

King Saud University

College of Engineering

IE – 462: “Industrial Information Systems”

Fall – 2023 (1<sup>st</sup> Sem. 1445H)

[Chapter 4:](#)

***Structured Analysis and Functional  
Architecture Design – p2 – DFD – iii – Case Studies***

Prepared by: Ahmed M. El-Sherbeeney, PhD

# Lesson Overview

- Modeling IIS – (p1)
- Integrated Computer-Aided Manufacturing Definition 0 (IDEF0) – (p1)
- **Data Flow Diagram (DFD) – (p2)**
  - i. Fundamentals
  - ii. Diagramming Rules
  - iii. Case Studies**

# DFD – part iii – Case Studies

1. [Inventory Control System](#)
2. [Business Process Reengineering \(BPR\)](#)
3. [Electronic Commerce Application](#)
4. [Converting IDEF0 Model to DFD](#)

# Functional/Process Modeling:

## 2. Data Flow Diagram (DFD) – cont'd

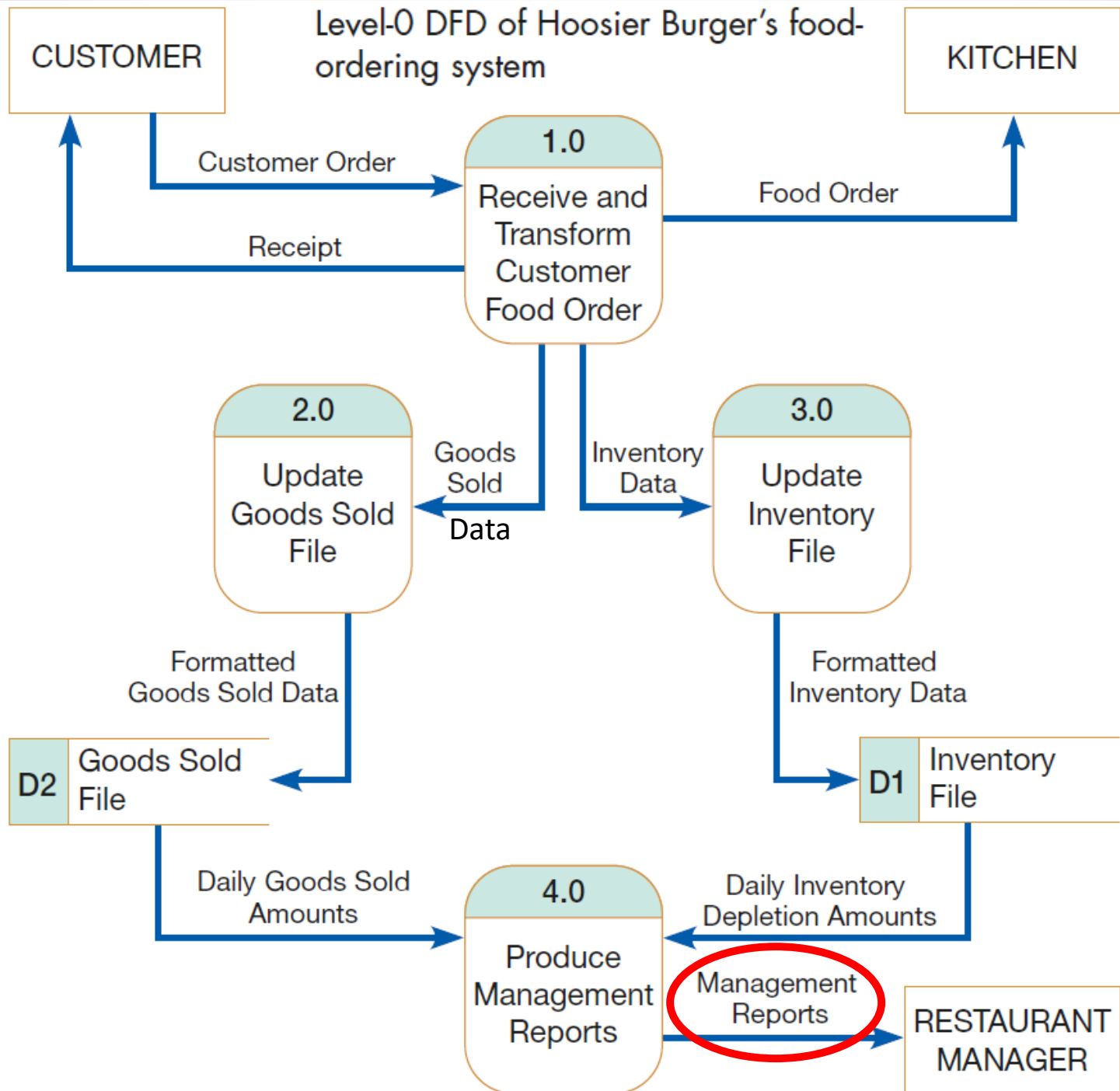
# Case Study 1 – Using DFD in Inventory Control System – “Hoosier Burger”



# Case Study 1: HB Inventory Control System

## Introduction:

- Remember: Hoosier Burger [food-ordering system](#) generates two types of usage data,
  - goods sold and
  - inventory
- At end of each day, manager, (Bob) generates inventory report that tells him
  - how much inventory *should* have been used,
  - items associated with each sale
- Bob uses a *manual* [inventory control system](#)



# Case Study 1: HB Inventory Control System

## FIGURE 7-12

List of activities involved in Bob Mellankamp's inventory control system for Hoosier Burger

1. Meet delivery trucks before opening restaurant.
2. Unload and store deliveries.
3. Log invoices and file in accordion file.
4. Manually add amounts received to stock logs.
5. After closing, print inventory report.
6. Count physical inventory amounts.
7. Compare inventory report totals to physical count totals.
8. Compare physical count totals to minimum order quantities. If the amount is less, make order; if not, do nothing.
9. Pay bills that are due and record them as paid.



# Case Study 1: HB Inventory Control System

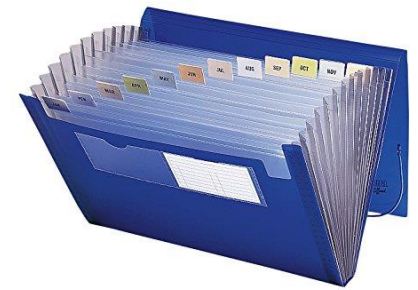
## Bob's Hoosier Burger Inventory System:

- 3 sources of input data (i.e. from outside system):
  1. suppliers
    - provide *invoices* (i.e. system input)
  2. food-ordering system [inventory report](#)
    - provide *inventory counts* (i.e. system inputs)
  3. stock on hand
    - also provides *inventory counts* (i.e. system inputs)
- System output:
  - Suppliers: *payments and orders*
- We can now create the context diagram shown in [Figure 7-14](#) for the system

# Case Study 1: HB Inventory Control System

## Bob's Hoosier Burger Inventory System (cont.):

- When Bob receives invoices from suppliers,
  - he records their receipt on an *invoice log sheet*,
  - and files the actual invoices in his *accordion file*



- Using the invoices, Bob records the amount of stock delivered on [stock logs](#):
  - these are paper forms posted near the *point of storage* for each inventory item

# Case Study 1: HB Inventory Control System

**FIGURE 7-13**

Hoosier Burger's stock log form

Stock Log					
Date:		Jan 1			Jan 2
Item	Reorder Quantity	Starting Amount	Amount Delivered	Amount Used	Starting Amount
Hamburger buns	50 dozen	5	50	43	12
Hot dog buns	25 dozen	0	25	22	3
English muffins	10 dozen	6	10	12	4
Napkins	2 cases	10	0	2	8
Straws	1 case	1	0	1	0

# Case Study 1: HB Inventory Control System

## Hoosier Burger's Stock Log Form:

- *Minimum order quantities*\* appear on the log form:
  - stock level at which orders *must be placed* in order to avoid running out of an item
- Stock log also has spaces for entering:
  - a) starting amount:
    - entered on the sheet when Bob logs stock deliveries
  - b) amount delivered, and
  - c) amount used for each item:
    - entered on sheet *after* Bob has compared amounts of stock used according to a *physical count* and according to the numbers on the [inventory report](#) (generated by the food-ordering system)\*\*

