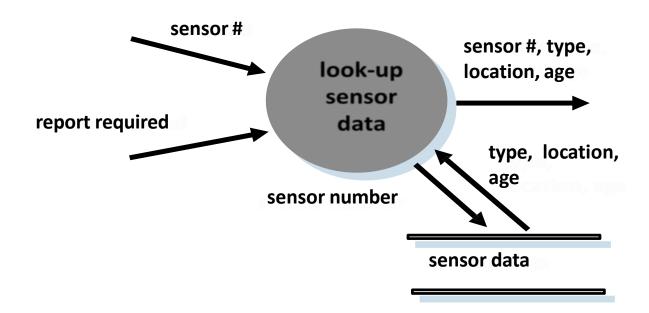**Data flows through a system, beginning as input and transformed into output.**

Data Store

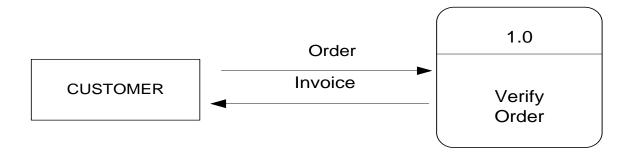| D1	Students

- Used in a DFD to represent data that the system stores
- Data at rest!
- Labels should be noun phrases
  - **(NO VERBS)**

Data Stores Example

Data is often stored for later use.

sensor #

look-up sensor data

sensor #, type, location, age

report required

type, location, age

sensor number

sensor data

External Entity aka Source/Sink

- – The origin or destination of data!
  - • This represents things outside of the system.
- – Source – Entity that supplies data to the system.
- – Sink – Entity that receives data from the system.
- – The labels should be noun phrases!

External Entity Example

A producer or consumer of data

Examples: **a person, a device, a sensor**

Another example: computer-based system

Data must always originate somewhere and must always be sent to something

DFD Rules and Tips

❑ Each process should have at least one input and an output.

❑ Each data store should have at least one data flow in and one data flow out.

❑ Data stored in a system must go through a process.

❑ All processes in a DFD go to another process or a data store.

DFD Rules and Tips

	YES	NO
A process to another process	✓	
A process to an external entity	✓	
A process to a data store	✓	
An external entity to another external entity		✓
An external entity to a data store		✓
A data store to another data store		✓

DFD vs. ERD

| DFD	ERD
It stands for Data Flow Diagram.	It stands for Entity Relationship Diagram or Model.
Main objective is to represent the processes and data flow between them.	Main objective is to represent the data object or entity and relationship between them.
It explains the flow and process of data input, data output, and storing data.	It explains and represent the relationship between entities stored in a database.
Symbols used in DFD are: rectangles (represent the data entity), circles (represent the process), arrows (represent the flow of data), ovals or parallel lines (represent data storing).	Symbols used in ERD are: rectangles (represent the entity), diamond boxes (represent relationship), lines and standard notations (represent cardinality).
Rule followed by DFD is that at least one data flow should be there entering into and leaving the process or store.	Rule followed by ERD is that all entities must represent the set of similar things.
It models the flow of data through a system.	It model entities like people, objects, places and events for which data is stored in a system.
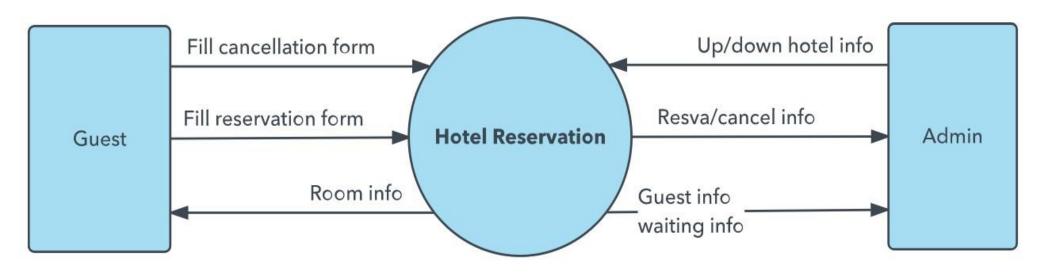
DFD levels and layers:
From context diagrams to pseudocode

❑ A data flow diagram can dive into progressively more detail by using levels and layers, zeroing in on a particular piece.

