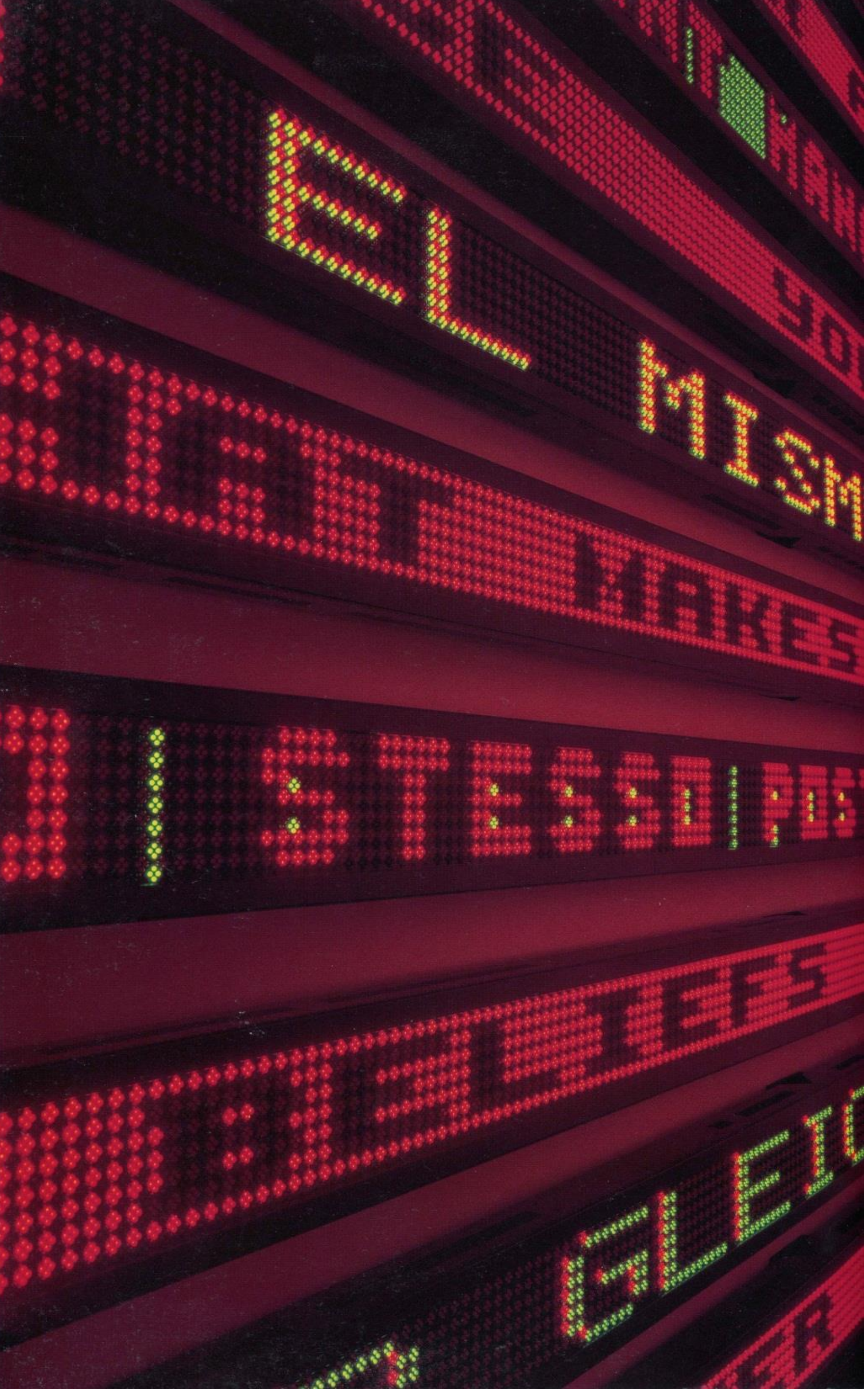


MIS 3504
Digital Design and Innovation

Process Flow

Stephen Salvia

Photo: Installation by Jenny Holzer, US Pavillion, Venice Biennale 1990

Process DIAGRAMMING

Understanding HOW people do their work

Think VISUALLY

TEXT Description

planning and presentation are strongly intertwined. Therefore both issues must be considered simultaneously.

The contributions of our work include:

Cognitive design principles for effective assembly instructions: We performed cognitive psychology experiments to identify how people conceive of the assembly process and to characterize the properties of well-designed instructions. Based on the results of these experiments and prior cognitive psychology research, we identify design principles for effective assembly instructions. These principles connect people's conceptual model of the assembly task to the visual representation of that task.

A system instantiating these design principles: Our assembly instruction design system consists of two parts: a planner and a presenter. The planner searches the space of feasible assembly sequences to find one that best matches the cognitive design principles. To do this the planner must also consider many aspects of presentation. The presenter then renders a diagram for each step of the assembly sequence generated by the planner. The presenter also uses the design principles to determine where to place parts, guidelines and arrows. In particular, the presenter can generate action diagrams which use the conventions of exploded views to clearly depict the parts and operation required in each assembly step.

2 Design Principles for Assembly Instructions

Before we can develop automated tools for designing assembly instructions, we must understand how people think about and communicate the process of assembling an object. Cognitive psychologists have developed a variety of techniques to investigate how people mentally represent ideas and concepts. We recently performed human subject experiments based on these techniques to determine the mental representations underlying assembly [Heiser and Tversky 2002]. We briefly describe our experimental setup.

In the first experiment, we asked participants to assemble a TV stand, given only a photograph of the completed stand as a guide. After they assembled the TV stand, we asked them to create a set of instructions that would show another person how to assemble it. Examples of the diagrams they drew are shown in Figure 2. In the second experiment, we asked a new group of participants to rank the effectiveness of a subset of the instructions produced in the first experiment. Finally, the third experiment tested whether the highly ranked instructions were more effective. Yet another group of participants used instructions ranked in the second experiment to assemble the TV stand, while experimenters recorded task completion time and error rates. We found that in general the highly rated instructions were easier to understand and follow. Participants spent less time assembling the TV stand and made fewer errors.

Based on these experiments, as well as earlier cognitive research, we identify a set of design principles for creating assembly instructions that are easy to understand and follow.

Hierarchy and grouping of parts: People think of assemblies as a hierarchy of parts. At the base level, parts are segmented by perceptual salience indexed by contour discontinuity; that is, parts that are disjoint are more likely to be segmented. Typically, the disjoint parts are also grouped by different functions (e.g. the legs of a chair or the drawers of a desk) [Tversky and Hemenway 1984]. When possible, people prefer that parts within a group are added to the assembly at the same time, or in sequence one after another. The part groups are usually considered as hierarchical structures, which parallel the subassembly structure of the object.

Structural Diagram   Action Diagram

Hierarchy of operations: People think of the attachment operations required to build an assembly as a hierarchy of actions on the parts [Zacks et al. 2001]. At the higher levels, people consider the operations required to combine separate subassemblies. Our experiments showed that as people work down the subassembly hierarchy, they eventually consider the operations required to join significant individual parts. At the lowest level of the hierarchy, people consider attaching smaller parts and fasteners to the more significant parts. The significance of a part depends on a number of factors including function, size, and symmetry.

While the hierarchy of operations may contain many levels for complicated objects with numerous subassemblies (e.g. a car engine), we have found that a two-level hierarchy (significant parts and less important parts + fasteners) is common for many build-at-home objects, including most furniture. In this paper we focus on design tools for these two levels.

Step-by-step instructions: Our experiments confirmed the results of Novick et al. [2000] showing that people prefer instructions that present the assembly operations across a sequence of diagrams rather than a single diagram showing all the operations. Moreover, if the assembly contains significant parts as well as less important parts, people generally prefer that each diagram show how to attach only one significant part at a time. However, each diagram will usually show multiple non-significant part attachments. In Figure 1, the non-significant parts include the fasteners and the wheels.

While it is essential that the assembly diagrams are clear and easy to read, each diagram should also present as much information as possible. If instructions are split across too many diagrams, they become tedious to use. Similarly, some assemblies require the same sequence of operations to be repeated many times. For example, when assembling a bookcase, each shelf is attached in exactly the same way. Depicting such repetitive operations in detail can make the instructions unnecessarily long and tiresome. A better approach is to skip repetitive operations after they have been presented in detail a few times.

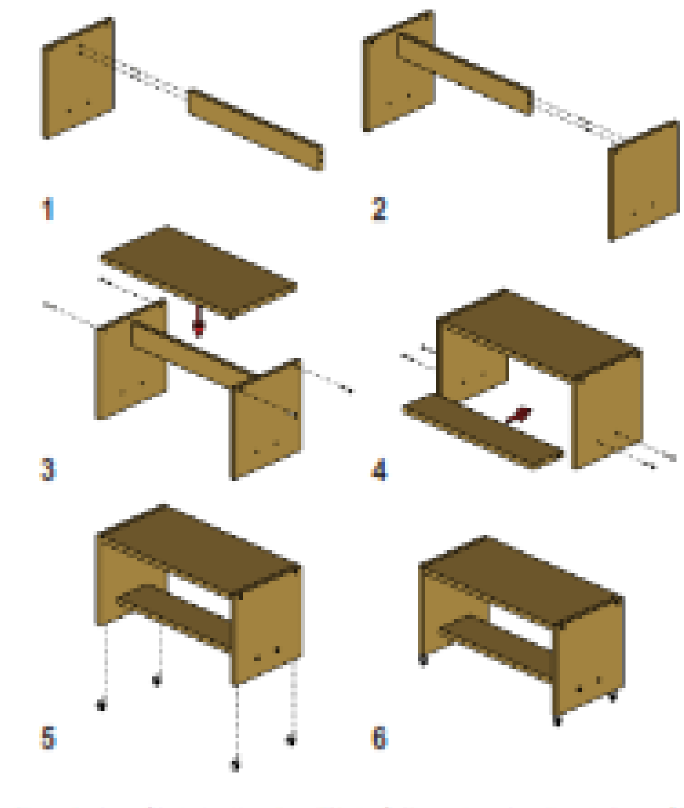
Structural diagrams and action diagrams: Based on analysis of the hand-drawn instructions we collected in the first experiment, we define two types of assembly diagrams: structural diagrams and action diagrams (see Figure 2). Structural diagrams present all the parts of the assembly in their final assembled positions; users must compare two consecutive diagrams to infer which parts are to be attached. Action diagrams spatially separate the parts to be attached from the parts that are already attached and use guidelines to indicate where the new parts attach to the earlier parts.