# Case Study 1: HB Inventory Control System

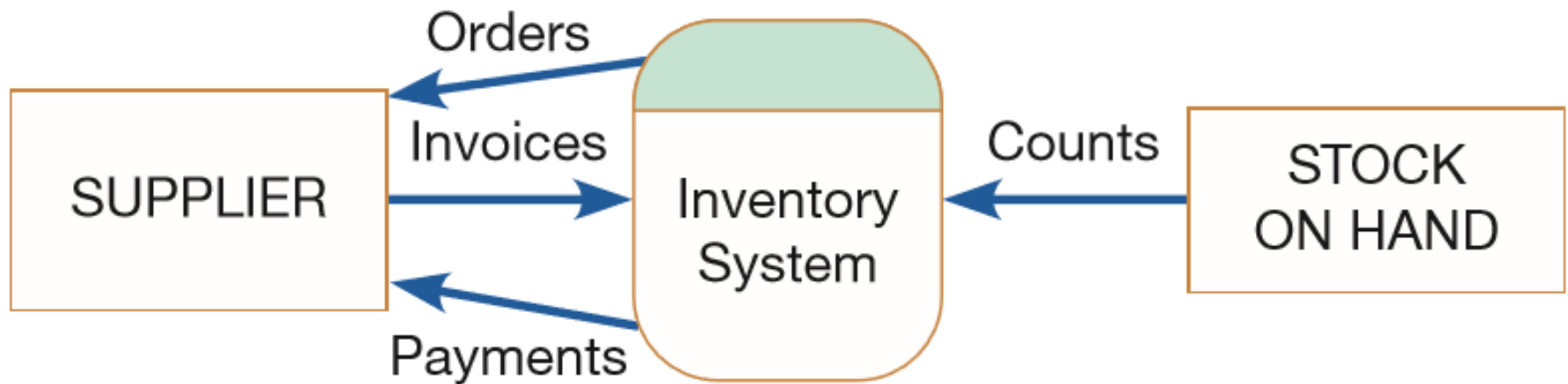
## Hoosier Burger's Stock Log Form (cont.):

- Hoosier Burger has *standing daily delivery orders*
  - for some perishable items that are used every day (e.g. burger buns, meats, and vegetables)
- Bob determines which orders need to be placed by comparing,
  - minimum order quantities and
  - the amount of stock on hand
- Bob uses the invoices,
  - determines which bills need to be paid, and
  - carefully records each payment

# Case Study 1: HB Inventory Control System

**FIGURE 7-14**

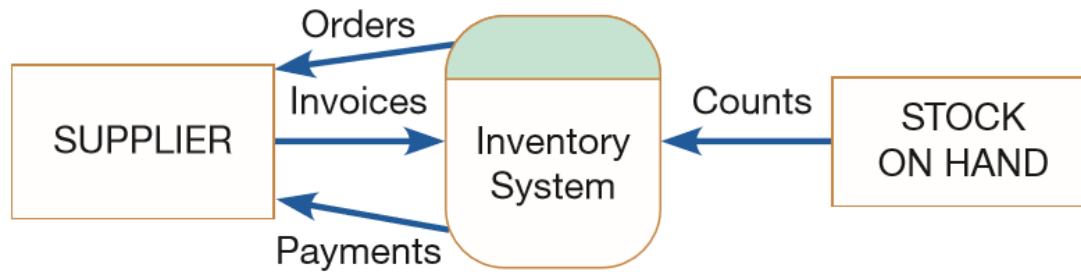
(a) Context diagram for Hoosier Burger's inventory control system



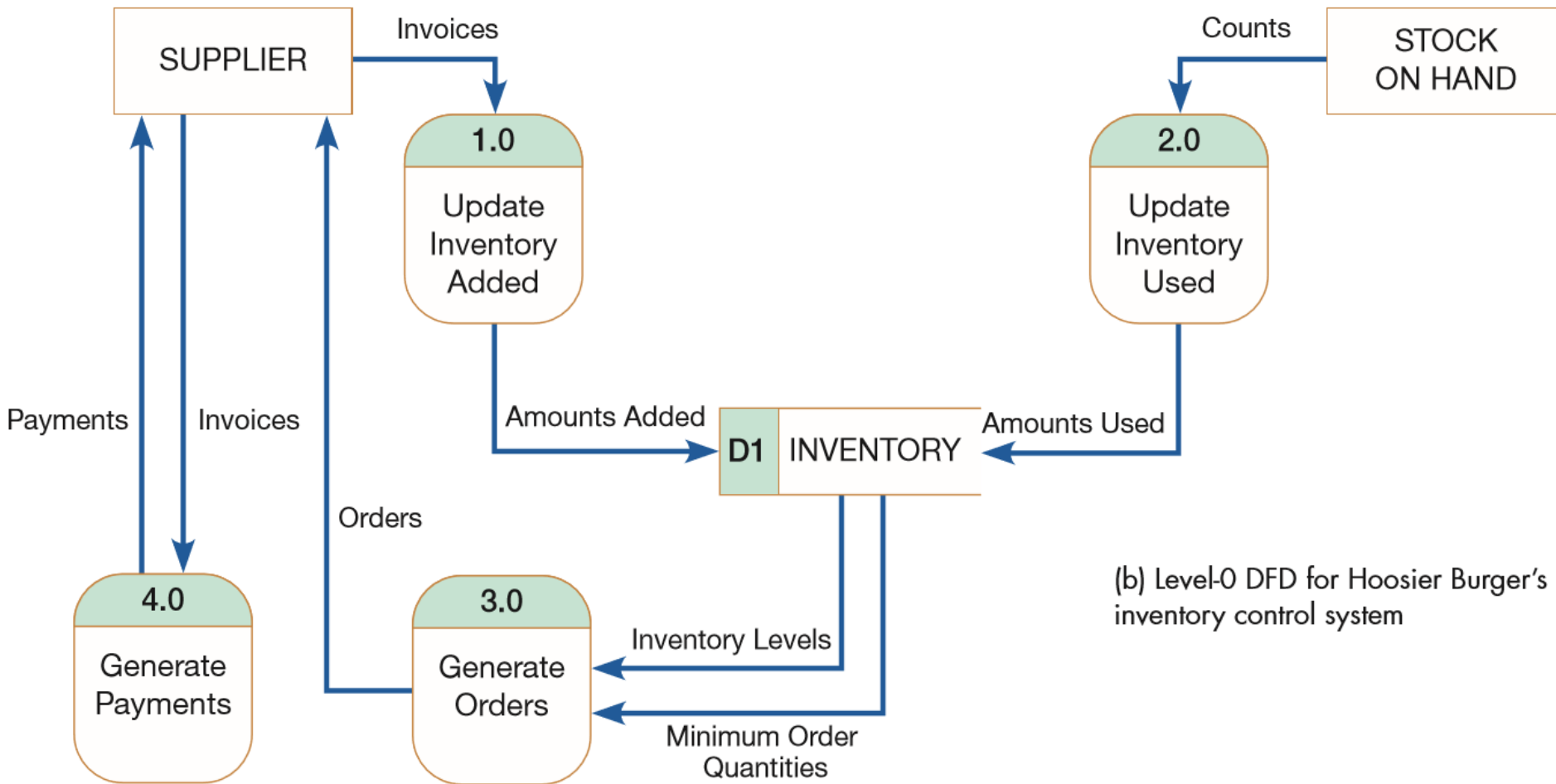
# Case Study 1: HB Inventory Control System

## Main Elements of Bob's Inventory System:

- Key processes ([see level-0 DFD](#)):
  1. account for anything *added to* inventory
  2. account for anything *taken from* inventory
  3. place orders
  4. pay bills
- Key data *used* by the system:
  - [inventories counts](#) (used by the system) and
  - stock-on-hand counts
- Key data *output* by the system:
  - orders
  - payments



**FIGURE 7-14**  
 (a) Context diagram for Hoosier Burger's inventory control system



(b) Level-0 DFD for Hoosier Burger's inventory control system



# Case Study 1: HB Inventory Control System

## Revised DFD for Bob's Inventory System:

- Bob would like to add 3 additional functions:
  1. data on *new shipments* should be entered into an *automated* system, thus:
    - no more paper [stock log sheets](#)
    - shipment data will stay as current as possible (i.e. will be entered into the system as soon as the new stock arrives at the restaurant)
  2. system should determine automatically whether a *new order* should be placed,
    - i.e. Bob would no longer worry whether Hoosier Burger has enough of everything in stock at all times\*

# Case Study 1: HB Inventory Control System

## Revised DFD for Bob's Inventory System (cont.):

- Bob would like to add 3 additional functions (cont.):
  3. Bob would like to be able to know, at any time, the *approximate inventory level* for each good in stock
    - for some items (e.g. buns), Bob can *visually inspect* the amount in stock and determine approximately how much is left and how much more is needed before closing time
    - for other items, however, Bob may need a *rough estimate* of what is in stock more quickly than he can estimate via a visual inspection

