Digital Factory
Data Flow Model Concept and Construction
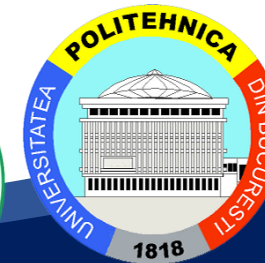
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Module II: Digital Factory Modeling: How to formulate a virtual world

Professor Athakorn Kengpol, PhD, DSc

Curriculum Development
of Master's Degree Program in
Industrial Engineering for Thailand Sustainable Smart Industry

Content

- **Learning Outcomes**

- **Introduction of Data Flow Diagram**

- **DFD Constructing**

- **DFD Example**

- **Case Study**

- **Lab Sheet**

- **Program for DFD Constructing**

Course Learning Outcomes

Formulate a data model representing data streamlining in a production line of an existing traditional factory using a data flow diagram (Develop, Module II)

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Introduction of Data Flow Diagram

"Cyber Physical System is a coordination between data operations in the form of cloud computing and physical device. When businesses want to develop into intelligent system, it is necessary to have step-by-step data flow management by using Data Flow Diagram"

System development life cycle (SDCL) is an essential process uses during the development of any system

SDLC consists of four main phases. They are planning, analysis, design and implementation.

Data-flow diagrams (DFDs) model a perspective of the system that is most readily understood by users

Maintenance Division

DFD with material Flow (www.Yourdon.com)
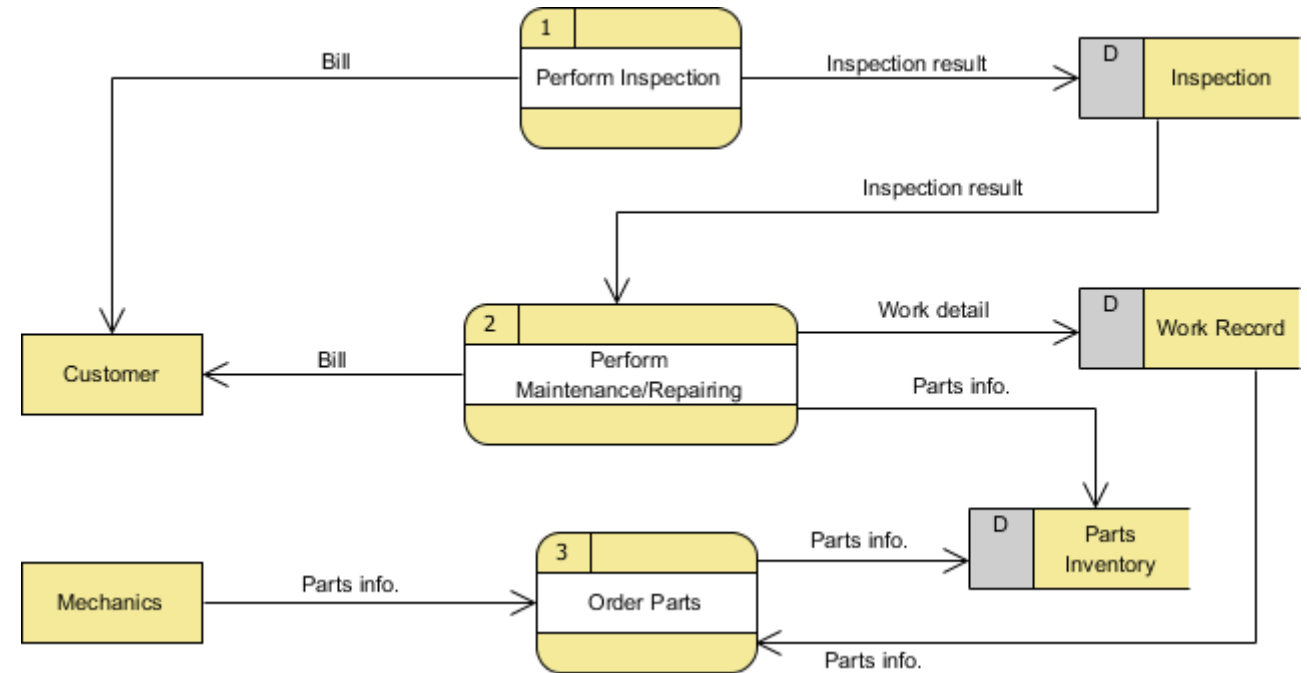
Introduction of Data Flow Diagram

The benefit of Data-Flow Diagram
- The system scope and boundaries are clearly indicated on the diagrams.
- The technique of decomposition of high level data-flow diagrams to set of more detailed diagrams, provides and overall view of complete system, as well as a more detail breakdown and description of individual activities, when this is appropriate, for clarification and understanding.
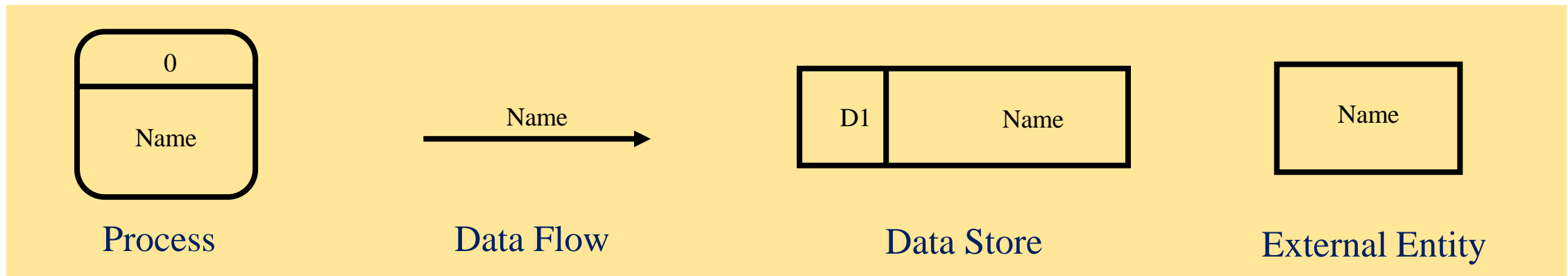
The motivation of formalizing the rules of data flow diagrams is because DFD has been used in a widely basis for modeling any system but still lacking a precise understanding. Therefore, by formalizing the DFD rules, we can get a formal model of DFD rules. This formal model can be used to ensure that the diagrams drawn are correct and they are consistent with each other.

Rosziati, I., & Siow, Y.' Y. (2010). Formalization of The Data Flow Diagram Rules for Consistency Check. International Journal of Software Engineering & Application (IJSEA), Vol. 1, No.4, October 2010.

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Introduction of Data Flow Diagram

The system can be physical or logical, manual or computer based.
Data flow diagram symbols consist of four symbols which are processes, data flows, data stores and external entities.

