Data Flow Diagrams

" *Talent hits the target no one else can hit;*
genius hits the target no one else can see

– Arthur Schopenhauer

At the end of this session you will be able to …

- ✧ Know the difference between Context Diagrams, Level 0 and Data Flow Diagrams

- ✧ Critique Context Diagrams

- ✧ Create level 0 Data Flow Diagrams

- ✧ Move between logical and physical DFDs

- ✧ Create an Event – Response Table

- ✧ Explain how Data Dictionaries relate to DFDs.

Analyst hat:
Where are we in the SDLC?

✧ Specification

  ▪ Identify Problem

  ▪ Gather requirements

  ▪ **Analyze & Model requirements**

  ▪ Select architecture/COTS

✧ Design and implementation

✧ Validation

✧ Evolution
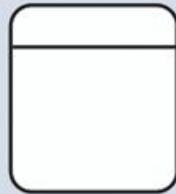
Context Diagrams Vs. DFD.

Data Flow Diagram Symbols

| Symbol	Name	Description
	Process	Step-by-step instructions are followed that transform inputs into outputs (a computer or person or both doing the work).
→	**Data flow**	Data flowing from place to place, such as an input or output to a process.
	External agent	The source or destination of data outside the system.
	Real-time link	Communication back and forth between an external agent and a process as the process is executing (e.g., credit card verification).

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Layers of DFD Abstraction for *Course Registration* System
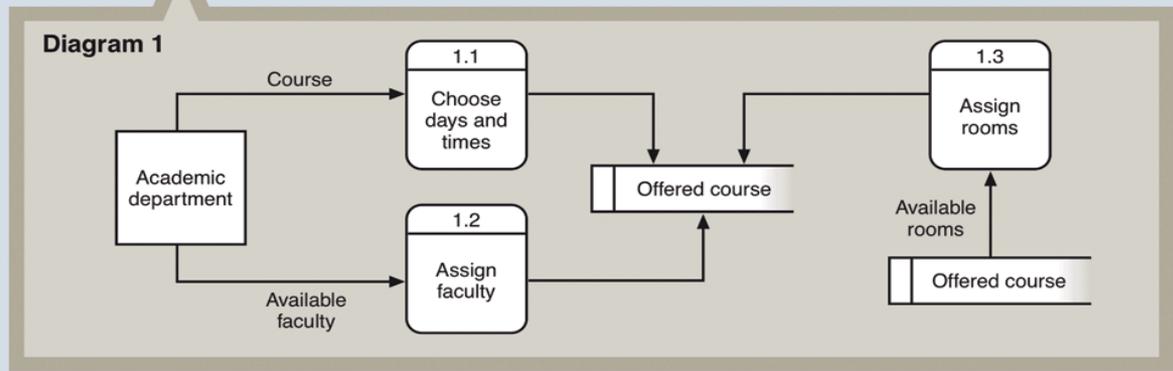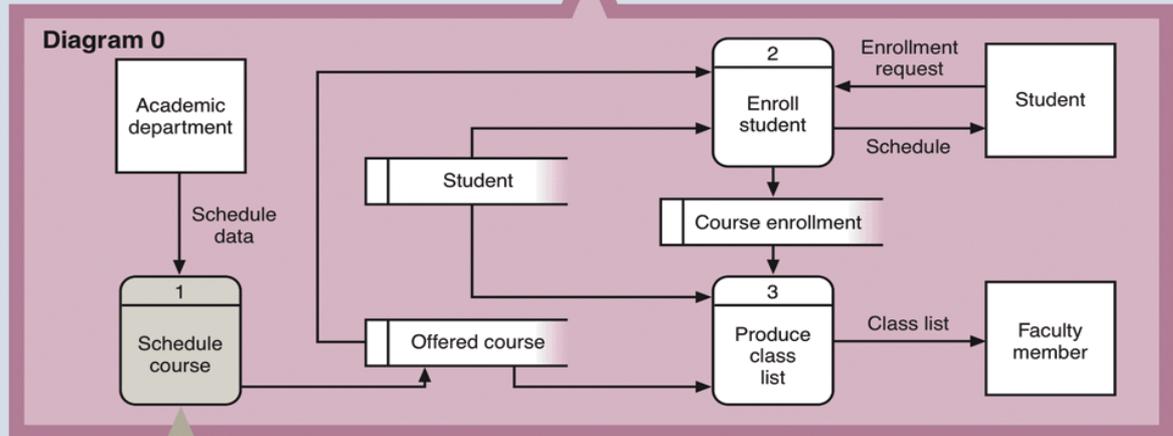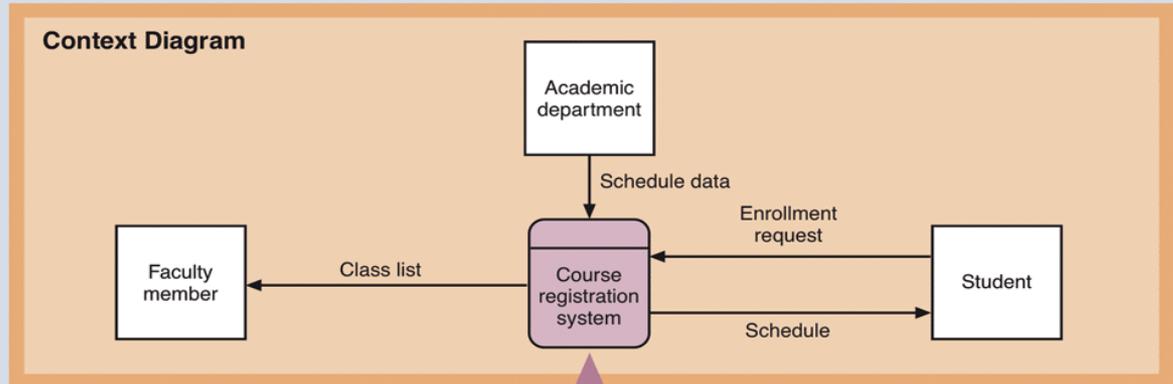
Difference between Context Diagram and Data Flow Diagram

◇ **Context diagram is a type of data flow diagram**. But each is used at **different level of abstraction**.

◇ The context diagram is used to show part of the scope of a project or a solution.

◇ If the context diagram shows that there is a report that needs to be produced by the solution for the HR department, the data flow diagram will use the added "Data process" element to show:

- where the data comes from,
- how this data is transformed to produce the report
- and where the data and the report are stored.

The Process

1. Make a list of "business" activities.

2. Create the context level diagram, including all external entities and the major data flow to or from them.

3. Create Diagram 0 by analyzing the major activities within the context process. Include the external entities and major data stores.

4. Create a child diagram for each complex process on Diagram 0. Include local data stores and detailed processes.

5. Check for errors and make sure labels for processes and data stores are meaningful.

Diagram 0 example
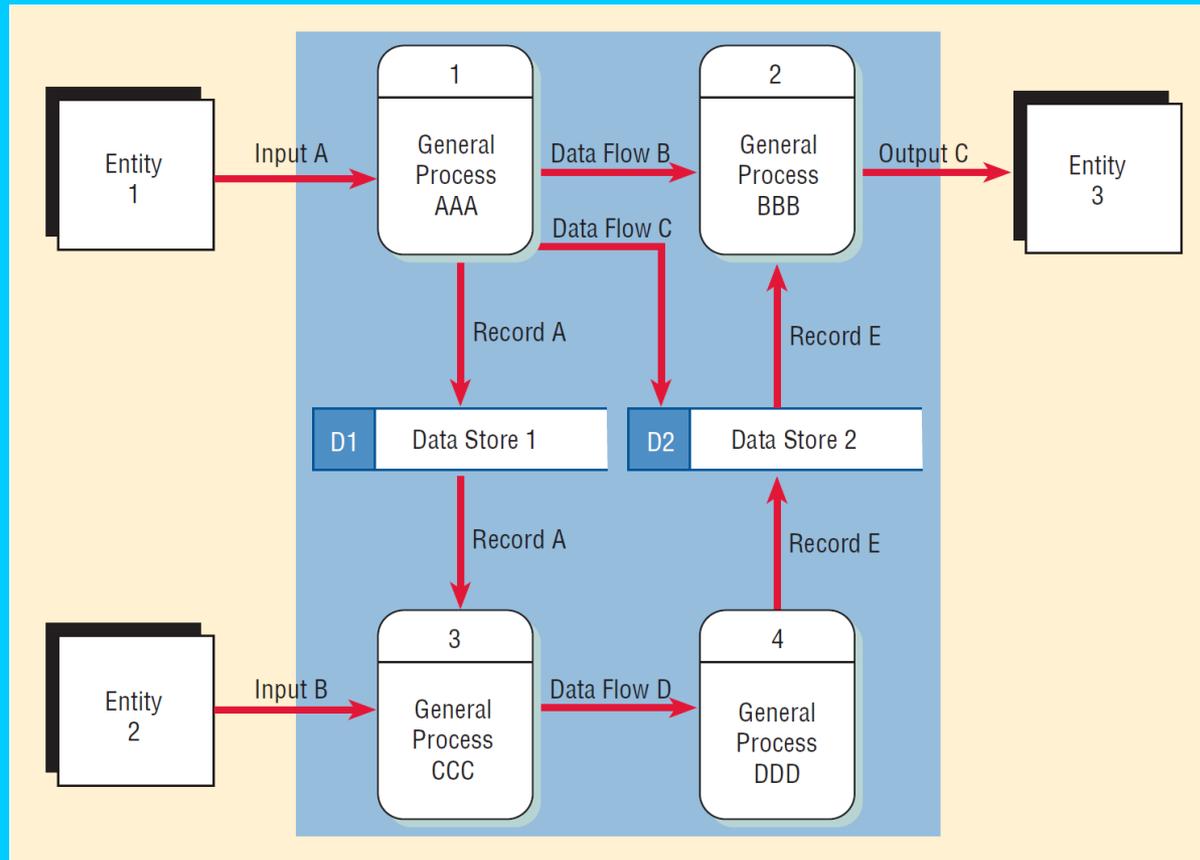
Child Diagram example
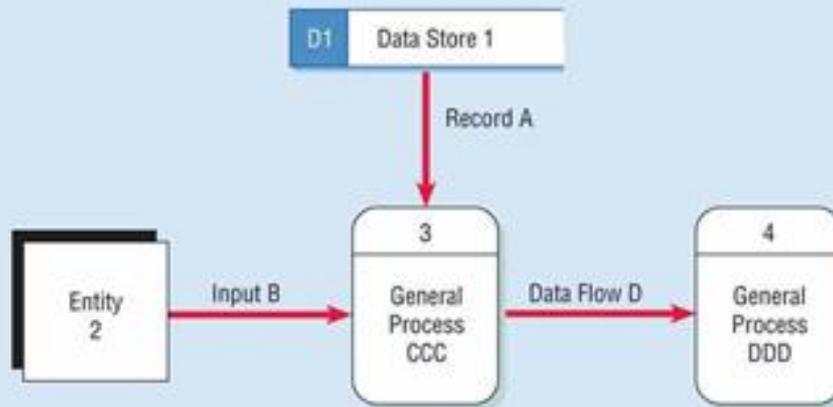
Checking DFD for errors

Evaluating DFD Quality

✧ Readable

✧ Internally consistent and balanced

✧ Accurately represents system requirements

✧ Reduces information overload – rule of 7 +/- 2

  ▪ Single DFD should not have more than 7 +/-2 processes

  ▪ No more than 7 +/- 2 data flows should enter or leave a process or data store in a single DFD

✧ Minimizes required number of interfaces

Data Flow Consistency Problems

Unbalanced DFDs are caused by

✧ Differences in data flow content between a process and its decomposition

✧ Data outflows without corresponding inflows

✧ Data inflows without corresponding outflows

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Black Hole and Miracle

✧ **black hole**, i.e. a process with data input that is never used to produce data output. The following rules help to avoid the black holes:

  ▪ All data that flow into a process must flow out of the process or be used to generated data that flow out of the process

✧ **Miracle -** a process with a data output that is created out of nothing ("miraculously appears")

  ▪ All data that flow out of a process must have flowed into the process or have been generated from data that flowed into the process

17
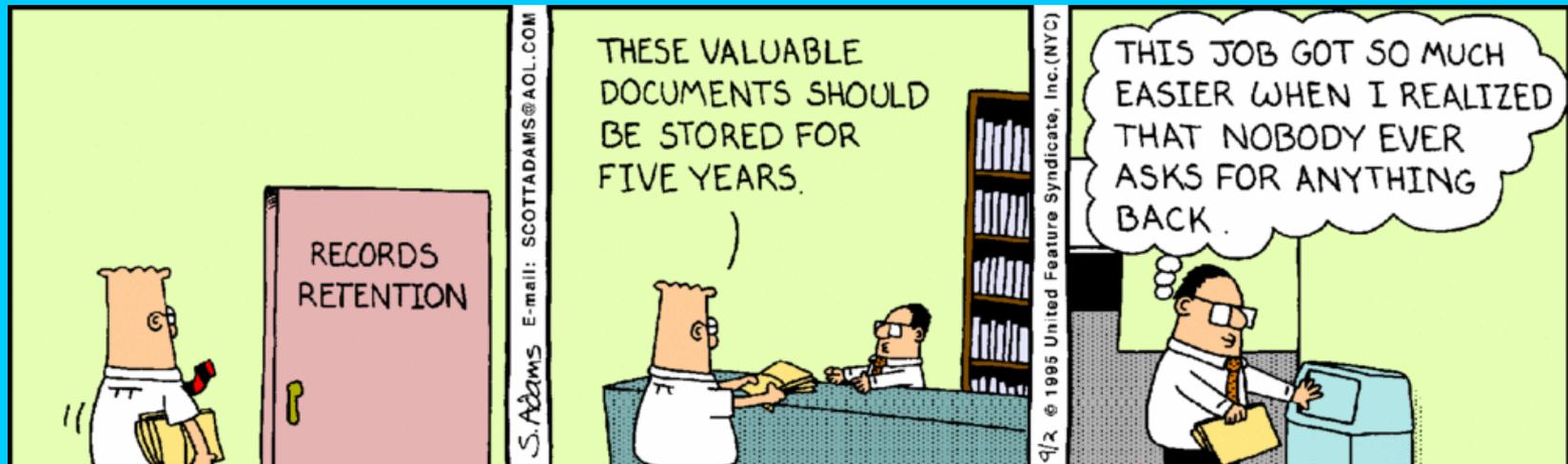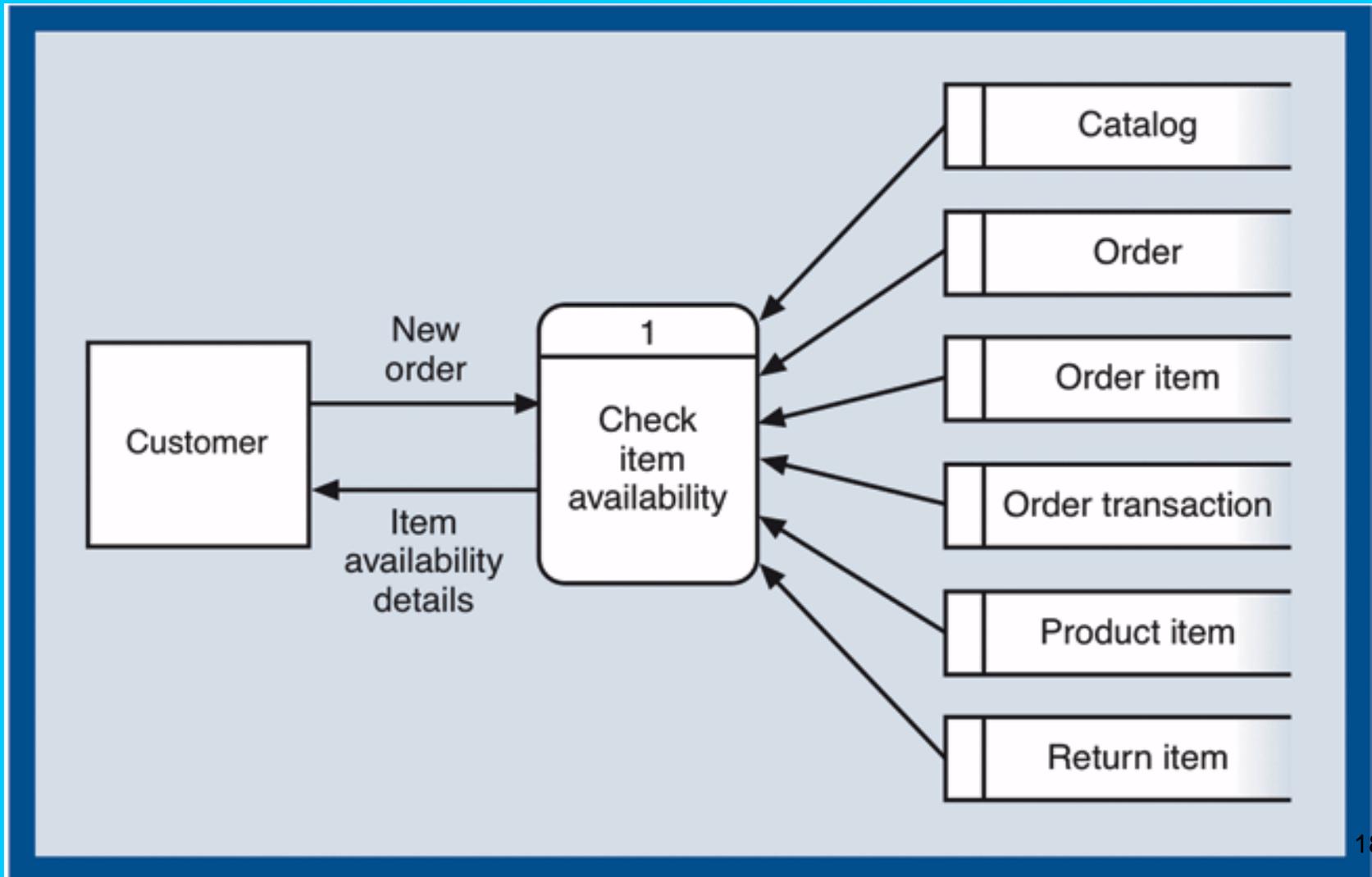
Process with Impossible Data Output: a Miracle

Compute X

A,B,C,X → Compute X → X

Process description

If A>5 Then
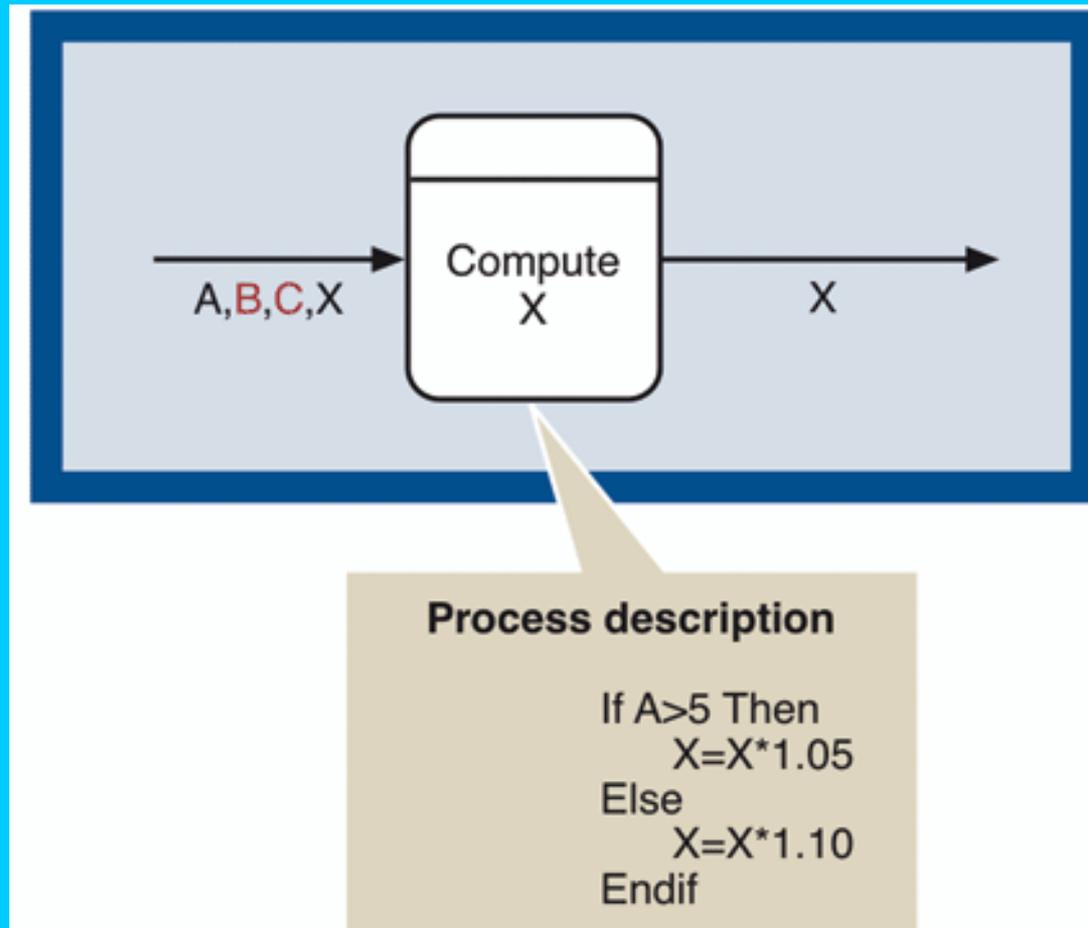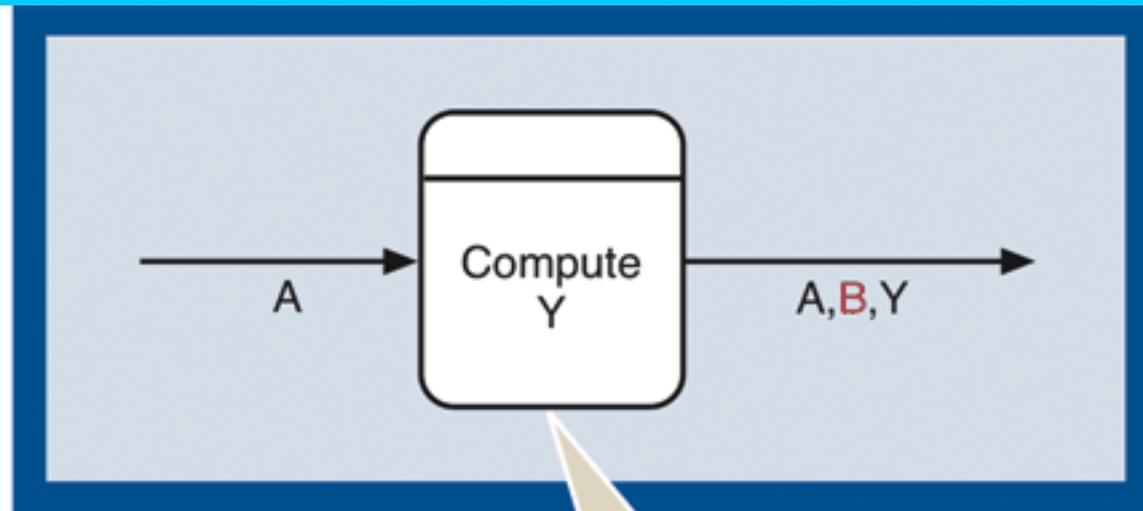   X=X*1.05
Else
    X=X*1.10
Endif