❑ DFD levels are numbered 0, 1 or 2, and occasionally go to even Level 3 or beyond.

DFD 0

It is also known as a context diagram. It's designed to be an abstraction view, showing the system as a single process with its relationship to external entities. It represents the entire system as a single bubble with input and output data indicated by incoming/outgoing arrows.
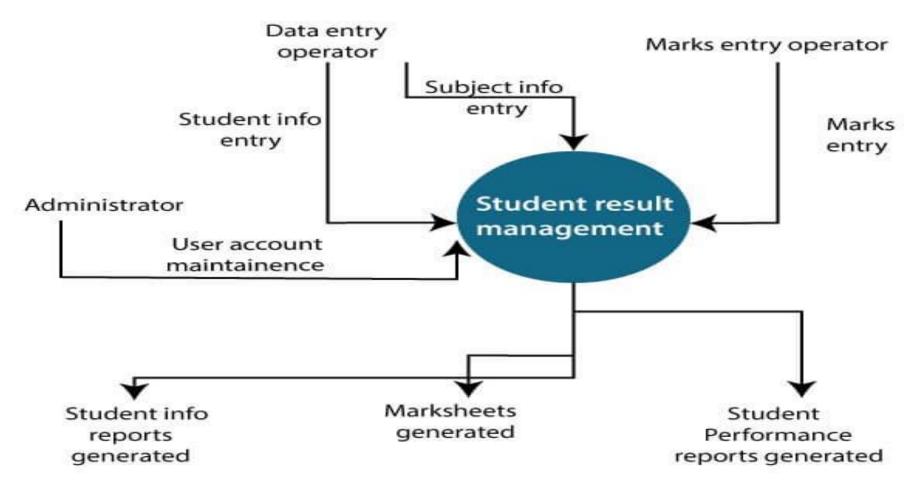
DFD 0

Guest

- Fill cancellation form →
- Fill reservation form →
- ← Room info

Hotel Reservation

- ← Up/down hotel info
- Resva/cancel info →
- Guest info waiting info →

Admin

Passenger

- Cancellation →
- Reservation →
- ← Ticket Info

Railway Reservation

- ← Up/Down Train Info
- Reserve/Cancel Info →
- Passenger Info →
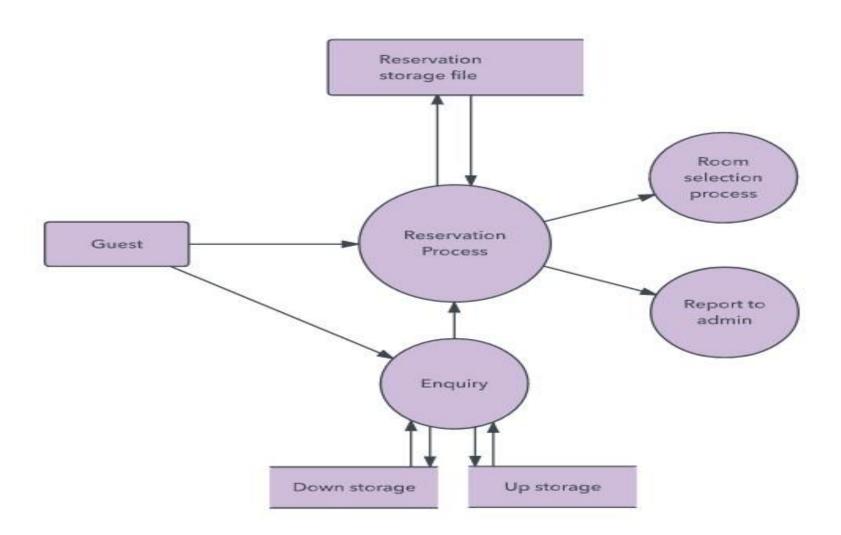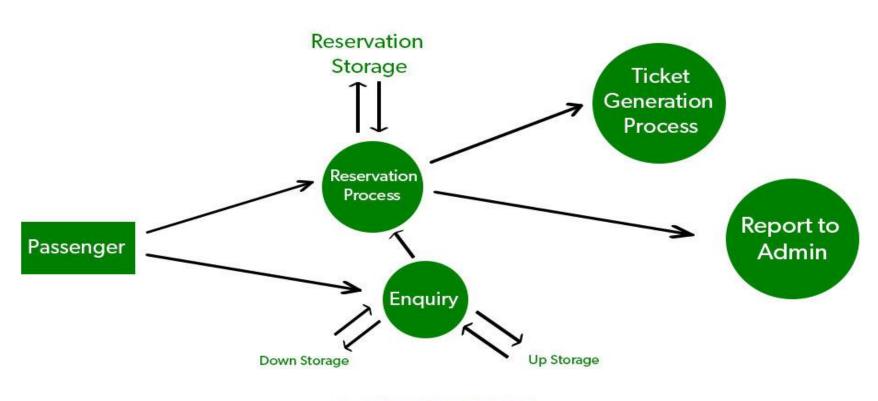
Admin