0 Name	Name →	D1 Name	Name
Process	Data Flow	Data Store	External Entity

Symbols of DFD Elements

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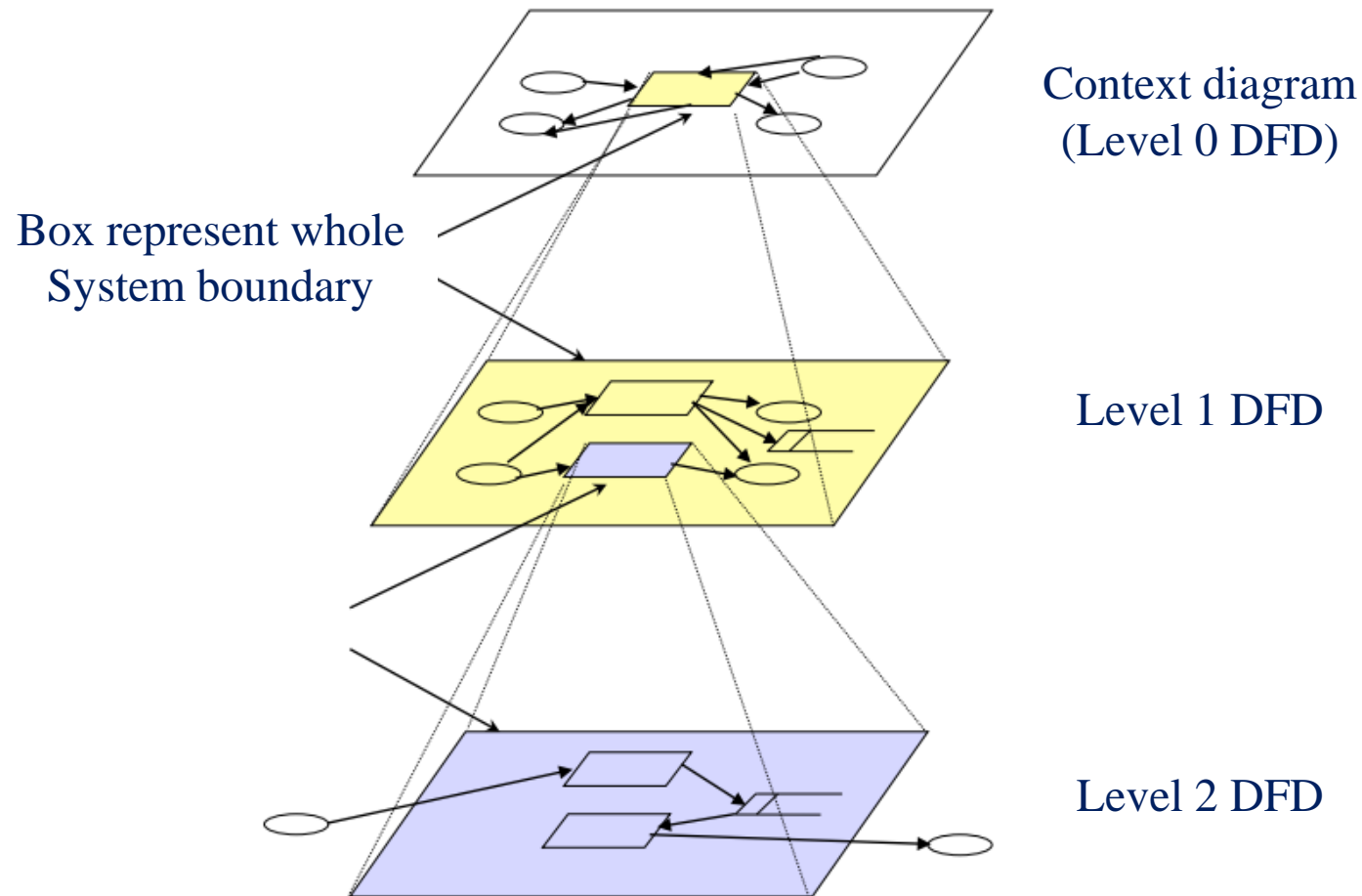
Introduction of Data Flow Diagram

The different kinds (and levels) of data-flow diagrams

Although all data-flow diagrams are composed of the same types of symbols, and the validation rules are the same for all DFDs, there are three main types of data-flow diagram:

• **Context diagrams** — context diagram DFDs are diagrams that present an overview of the system and its interaction .

• **Level 1 data-flow diagrams** — Level 1 DFDs present a more detailed view of the system than context diagrams, by showing the main sub-processes and stores of data that make up the system as a whole.

• **Level 2 (and lower) data-flow diagrams** — a major advantage of the data-flow modelling technique is that, through a technique called "levelling", the detailed complexity of real world systems can be managed and modeled in a hierarchy of abstractions. Certain elements of any dataflow diagram can be decomposed ("exploded") into a more detailed model a level lower in the hierarchy.
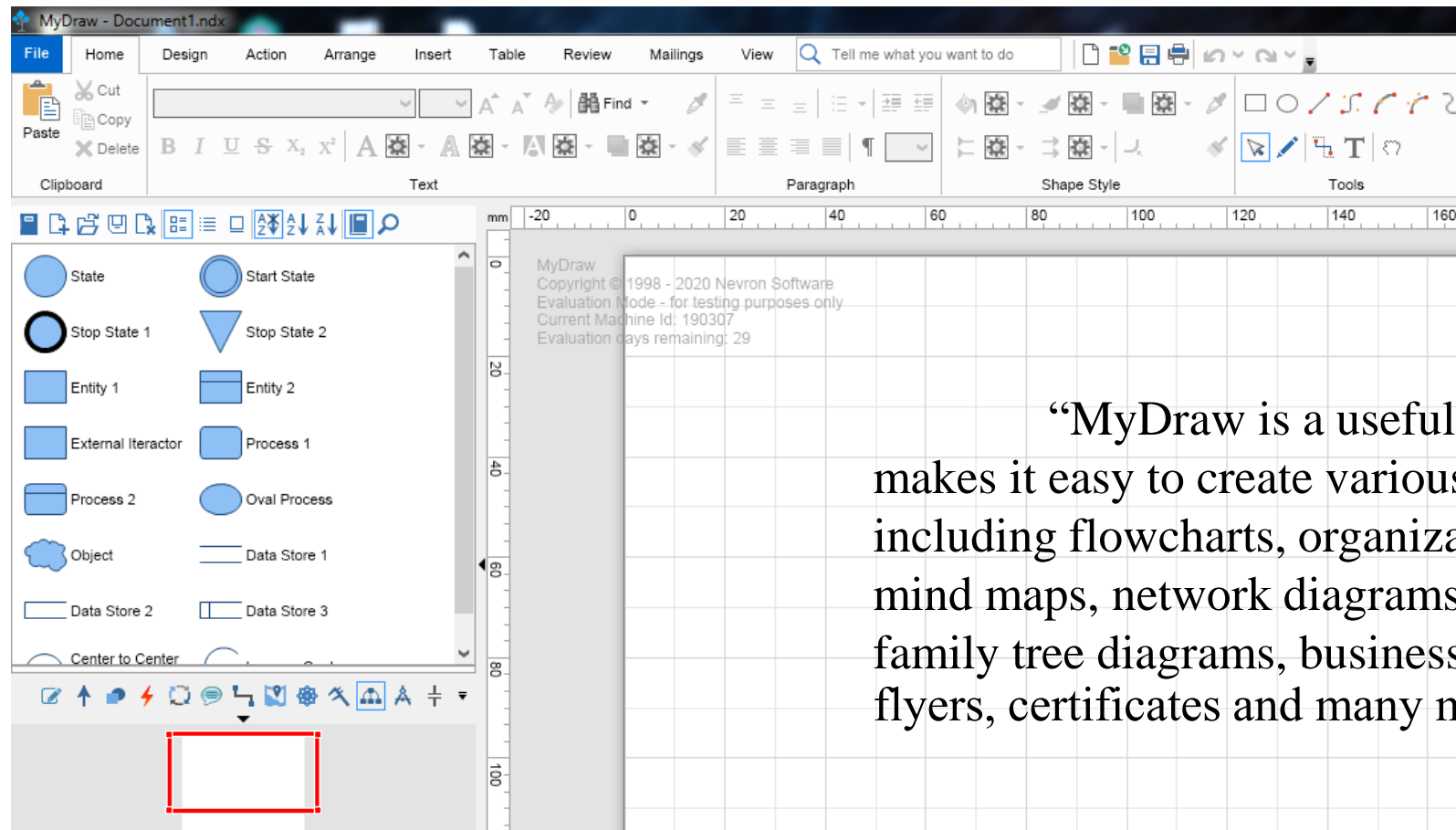
Introduction of Data Flow Diagram

Context diagram
(Level 0 DFD)

Box represent whole
System boundary

Level 1 DFD

Level 2 DFD

DFD Constructing

- **Identify the system boundaries**
- **Follow inputs**
- **Follow event**
- **Fill in gaps**
- **Repeat**
- **Explain to level 1, 2, …, n DFD**

Goodland M., Slater C., SSADM - A Practical Approch, McGraw Hill, 1995.
Kendall., K., Kendall J., System Analysis and Design, Prentice Hall, 1998

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Introduction of Data Flow Diagram

"MyDraw is a useful program, which makes it easy to create various types of diagram including flowcharts, organizational charts, mind maps, network diagrams, floor plans, family tree diagrams, business model diagram, flyers, certificates and many more."