Process description

If A>5 Then
    Y=100
Else
    Y=250
Endif

Simple DFD mistakes
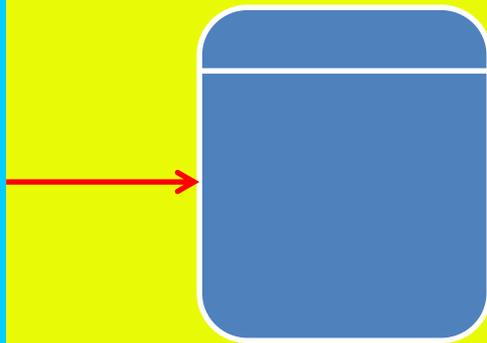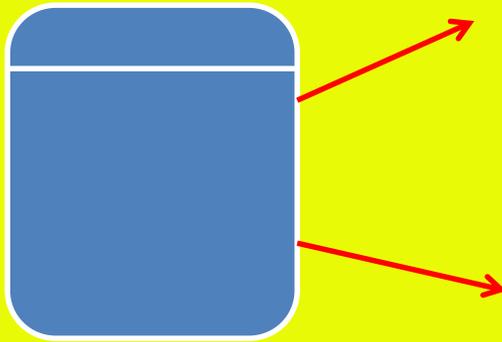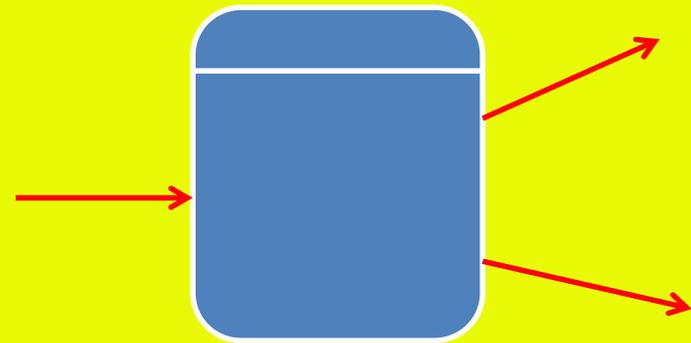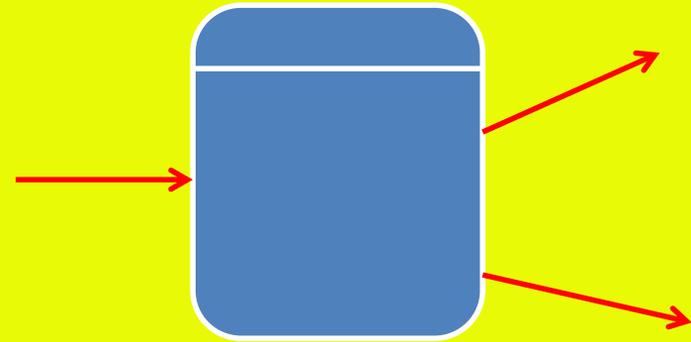
Common DFD mistakes

Table 2: Common data flow diagramming mistakes

Wrong	Right	Description
		A source or a sink cannot provide data to another source or sink without some processing occurring.
		Data cannot move directly from a source to a data store without being processed.
		Data cannot move directly from a data store to a sink without being processed.
		Data cannot move directly from one data store to another without being processed.

Source: Adapted from Figure 9.9, p. 360 in Whitten, J. L.; Bentley, L. D.; Barlow, V. M. (1994). Systems Analysis and Design Methods (Third Edition). Burr Ridge, IL: Irwin.

Other DFD mistakes
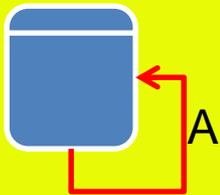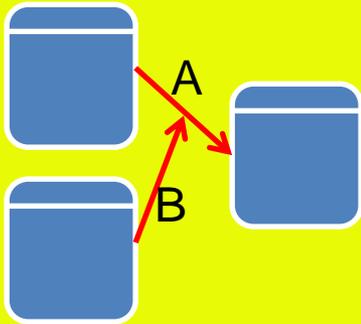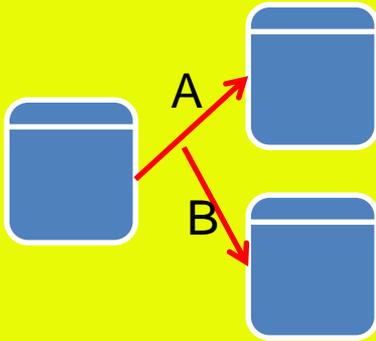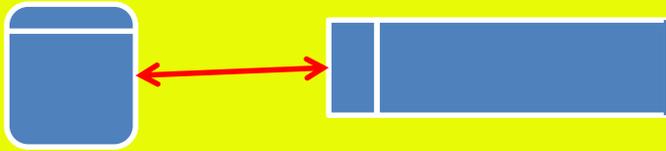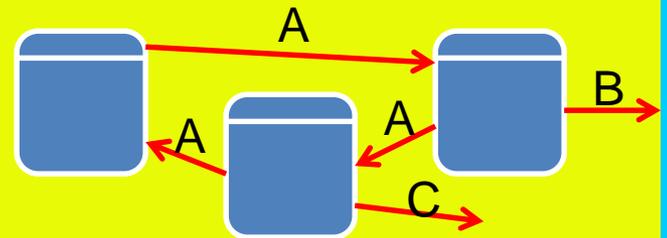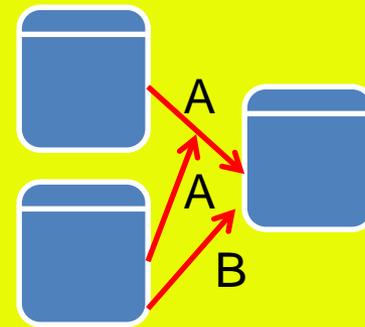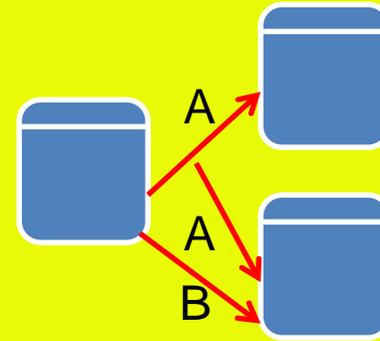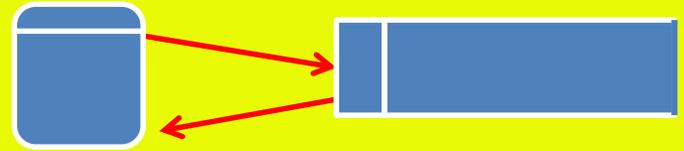
Typical errors that can occur in a data flow diagram
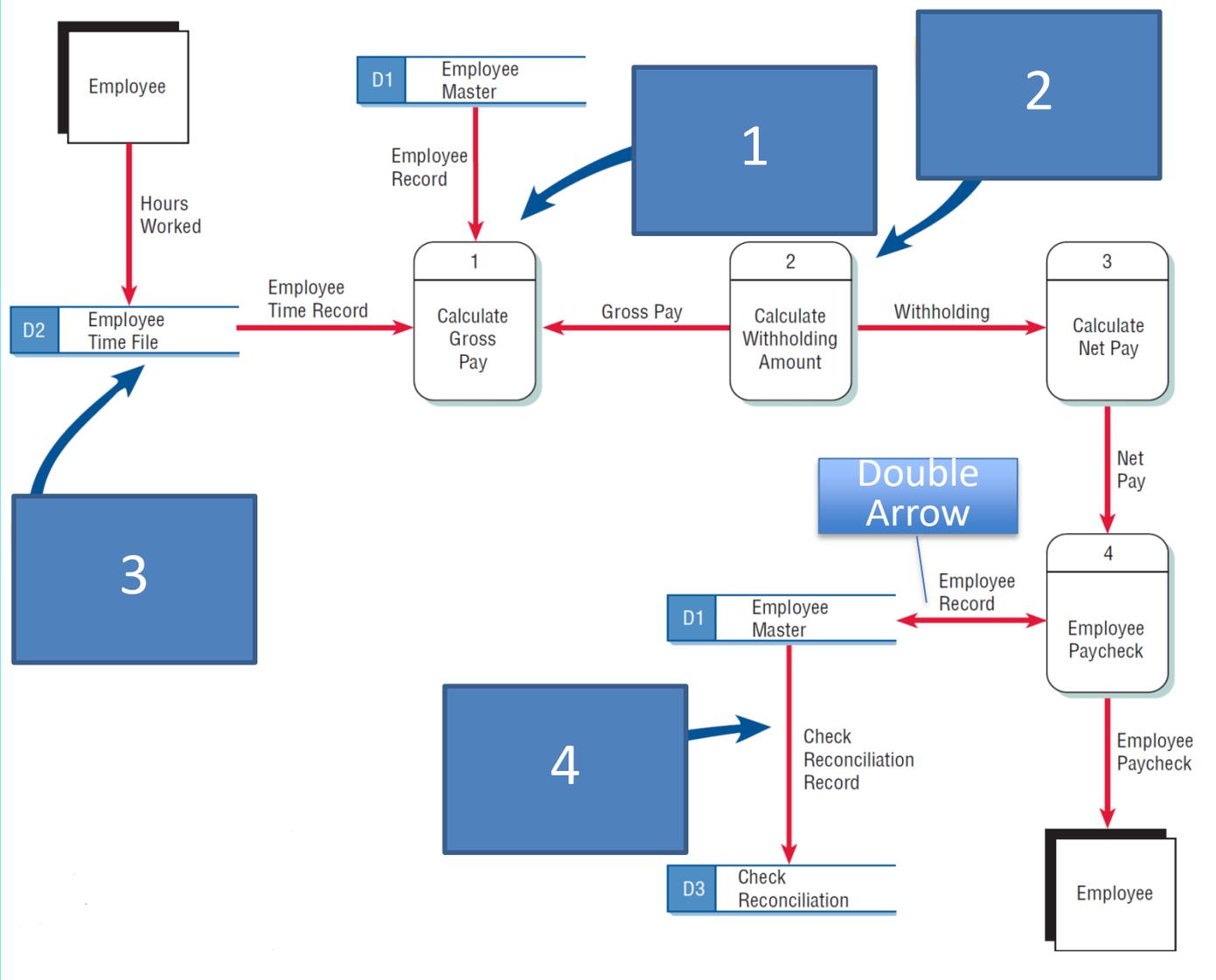
Exercise 1 – create the context diagram

✧ On the next slide

✧ Look for the nouns in the narrative.

✧ Look for adjectives attached to these nouns in the narrative.

✧ Summarize the business activities obtained from interviews with the owners of FilmMagic.

1). The customer rents video rental items by presenting the clerk with his or her video rental card along with the rental items (DVDs or video games) to be rented. The rental card contains the customer ID. The customer also gives the clerk some method of payment.

2. Info about the video is retrieved from the system and the inventory is updated.

3. The clerk completes the transaction and gives the customer a printed receipt. The customer record is updated.

4).Information about rental and payment are summarized into management reports and sent to management on a monthly basis.

5). A summarized report on day's monetary transactions is sent to accounting daily.

6). When a customer who is not yet in the system is added, a video rental card containing the customer ID is issued. When customer returns video, the customer record and the inventory are updated to show that the video has been returned.

7). Once a month a bonus letter is produced, and, if the customer records show that a customer's rentals are greater than or equal to the bonus level of 50.00, customers received a bonus letter thanking them for their business as well as issuing them several free rental coupons (depending on the total amount of rental for the month).