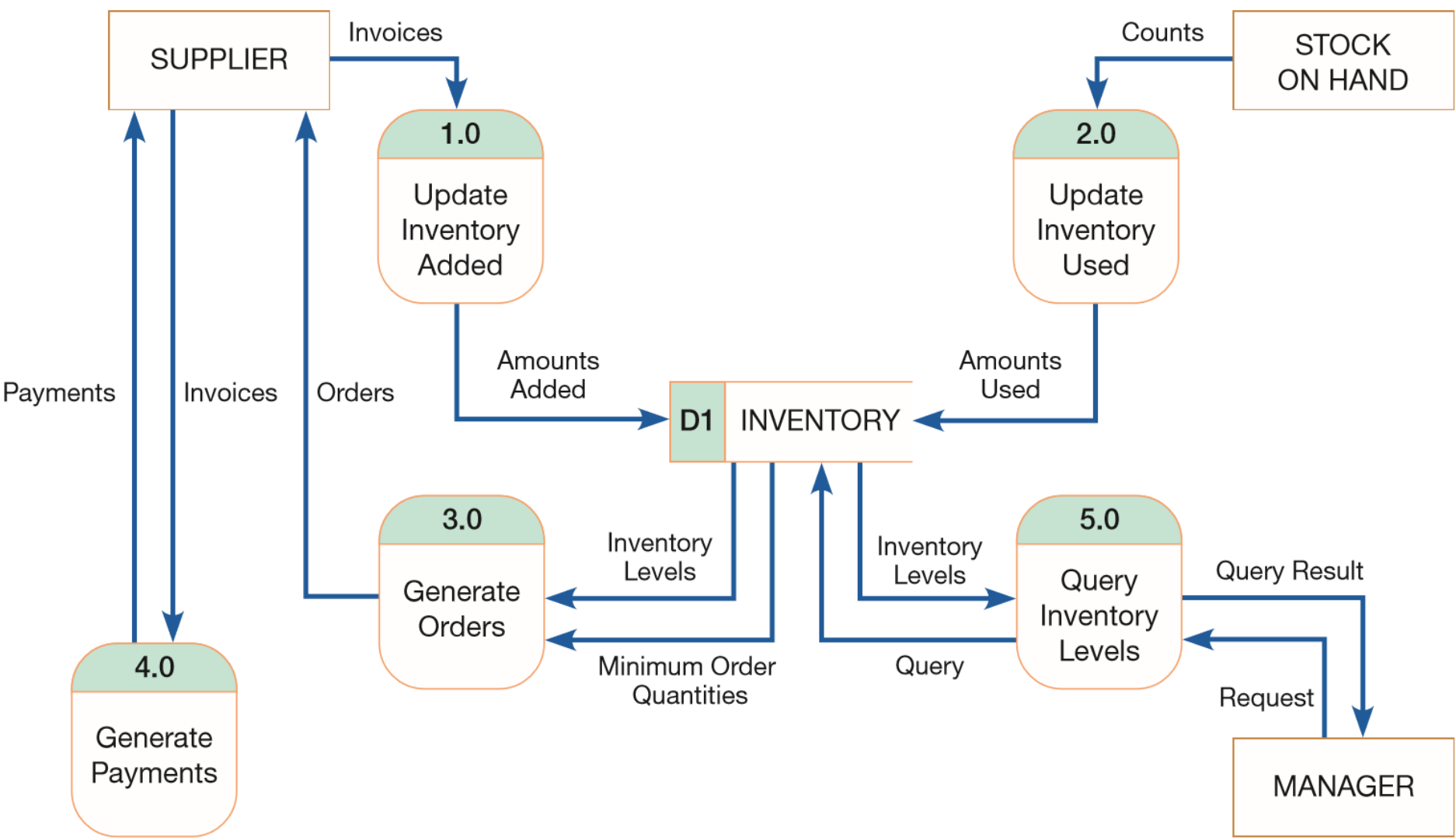
# Case Study 1: HB Inventory Control System

## Revised DFD for Bob's Inventory System (cont.):

- Compare between [original](#) and [revised](#) DFDs:
  - new Process 5.0 allows for *querying*\* the inventory data to get an estimate of how much of an item is in stock
  - Bob's 2 other requests for change can both be handled *within the existing* logical view of the inventory system

**FIGURE 7-15**

Revised level-0 DFD for Hoosier Burger's inventory control system



**Case Study 2 –  
Using DFDs in  
Business Process Reengineering  
(BPR) –  
“IBM Credit Corporation”**

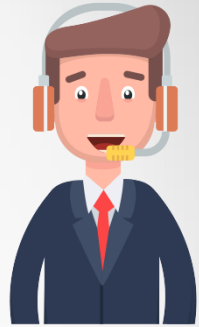


# Case Study 2: BPR – IBM Credit

## **IBM Credit Corporation:**

- Case study by *Hammer and Champy* (1993)
- IBM Credit Corporation
  - provides financing for customers making large purchases of IBM computer equipment
  - analyzes deals proposed by salespeople and writes the final contracts governing those deals
  - it typically took six business days to process each financing deal

# Case Study 2: BPR – IBM Credit



## Steps in processing each financing deal:

1. salesperson calls in with a proposed deal
  - clerk **logs** it and writes details on a piece of paper

2. second person:

- enters data into a computer system and
- checks client's **creditworthiness**
- writes details on a piece of paper and carries paper (along with original documentation) to a loan officer



3. loan officer:

- modifies standard IBM **loan agreement** for the customer
- involves separate computer system from one used in step 2

# Case Study 2: BPR – IBM Credit

## Steps in processing each financing deal (cont.):

4. details of modified loan agreement:
  - sent on to the next station in the process
  - different clerk **determines interest rate** for loan
  - again, this involves its own information system



5. **quote letter** is created at the next stop:

- using resulting interest rate and
- all of the paper generated up to this point
- quote letter is sent via overnight mail back to the salesperson



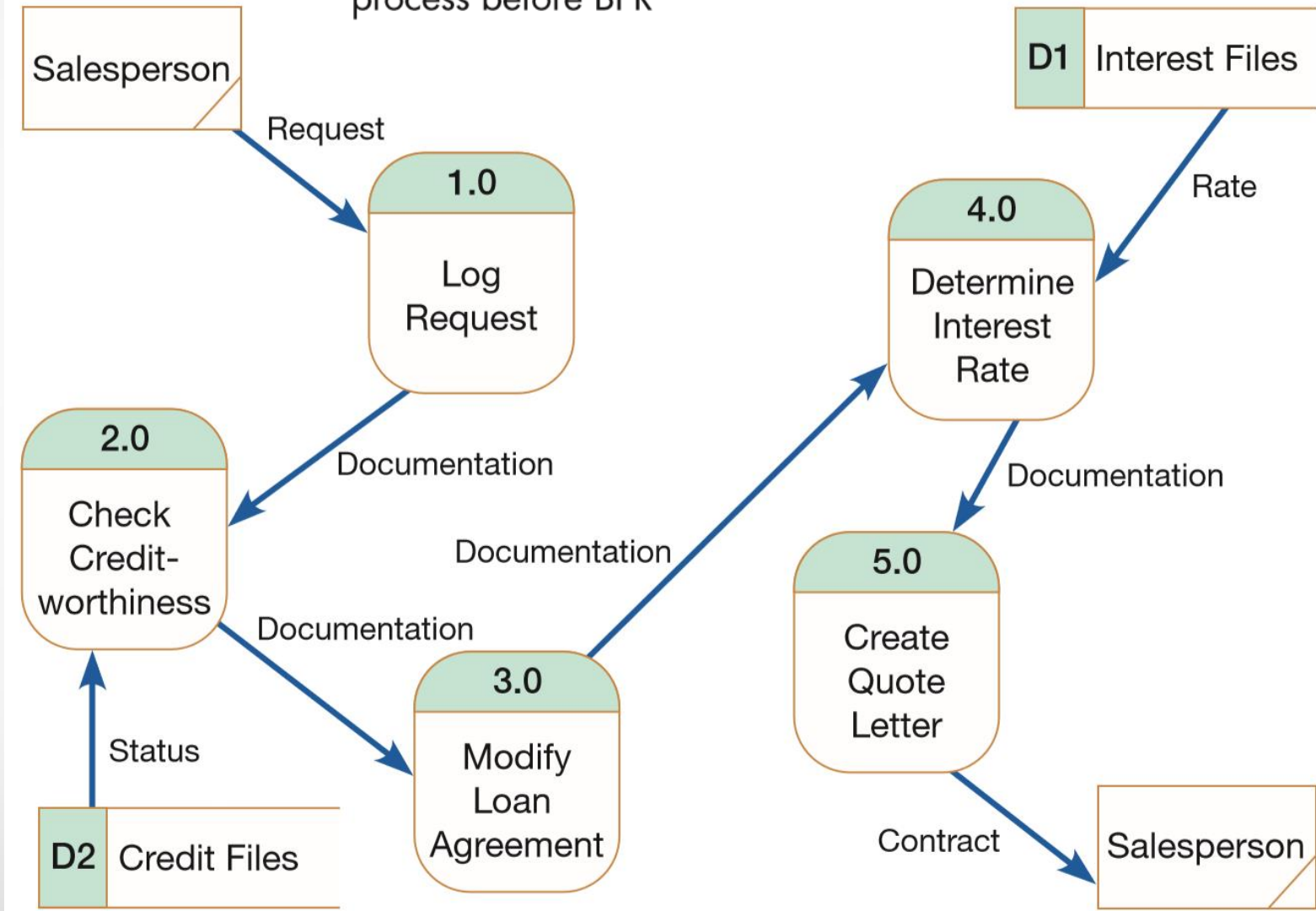
- [DFD](#) illustrates the overall process, people, computers, and shows it is not that complicated



# Case Study 2: BPR – IBM Credit

**FIGURE 7-16**

IBM Credit Corporation's primary work process before BPR



# Case Study 2: BPR – IBM Credit

## Steps after applying Business Process Reengineering:

- five sets of task specialists were replaced with *generalists*:
  - call from the field goes to a *single clerk*
  - clerk does all the work necessary to process the contract
  - i.e. now *only 1 person*: checks for creditworthiness, modifies basic loan agreement, & determines appropriate interest rate
- company still has specialists for few cases that are significantly different from routine encounters
- process is now supported by a single computer system