O-LEVEL DFD

DFD 0

Fig: Level-0 DFD of result management system

DFD-1

In 1-level DFD, the context diagram is decomposed into multiple bubbles/processes. In this level, we highlight the main functions of the system and breakdown the high-level process of 0-level DFD into sub-processes.
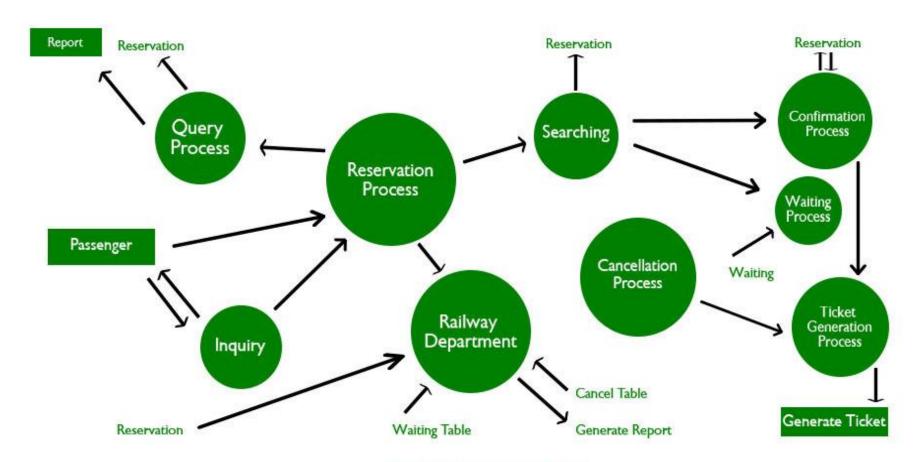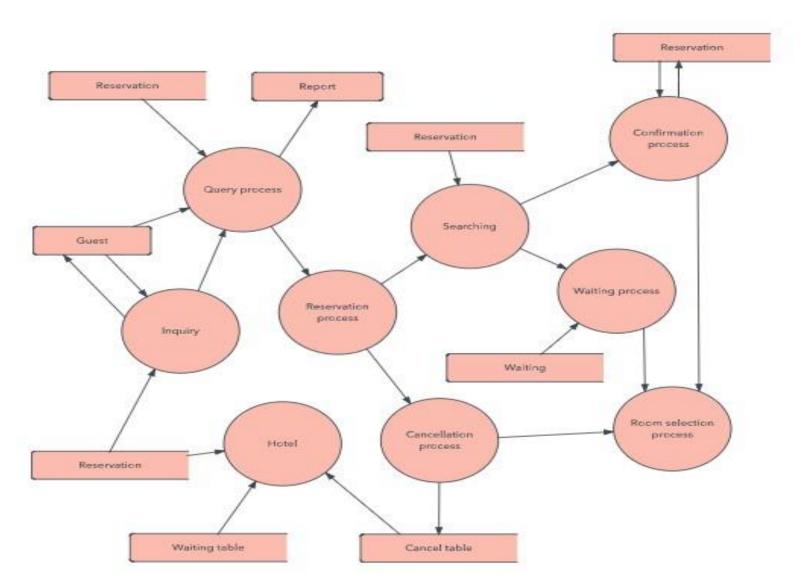
DFD-1