MyDraw

Video Rental Data Flow Diagram (Context Diagram)

Expand to Level 1 DFD
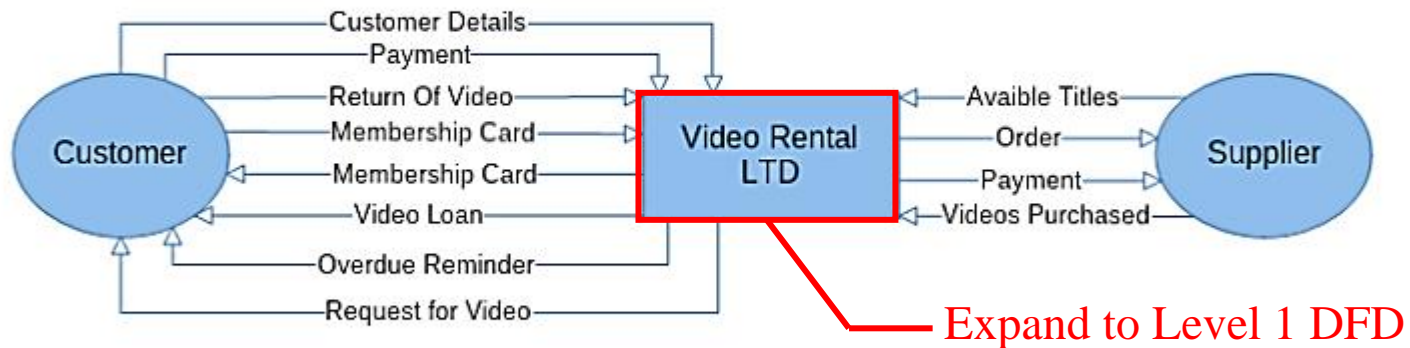
This is a context level data flow diagram of a video rental system. The example illustrates the flow of information between the system of interest (Video Rental system) and the external entities connected to it (the Customers and the Supplier).
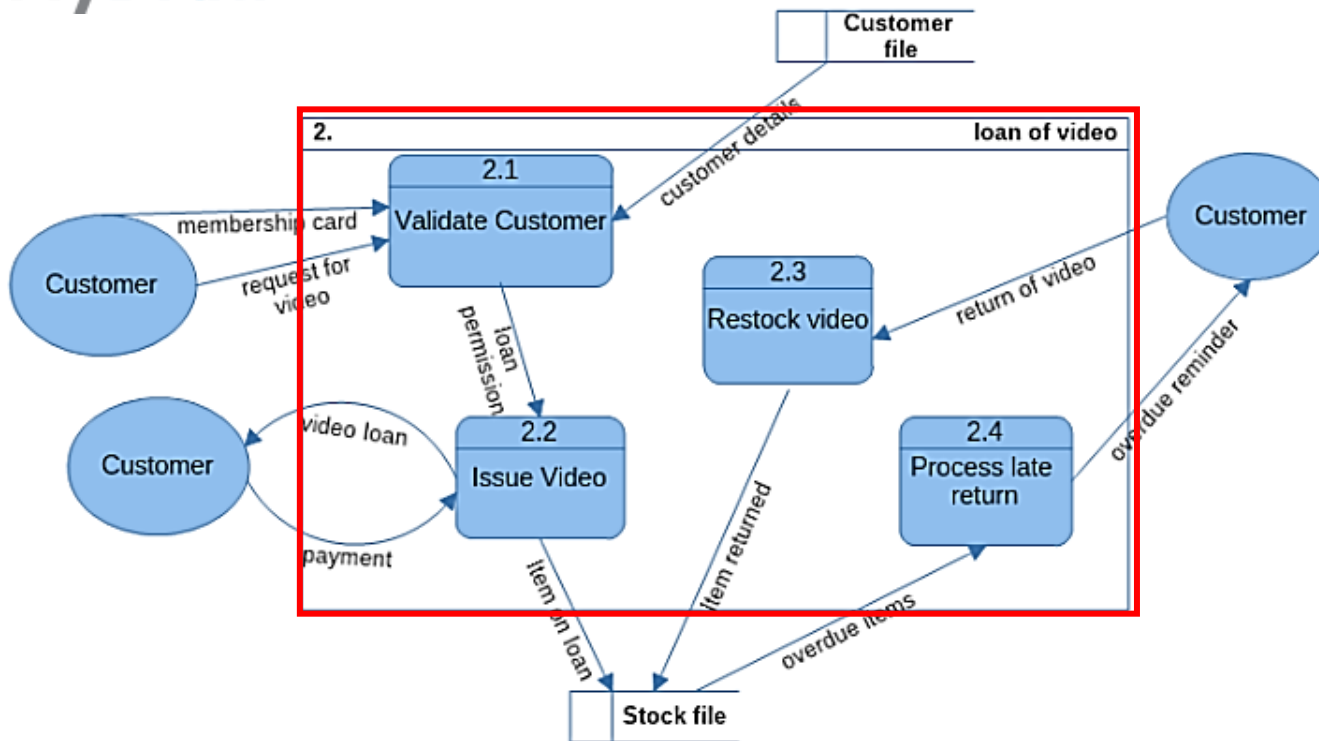
DFD Constructing

Video Rental DFD (Level 1)