# Case Study 2: BPR – IBM Credit

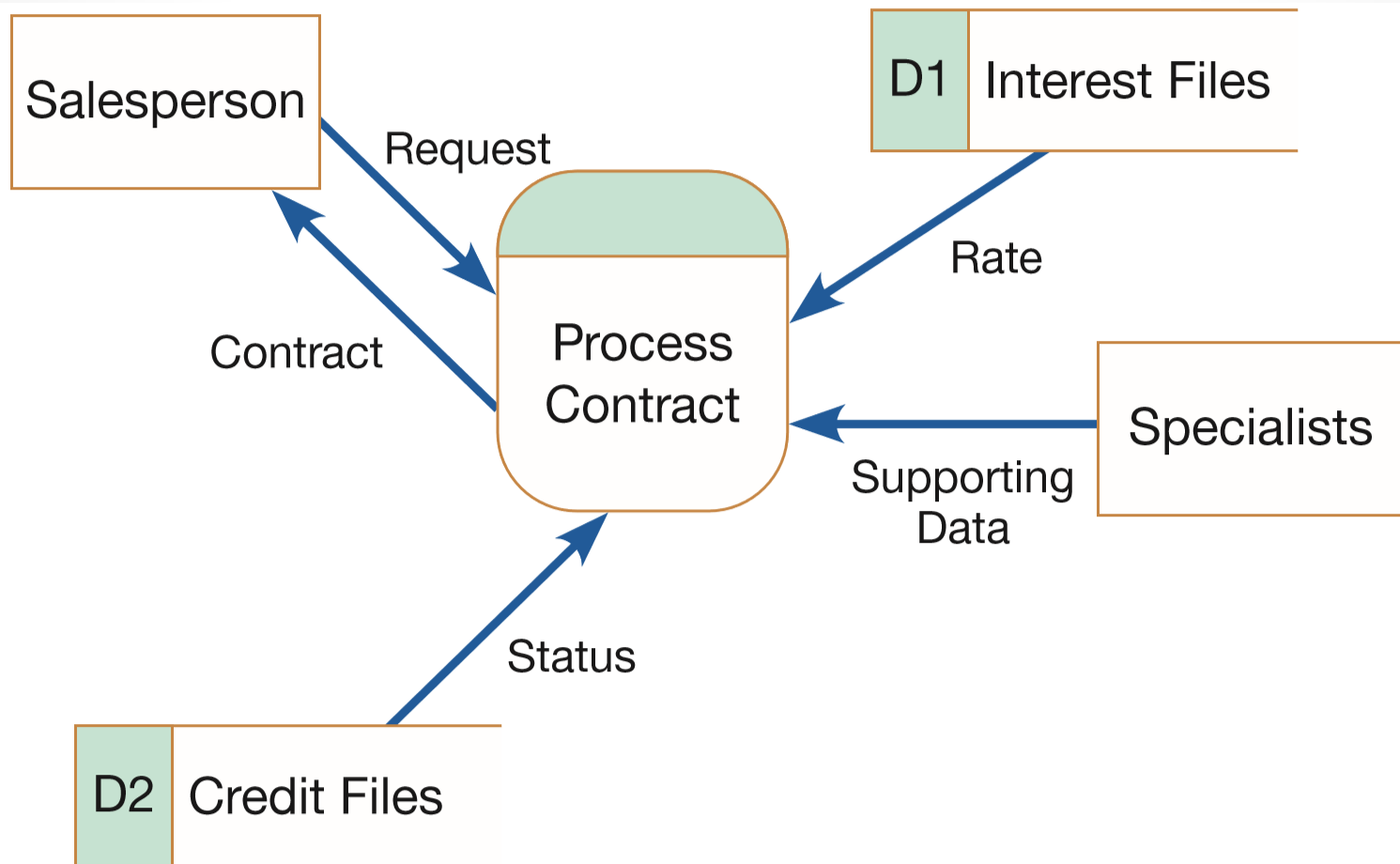
## Steps after applying BPR (cont.):

- Note some differences in [revised DFD](#) vs [original DFD](#)
  - compare the number of *process boxes*
  - *lack of documentation flow* in revised DFD ( $\Rightarrow$  process is much simpler, cuts down dramatically on any chance of documentation getting lost between steps)
- Redesigning process from beginning to end:
  - allowed IBM Credit Corporation to increase the number of contracts it can handle by *100-fold!*
  - i.e. allowed company to handle *100 times* more work in the same amount of time and with fewer people

# Case Study 2: BPR – IBM Credit

**FIGURE 7-17**

IBM Credit Corporation's primary work process after BPR



# Case Study 3 – Using DFDs in Electronic Commerce Application – “Pine Valley Furniture” WebStore



# Case Study 3: PVF Furniture Webstore

## Background:

- Process modeling (using DFD) is similar to the process followed for other applications
- *Pine Valley Furniture* (PVF) made a project to sell furniture products over the Internet (i.e. *webstore*)
- Objectives:
  - analyze webstore's high-level system structure,
  - develop a level-0 DFD for those requirements

# Case Study 3: PVF Furniture Webstore

## Steps in translating webstore system structure into DFD:

- Senior systems analyst (Jim Woo)
  - first, completed JAD (*Joint Application Design*) session
  - then adopted following steps to create DFD for webstore:
- 1. Identify level-0 –**major system– processes**:
  - examined the outcomes of the JAD session, and
  - defined *system structure* of webstore system
  - he identified six *high-level processes*, which were the “work” or “action” parts of the website ([see Table 7-4](#))
  - note how each process corresponds to *major processing items* listed in the system structure

# Case Study 3: PVF Furniture Webstore

**TABLE 7-4 System Structure of the WebStore and Corresponding Level-0 Processes**

WebStore System	Processes
<ul style="list-style-type: none"> <li>❑ Main Page               <ul style="list-style-type: none"> <li>• Product Line (Catalog)                   <ul style="list-style-type: none"> <li>✓ Desks</li> <li>✓ Chairs</li> <li>✓ Tables</li> <li>✓ File Cabinets</li> </ul> </li> <li>• Shopping Cart</li> <li>• Checkout</li> <li>• Account Profile</li> <li>• Order Status/History</li> <li>• Customer Comments</li> </ul> </li> <li>❑ Company Information</li> <li>❑ Feedback</li> <li>❑ Contact Information</li> </ul>	<p>Information Display (minor/no processes)</p> <ul style="list-style-type: none"> <li>1.0 Browse Catalog</li> <li>2.0 Select Item for Purchase</li>   <li>3.0 Display Shopping Cart</li> <li>4.0 Check Out Process Order</li> <li>5.0 Add/Modify Account Profile</li> <li>6.0 Order Status Request</li> </ul> <p>Information Display (minor/no processes)</p>



# Case Study 3: PVF Furniture Webstore

## Translating webstore system structure into DFD (cont.):

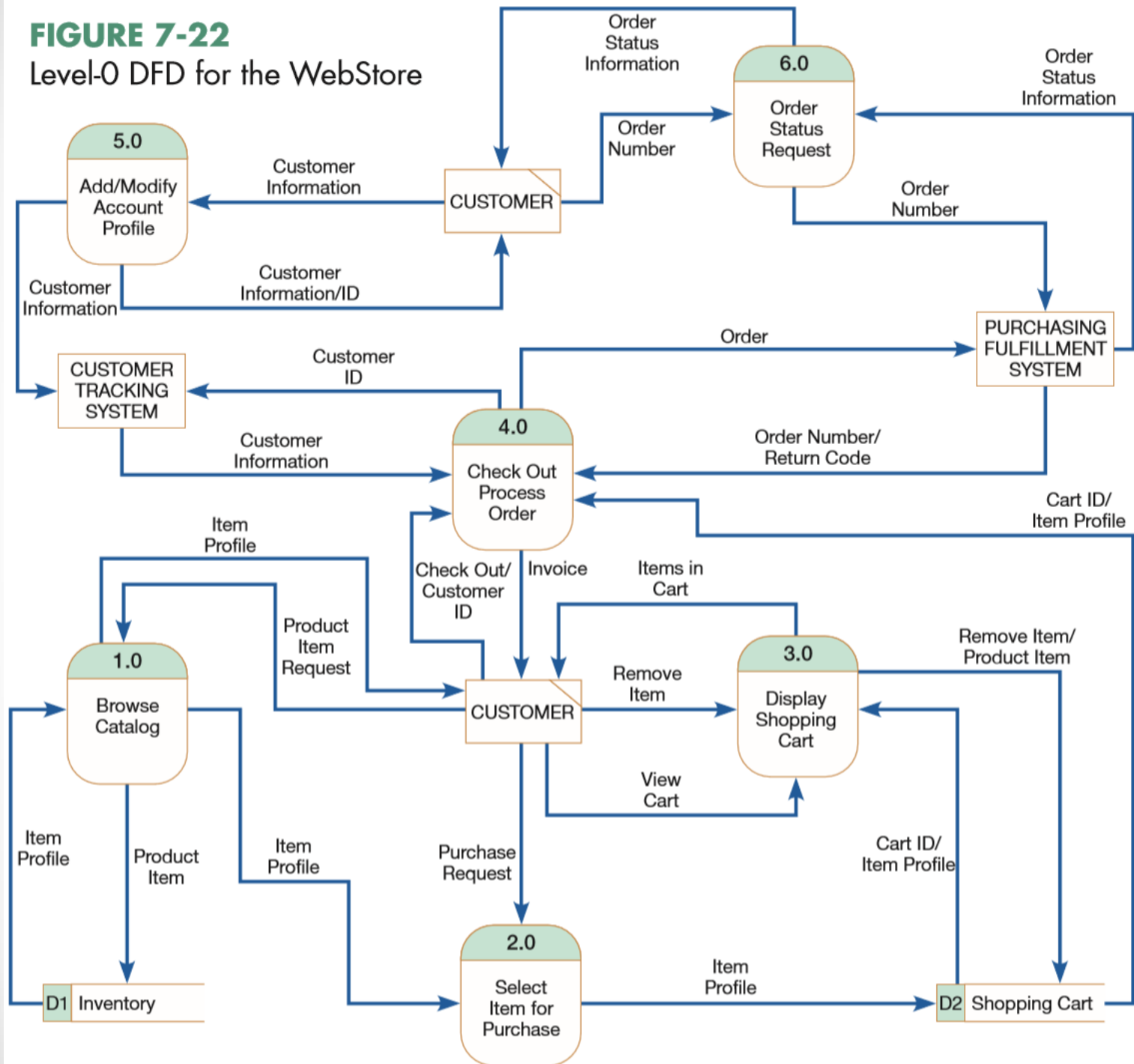
2. Determine **existing PVF systems** with which webstore can exchange information:
  1. *Customer Tracking System* (for managing customer information)
    - info. is *passed from webstore* system to this system when customer opens an account
  2. *Purchasing Fulfillment System* (for tracking orders)
    - info. is *stored in this system* when an order is placed, and
    - *retrieves* status info. on a prior order (at customer request)
- These 2 existing systems will be
  - “**sources**” (providers) of information, and
  - “**sinks**” (receivers) of information
- for webstore system