DFD-1

1-LEVEL DFD

DFD-1

Fig: Level-1 DFD of result management system

DFD-2

2-level DFD goes one step deeper into parts of 1-level DFD. It can be used to plan or record the specific/necessary detail about the system's functioning.
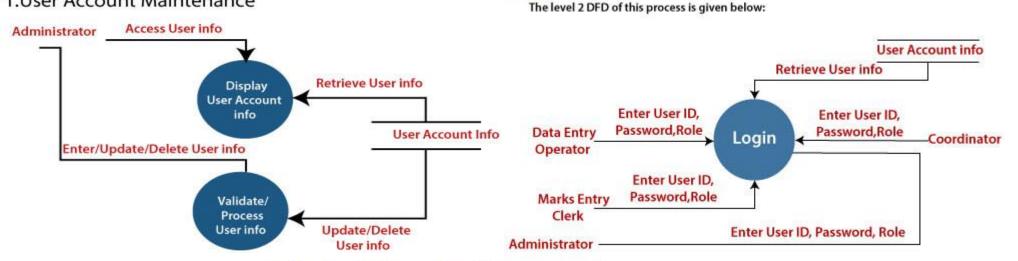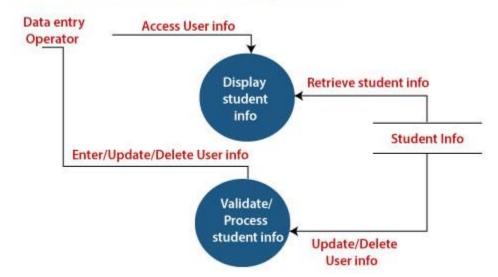
DFD-2

2-LEVEL DFD

DFD-2

DFD-2, Result Management System

DFD-2
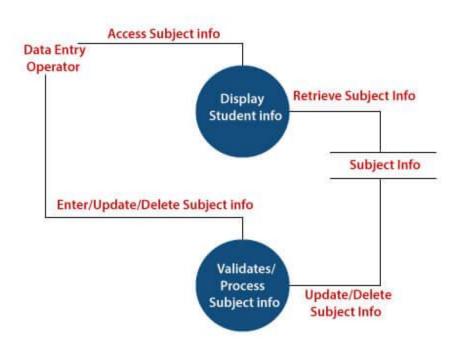
4. Subject Information Management

The level 2 DFD of this process is given below:

Data Entry Operator

Access Subject info

Display Student info

Retrieve Subject Info

Subject Info

Enter/Update/Delete Subject info

Validates/ Process Subject info

Update/Delete Subject Info
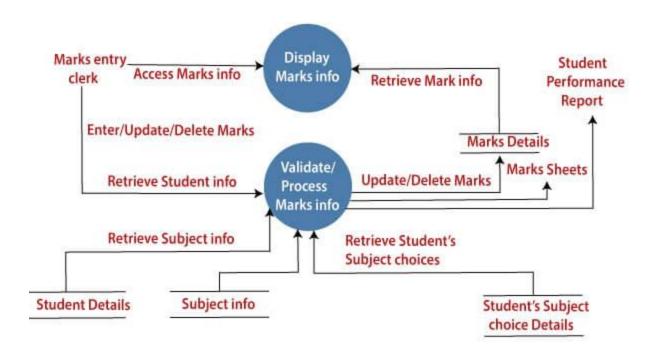
5. Student's Subject Choice Management

The Level 2 DFD of this Process is given below:

Subject info

Retrieve Subject Info

Data Entry Operator

Access Subject Details

Display Subject Choices

Student info

Access Student Details

Display Student Details

Retrieve Student info

Enter/Update/Delete Student's choices of Subject

Validate/ Process student's Subject Choices

Update/Delete Choices

Student Report Generated

Student's Subject Choice Details

DFD-2

6. Marks Information Managment

The Level 2 DFD of this Process is given below:

Marks entry clerk — Access Marks info → Display Marks info ← Retrieve Mark info — Student Performance Report

Enter/Update/Delete Marks

Marks Details

Retrieve Student info → Validate/Process Marks info — Update/Delete Marks → Marks Sheets

Retrieve Subject info

Retrieve Student's Subject choices

Student Details

Subject info

Student's Subject choice Details

DFD 3, 4

❑ Progression to Levels 3, 4 and beyond is possible, but going beyond Level 3 is uncommon.