Expand to Level 2 DFD
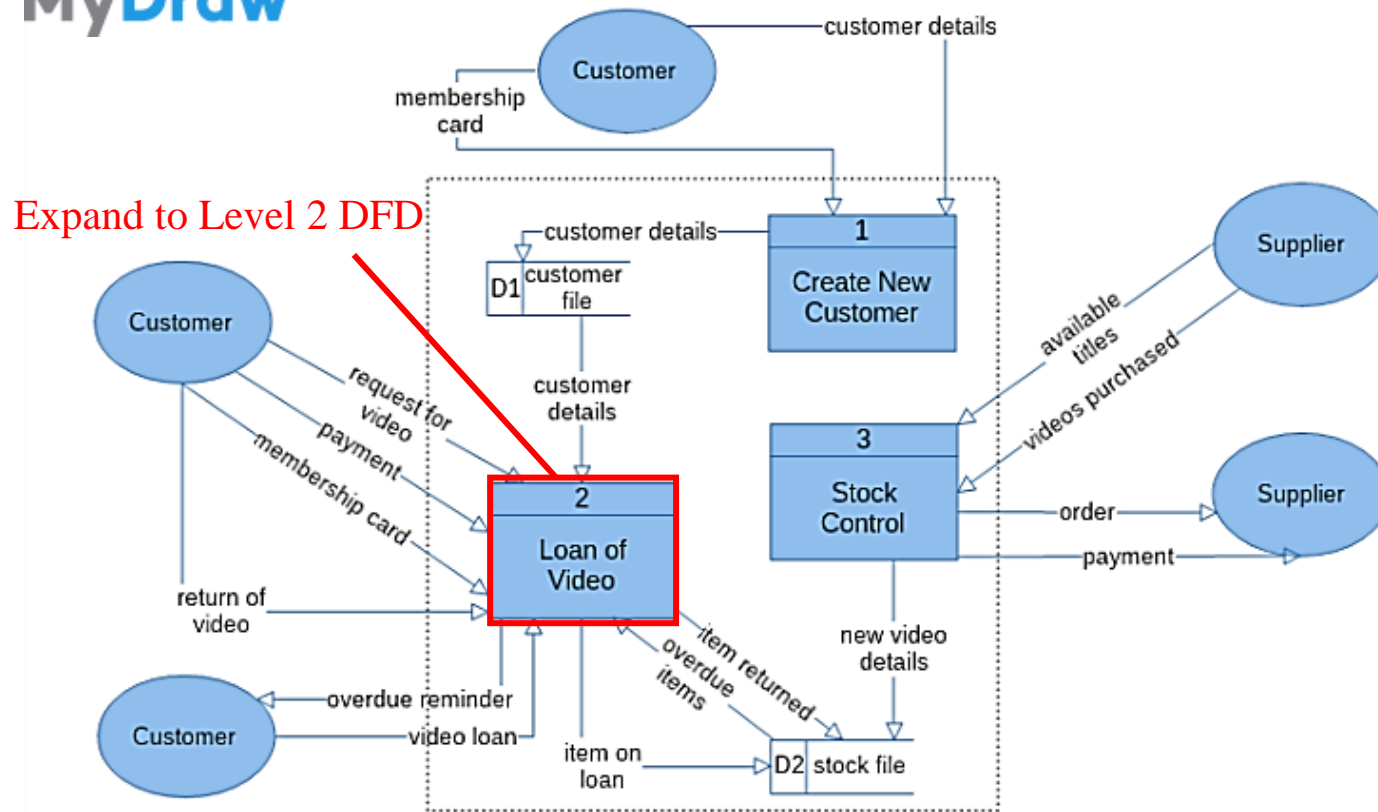
This is a level 1 Data Flow Diagram illustrating a video rental system. This level of DFD describes in a greater detail the kind of data flowing between the main processes of the system.

DFD Constructing

Video Rental DFD (Level 2 - Loan of Video)

This is a level 2 Data Flow Diagram illustrating a video rental system. This level of DFD concentrates in a greater detail of one of the system's processes and the kind of data flowing between its main sub-processes and the external entities it is directly connected to.

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DFD Example

The case study of Manufacture and assembly of electrical wiring for car

"From company case study, the product design department has a collection of product data including a lot of technical data. Causing delay in searching for the desired information and data-loss problem, therefore DFD must be created for the systematic overview to identify further problem"

The product of case study company

T. Pornthip, "Management system development database for product development parts of product design agency case study the company products and assembles the wiring harness," M.S. thesis, Department of Industrial Engineering, Faculty of Engineering, KMUTNB, 2015.

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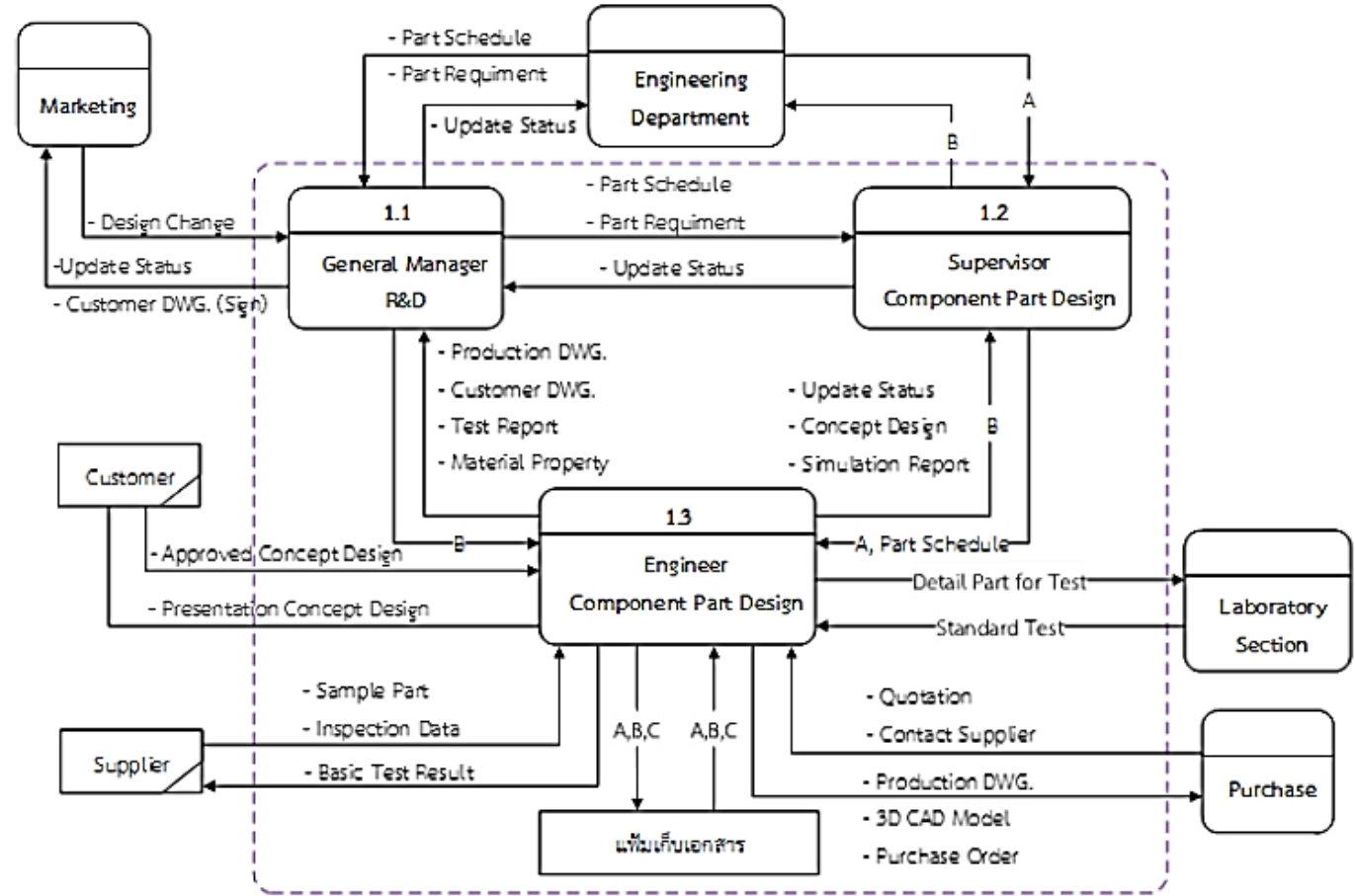of the European Union

A -DWG. Part for Development
   -Material Property
   -Functional of part

B -Production DWG. (Sign)
   -Customer DWG. (Sign)
   -Test Report (Sign)
   -Material Property (Sign)

C -Simulation Report
   -Concept Design
   -3D CAD Model
   -Inspection Data
   -Standard Test
   -Training Data Support
   -Result Test Mechanical
Property of material.