# Case Study 3: PVF Furniture Webstore

## Translating webstore system structure into DFD (cont.):

3. Determine additional data sources (i.e. **data stores**):
  1. access to *inventory database*
    - to produce an online product catalog
  2. *webstore shopping cart*
    - a temporary database
    - used to store the items a customer wants to purchase
    - shopping cart data can be deleted once transaction is completed
- Jim used these steps to develop [level-0 DFD for webstore system](#)

**FIGURE 7-22**  
Level-0 DFD for the WebStore



# Case Study 3: PVF Furniture Webstore

## Results of developing DFD for webstore:

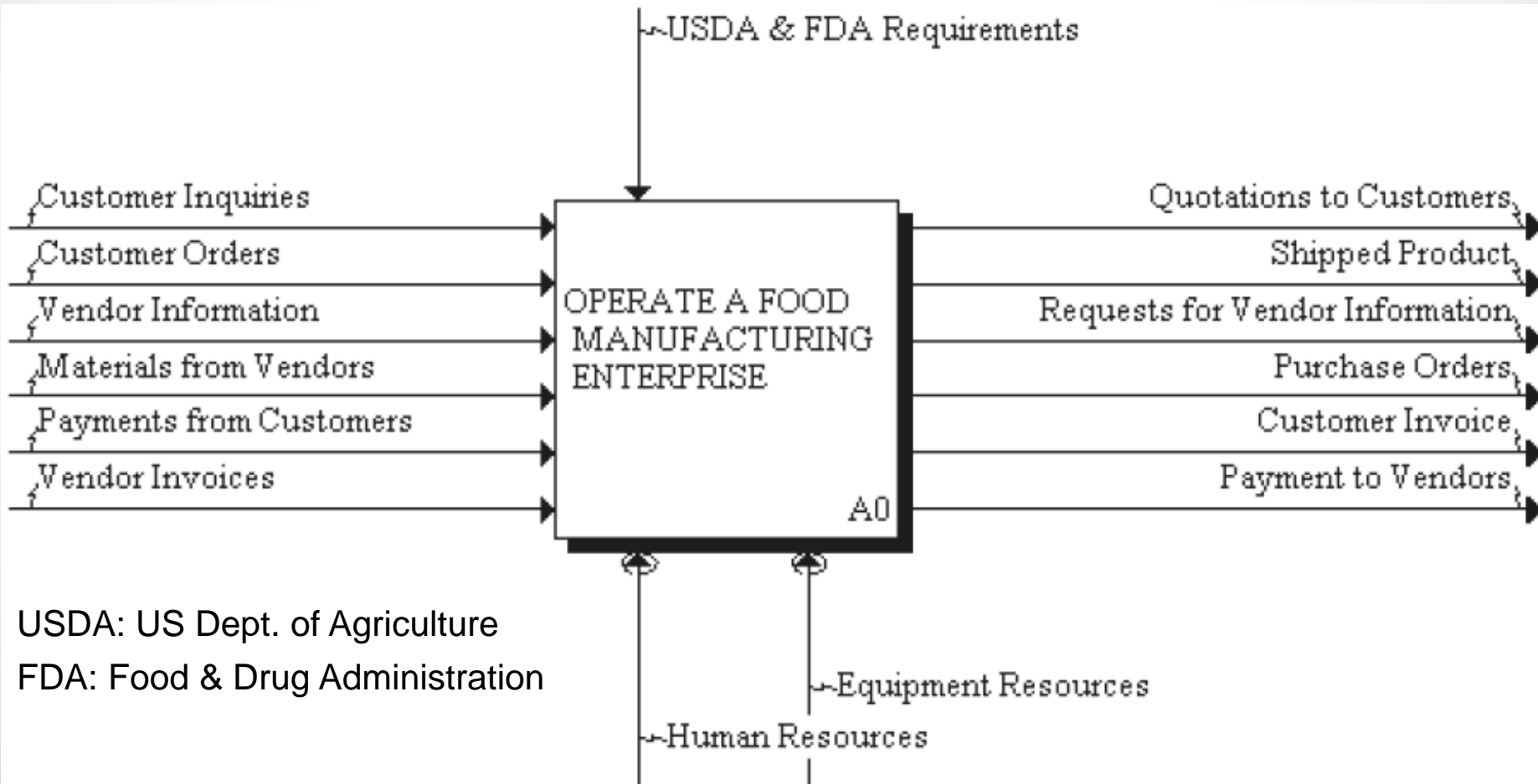
- good understanding of *information flow* through the webstore
- good understanding of *customer interaction* with the system
- good understanding of how the webstore *shares information* with existing PVF systems
- Note, each of these high-level processes needs (eventually) to be further decomposed before system design could proceed
- Also, another outcome of this analysis activity is *conceptual data modeling* (discussed later)