8). Once a year the customer records are examined for customers who have rented more than a yearly bonus level (currently 250.00). A letter, rental coupons, and a certificate for a free video (if the customer has rented over two times the bonus level) are sent to the customer.

Context Diagram

```
┌──────────────┐                                              ┌──────────────┐
│    Video     │                                              │              │
│   Purchase   │    Video Information      Management Reports  │  Management  │
│    System    │◄─────────────────────────────────────────────►│              │
└──────────────┘                                              └──────────────┘


           New Customer info
┌──────────────┐                          ┌──────────────┐
│              │                          │      0       │    Rental Receipt   ┌──────────────┐
│              │    Video Rental Item     ├──────────────┤───────────────────► │              │
│   Customer   │─────────────────────────►│              │    Video Rental Card│              │
│              │                          │              │───────────────────► │   Customer   │
│              │    Customer ID           │    Video     │    Monthly Bonus Letter│          │
│              │─────────────────────────►│   Rental     │───────────────────► │              │
│              │                          │   System     │    Yearly Bonus Letter│            │
│              │    Payment               │              │───────────────────► └──────────────┘
│              │─────────────────────────►│              │
└──────────────┘                          └──────────────┘
    Returned Video Info                           │
                                                  │    Total Cash Received   ┌──────────────┐
                                                  └─────────────────────────►│  Accounting  │
                                                                             └──────────────┘
```
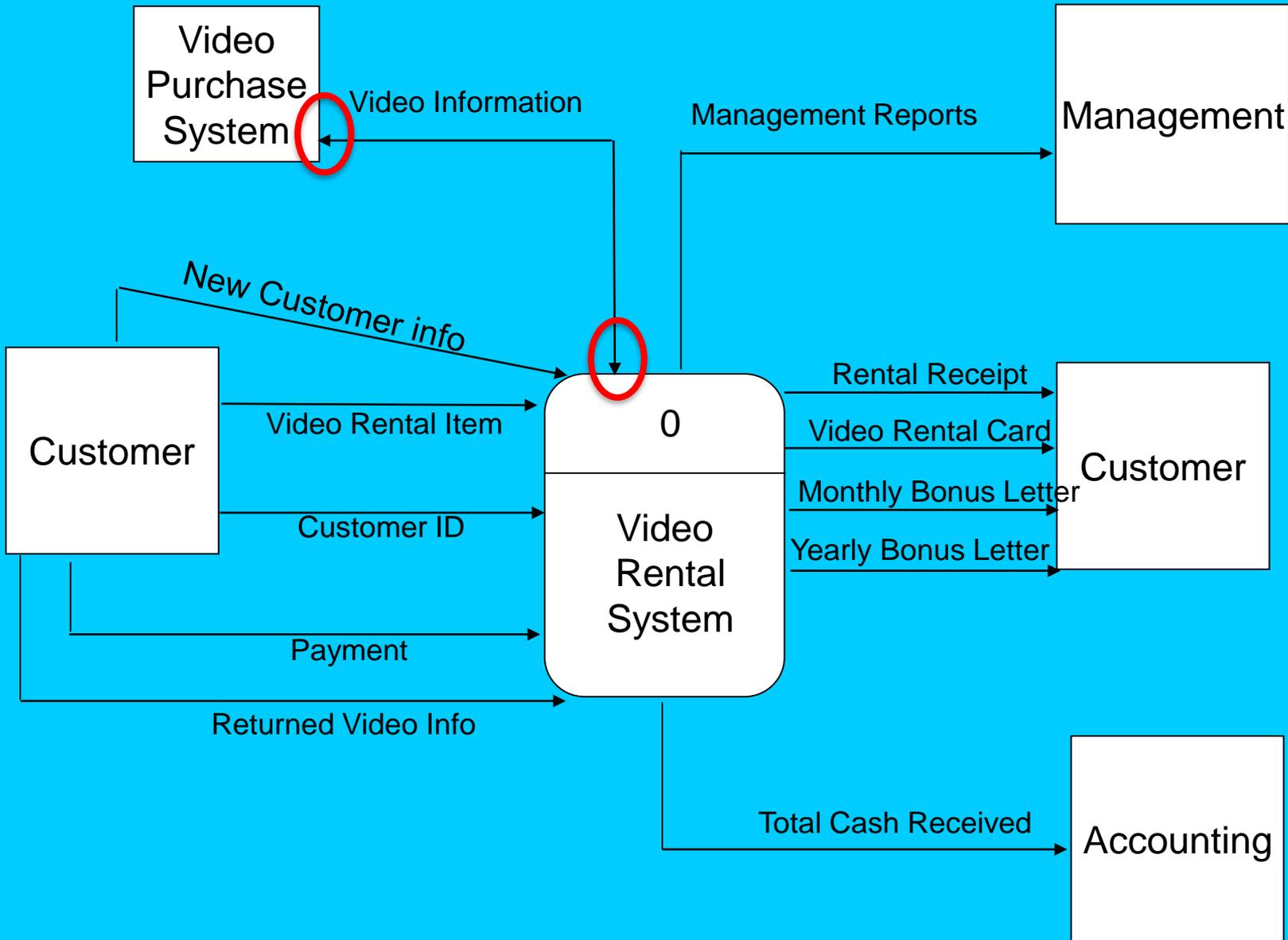
Note that the context diagram is relatively simple

Drawing Diagram 0

✧ Avoid the explosion of the context diagram

✧ May include up to nine processes

✧ Each process is numbered

✧ Major data stores and all external entities are included

Drawing Diagram 0

✧ Start with the data flow from an entity on the input side

✧ Work backwards from an output data flow

✧ Examine the data flow to or from a data store

✧ Analyze a well-defined process

✧ Take note of any fuzzy areas

Level 1

⬦ Questions:

1). What are the verbs in the narrative?

2). Where do they occur in the narrative?

3). Can you group any of these verbs together to form a process?

4). Are there any data repositories identified in the narrative?

5). If yes, what person/process gets or gives data to the repository?

1). The customer rents video rental items by presenting the clerk with his or her video rental card along with the rental items (DVDs or video games) to be rented. The rental card contains the customer ID. The customer also gives the clerk some method of payment.

2. Info about the video is retrieved from the system and the inventory is updated.

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Level 1
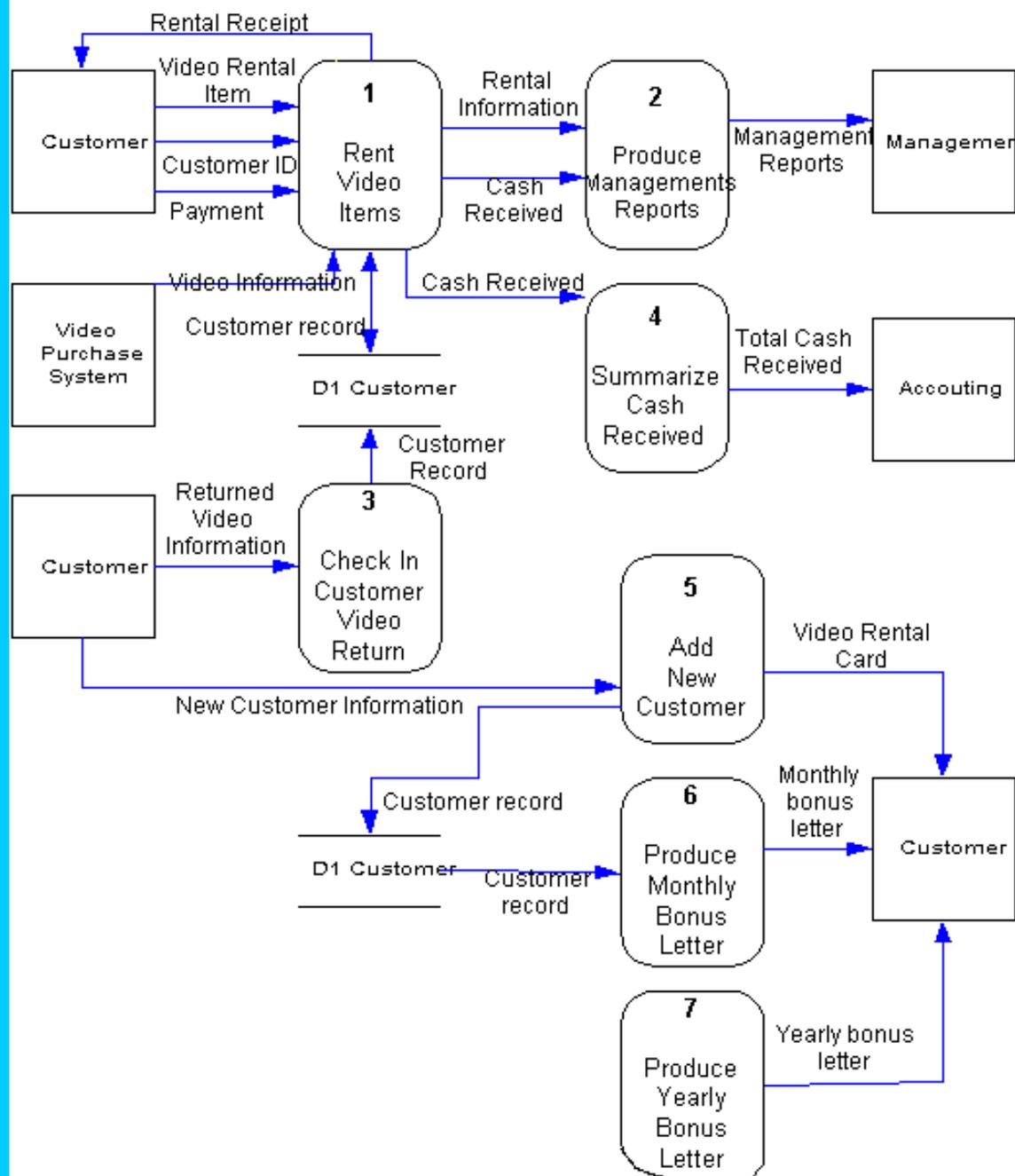
1-Level Diagram for the FilmMagic video rental system shows seven major processes

✧ To correctly draw the data flow diagram, questions must be asked such as, "What information is needed to rent a video?"