❑ Doing so can create complexity that makes it difficult to communicate, compare or model effectively.

Developing/Creating Data Flow Diagrams

Steps:

1. Create a list of activities

2. Construct Context Level/Level 0 DFD
   (identifies external entities and processes)

3. Construct Level 1 DFD
   (identifies manageable sub process)

4. Construct Level 2- n DFD
   (identifies actual data flows and data stores)

5. Check against rules of DFD

DFD Naming Guidelines

- External Entity → Noun

- Data Flow → Names of data

- Process → verb phrase

  - a system name

  - a subsystem name

- Data Store → Noun

Developing/Creating Data Flow Diagrams

Lemonade Stand Example

Creating Data Flow Diagrams

Example

The operations of a simple lemonade stand will be used to demonstrate the creation of dataflow diagrams.

Steps:

1. Create a list of activities

   • Old way: no Use-Case Diagram

   • New way: use Use-Case Diagram

2. Construct Context Level/Level 0 DFD (identifies sources and sink)

3. Construct Level 1 DFD (identifies manageable sub processes)

4. Construct Level 2- n DFD (identifies actual data flows and data stores)

Creating Data Flow Diagrams

Example

Think through the activities that take place at a lemonade stand.

1. Create a list of activities

   Customer Order
   Serve Product
   Collect Payment
   Produce Product
   Store Product

Creating Data Flow Diagrams

Example

Also think of the additional activities needed to support the basic activities.

1. Create a list of activities

   Customer Order
   Serve Product
   Collect Payment
   Produce Product
   Store Product
   Order Raw Materials
   Pay for Raw Materials
   Pay for Labor

Creating Data Flow Diagrams

Example

Group these activities in some logical fashion, possibly functional areas.

1. Create a list of activities

   Customer Order
   Serve Product
   Collect Payment

   Produce Product
   Store Product

   Order Raw Materials
   Pay for Raw Materials

   Pay for Labor

Creating Data Flow Diagrams

Example

Create a context level diagram identifying the sources and sinks (users).

Customer Order
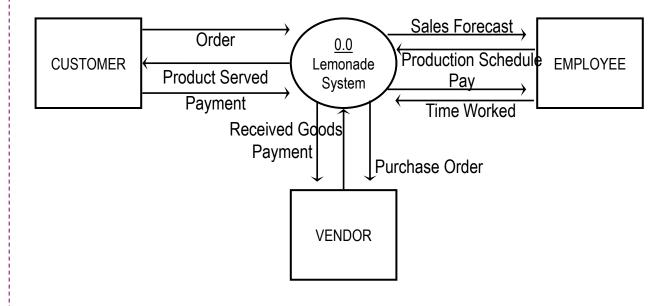Serve Product
Collect Payment

Produce Product
Store Product

Order Raw Materials
Pay for Raw Materials

Pay for Labor

2. Construct Context Level/Level 0 DFD (identifies sources and sink)

Context Level DFD

Creating Data Flow Diagrams

Example

Create a level 0 diagram identifying the logical subsystems that may exist.

Customer Order
Serve Product
Collect Payment

Produce Product
Store Product

Order Raw Materials
Pay for Raw Materials

Pay for Labor

3. Construct Level 1 DFD
   (identifies manageable sub processes)

Level 1 DFD

Creating Data Flow Diagrams

Example

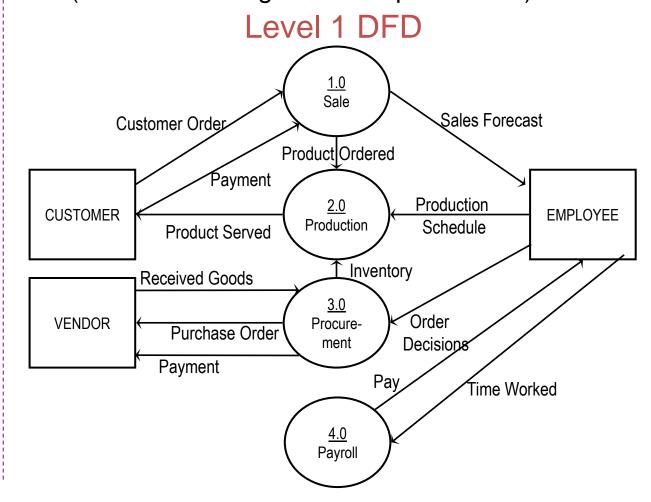Create a level 1 decomposing the processes in level 0 and identifying data stores.