# Case Study 4 – Converting IDEF0 Model to DFD – Food Manufacturing Company



# Integrated IDEF0 Model of Mfg. Enterprise

- Top-level view of the enterprise: Node A0



# Decomposition of Node A0

A0 — Operate a Food Manufacturing Enterprise

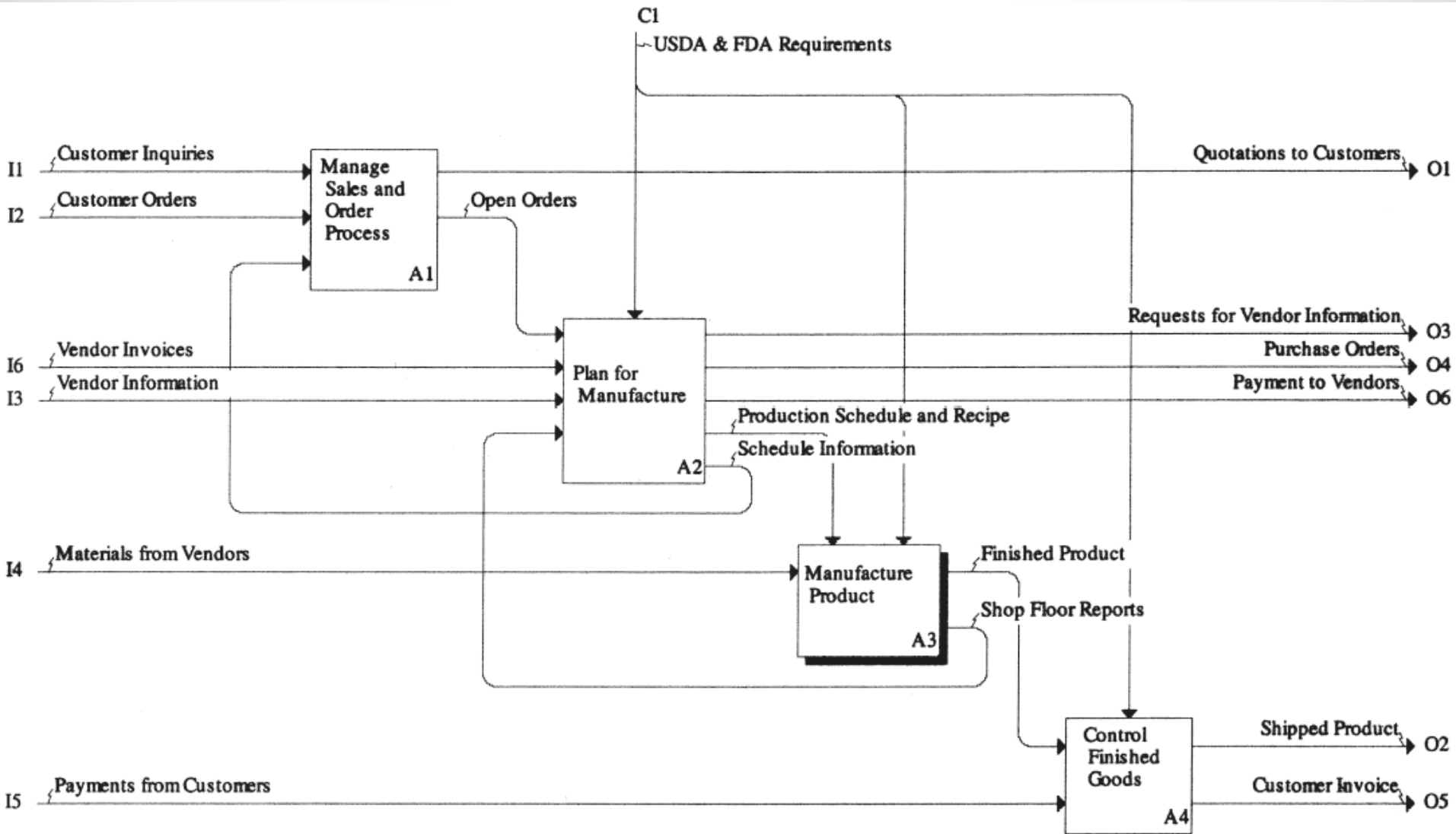
A1 — Manage Sales and Order Process

A2 — Plan for Manufacture

A3 — Manufacture Product

A4 — Control Finished Goods

# Decomposition of Node A0





# Decomposition of Node A3

A0 — Operate a Food Manufacturing Enterprise

A1 — Manage Sales and Order Process

A2 — Plan for Manufacture

A3 — Manufacture Product

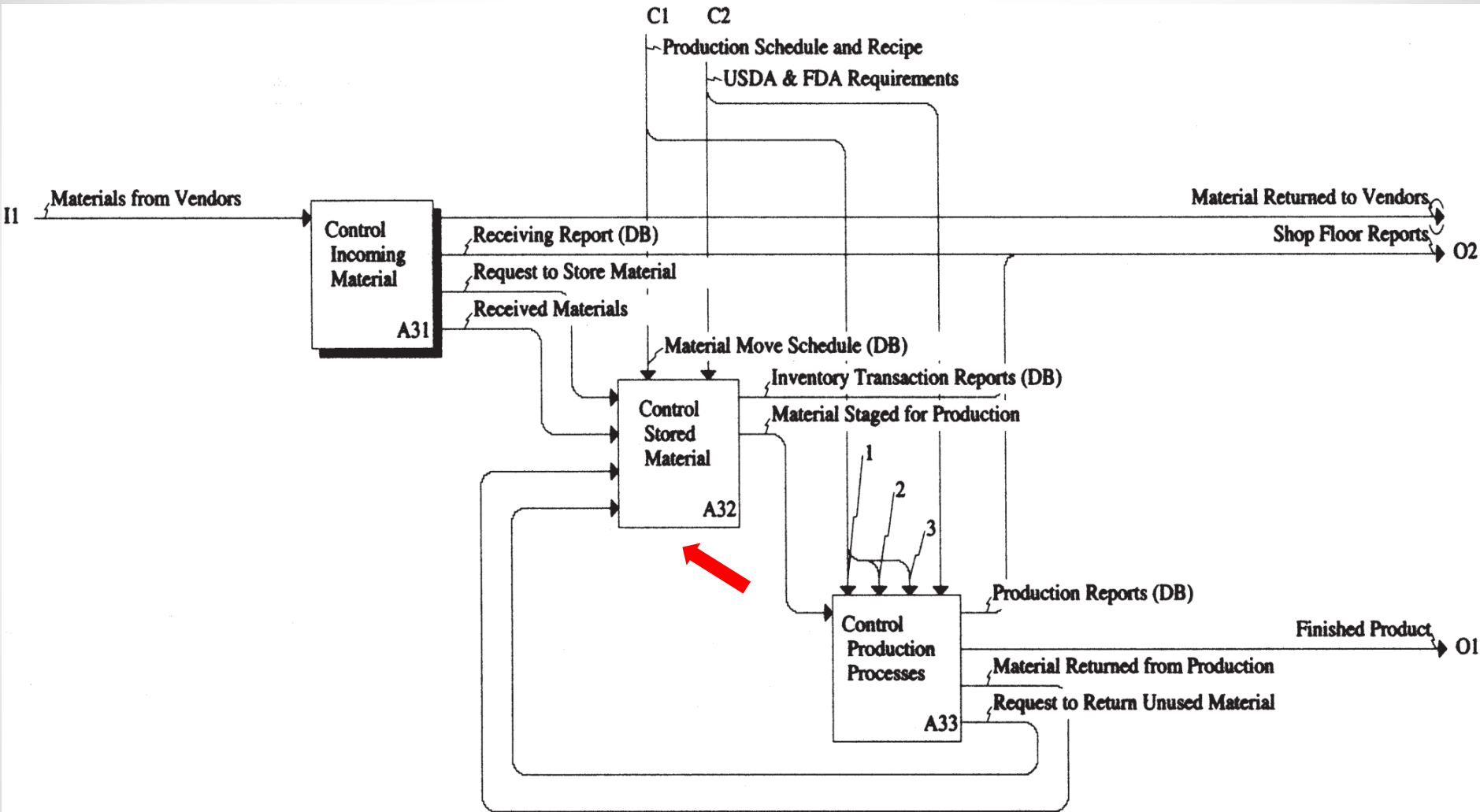
**A31 — Control Incoming Materials**

**A32 — Control Stored Material**

**A33 — Control Production Processes**

A4 — Control Finished Goods

# Hierarchic Decomposition Illustrated: Node A3

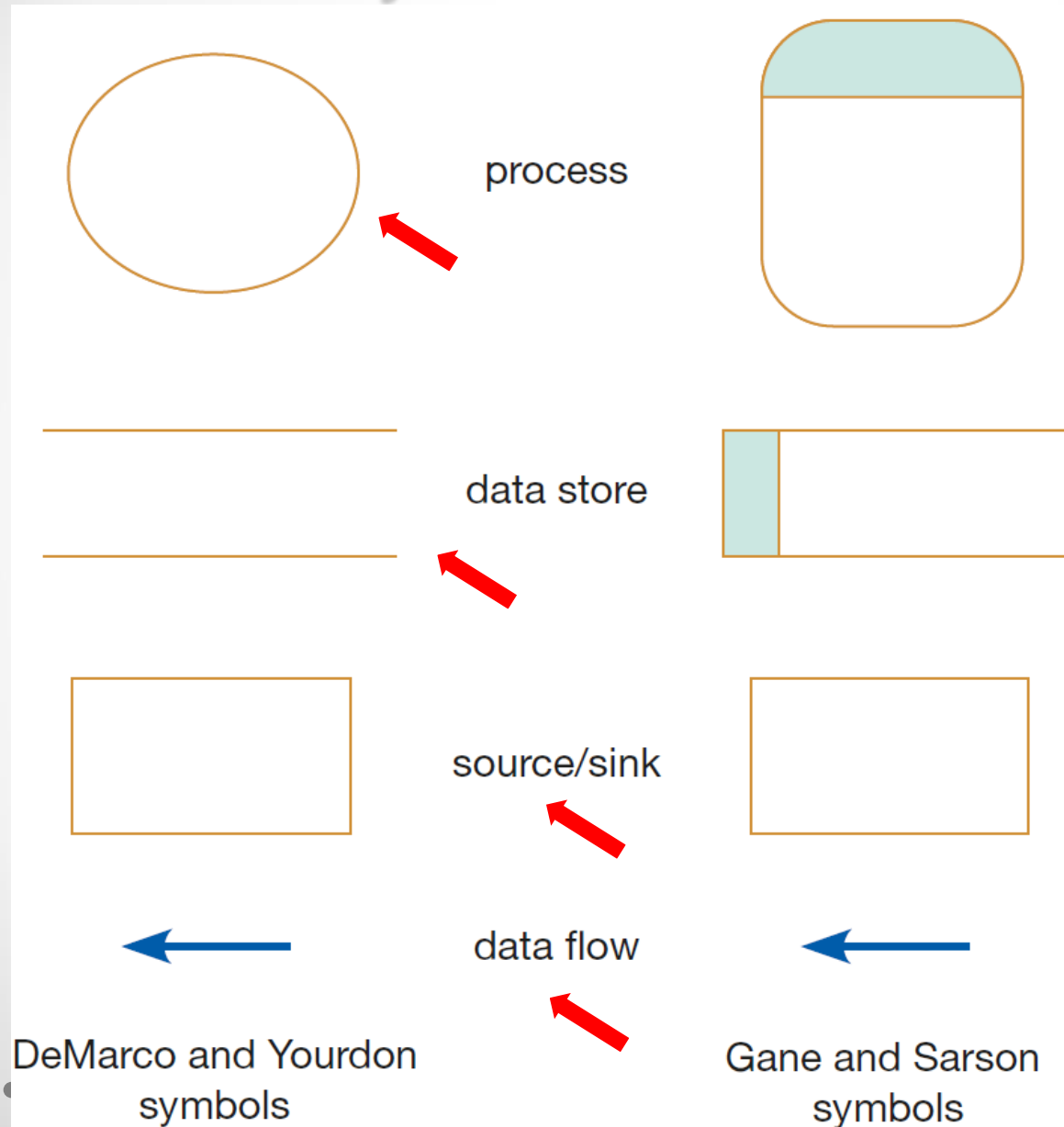


1 - Retort Processing Information (DB)