▪ A VIDEO RENTAL ITEM (which may be either a video cassette or a video game),

▪ a PAYMENT, and

▪ a CUSTOMER ID (a rental card) are required from the CUSTOMER.
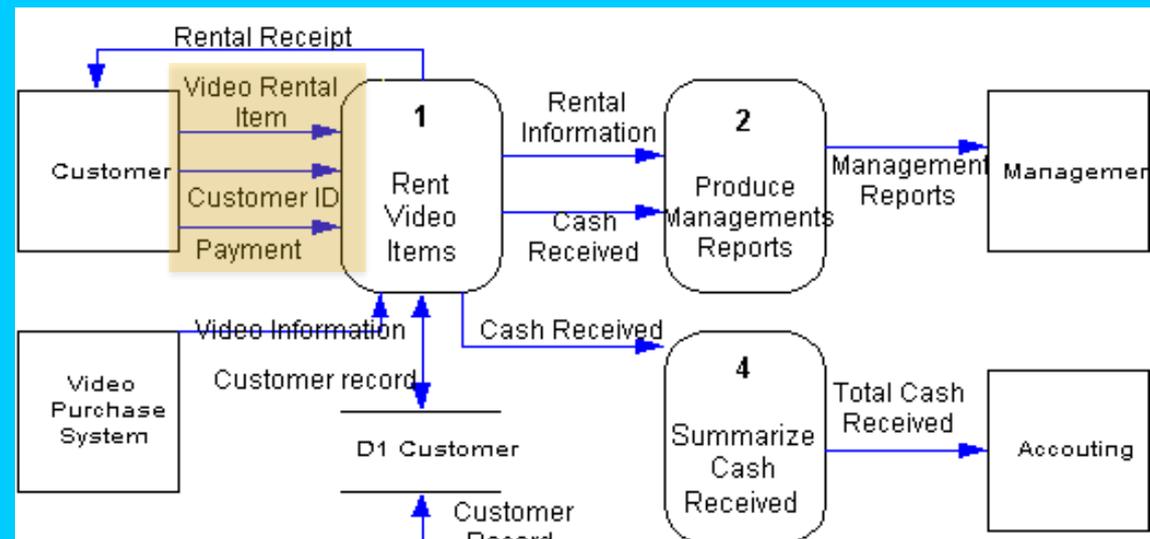
Level 1
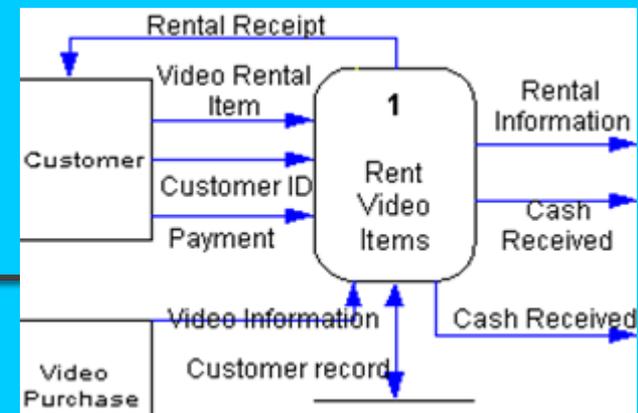
✧ The VIDEO RENTAL ITEM is used to find matching information about the video, such as the price and description.

✧ The process creates a CASH TRANSACTION, that will eventually produce information about the total cash received.

✧ The CUSTOMER RECORD is obtained and updated with the total amount of the rental.

  ▪ A double-headed arrow indicates that the CUSTOMER RECORD is obtained from and replaced in the same file location. We should probably fix that.

Level 1
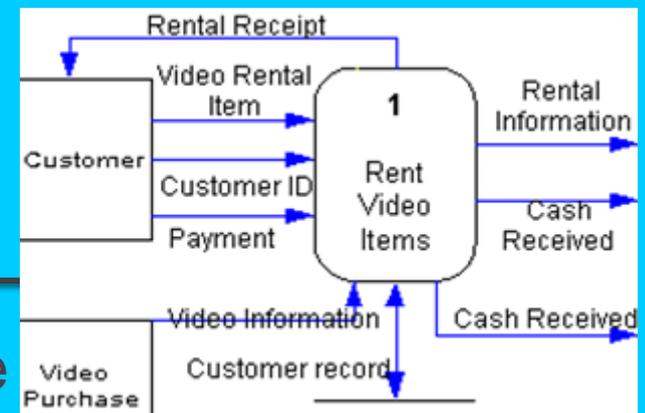
✧ the RENTAL RECEIPT and video are given to the CUSTOMER .

✧ RENTAL INFORMATION such as the date and the item rented is produced for later use to generate MANAGEMENT REPORTS.

✧ The other processes are simpler, with less input and output.

- Process 3, CHECK IN CUSTOMER VIDEO RETURN, updates the CUSTOMER data store indicating that items are no longer checked out.

- New customers must be added to the CUSTOMER data store before a video may be checked out.

Level 1

◇ **Processes 2 and 4** produce useful information **to manage the business** and make decisions, such as

- **when to lower the price** of videos that are in demand and

- **when to advertise** to draw more customers, thereby increasing cash flow.
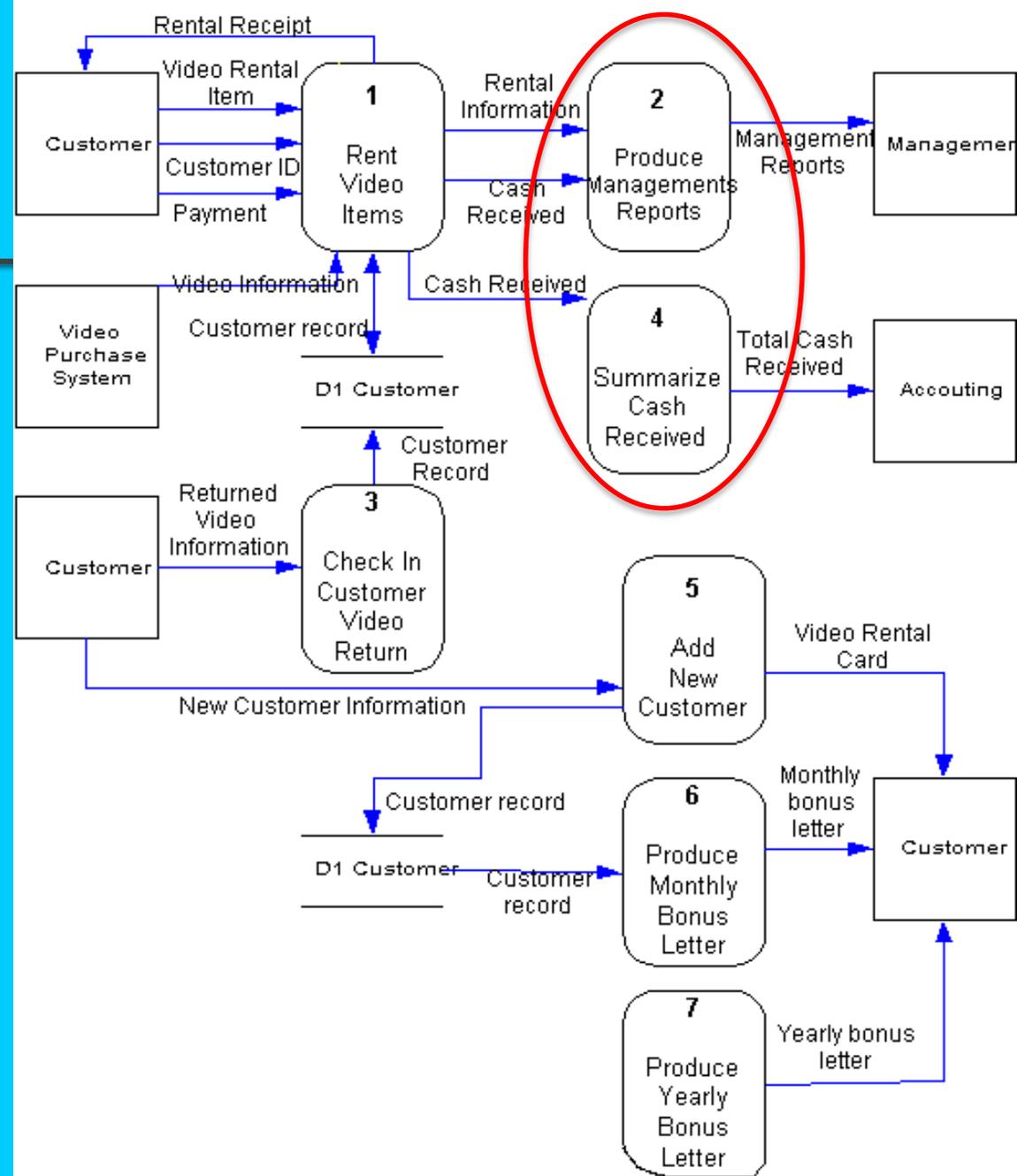
1-Level Diagram for the FilmMagic video rental system shows seven major processes

Level 1

1-Level Diagram for the FilmMagic video rental system shows seven major processes

✧ **Process 5, ADD NEW CUSTOMER**, takes NEW CUSTOMER INFORMATION and issues the customer a VIDEO RENTAL CARD.

- The card must be presented each time a customer wishes to check out a video.
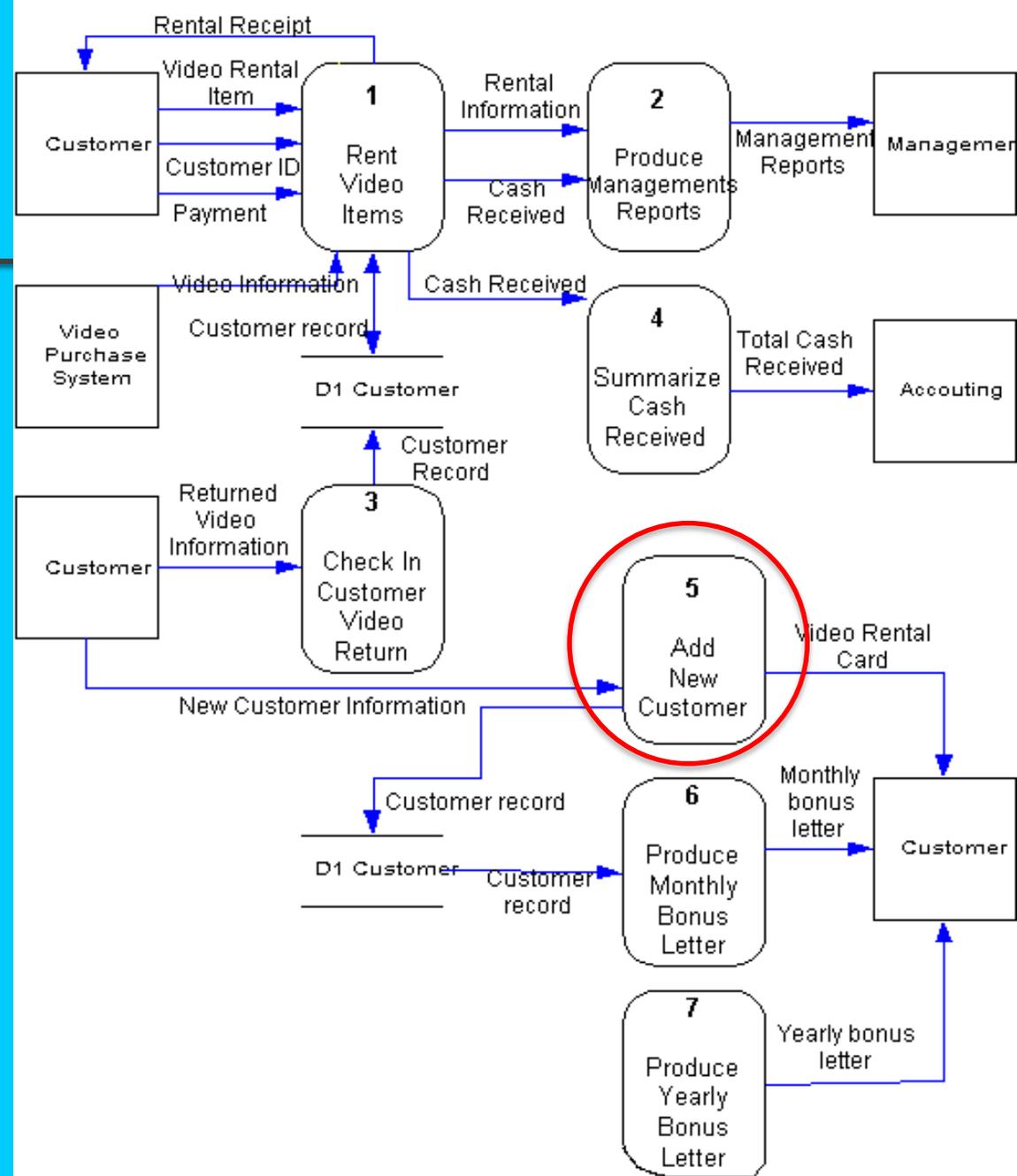
Level 1