T. Pornthip, "Management system development database for product development parts of product design agency case study the company products and assembles the wiring harness," M.S. thesis, Department of Industrial Engineering, Faculty of Engineering, KMUTNB, 2015.
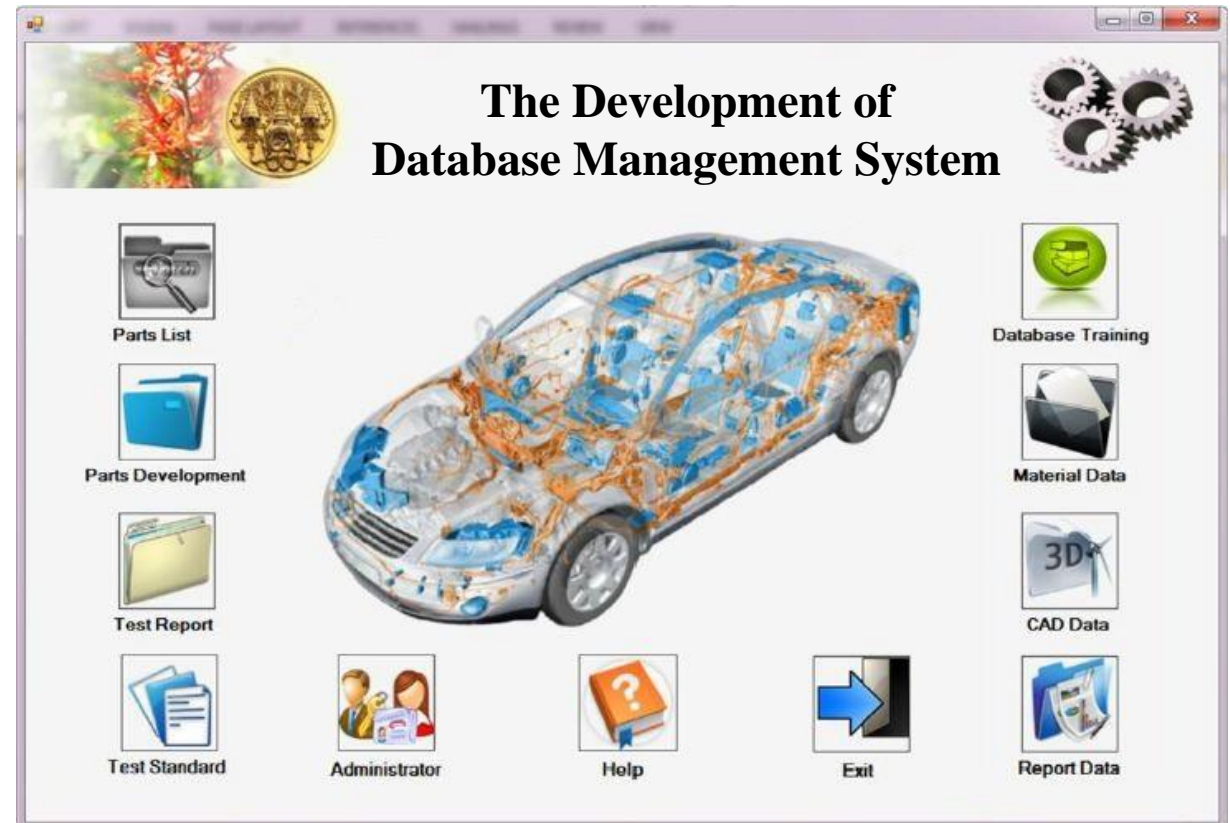
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A -DWG. Part for Development
   -Material Property
   -Functional of part

B -Production DWG. (Sign)
   -Customer DWG. (Sign)
   -Test Report (Sign)
   -Material Property (Sign)

C -Simulation Report/ Concept Design
   -3D CAD Model/ 2D DWG.
   -Inspection Data/ Test Report
   -Standard Test/ Material Property
   -Training Data Support
   -Result Test Mechanical Property of
material.
   -Help
   -Cost Save Part Report
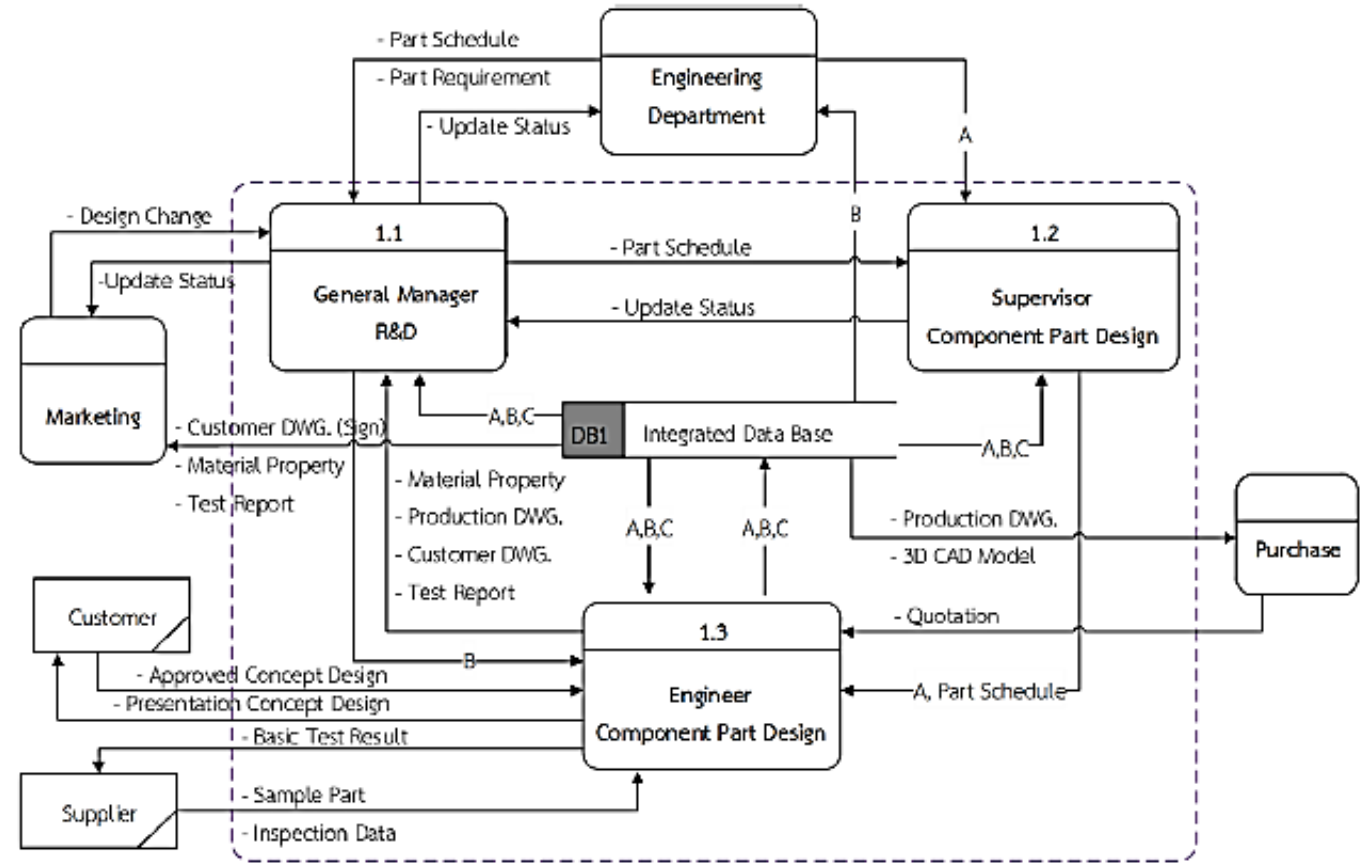
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The case study of Manufacture and assembly of electrical wiring for car

"After the database improvement by using DFD together with Microsoft Visual Studio 2015 and Microsoft SQL Server 2012 program*, it was found that it reduced the time needed to find the document 92.92%, reduce the time to search the files 91.92% and the document is no longer lost"

*This programs are used to manage information and documents, which is convenient to use.