We found that action diagrams are superior to structural diagrams for the TV stand assembly task. We believe that this is because action diagrams contain all the information in the structural diagrams and also explicitly depict the attachment operations required in each step. However, toys such as LEGO often use structural diagrams rather than action diagrams. Showing the attachment operations may be less important because most LEGO parts fasten in the same way.

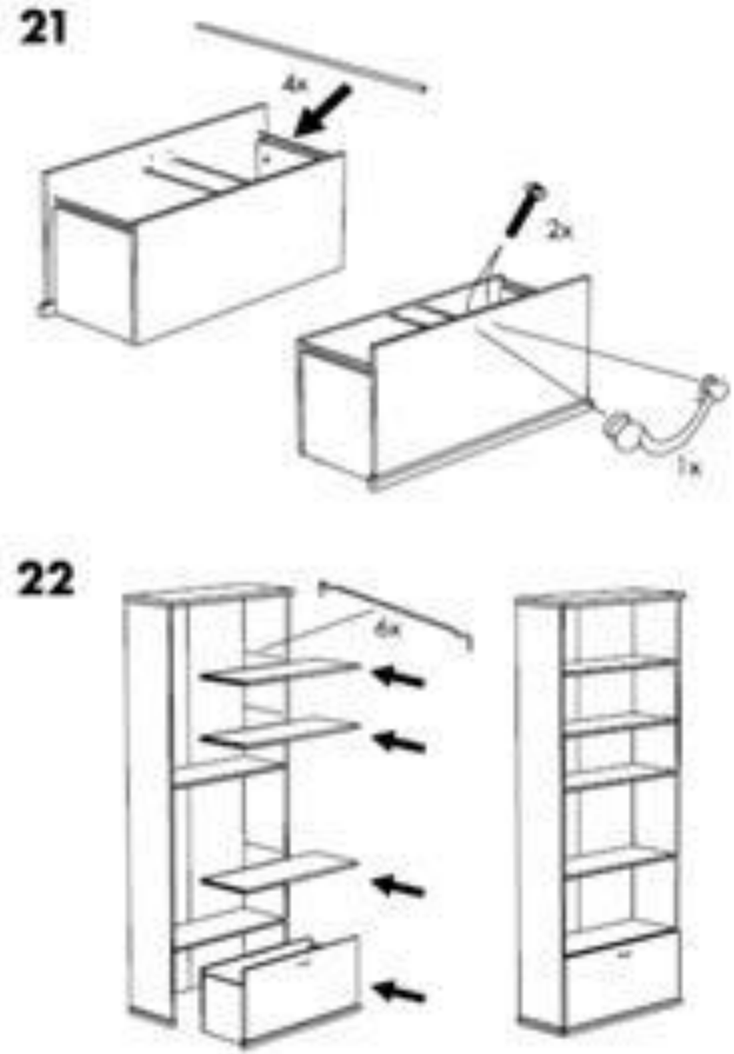
Orientation: Most objects have a set of natural orientations or preferred views [Palmer et al. 1981; Blanz et al. 1999]. These orien-

OR

Visual Diagram



What tells a better Story



assembly process: IKEA

What tells a better Story

If you need to explain to your team members how Steve's consultants firm is financially performing in terms of

- **Income vs Expense over twelve months**
- **Profitability over twelve months**

Which approach would you prefer?

- **Textual**
- **Graphical**

Example

Steve's Consulting Company Profitability

January income was four thousand dollars and the expenses were three thousand nine hundred dollars generating a profit of one hundred dollars.

February income was four thousand two hundred and thirty dollars and the expenses were four thousand one hundred dollars generating a profit of one hundred and thirty dollars.

March income was five thousand dollars and the expenses were four thousand nine hundred dollars generating a profit of one hundred dollars.

April income was six thousand two hundred dollars and the expenses were six thousand dollars generating a profit of two hundred and thirty dollars.

May income was six thousand dollars and the expenses were fiver thousand nine hundred dollars generating a profit of one hundred dollars.

June income was five thousand nine hundred and the expenses were fiver thousand eight hundred dollars generating a profit of one hundred dollars.

July income was six thousand one hundred and forty dollars and the expenses were six thousand dollars generating a profit of one hundred and forty dollars.

August income was six thousand four hundred and thirty dollars and the expenses were six thousand one hundred and fifty dollars generating a profit of two hundred and fifty dollars.

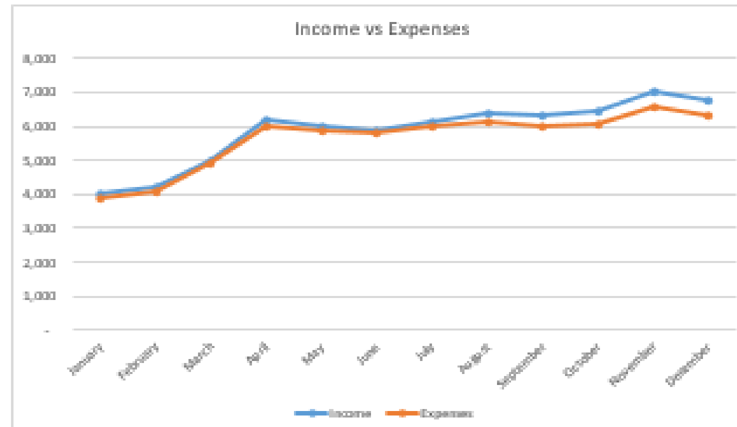
September income was six thousand three hundred and the expenses were six thousand dollars generating a profit of three hundred and thirty dollars.

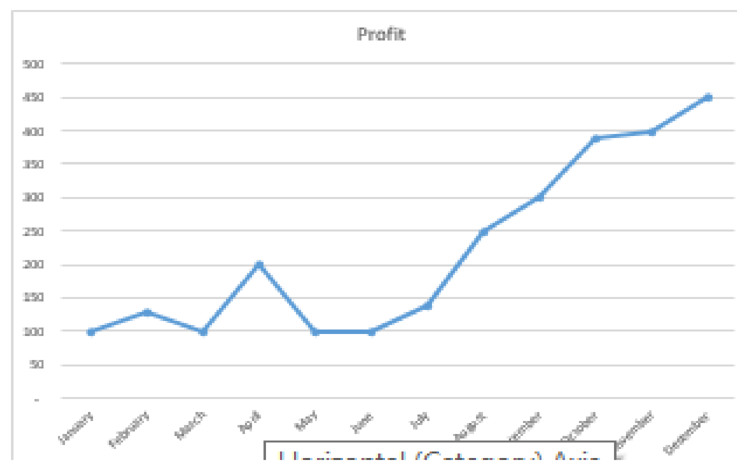
October income was six thousand four hundred and fifty dollars and the expenses were six thousand and sixty dollars generating a profit of three hundred and ninety dollars.

November income was seven thousand dollars and the expenses were six thousand six hundred dollars generating a profit of four hundred and thirty dollars.

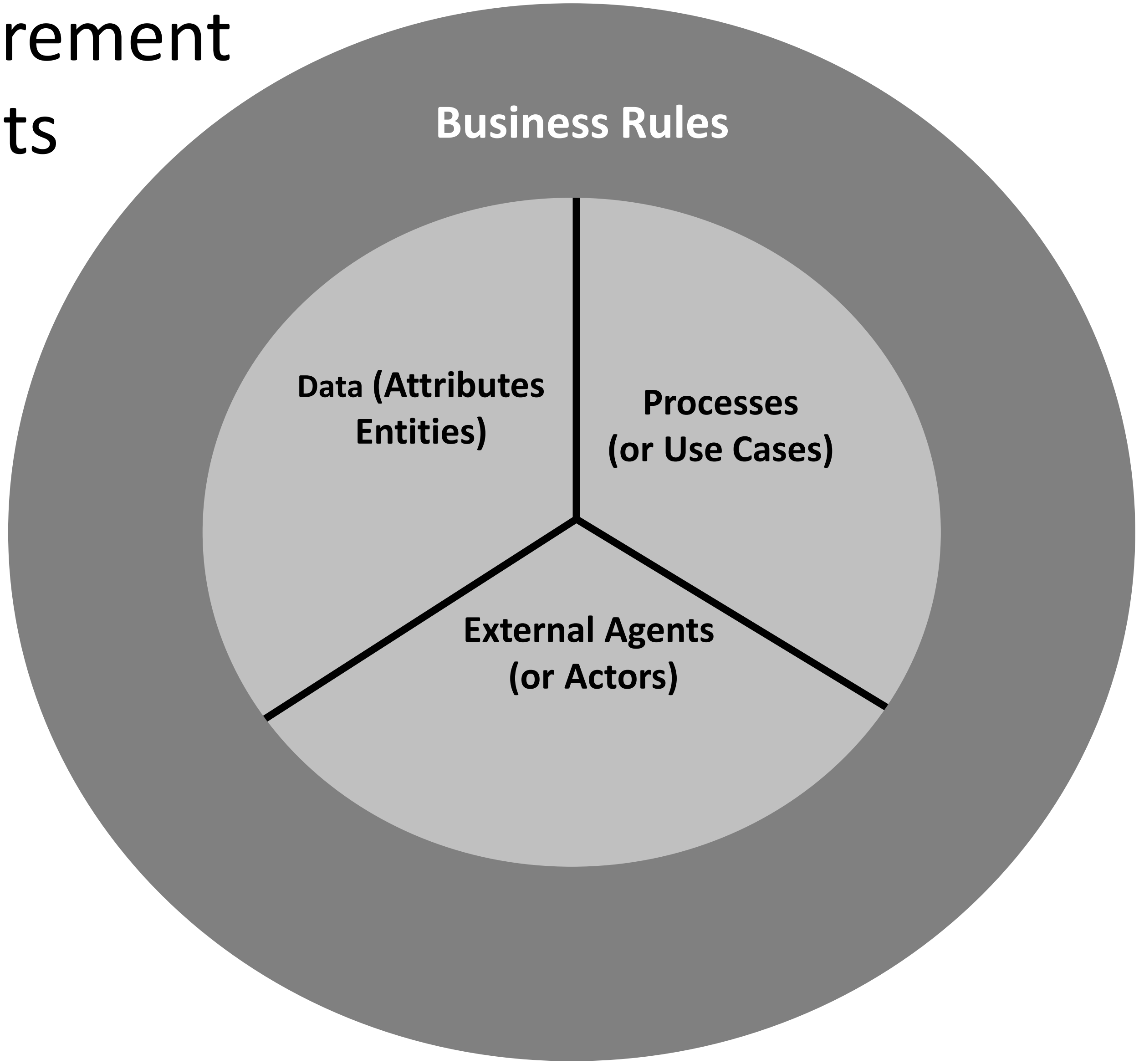
December income was six thousand eight hundred dollars and the expenses were six thousand three hundred and fifty dollars generating a profit of four hundred and fifty dollars.