✧ **Processes 6 and 7** use CUSTOMER data store information to PRODUCE MONTHLY and YEARLY CUSTOEMR BONUS LETTERS.
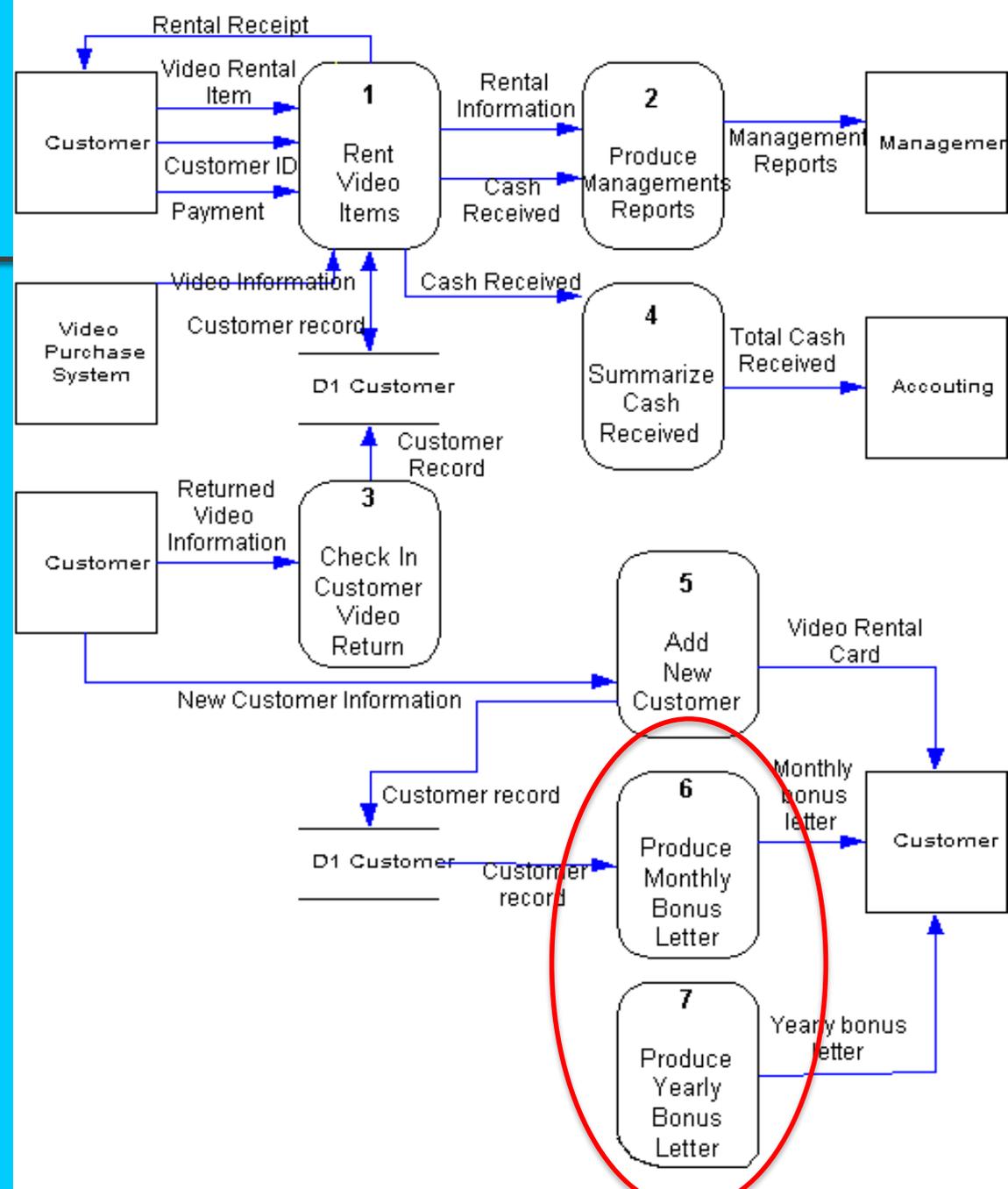
1-Level Diagram for the FilmMagic video rental system shows seven major processes

Level 1

 ✧ Notice that the names of the data flows going into and out of the processes are different, indicating that something has transformed input data to produce output.

 ✧ All processes start with a verb such as RENT, PRODUCE, or ADD.
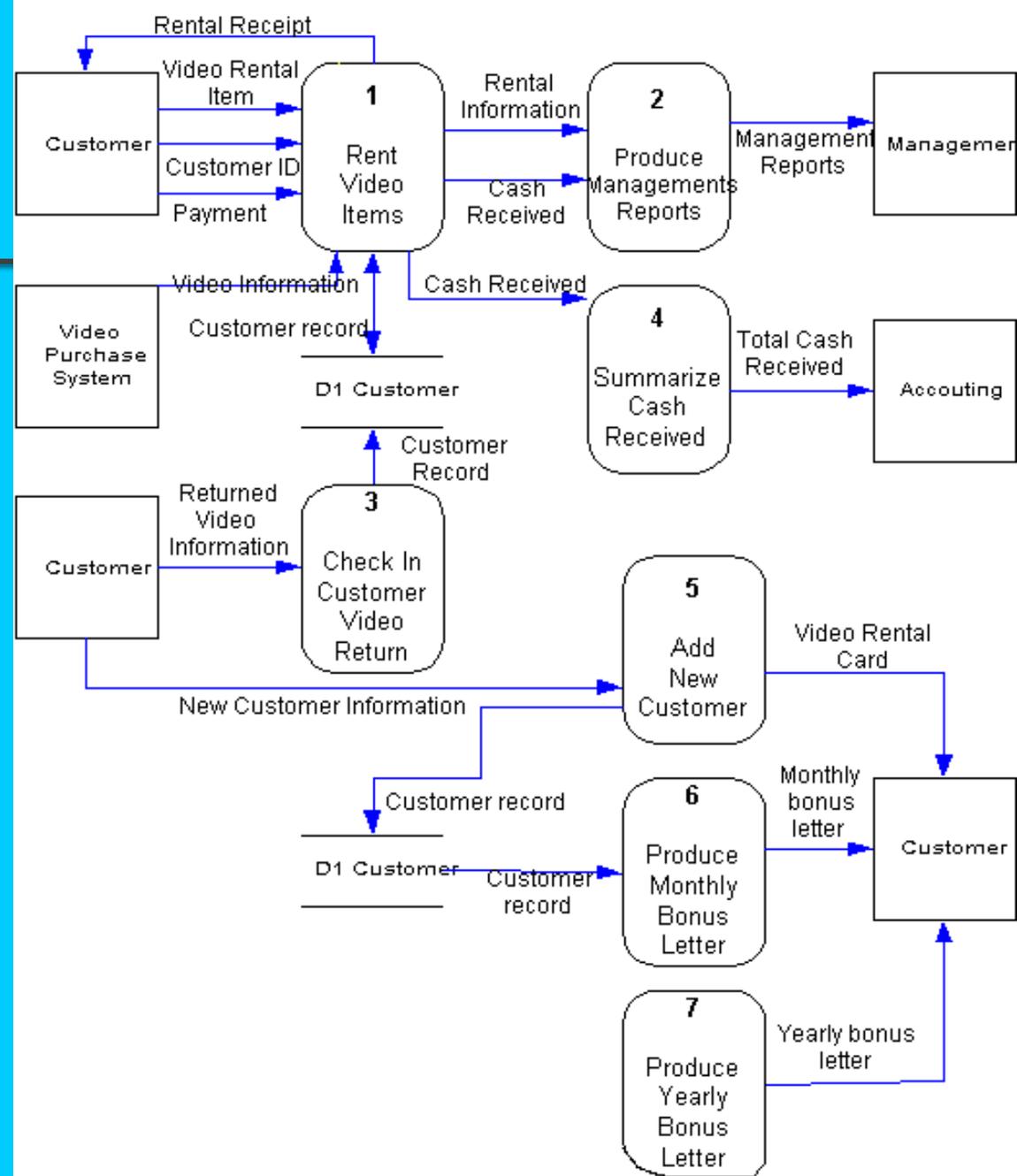
1-Level Diagram for the FilmMagic video rental system shows seven major processes

From Level 1 to Level 2
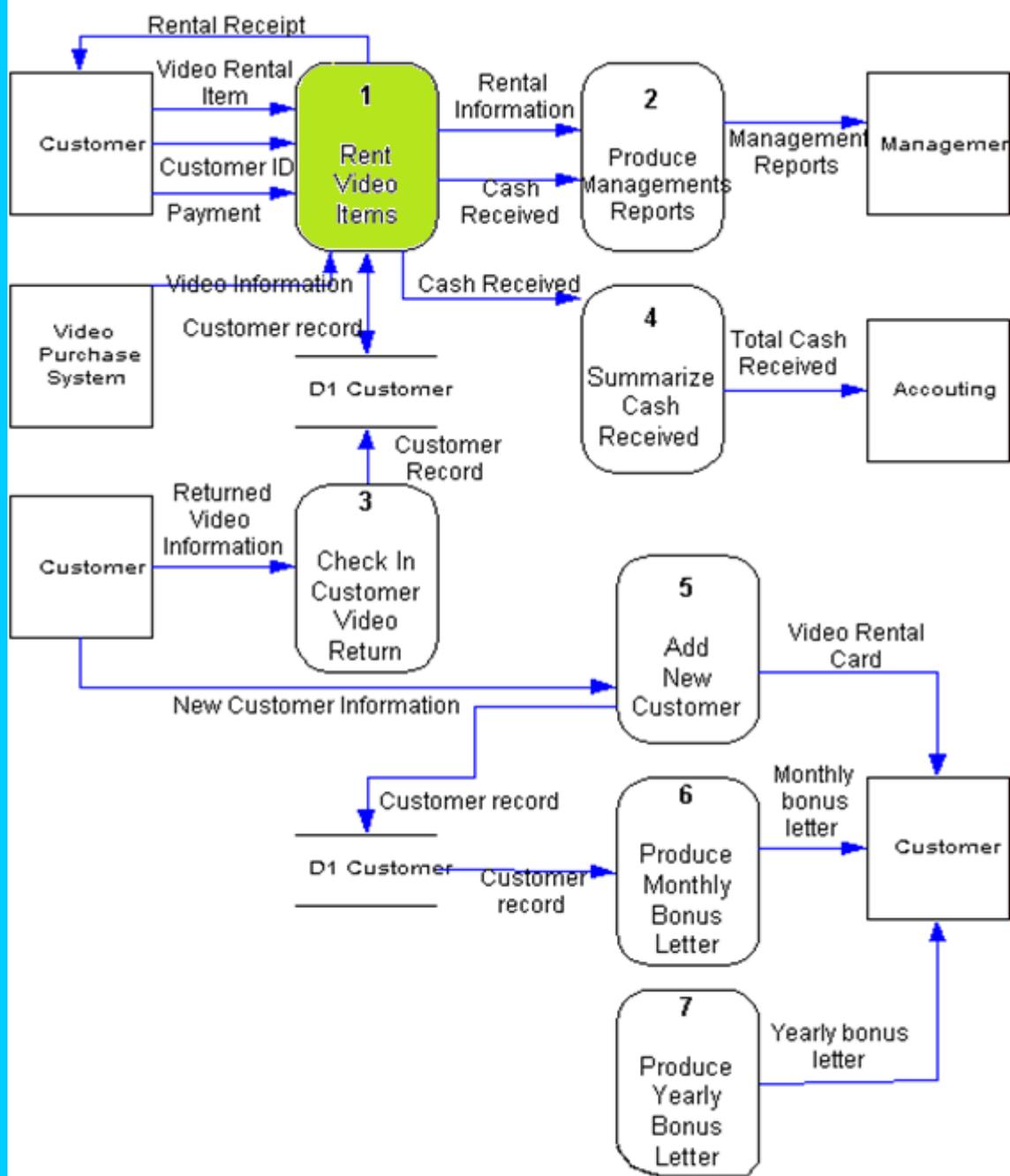
1-Level Diagram for the FilmMagic video rental system shows seven major processes