Customer Order
Serve Product
Collect Payment

Produce Product
Store Product

Order Raw Materials
Pay for Raw Materials

Pay for Labor

4. Construct Level 2- n DFD
    (identifies actual data flows and data stores)

Level 2 DFD

- Customer Order
- CUSTOMER
- ORDER
- 1.1 Record Order
- Request for Forecast
- 1.3 Produce Sales Forecast
- Severed Order
- Sales Forecast
- Payment
- 1.2 Receive Payment
- PAYMENT

Creating Data Flow Diagrams

Example

Create a level 1 decomposing the processes in level 0 and identifying data stores.

Customer Order
Serve Product
Collect Payment

Produce Product
Store Product

Order Raw Materials
Pay for Raw Materials

Pay for Labor

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4. Construct Level 2 (continued)

Level 2 DFD

Product Order

ORDER

2.1
Serve
Product

Quantity Severed

Production
Schedule

RAW MATERIALS

2.2
Produce
Product

Quantity Used

INVENTORTY

Production   Data

2.3
Store
Product

Quantity Produced &
Location Stored

Creating Data Flow Diagrams

Example

Create a level 1 decomposing the processes in level 0 and identifying data stores.

Customer Order
Serve Product
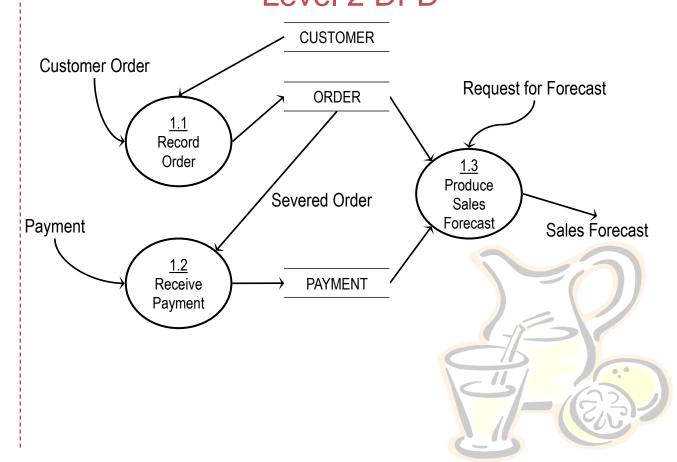Collect Payment

Produce Product
Store Product

Order Raw Materials
Pay for Raw Materials

Pay for Labor

4. Construct Level 2 (continued)

Level 2 DFD

Creating Data Flow Diagrams

Example

Create a level 1 decomposing the processes in level 0 and identifying data stores.