The Development of
Database Management System

Parts List · Database Training
Parts Development · Material Data
Test Report · CAD Data
Test Standard · Administrator · Help · Exit · Report Data

T. Pornthip, "Management system development database for product development parts of product design agency case study the company products and assembles the wiring harness," M.S. thesis, Department of Industrial Engineering, Faculty of Engineering, KMUTNB, 2015.
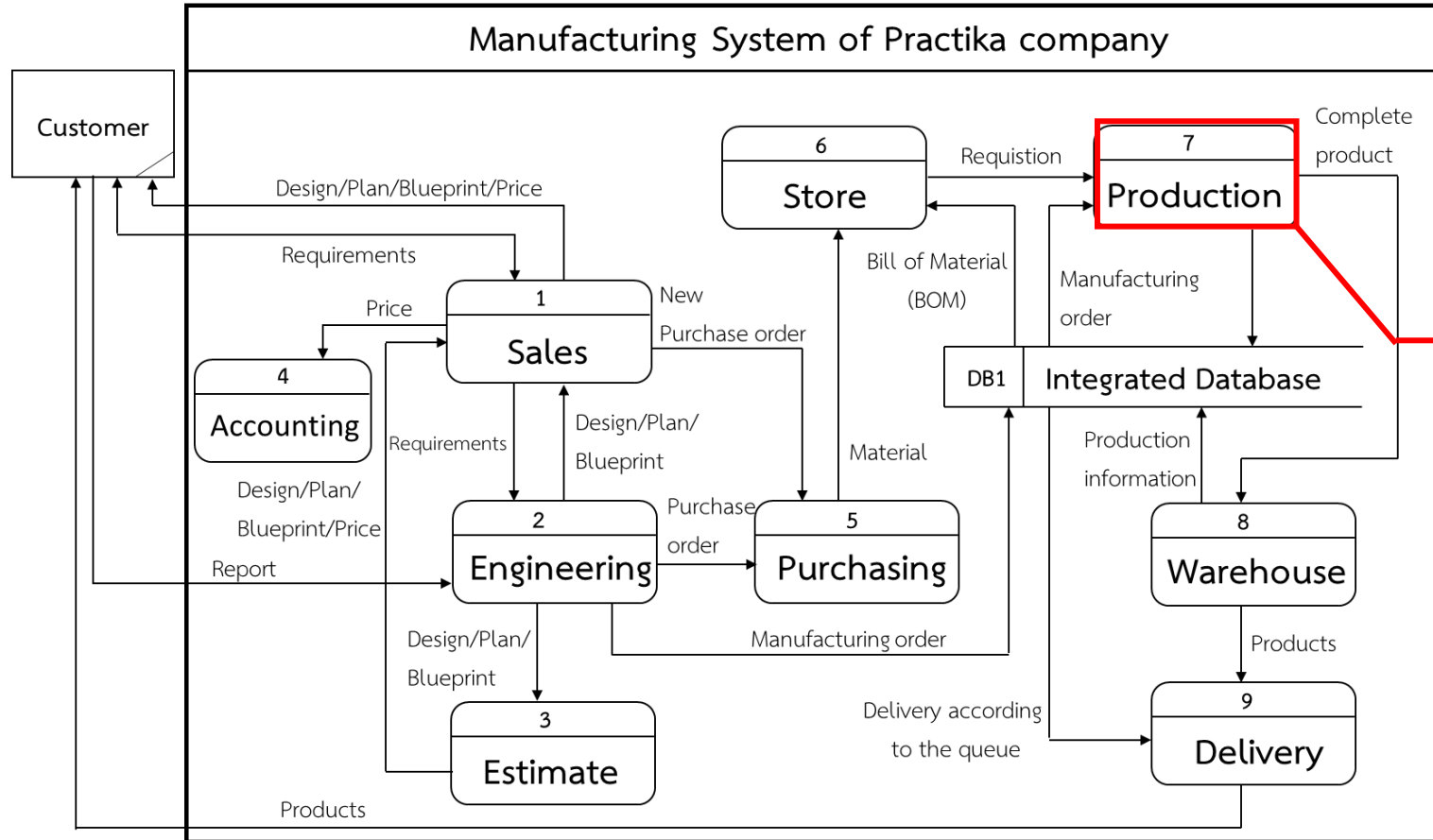
Case Study: Furniture Company

The case study company is an integrated furniture manufacturing company. By the process starting form accepting customers' needs to designing the furniture, the price evaluating and producing according to the design, Until deliver to customers.

Case Study: Furniture Company

Responding to the Industrial 4.0, the case study factory needs to be transformed into a digital factory to increase production potential. For this purpose, a group of students in the Digital Factory subject (KMUTNB) have studied the production process of the factory in order to find ideas to develop each production lines according to the digital factory guidelines.

This case, production process is focused on development. Then, it is expanded to level 2 DFD.

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20/29

Boundary of Interest
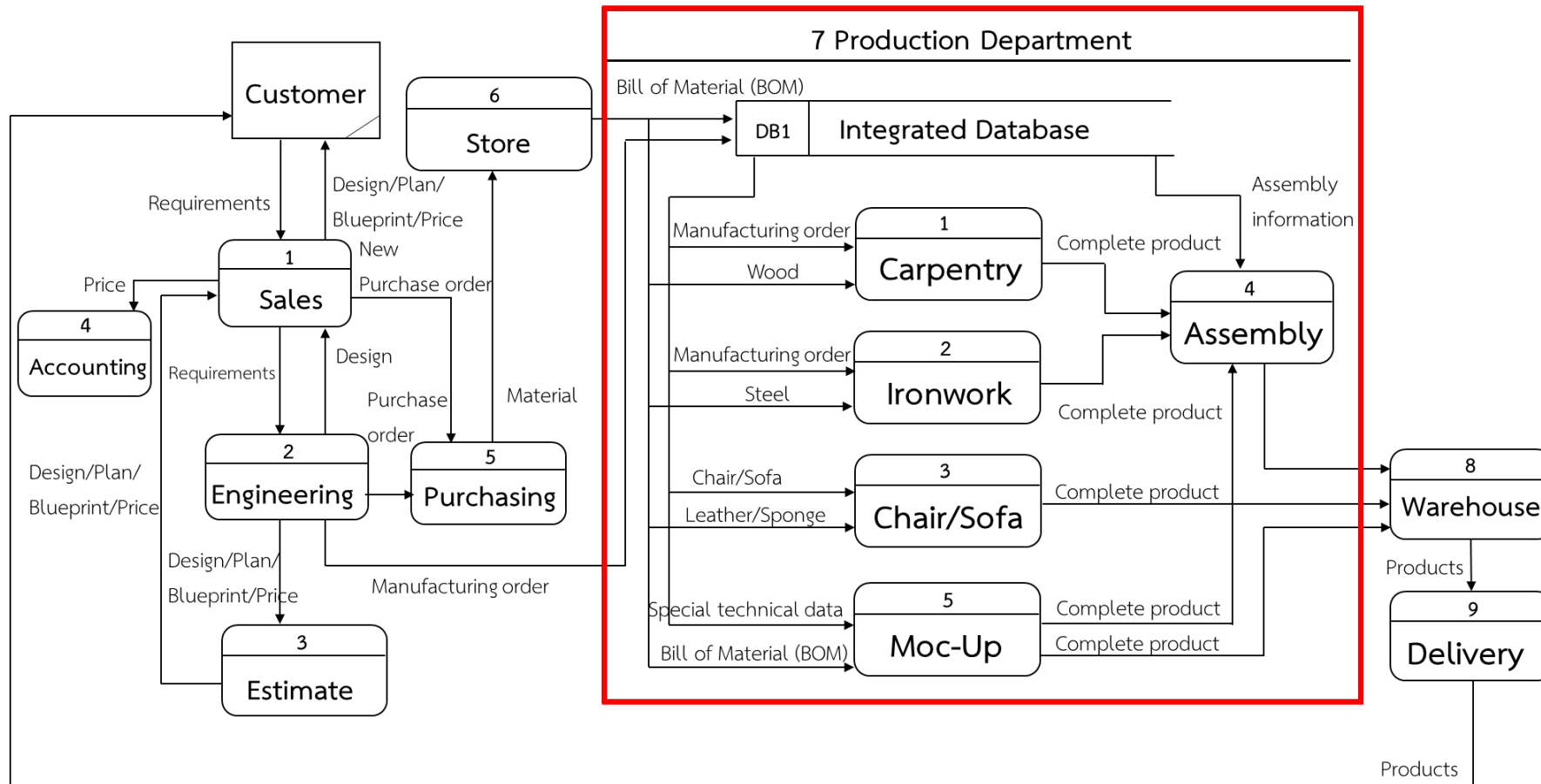
Case Study: Furniture Company