Level 2

The level2 diagram for process 1 shows more detail than does Context diagram
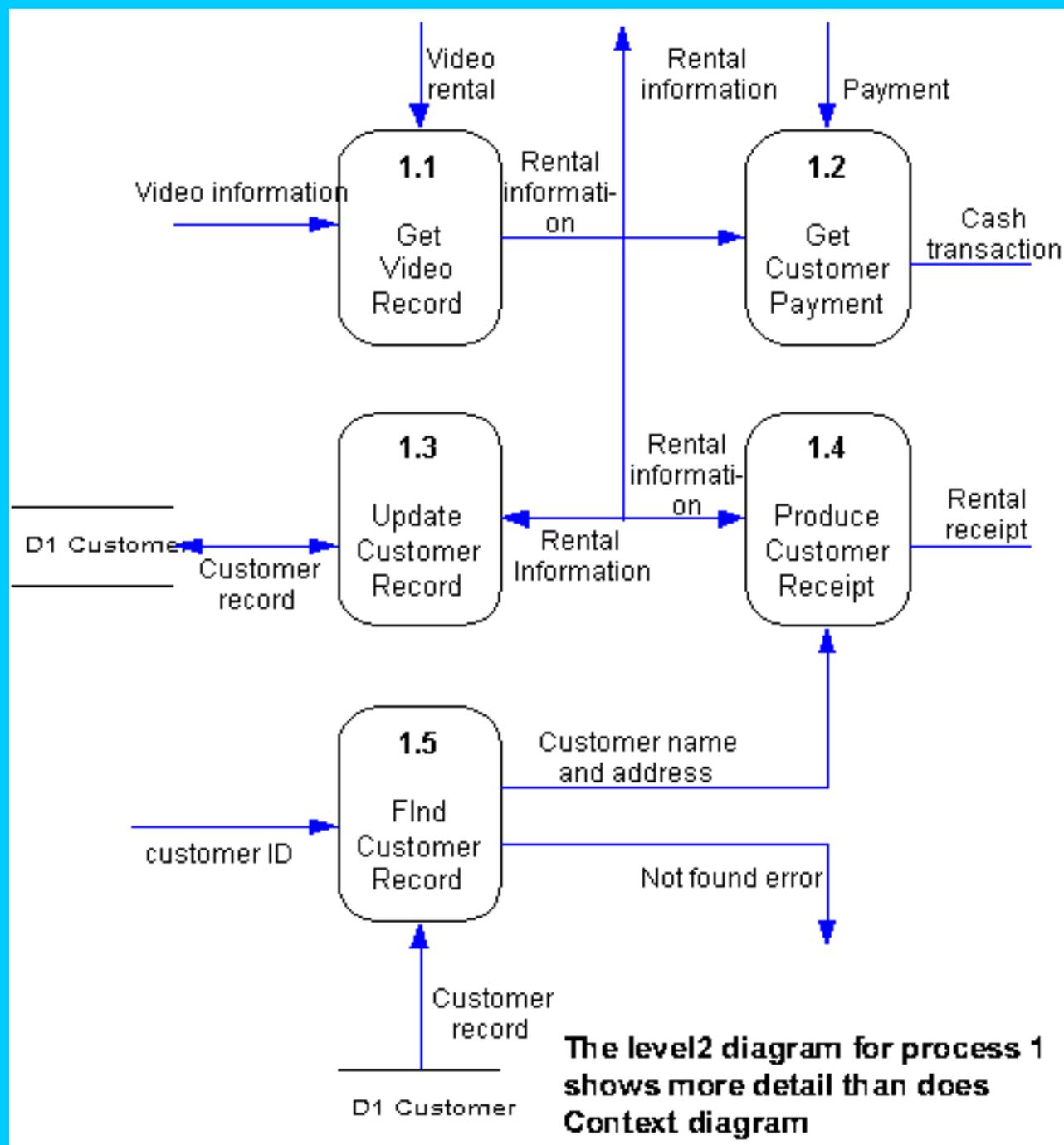
Level 2

✧ The input data flow VIDEO INFORMATION is connected only to the process GET VIDEO RECORD.

✧ The source of this input is a blank area on the drawing.

The level2 diagram for process 1 shows more detail than does Context diagram

Level 2

✧ This is incomplete interface flow **matches the flow into process 1 on 1-level diagram.** The same is true for VIDEO RENTAL, PAYMENT, and CUSTOMER ID.

The level2 diagram for process 1 shows more detail than does Context diagram
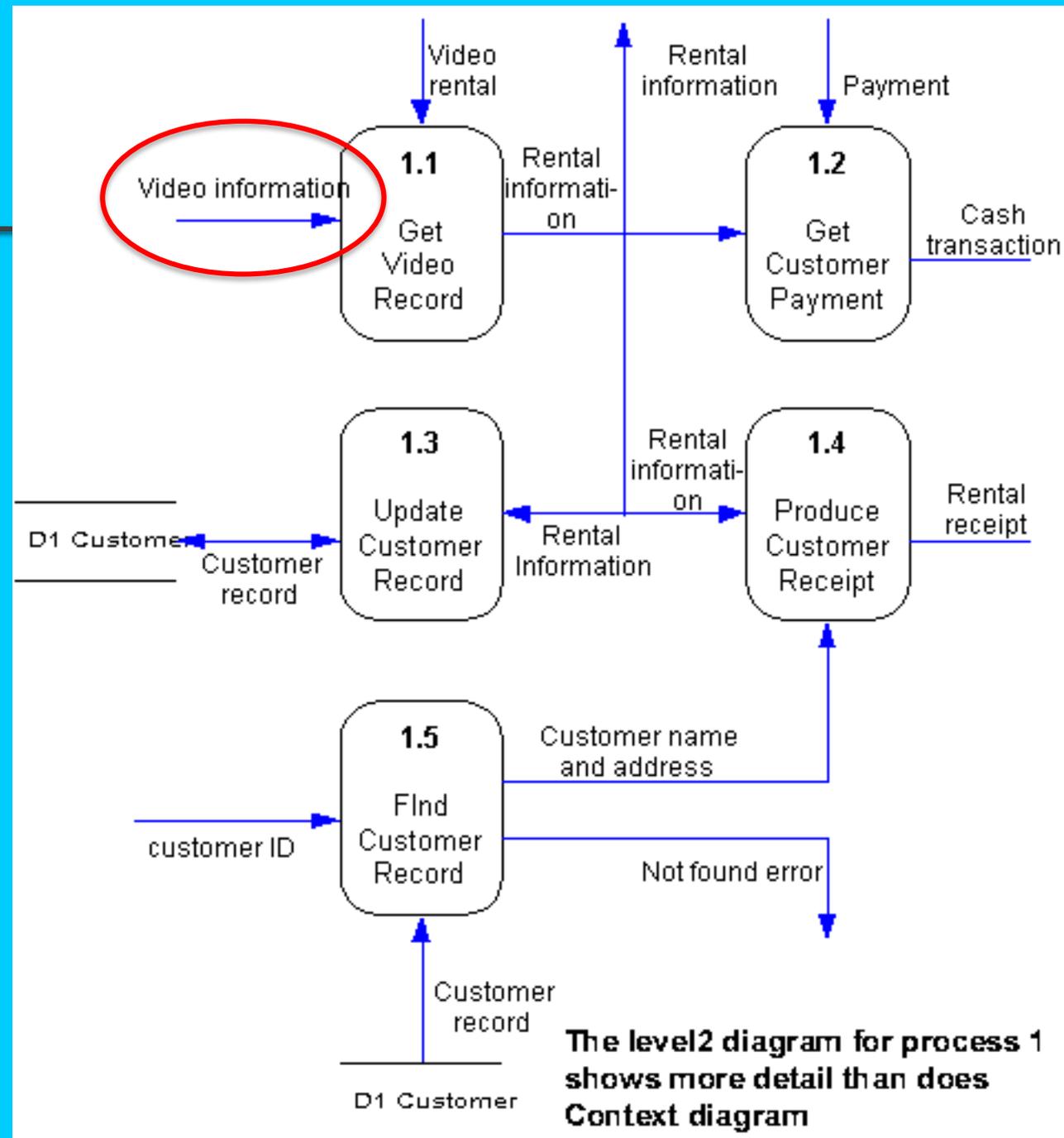
Level 2

✧ In contrast, the flow **NOT FOUND ERROR** is **not depicted in the parent process** since an error line is considered **a minor output**.

Video rental

Video information

1.1
Get Video Record

Rental information

Rental information

Payment

1.2
Get Customer Payment

Cash transaction

1.3
Update Customer Record

D1 Customer

Customer record

Rental Information

Rental information

1.4
Produce Customer Receipt

Rental receipt

1.5
FInd Customer Record

customer ID

Customer name and address

Not found error

Customer record

D1 Customer

The level2 diagram for process 1 shows more detail than does Context diagram

Logical Vs. Physical DFDs

Logical and Physical Data Flow Diagrams

✧ Logical

- Focuses on the business and how the business operates
- Not concerned with how the system will be constructed
- Describes the business events that take place and the data required and produced by each event

✧ Physical

- Shows how the system will be implemented
- Depicts the system

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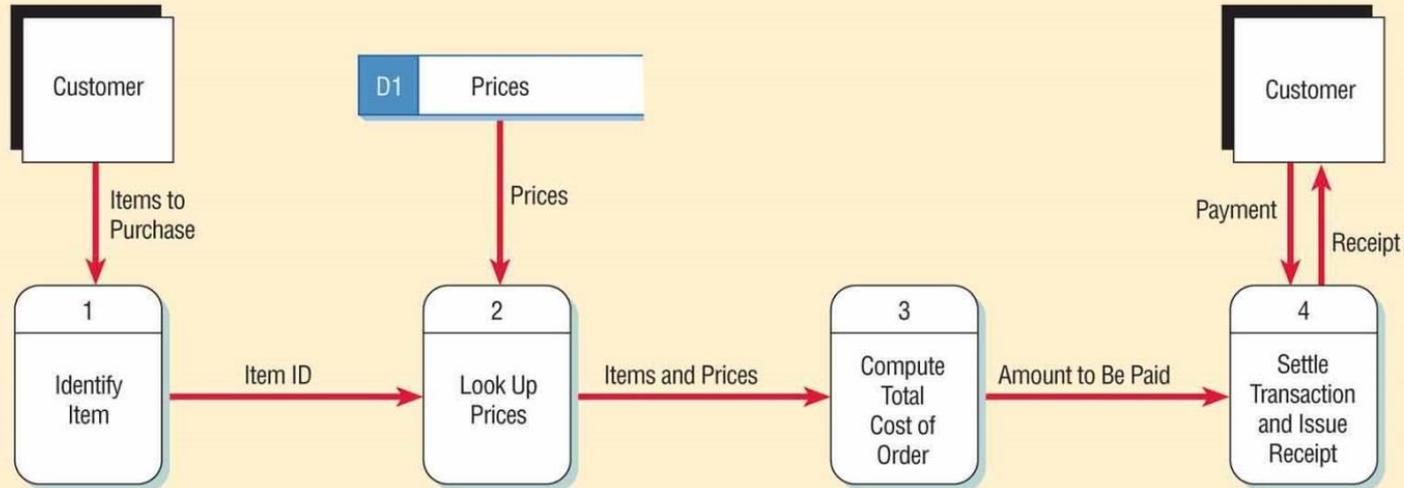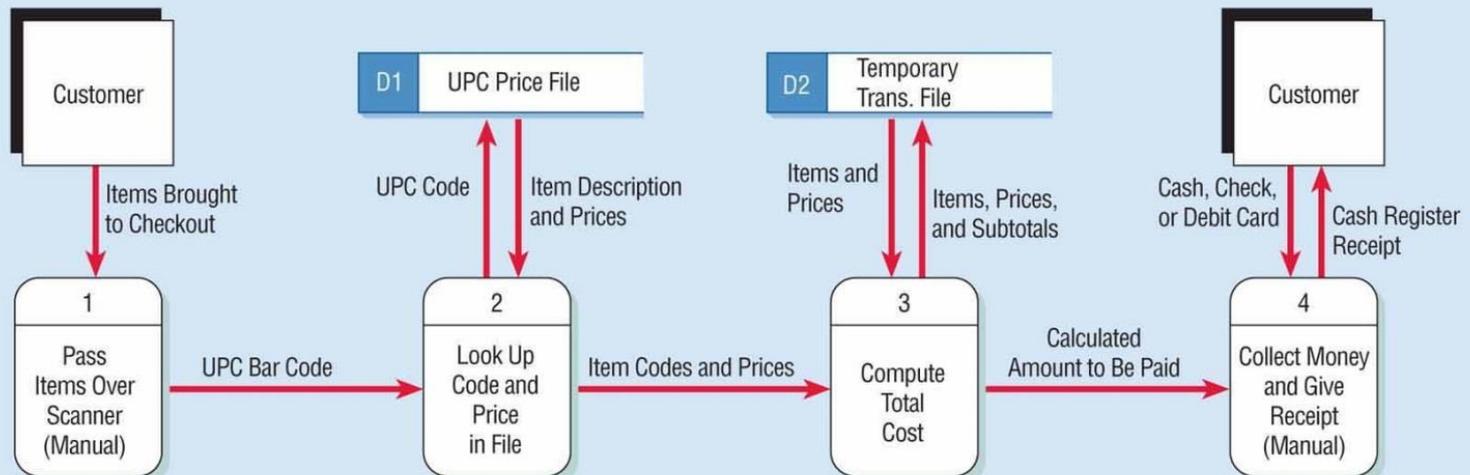
DFD process