Steve's Consulting Company Profitability





Core Requirement Components



Workflow Diagrams

- How would you describe a process you routinely use to a friend who wanted to do the same thing?
- Is it easier to use words or draw a picture of the steps you take?
- What would some uses of this approach be?

ASK THEM QUESTIONS:

- Capturing a routine process and explaining it to someone else is difficult, especially for more complex processes. Understanding how something works is critical to improving it. Therefore, getting a good understand of what happens when, how its done, how the steps relate and who decides what questions with what information along the way is a key skill for the BA.

- Word descriptions can be ambiguous. Drawing out the steps is usually seen as a better way to communicate the information of how a process works.
  - Mapping a work process for general understanding
  - process improvement
  - documenting computer logic to be written
  - writing emergency procedures, etc.

- This is a key technique for BA, systems development, process improvement, startups, etc.

Workflow Diagrams

- One of a Business Analyst’s key tools, especially for analyzing the as-is situation
- Great way to begin to understand process you are dealing with at high level
- Different levels of workflow can be used to explain the process to different audiences
- Can document Standard Operating Procedures (SOP’s)
- Revising the flow to facilitate improvements is standard design technique

What Does a Workflow Diagram Reveal:

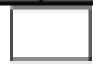
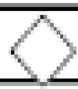
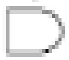
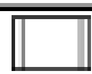
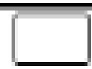
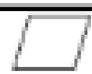
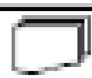
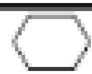
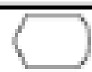
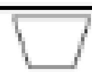
- The steps in a process
- A sequence of actions and responses/ decisions
- Problems in a process and revisions to improve it
- How work is accomplished
- how tasks interrelate
- What information flows through the process
- What decisions are made
- How individual workers are involved with the process

Workflow Diagrams

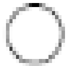
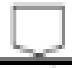
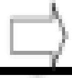
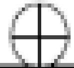
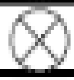
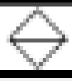
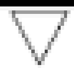
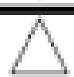
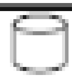
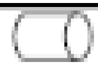
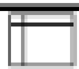
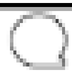
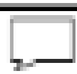
- What would we want to include in a workflow diagram?
- There are many different types of workflow diagrams, we will focus on one.
  - **Swim Lane Flowcharting**
  - ANSI Flowcharting
  - UML Activity Diagrams
  - SIPOC (supplier-input-process-output-customer)
  - Use Case Diagram

Flow Chart
Symbols

Flowchart Symbol Cheat Sheet

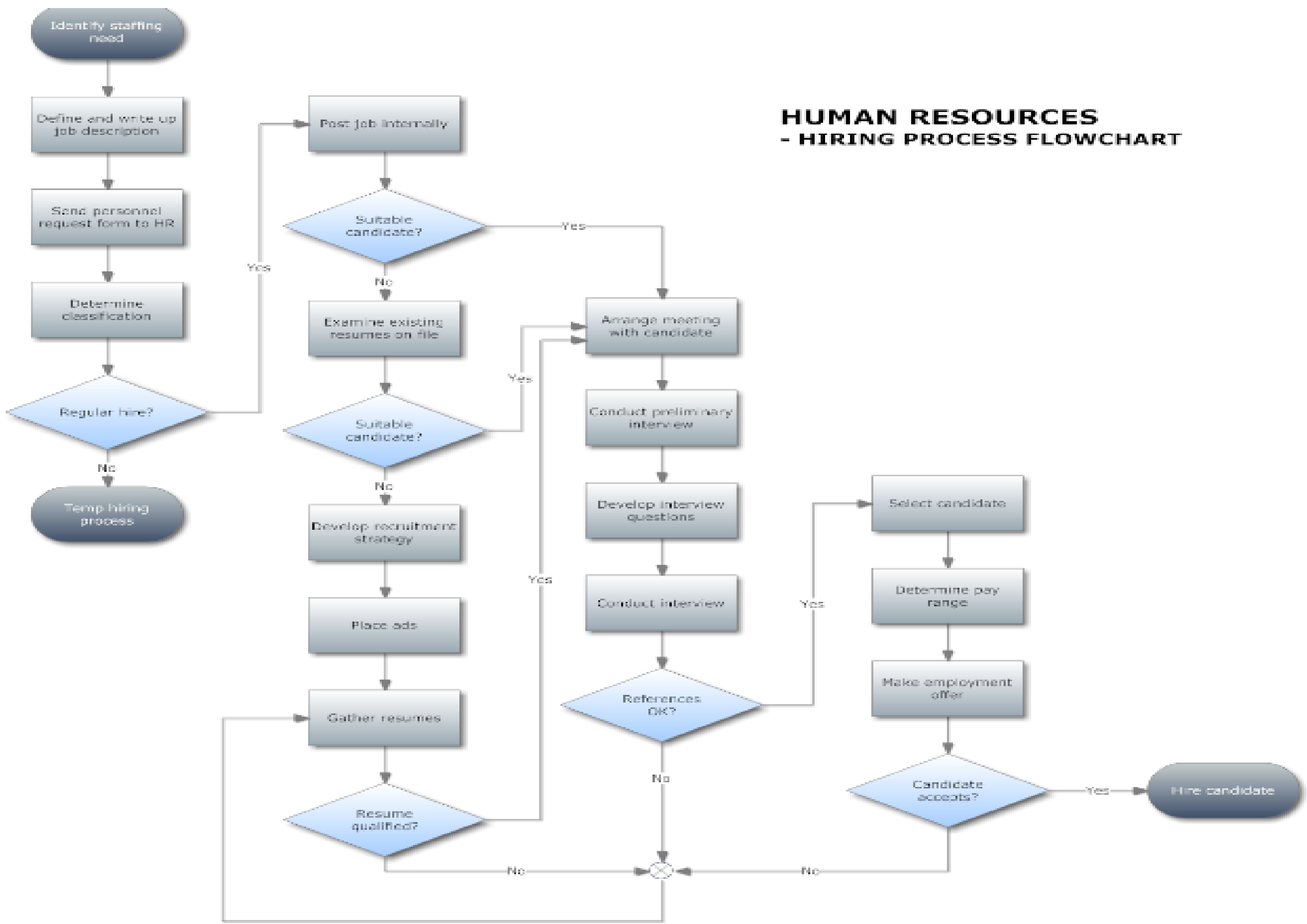
Flowchart Symbol	Name (Alternates)	Description
	Process	An operation or action step.
	Terminator	A start or stop point in a process.
	Decision	A question or branch in the process.
	Delay	A waiting period.
	Predefined Process	A formally defined sub-process.
	Alternate Process	An alternate to the normal process step.
	Data (I/O)	Indicates data inputs and outputs to and from a process.
	Document	A document or report.
	Multi-Document	Same as Document, except, well, multiple documents.
	Preparation	A preparation or set-up process step.
	Display	A machine display.
	Manual Input	Manually input into a system.
	Manual Operation	A process step that isn't automated.
	Card	A old computer punch card.

Flow Chart Symbols

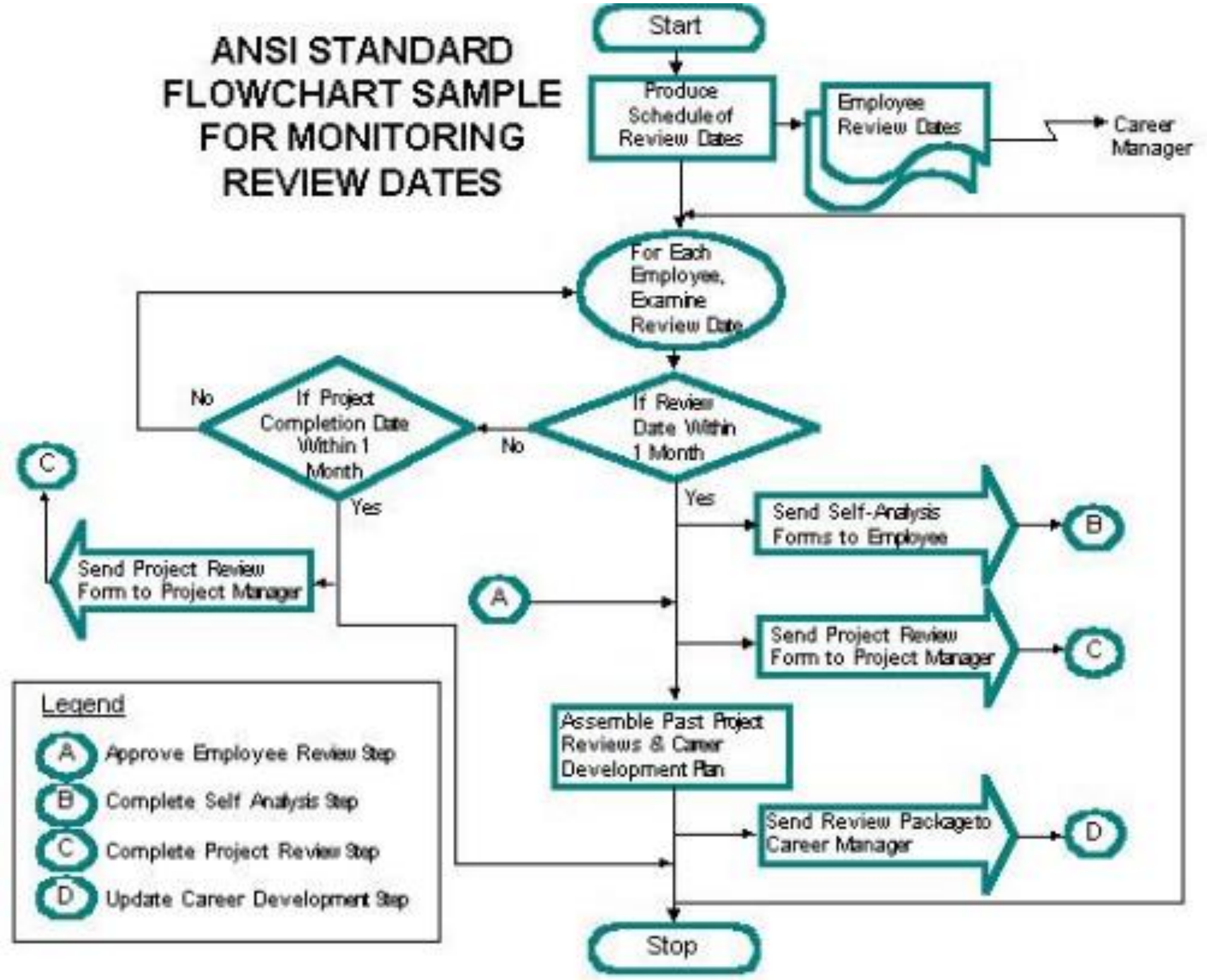
	Punched Tape	An old computer punched tape input.
	Connector	A jump from one point to another.
	Off-Page Connector	Continuation onto another page.
	Transfer	Transfer of materials.
	Or	Logical OR
	Summing Junction	Logical AND
	Collate	Organizing data into a standard format or arrangement.
	Sort	Sorting of data into some pre-defined order.
	Merge (Storage)	Merge multiple processes into one. Also used to show raw material storage.
	Extract (Measurement) (Finished Goods)	Extract (split processes) or more commonly - a measurement or finished goods.
	Stored Data	A general data storage flowchart symbol.
	Magnetic Disk (Database)	A database.
	Direct Access Storage	Storage on a hard drive.
	Internal Storage	Data stored in memory.
	Sequential Access Storage (Magnetic Tape)	An old reel of tape.
	Callout	One of many callout symbols used to add comments to a flowchart
	Flow Line	Indicates the direction of flow for materials and/or information