2 - Cook Sheet (DB)

3 - Day Production Schedule (DB)

# DFD Symbols/Notation (Reminder)



**FIGURE 7-2**  
Comparison of DeMarco and Yourdon and Gane and Sarson DFD symbol sets

# Context DFD of Node A32

- There are 3 source entities at boundary of system ([A32](#)):
  1. receiving (i.e. input from [Node A31](#))
  2. production planning (i.e. input from [Node A2](#)), and
  3. production (i.e. feedback from [Node A33](#))

## 1. **Receiving** ([Node A31](#)):

- this is the entity in charge of the process “Control Incoming Material”
- receiving is a “trigger” for process “Control Stored Materials” (i.e. it initiates an action in the process when it makes a **“request to store materials”**)

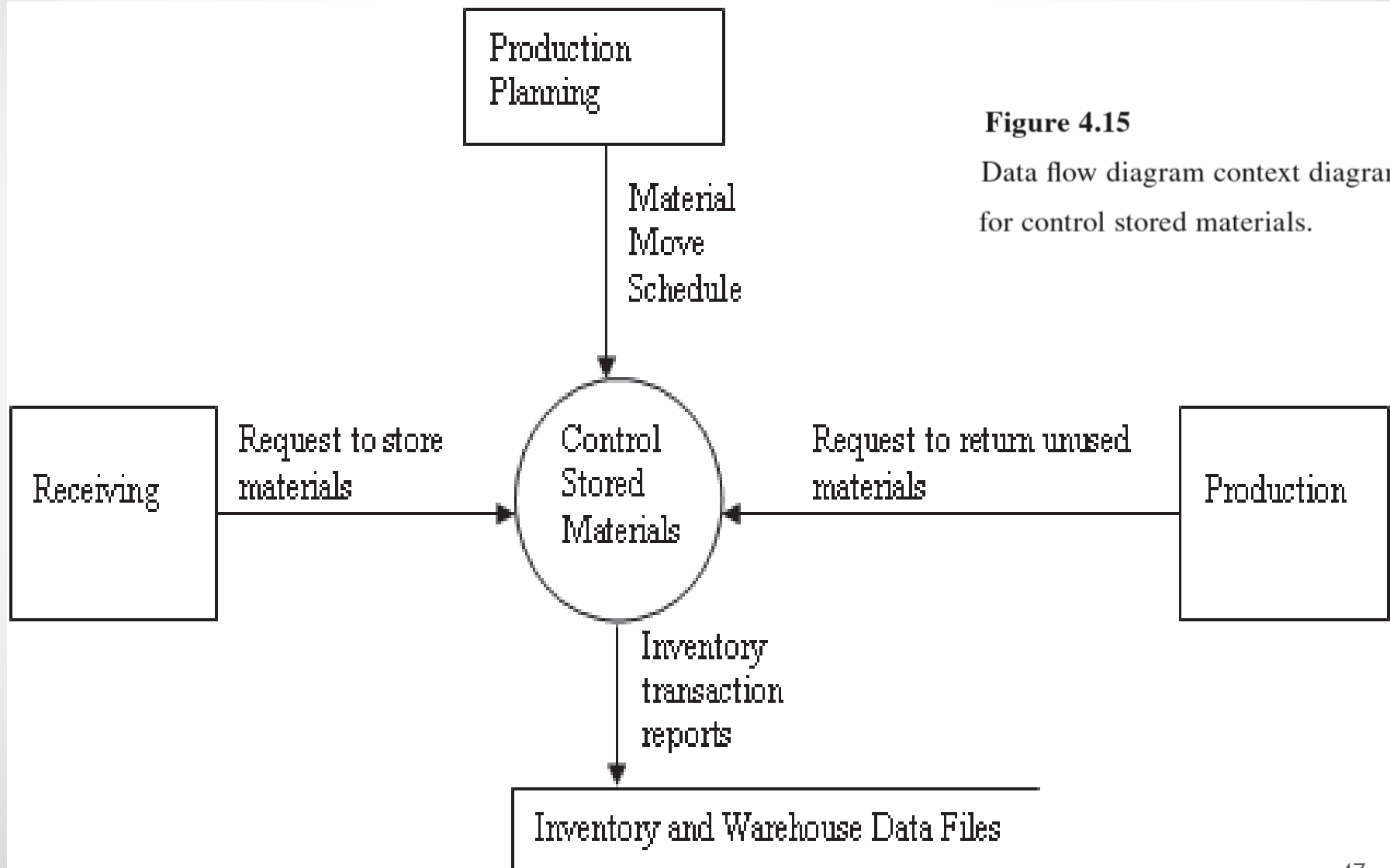
## Context DFD of Node A32 (cont.)

- There are 3 source entities at boundary of system ([A32](#)):
  1. receiving (i.e. input from [Node A31](#))
  2. production planning (i.e. input from [Node A2](#)), and
  3. production (i.e. feedback from [Node A33](#))
- 2. **Production planning** department ([Node A2](#))
  - source of another trigger
  - trigger (“**material move schedule**”) is to move raw material from warehouse to work in process – WIP

## Context DFD of Node A32 (cont.)

- There are 3 source entities at boundary of system ([A32](#)):
  1. receiving (i.e. input from [Node A31](#))
  2. production planning (i.e. input from [Node A2](#)), and
  3. production (i.e. feedback from [Node A33](#))
- **3. Production** ([Node A33](#))
  - “**request to return unused materials**” from production supervisor is another trigger to the process
  - raw material that has been moved into production but not used must be returned to storage
- Finally, the process sends (i.e. as output) an “**inventory transaction report**” to a *data store* ([see context DFD](#))

# Context DFD of Node A32 (cont.)



**Figure 4.15**

Data flow diagram context diagram for control stored materials.

# Decomposition of Context Data Flow Diagram

- The context process ([Control Stored Materials](#)) is composed of four level-0 processes ([see level-0 DFD](#)):
  1. **Store Raw Materials**
  2. **Move Raw Materials to WIP**
  3. **Return Unused Raw Materials to Storage**
  4. **Transfer Daily Records**



# Decomposition of Context Data Flow Diagram

- The overall structure of the data flow diagram hierarchy is often shown in a [process hierarchy chart](#)
- Process hierarchy chart:
  - series of block diagrams
  - show the hierarchic relationship among processes that are documented in the data flow diagrams

# Decomposition of Context Data Flow Diagram

The hierarchic process function:

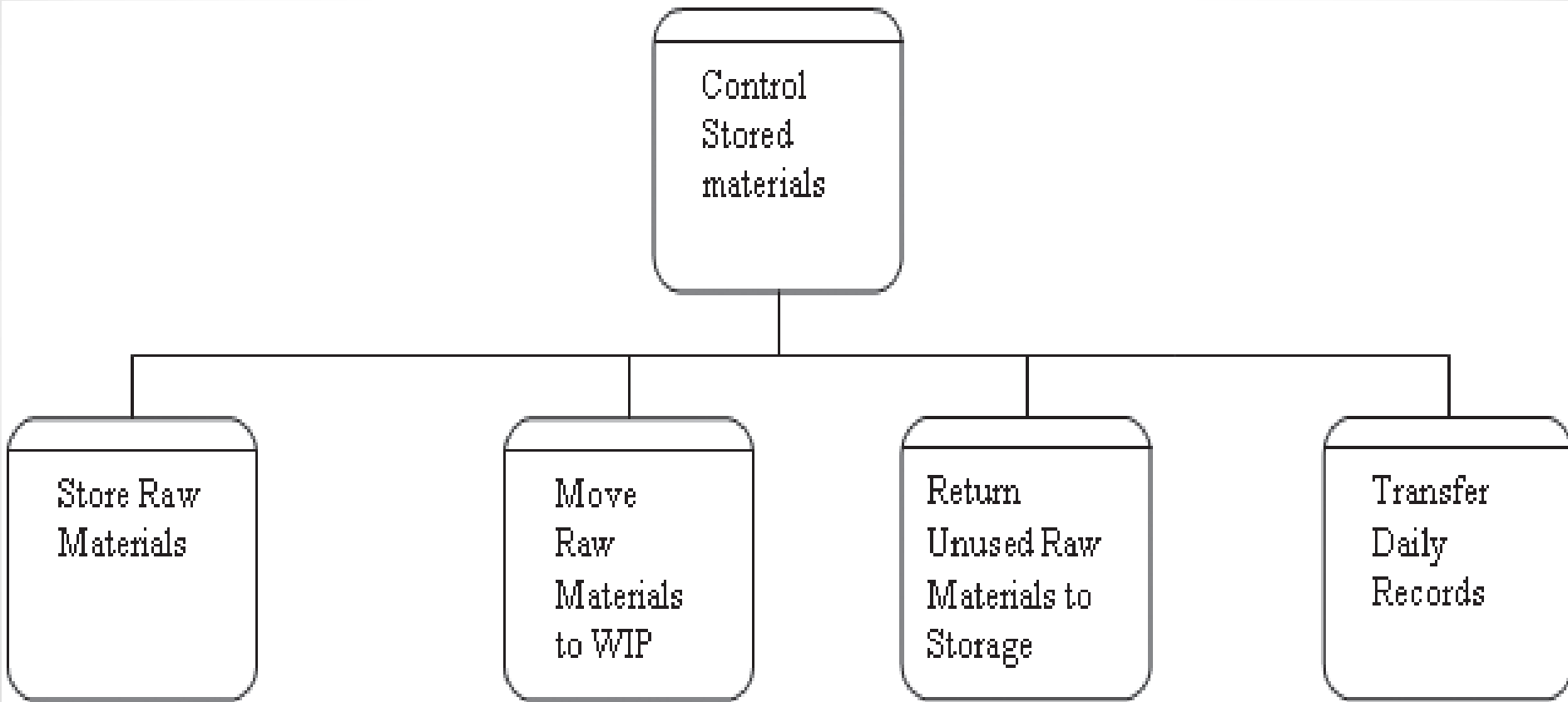
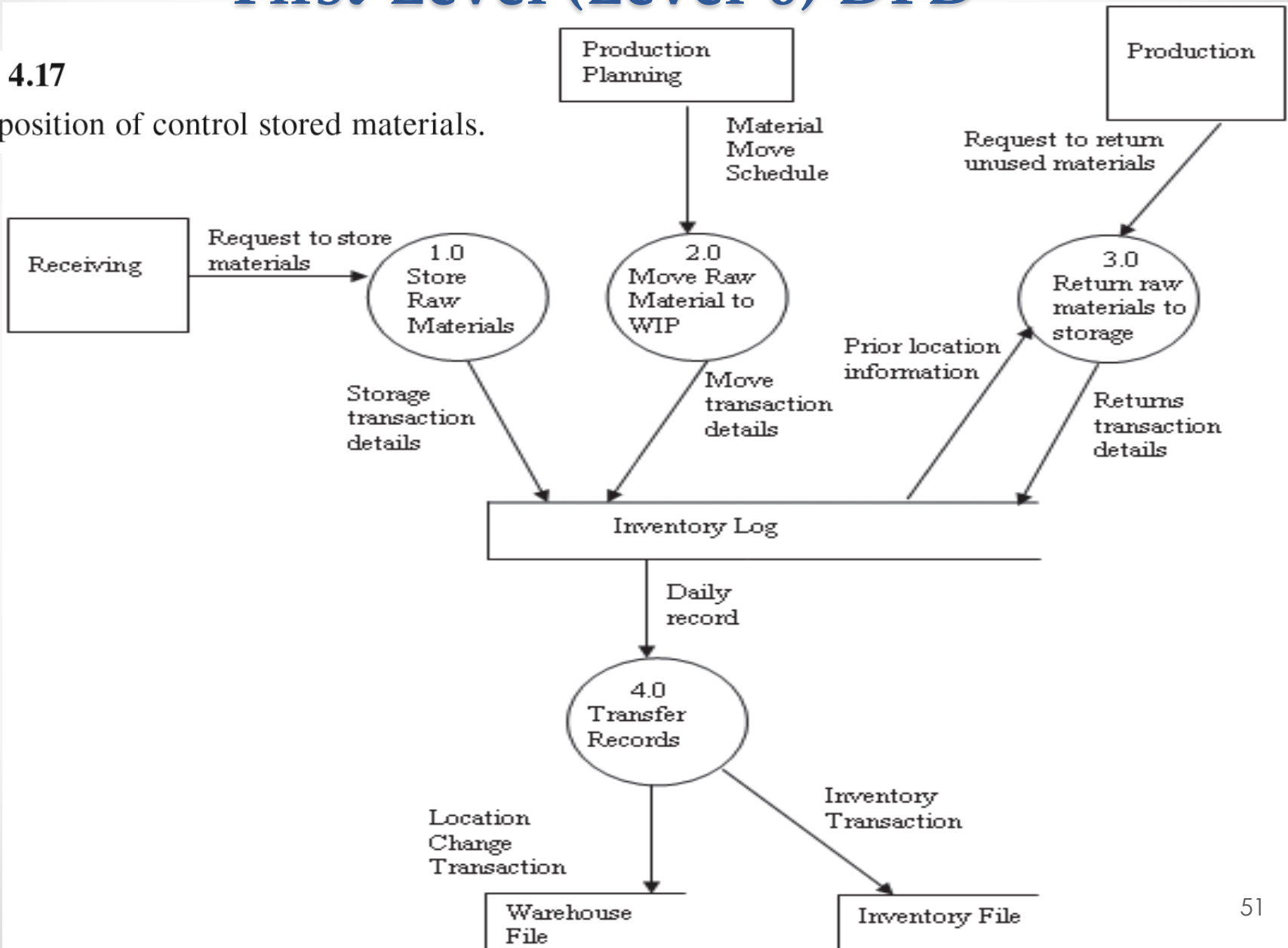


Figure 4.16 Process hierarchy chart.

# First-Level (Level-0) DFD

Figure 4.17

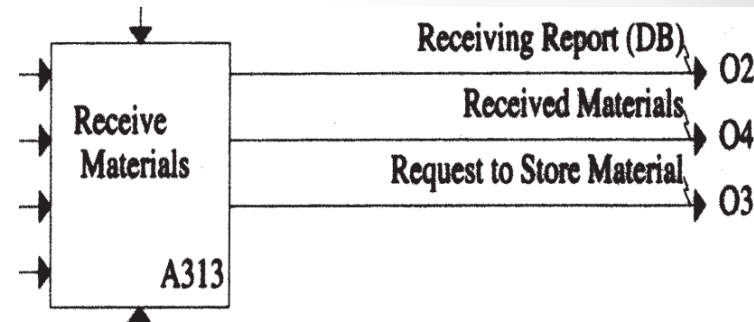
Decomposition of control stored materials.



# Description of First-Level (Level-0) DFD

## 1. Store raw materials:

- Receiving requests forklift truck driver to move material from the loading dock to inventory storage



- Driver takes the material to the warehouse
- Driver places the material in the required location
- Driver then records the following in the log,
  - material
  - location used, and
  - date and time of the transaction

# Description of First-Level (Level-0) DFD

## 2. Move raw material to WIP:

- Forklift truck driver is given the schedule of material moves from storage to the factory floor
- Each time the driver makes a move,
  - raw material inventory is *debited* and
  - status of the warehouse location is *updated*
- This is done by indicating a transaction to relieve inventory in the log:
  - recording the material
  - material location
  - date and time of the transaction

# Description of First-Level (Level-0) DFD

## 3. Return unused raw material to storage:

- Some materials that are brought to the factory floor may be returned if they are not used during production
- Upon request from production supervisor,
  - driver takes material *back to storage* and
  - *logs* the credit entry into the log

# Description of First-Level (Level-0) DFD

## 4. Transfer records:

- Forklift truck driver's inventory log is used as the primary record for updating
  - warehouse records and
  - inventory records
- This process is done at the end of the shift
- Materials management checks for any discrepancies between the receiving report and actual location of material
  - i.e. by comparing the log with the [receiving report](#)

## RECEIVING REPORT

**Supplier: General Provisions**  
**125 Common St.**  
**Boise, ID 44830**

**Purchase Order No.: PO3502**  
**Date Received: June 25 2006**

Quantity		Mfg. Lot No.	Item Code	Mat'L Lot No.	Description	Storage Location
accepted	not accepted					
1000		1275	RM805	97275	Tomato Paste, 1 gallon cans	Area A, Aisle 1 tier 1, bins 10-18
300		1283	"	97276	" " " "	Area A, Aisle 1 Tier 2, Bins 10-13
	100	"	"		" " " "	returned <sup>(1)</sup>

**Comments: (1) returned due to case damage and badly dented containers.**

**Received by: J. Debbis**



# Videos to Watch

- **What is DFD? Data Flow Diagram Symbols and More**  
<https://youtu.be/6VGTvgaJlIM> (*Smartdraw*)
- **How to Draw Data Flow Diagram?**  
<https://youtu.be/ztZsEl6C-mI> (*Visual Paradigm*)
- **DFD Diagram 0**  
<https://youtu.be/lk85hZkyYPA> (*Visible Analyst*)

# Sources

- **Modern Systems Analysis and Design.** Joseph S. Valacich and Joey F. George. Pearson. Eighth Ed. 2017. Chapter 7.
- **Design of Industrial Information Systems.** Thomas Boucher, and Ali Yalcin. Academic Press. First Ed. 2006. [Chapter 4](#).