The progression of creating data flow diagrams is:

1. Create a logical data flow diagram of the current system.

2. Next, add all the data and processes which must be present in the new system → a logical DFD for the new system.

3. Finally, derive the physical DFD for the new system.

What goes into the Physical DFD?

Contents of Physical Data Flow Diagrams

- Manual processes
- Processes for adding, deleting, changing, and updating records
- Data entry and verifying processes
- Validation processes for ensuring accurate data input
- Sequencing processes to rearrange the order of records
- Processes to produce every unique system output
- Intermediate data stores
- Actual file names used to store data
- Controls to signify completion of tasks or error conditions

Physical DFD for Scheduling Courses
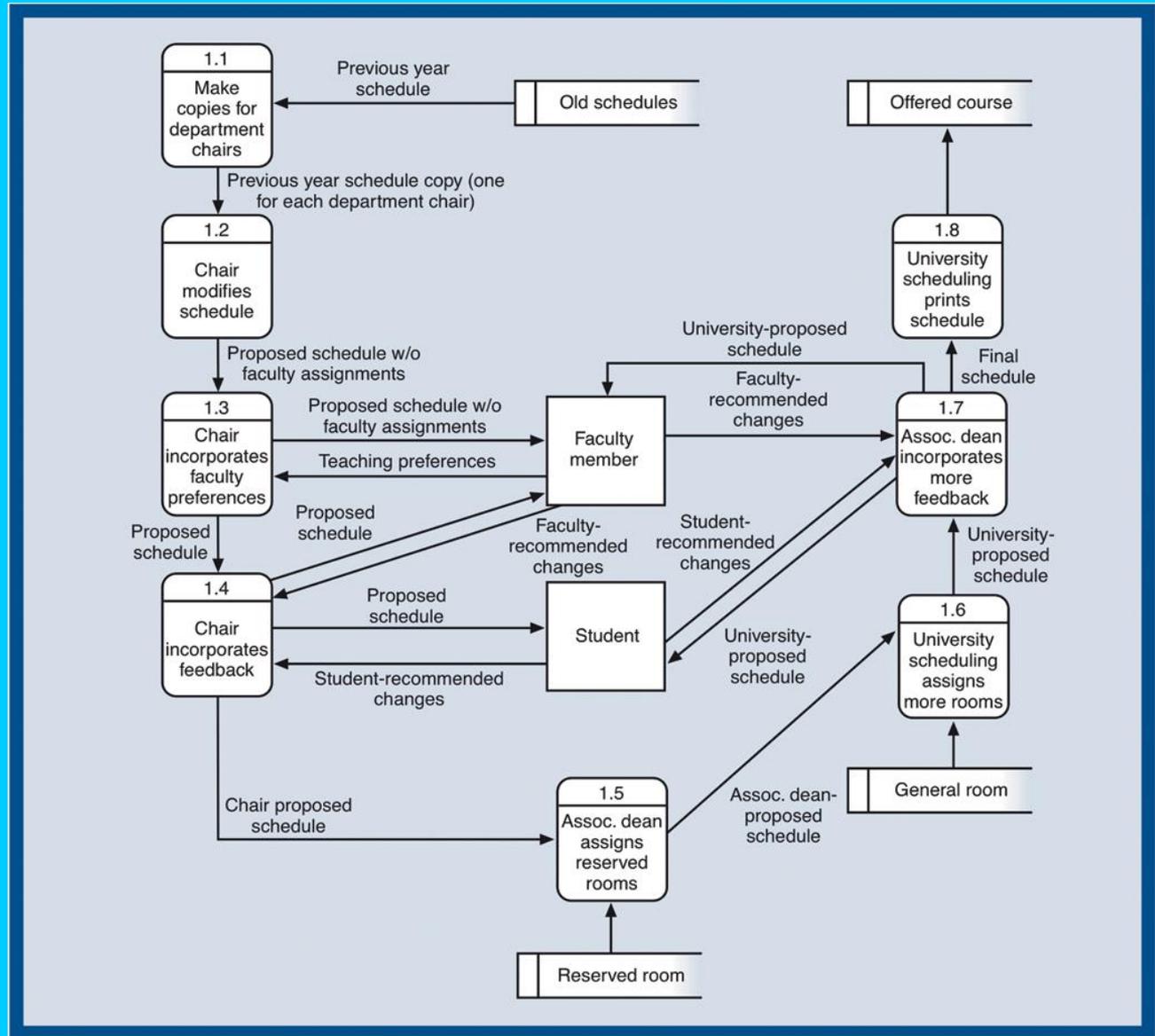
CRUD (Create, read, update and delete) matter

Internet Storefront: common activities

Activity	Customer	Item	Order	Order Detail
Customer Logon	R			
Item Inquiry		R		
Item Selection		R	C	C
Order Checkout	U	U	U	R
Add Account	C			
Add Item		C		
Close Customer Account	D			
Remove Obsolete Item		D		
Change Customer Demographics	RU			
Change Customer Order	RU	RU	RU	CRUD
Order Inquiry	R	R	R	R

Response Table: Use cases -> DFDs

Event	Source	Trigger	Activity	Response	Destination
Customer logs on	Customer	Customer number and password	Find customer record and verify password. Send Welcome Web page.	Welcome Web page	Customer
Customer browses items at Web storefront	Customer	Item information	Find item price and quantity available. Send Item Response Web page.	Item Response Web page	Customer
Customer places item into shopping basket at Web storefront	Customer	Item purchase (item number and quantity)	Store data on Order Detail Record. Calculate shipping cost using shipping tables. Update customer total. Update item quantity on hand.	Items Purchased Web page	Customer
Customer checks out	Customer	Clicks "Check Out" button on Web page	Display Customer Order Web page.	Verification Web page	
Obtain customer payment	Customer	Credit card information	Verify credit card amount with credit card company. Send.	Credit card data Customer feedback	Credit card company Customer
Send customer email		Temporal, hourly	Send customer an email confirming shipment.		Customer

Response Table: Use cases -> DFDs

Event	Source	Trigger	Activity	Response	Destination
Customer logs on	Customer	Customer number and password	Find customer record and verify password. Send Welcome Web page.	Welcome Web page	Customer
Customer browses items at Web storefront					Customer
Customer places item into shopping basket at Web storefront		quantity)	Calculate shipping cost using shipping tables. Update customer total. Update item quantity on hand.	page	Customer
Customer checks out	Customer	Clicks "Check Out" button on Web page	Display Customer Order Web page.	Verification Web page	
Obtain customer payment	Customer	Credit card information	Verify credit card amount with credit card company. Send.	Credit card data Customer feedback	Credit card company Customer
Send customer email		Temporal, hourly	Send customer an email confirming shipment.		Customer

Customer — Customer Number and Password → 1 Get Customer Signin ← Customer Record — D1 Customer Master

Get Customer Signin → Welcome Web Page → Customer

Response Table: Use cases -> DFDs

Event	Source	Trigger	Activity	Response	Destination
Customer logs on	Customer	Customer number and password	Find customer record and verify password. Send Welcome Web page.	Welcome Web page	Customer
Customer browses items at Web storefront	Customer	Item information	Find item price and quantity available. Send Item Response Web page.	Item Response Web page	Customer
Customer places item into shopping basket at Web storefront					Customer

Event	Source	Trigger	Activity	Response	Destination
Customer checks out	Customer	Clicks "Check Out" button on Web page	Display Customer Order Web page.	Verification Web page	
Obtain customer payment	Customer	Credit card information	Verify credit card amount with credit card company. Send.	Credit card data / Customer feedback	Credit card company / Customer
Send customer email		Temporal, hourly	Send customer an email confirming shipment.		Customer

Process Tables Here - DFD

Event	Source	Trigger	Activity	Response	Destination
Customer logs on	Customer	Customer number and password	Find customer record and verify password. Send Welcome Web page.	Welcome Web page	Customer
Customer browses items at Web storefront	Customer	Item information	Find item price and quantity available. Send Item Response Web page.	Item Response Web page	Customer
Customer places item into shopping basket at Web storefront	Customer	Item purchase (item number and quantity)	Store data on Order Detail Record. Calculate shipping cost using shipping tables. Update customer total. Update item quantity on hand.	Items Purchased Web page	Customer
Customer checks out					
Obtain customer payment					Credit card company / Customer
Send customer email					Customer

- *Which of the following are examples of reasons why an analyst might use a data flow approach over a narrative explanation of data movement?*
- A). Freedom from committing to the technical implementation of the system too early.
- B). Analysis of the system to determine if all the necessary data and processes have been defined.
- C). Further understanding of the interrelationships of users and scenarios.
- D). All of the above
- E). A and B

- *Which of the following characteristics can be found on a physical data flow diagram?*
- *A).* Temporary data stores and transaction files
- B). Specifying actual document and file names
- C). Showing how the business operates
- D). A and B
- E). B and C

Logical
- How the business operates.
- Business activities.
- Collections of data regardless of how the data are stored.
- Show data stores representing permanent data collections.
- Show business controls.

Physical
- How the system will be implemented (or how the current system operates).
- Programs, program modules, and manual procedures.
- Physical files and databases, manual files.
- Master files, transition files. Any processes that operate at two different times must be connected by a data store.
- Show controls for validating input data, for obtaining a record (record found status), for ensuring successful completion of a process, and for system security (example: journal records)

Contents of Physical Data Flow Diagrams
- Manual processes
- Processes for adding, deleting, changing, and updating records
- Data entry and verifying processes
- Validation processes for ensuring accurate data input
- Sequencing processes to rearrange the order of records
- Processes to produce every unique system output
- Intermediate data stores
- Actual file names used to store data
- Controls to signify completion of tasks or error conditions