Customer Order
Serve Product
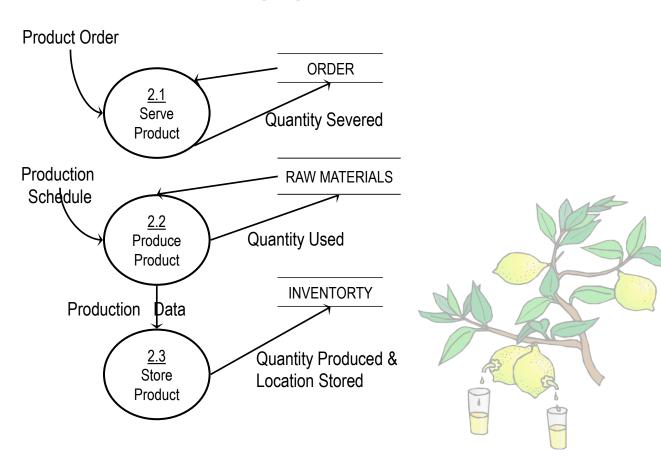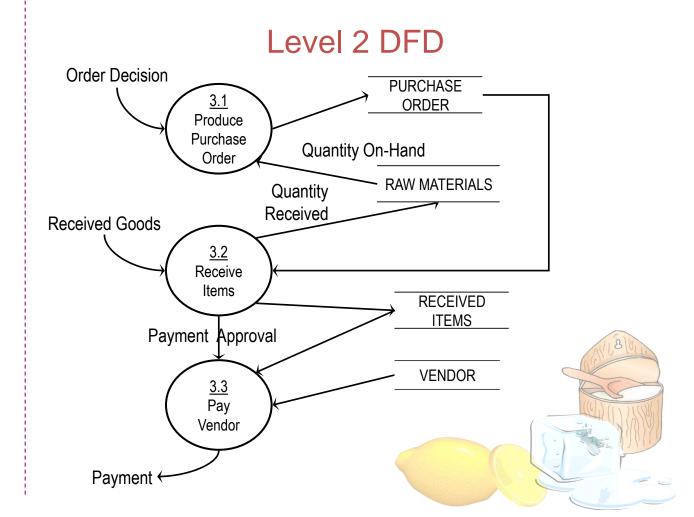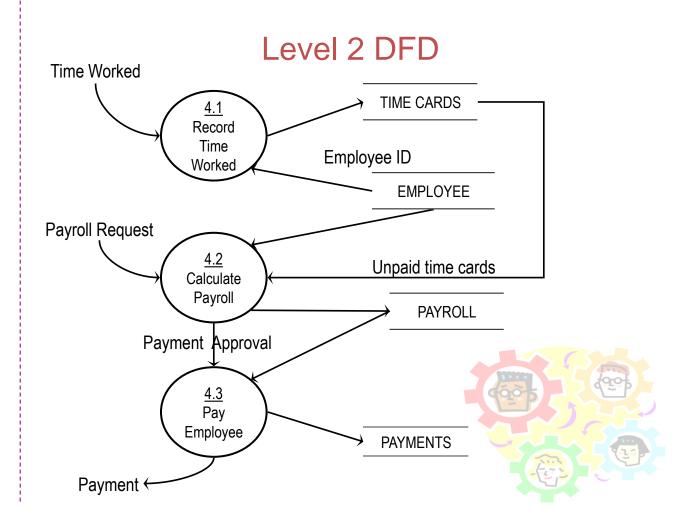Collect Payment

Produce Product
Store Product

Order Raw Materials
Pay for Raw Materials

Pay for Labor

4. Construct Level 2 (continued)

Level 2 DFD

Time Worked → 4.1 Record Time Worked → TIME CARDS

EMPLOYEE → Employee ID → 4.1 Record Time Worked

Payroll Request → 4.2 Calculate Payroll

Unpaid time cards → 4.2 Calculate Payroll

4.2 Calculate Payroll → PAYROLL

4.2 Calculate Payroll → Payment Approval → 4.3 Pay Employee

PAYROLL → 4.3 Pay Employee

4.3 Pay Employee → PAYMENTS

4.3 Pay Employee → Payment

Process Decomposition

| Context Level/Level 0 | Level 1 | Level 2 |

Context Level/Level 0 (0.0 Lemonade System)

Level 1:
- 1.0 Sale
- 2.0 Production
- 3.0 Procurement
- 4.0 Payroll

Level 2:
- 1.1 Record Order
- 1.2 Receive Payment
- 2.1 Serve Product
- 2.2 Produce Product
- 2.3 Store Product
- 3.1 Produce Purchase Order
- 3.2 Receive Items
- 3.3 Pay Vendor
- 4.1 Record Time Worked
- 4.2 Calculate Payroll
- 4.3 Pay Employee

Advantages of DFDs

– Simple graphical techniques which are easy to understand

– Helps define the boundaries of the system

– Useful for communicating current system knowledge to users

– Explains the logic behind the data flow within the system

– Used as the part of system documentation file

References

1. **System Analysis and Design,** by Elias M. Awad
2. **Systems Analysis and Design,** Kendall and Kendall, Fifth Edition
3. **Management Information Systems: Managing the Digital Firm** (11th edition), Pearson/Prentice-Hall
4. https://www.visual-paradigm.com/tutorials/data-flow-diagram-example-supermarket-app.jsp