Flowchart

Samples links:

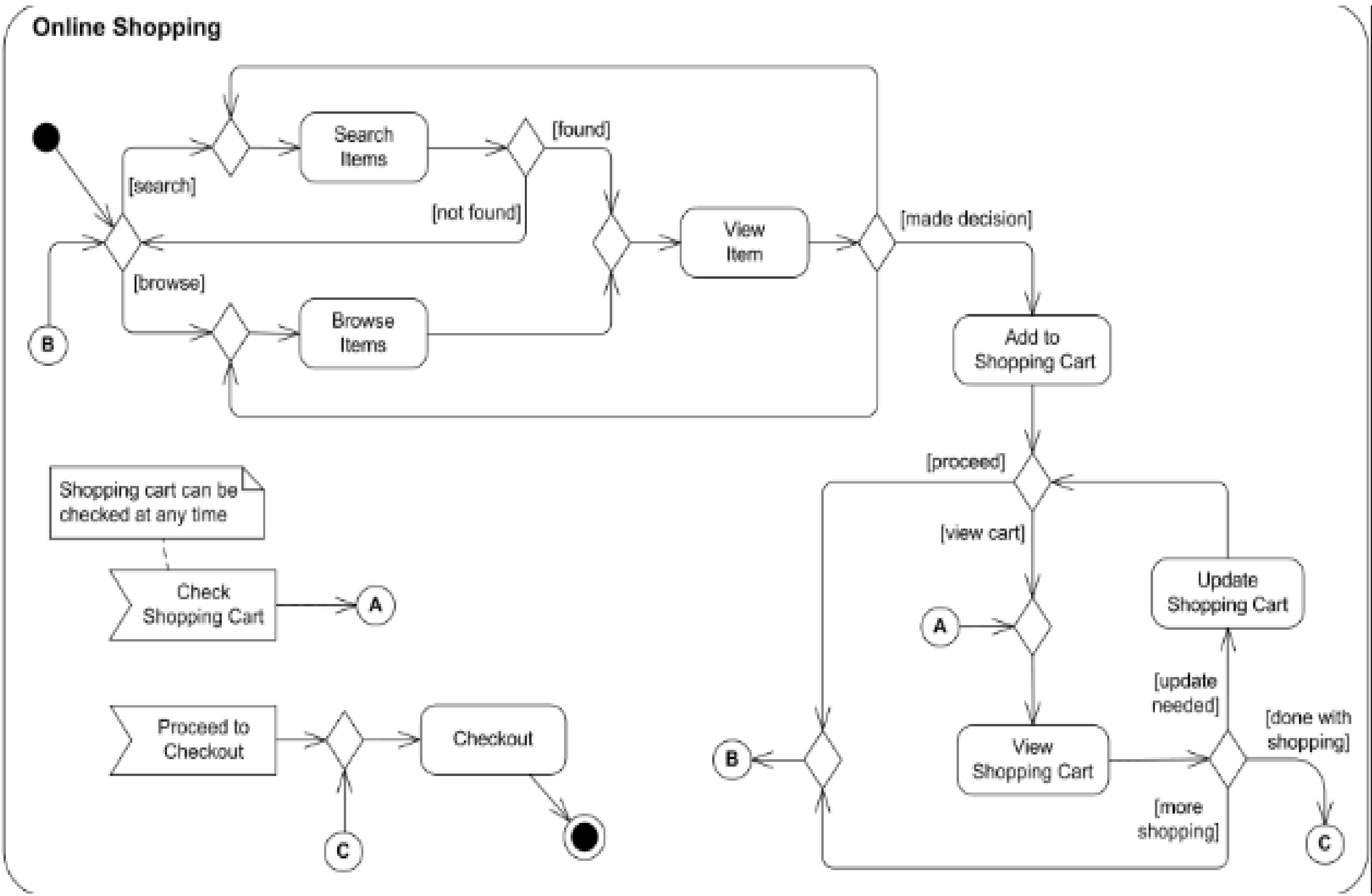


Flow Chart
Example



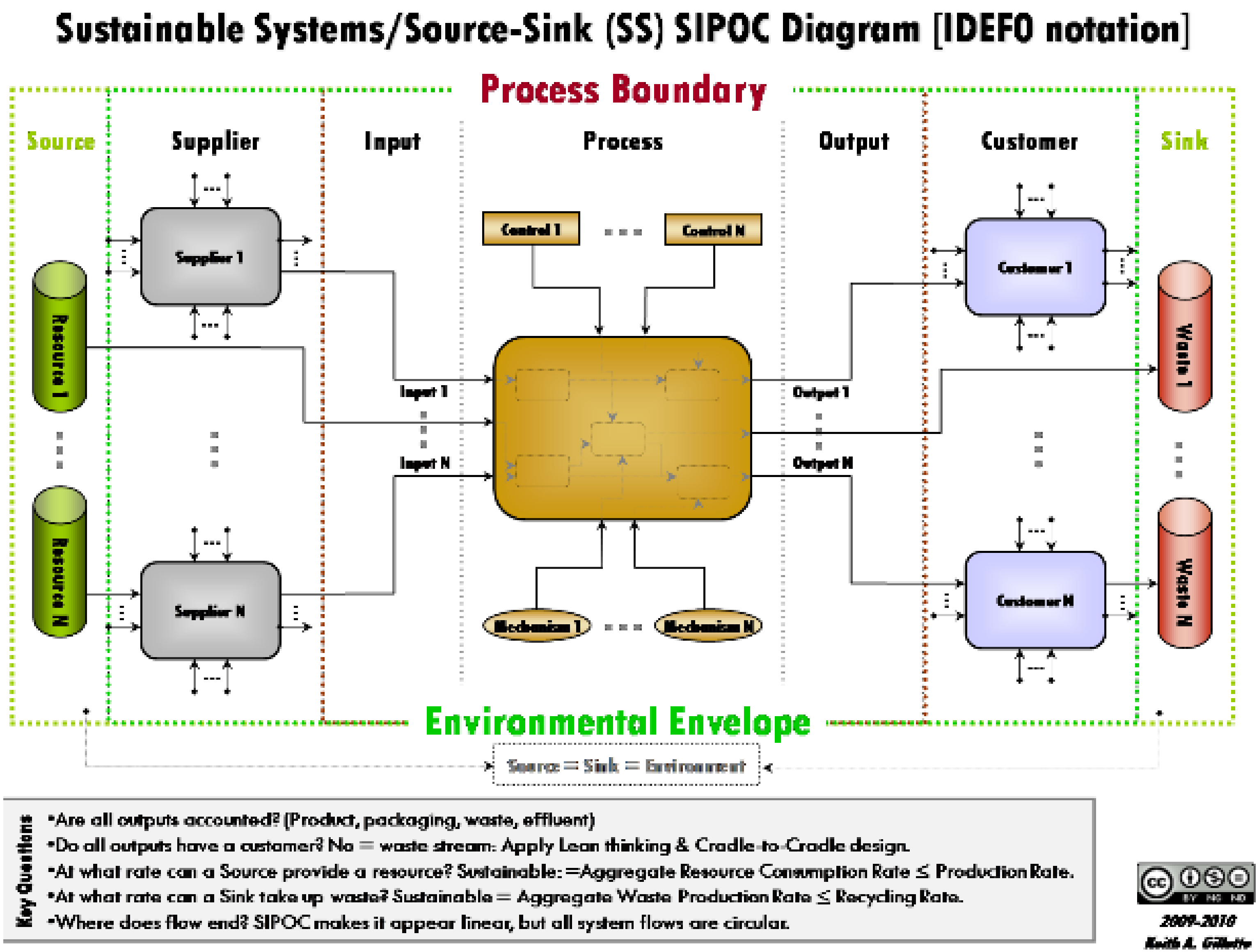
UML Activity Diagram

[Samples links:]()