Transform to the Digital Factory

Traditional Factory
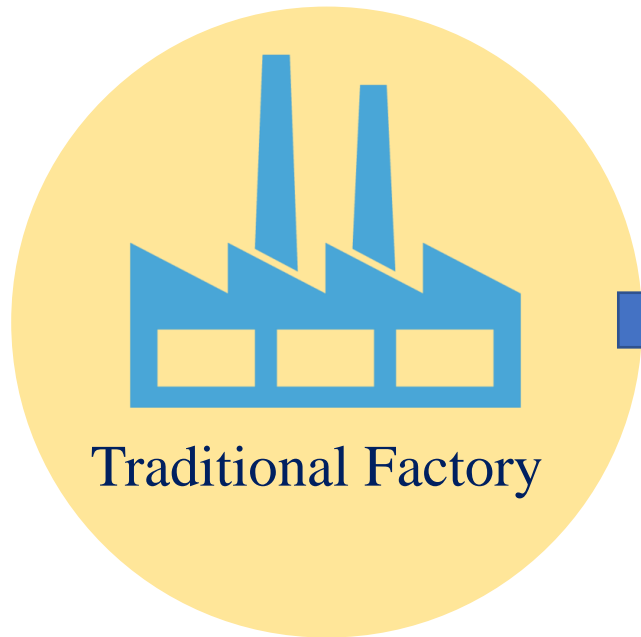
Cloud Computing

AR Technology
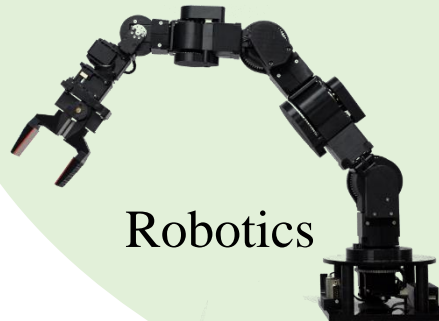
Robotics

MetraSCAN

PLY AGV

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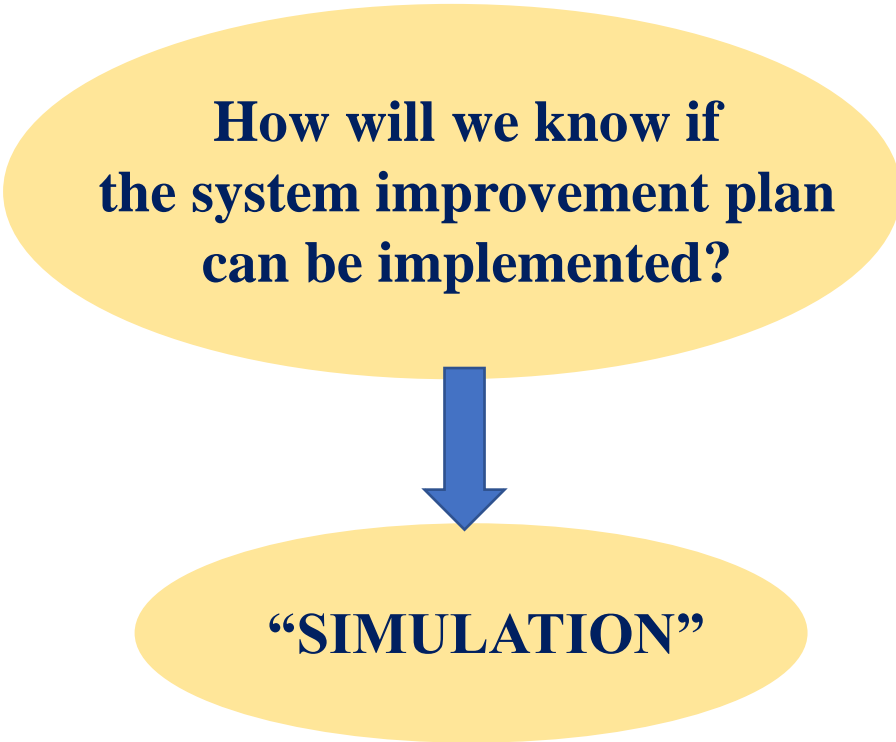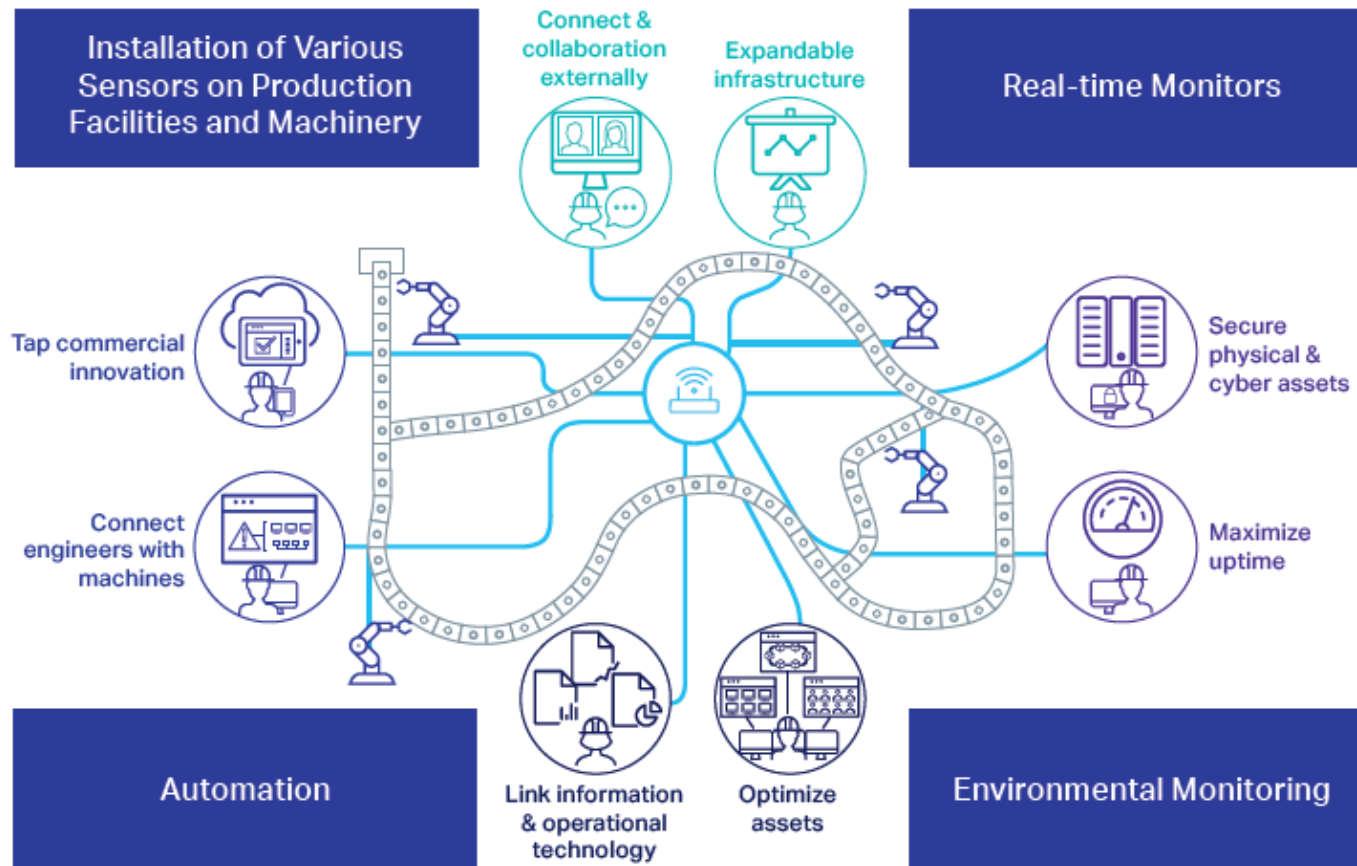
Figure 3.1: Data Generated at a Manufacturing Plant[5]