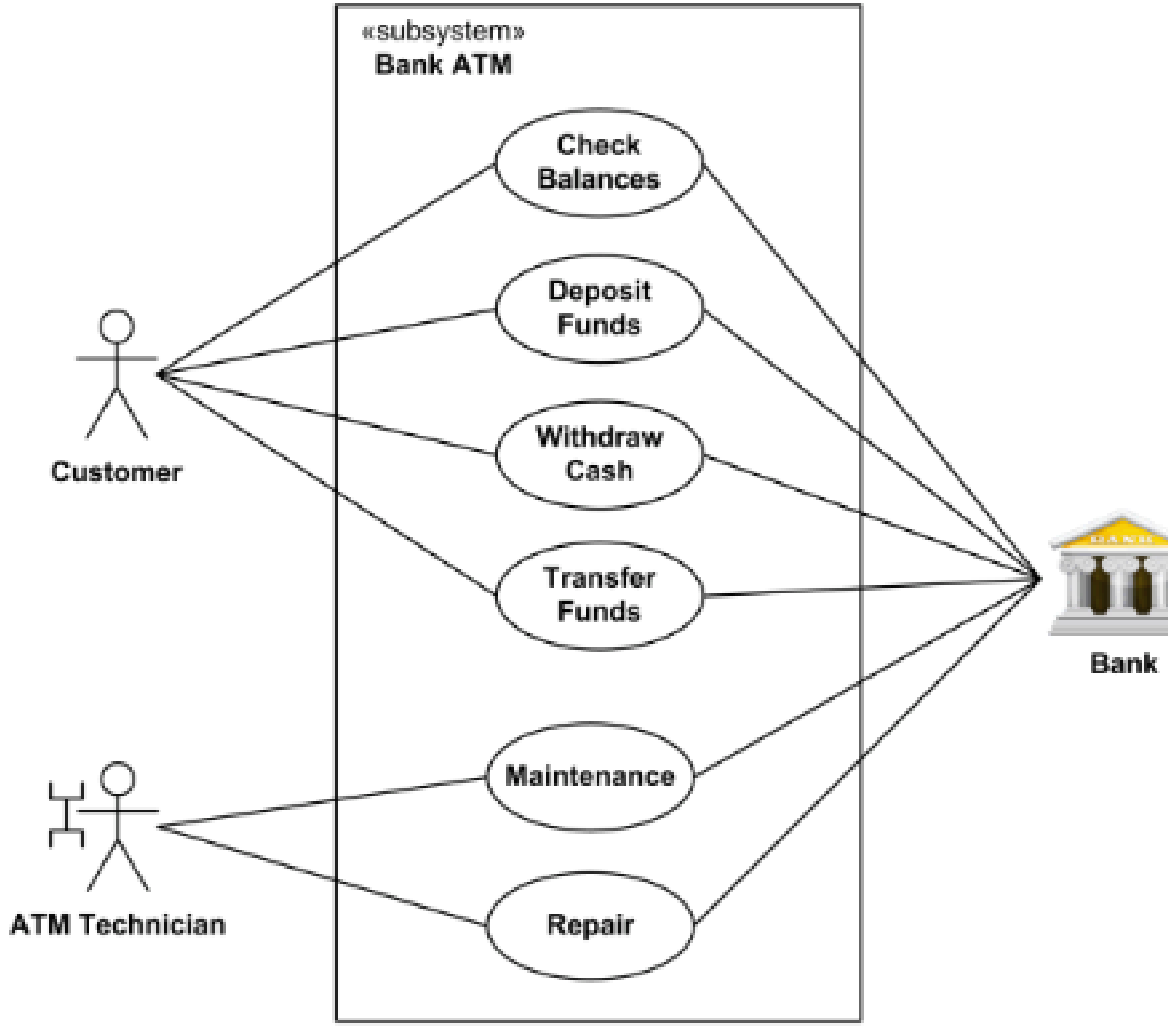
SIPOC (supplier-input-process-output-customer)

[Samples links:]



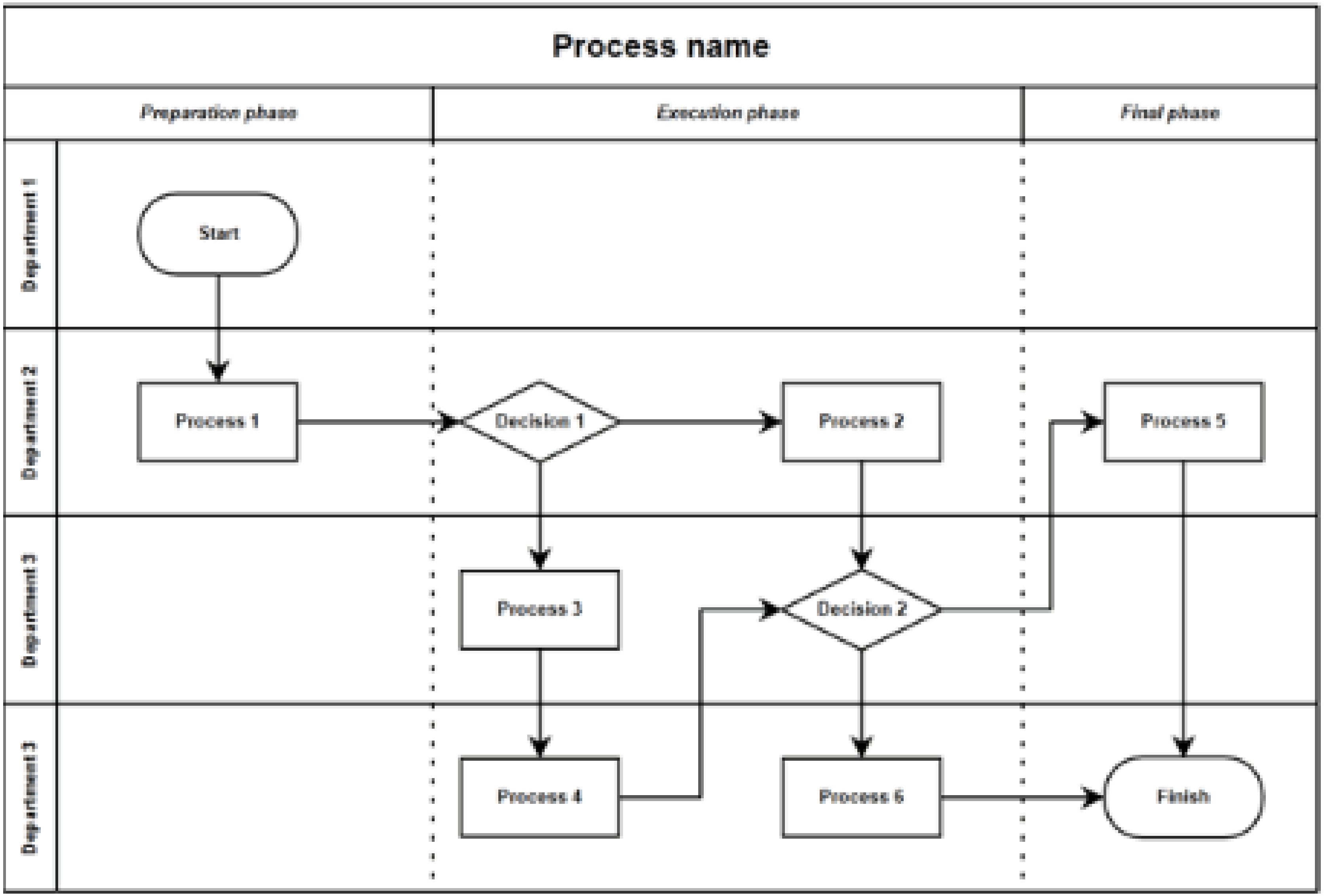
Use Case Diagram

[Samples links:]

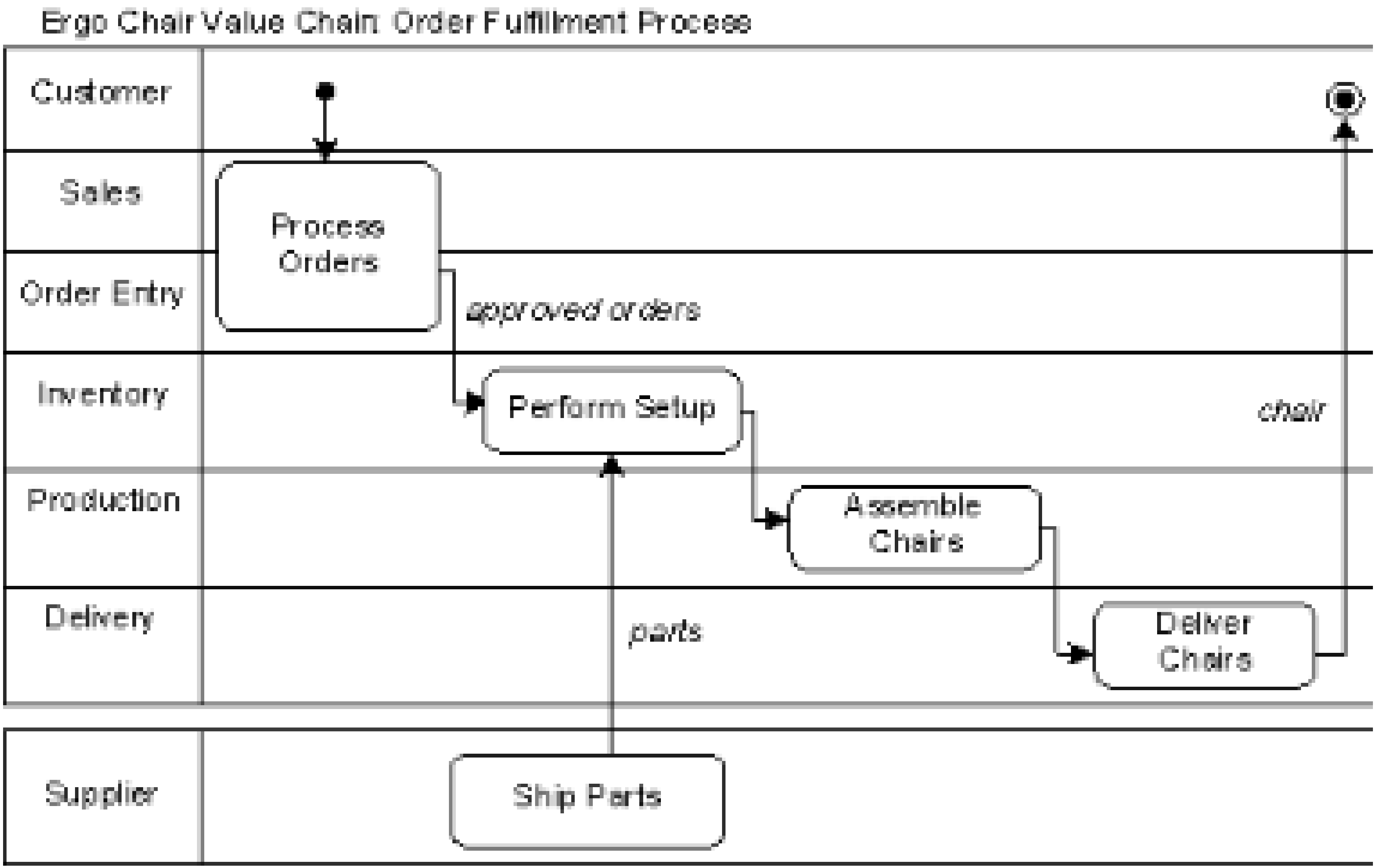


Swim Lane Diagram

Samples links:



Swim Lane Diagram



Think:

Actors [who]

Actions [what]

Decisions

Sequence [when]

Space [where]

RELATIONSHIPS

Swim Lane Process Mapping

1. Name the process - subject+verb+object

1. What’s the business event that initiates the process?

1. What’s the outcome of the process?

Swim Lane Process Mapping

1. Name the process - subject+verb+object

Warehouse Receives Materials

1. What's the business event that initiates the process?

Receive Materials

1. What's the outcome of the process?

Materials are Stored

ABC Assembly Company
Material Delivery Process

- Manufacture delivers and unloads materials at the ABC Assembly Company Loading Dock
- Receiving Clerk receives invoice paper work describing delivered materials and creates new entries of the materials in the Warehouse Management System
- Receiving Clerk send memo via hardcopy to the Warehouse Foreman indicating the new materials have arrived on the loading doc and are ready to be stored in the proper material bin locations which will later be used in the assemble process by the production teams.
- The Warehouse Foreman performs a visual scan of the location bins to determine where to store the arriving materials. The location for storage is critical as there are physical weight limitations on the quantity of material store in each bin and the material has expiration dates that require first in first out usage during manufacturing
- The Warehouse Foreman make the material location determinations and then will verbally tell the Forklift Driver where to place the newly arrived materials
- When the Forklift Driver has completed storing all the new materials in the verbally assigned bin location(s), they will then verbally communicate to the Warehouse Foreman the storage locations
- The Warehouse Foreman will log into the Warehouse Management System to update the new entries that the Receiving Clerk initially entered into the system with the storage locations
- The Receiving Clerk will periodically check the Warehouse Management System confirm the bin locations have been updated by the Warehouse Foreman
- The Material Delivery Process is completed

Swim Lane Workflow Exercise

- With your teammates,
- Take 15 minutes to imagine the steps of the steps a warehouse goes through when it receives material from its suppliers
- Sketch it out if you can
- Be ready to share your ideas