How will we know if the system improvement plan can be implemented?

"SIMULATION"

Lab Sheet: DFD Constructing #1

Estate Agency case study

Clients wishing to put their property on the market visit the estate agent, who will take details of their house, flat or bungalow and enter them on a card which is filed according to the area, price range and type of property.

Potential buyers complete a similar type of card which is filed by buyer name in an A4 binder.

Weekly, the estate agent matches the potential buyer's requirements with the available properties and sends them the details of selected properties.

When a sale is completed, the buyer confirms that the contracts have been exchanged, client details are removed from the property file, and an invoice is sent to the client. The client receives the top copy of a three part set, with the other two copies being filed.

On receipt of the payment the invoice copies are stamped and archived. Invoices are checked on a monthly basis and for those accounts not settled within two months a reminder (the third copy of the invoice) is sent to the client.

Try to create the context DFD & Level 1 DFD

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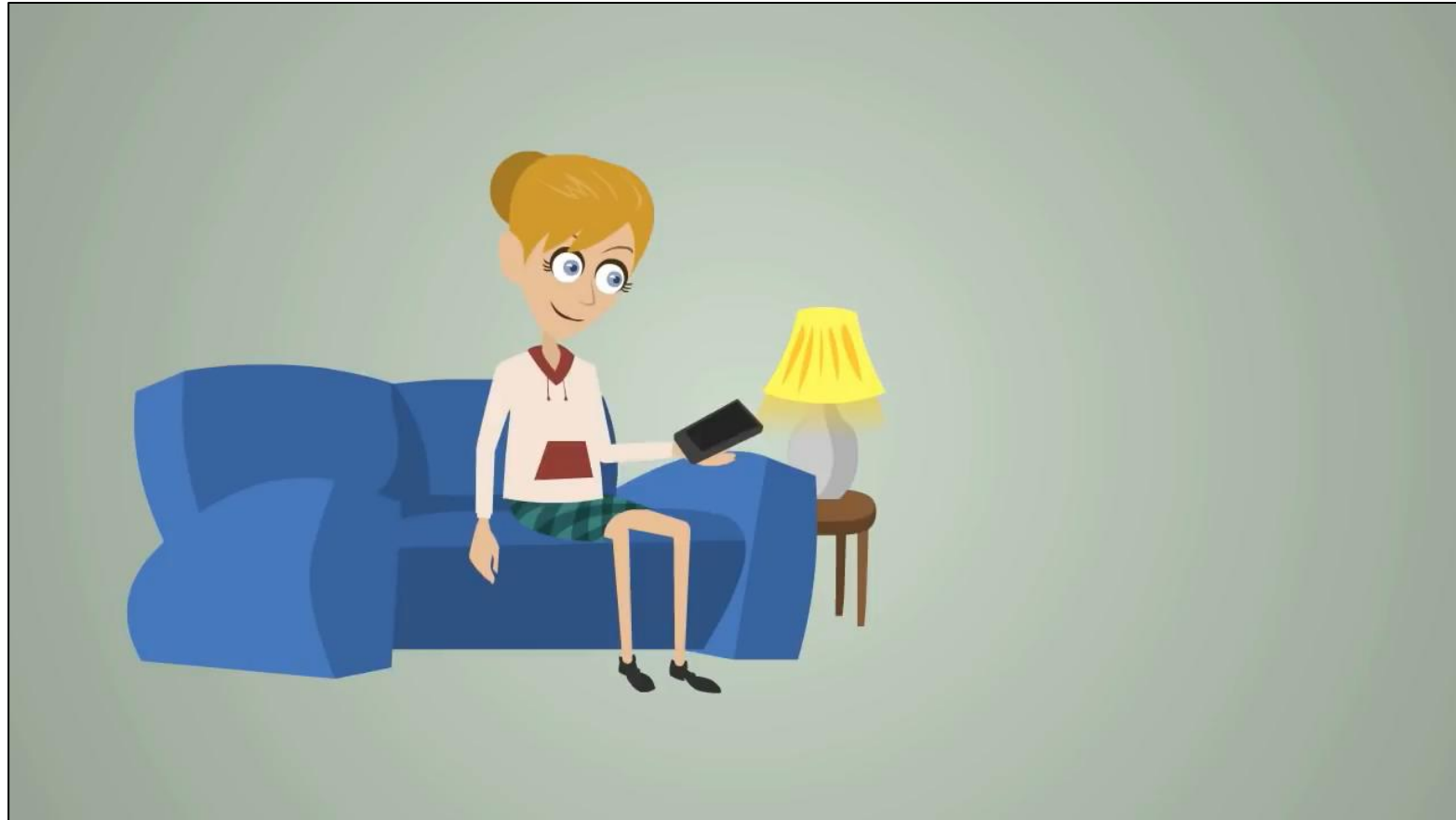
Lab Sheet: DFD Constructing #2

Estate Agency case study

The Estate Agency needed to improve data management by using a matching application between the client's properties and the potential buyer demanding in order to matching reduce the complexity and waste time for increasing customer satisfaction to the Estate Agency.

Try to create the DFD again

DFD Constructing Program

DFD Constructing Program
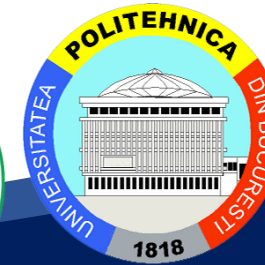
Course Learning Outcomes

Formulate a data model representing data streamlining in a production line of an existing traditional factory using a data flow diagram (Develop, Module II)

Thank you