Swim Lane Process Mapping

Receiving Dock

Receiving Clerk

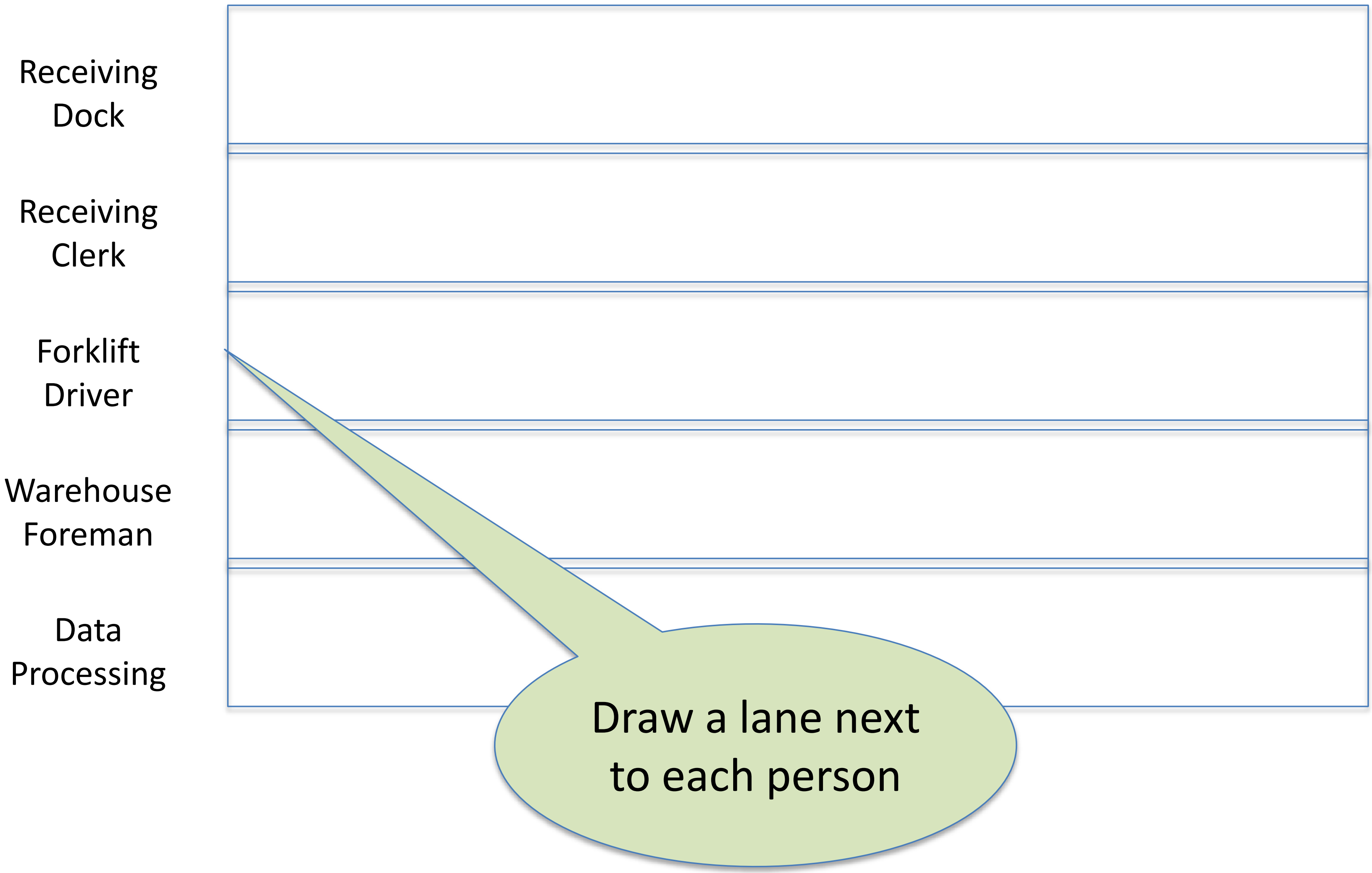
Forklift Driver

Warehouse Foreman

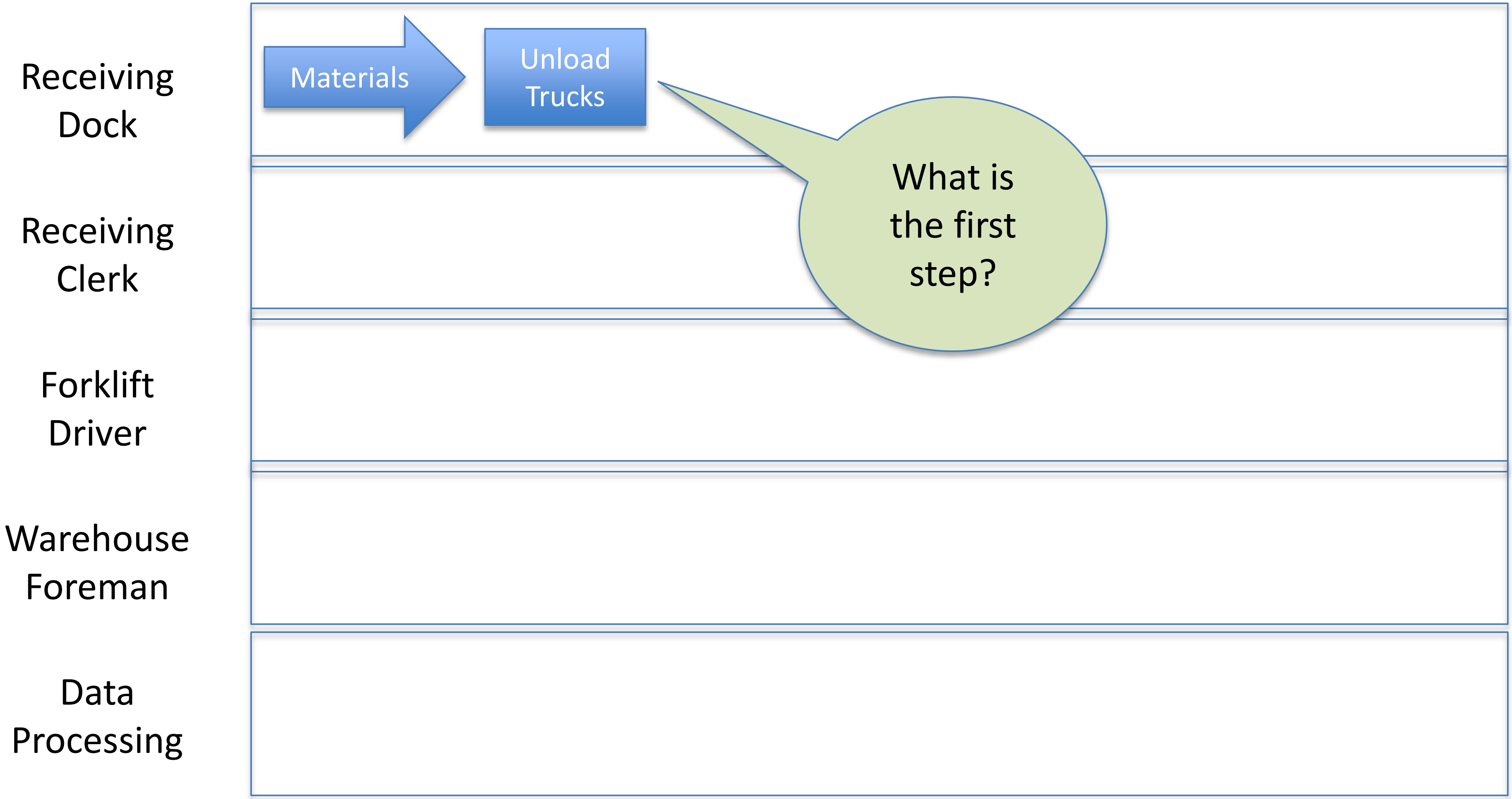
Data Processing

List all people and departments that may be involved in the process

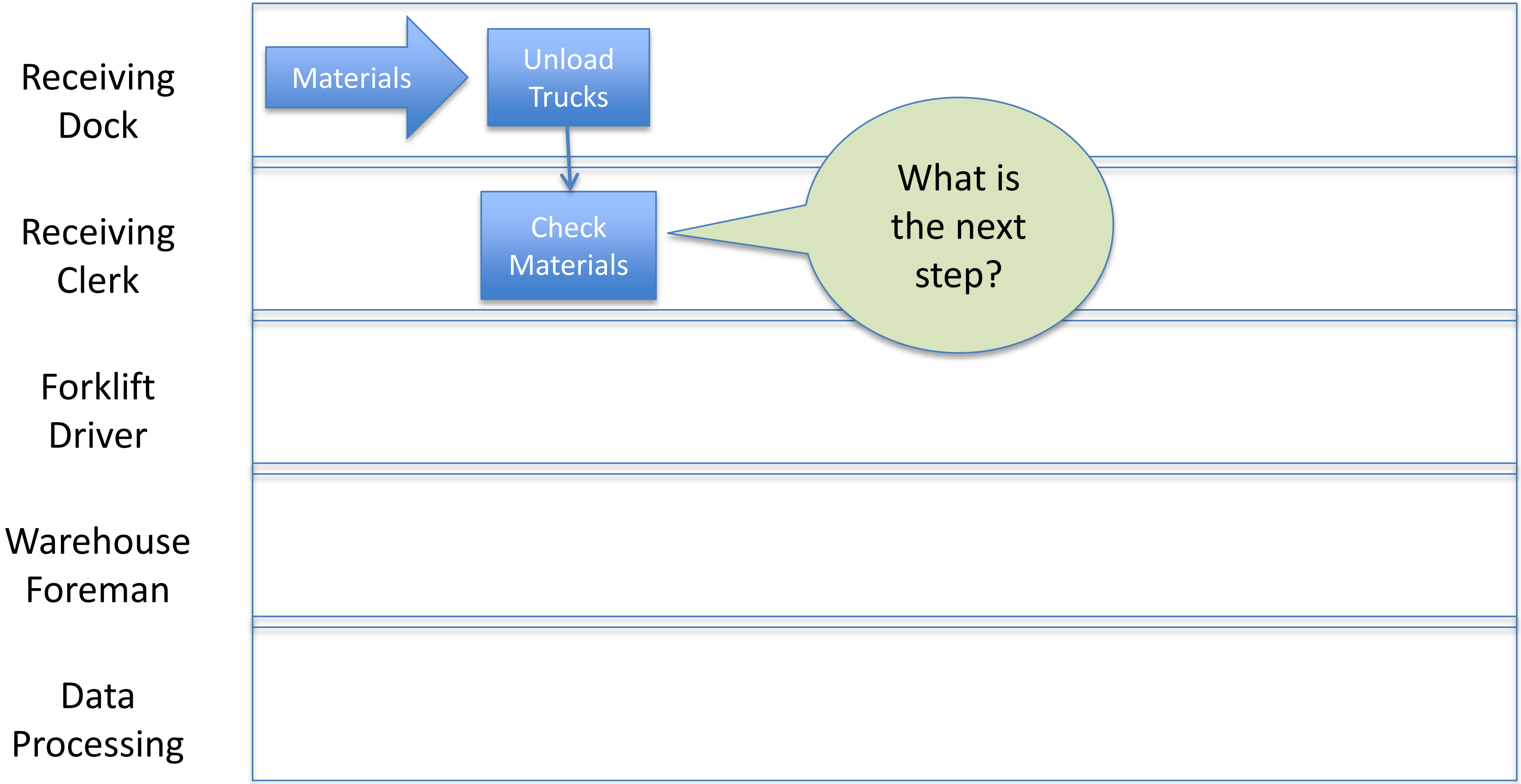
Swim Lane Process Mapping



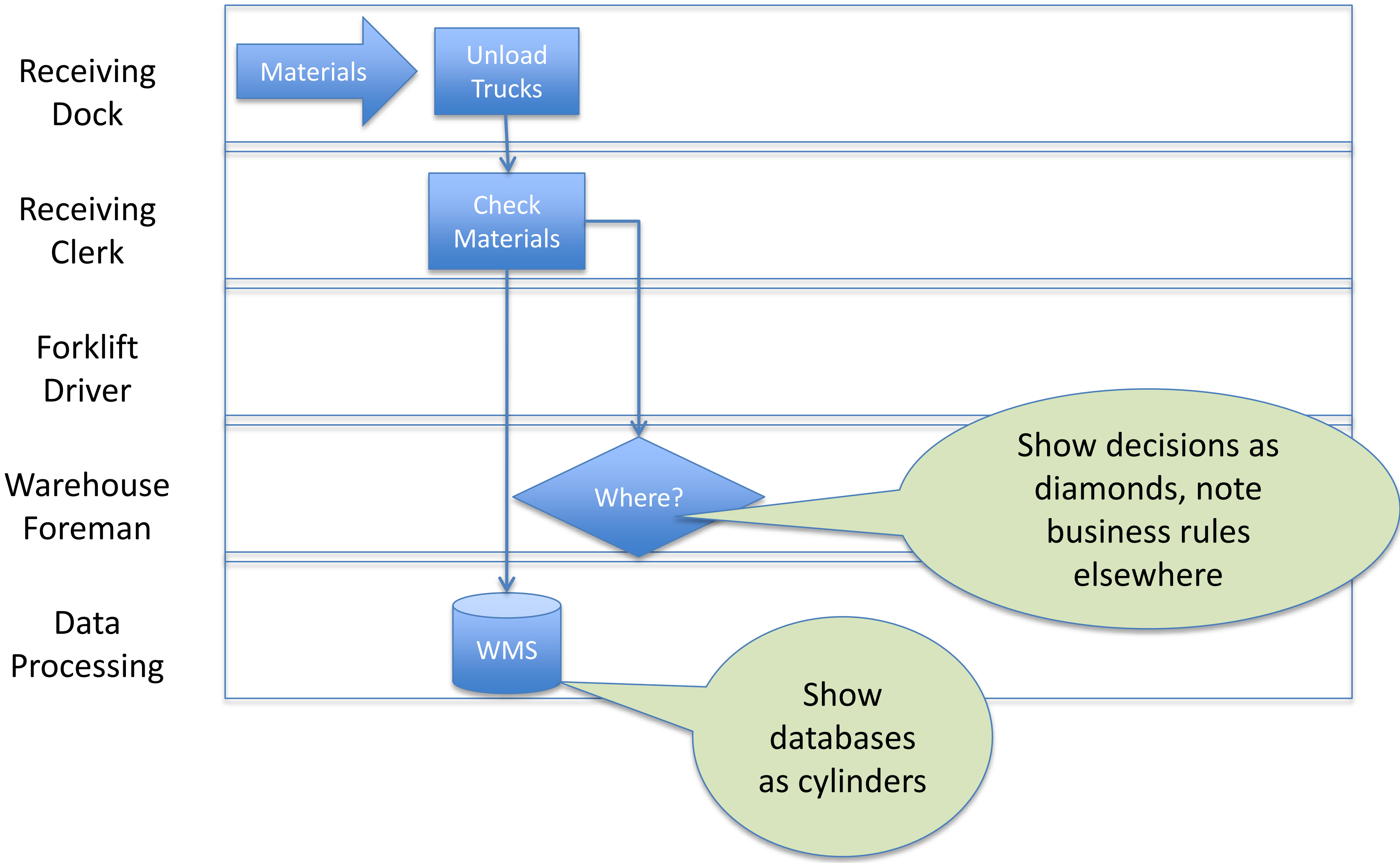
Swim Lane Process Mapping



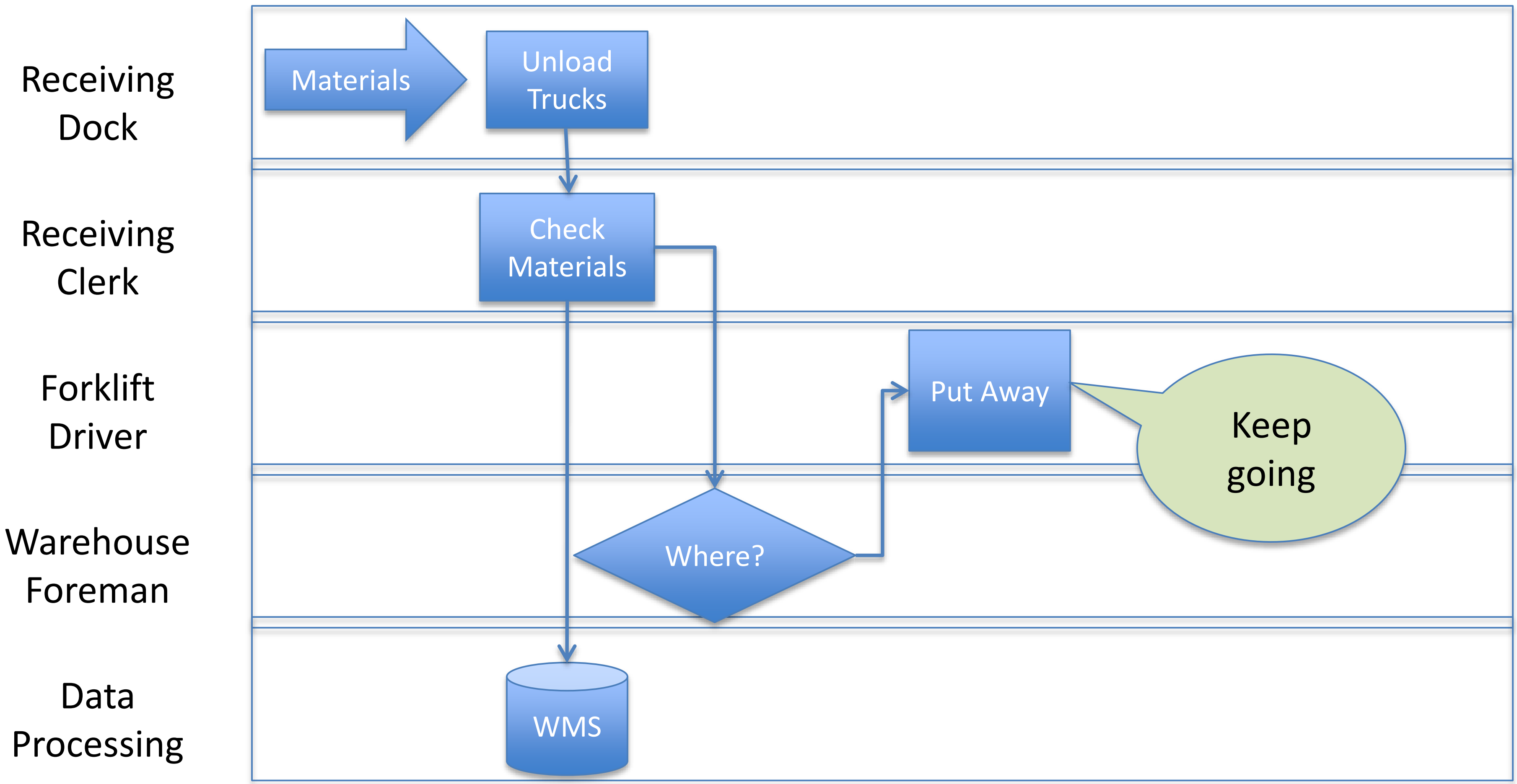
Swim Lane Process Mapping



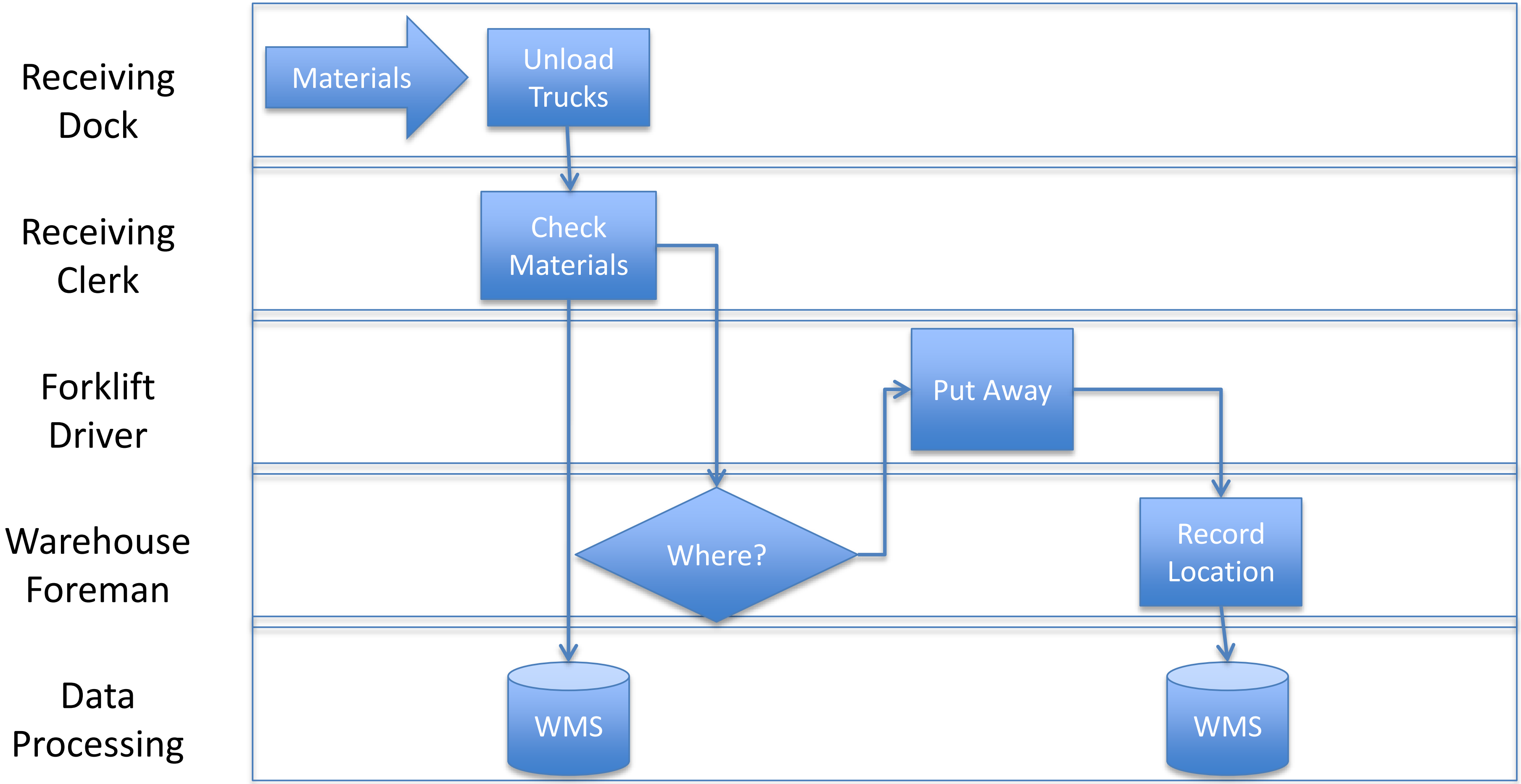
Swim Lane Process Mapping



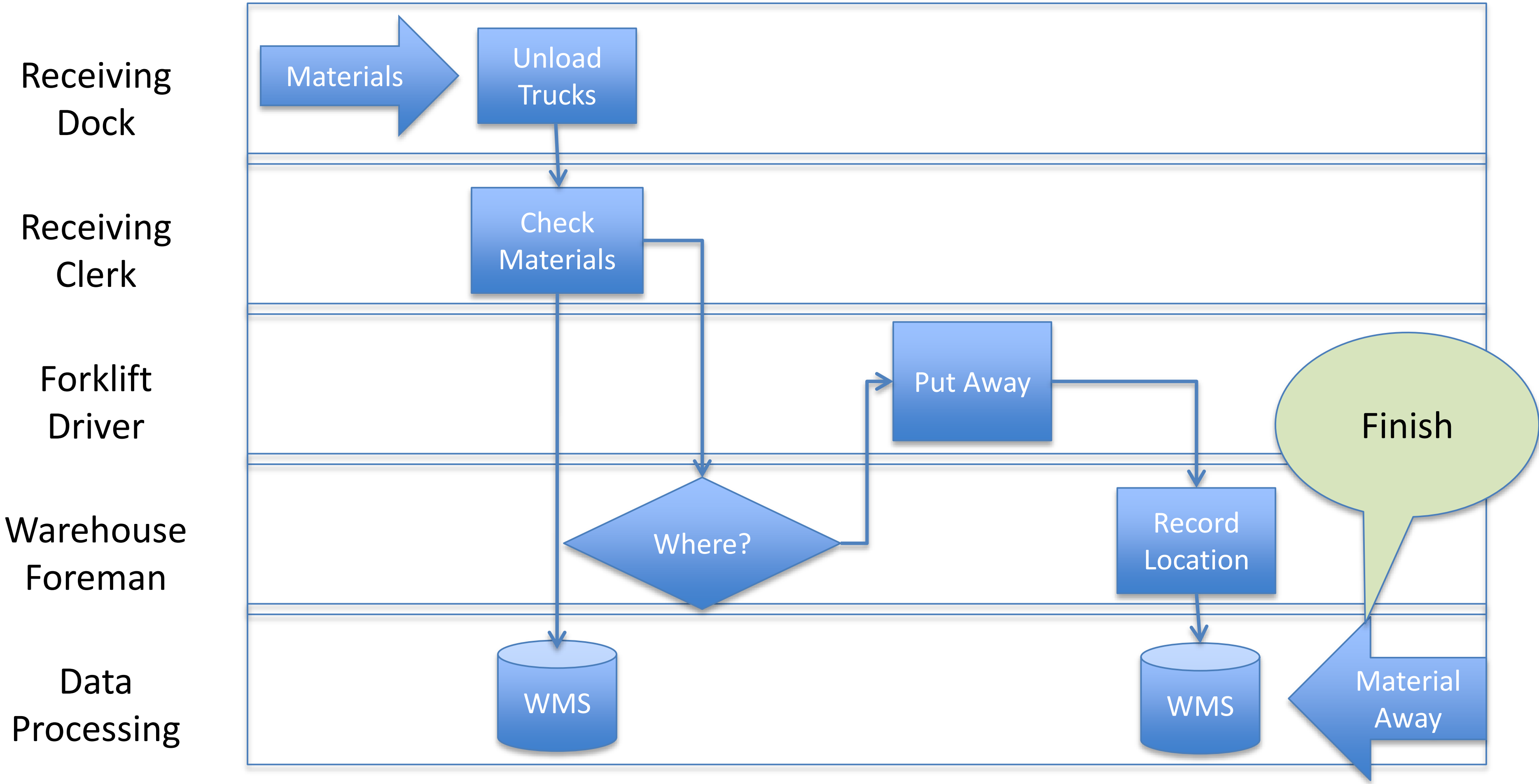
Swim Lane Process Mapping



Swim Lane Process Mapping



Swim Lane Process Mapping



Individual Case Assignment:
Sales Order Case
Develop Swim lane Process flow

Links to documents on the MIS 3504 Blog site

- Case background (Discount Auto Parts - Sales Order)
- Swim Lane Excel Template
- Swim Lane PPT Template

Due class 6, September 29, 2015

Exercise: draw the sales process described in the sales order case

- Actors – Who are all of the people/departments involved?
- Actions – What are the steps they perform in the process?
- Sequence – Map the process in sequence using the swim lane method.