MANUFACTURING SYSTEM
BETP 3814
INTRODUCTION TO MANUFACTURING SYSTEM

Tan Hauw Sen Rimo[1], Engr. Mohd Soufhwee bin Abd Rahman[2],
[1]tanhauwsr@utem.edu.my, [2]soufhwee@utem.edu.my

LESSON OUTCOMES

At the end of this lecture, you should be able to:

- Briefly describe definition and diagram of a system
- Explain elements of system
- Explain manufacturing as system
- Describe types of manufacturing system
- Describe model of a system and its types

Contents

- What is System?
- System Environment
- System Diagram
- Elements of a System
- Manufacturing as a System
- Types of Manufacturing System
- Model of a System
- Types of Model

What is System?

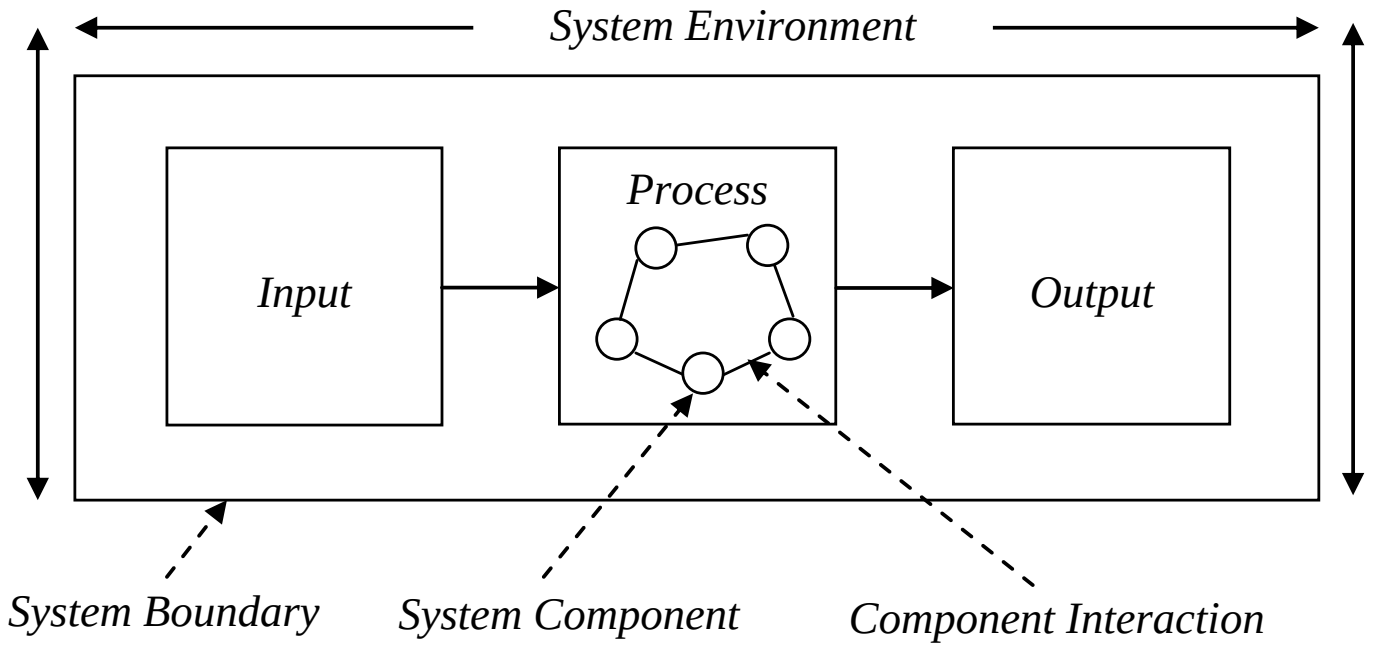
- A group of components, working together, have same goal
- Inputs → outputs
- Has regular/orderly interactions or interdependence
- Systematic, observable and measurable.

Give example(s) of a system.

System Environment

- Exists in its “world”
- Affected by environment, i.e. elements outside the system
- Boundary – separate the system with its environment
- Boundary is defined base on system’s purpose(s)

System Diagram



Elements of a System

- ENTITIES : objects/components in the system.
- ATTRIBUTES: Entities' properties that describe them.
- Interactions between the entities : ACTIVITIES and EVENTS
  - Event: occurring instantly
  - Activity: has a duration, begin-end, start-finish
- STATE OF A SYSTEM : system's snapshot at a any time

Endogenous and Exogenous Events and/or Activities

- *Endogenous* : events and/or activities occurring within a system
- *Exogenous* : events and/or activities in the environment that affect the system

Give example for endogenous an exogenous events and/or activities

Examples of Systems & Their Components

System	Entities	Attributes	Activities	Events	State Variables
Banking	Customers	Account Balance	Making Deposits	Arrival, Departure	Number of Busy Tellers, Numbers of Customers Waiting
MRT	Passengers	Origin, Destination	Traveling	Arrival at Station, arrival at Destination	Number of passengers waiting at station, Number of passenger in a train
Communication	Messages	Length, Destination	Sending	Arrival at destination	Delivered, Read
Inventory	Warehouse	Capacity	Withdrawing	Demand	Levels of inventory, backlogged demands
Production	Machines	Speed, Capacity, Breakdown rate	Stamping, Drilling	Breakdown	Status of machines (busy, idle or down)

Manufacturing as a System

- Manufacturing : Transformation of material into something more useful and valuable
- Manufacturing System : A set of machines, transportation elements, people, storage, computers, and other items that are used together for manufacturing
- Should be designed, operated and treated as a system to run most effectively

Types of Manufacturing System

- A complex system
- The system types do overlap
- Terminology, notation, basic assumptions are not standardized
- Could be divided from five perspectives :
  1. Product Type : Discrete Manufacturing and Continuous Process
  2. Product Variety : Single-Model and Multiple-Model
  3. Production planning/control : Make-to-stock Vs. Make-to-order
  4. Facilities Layout : Product layout, Process layout, Cellular Manufacturing/Group technology, and Fixed position
  5. Material flow : Assembly line, Batches, Buffers and JIT/Kanban

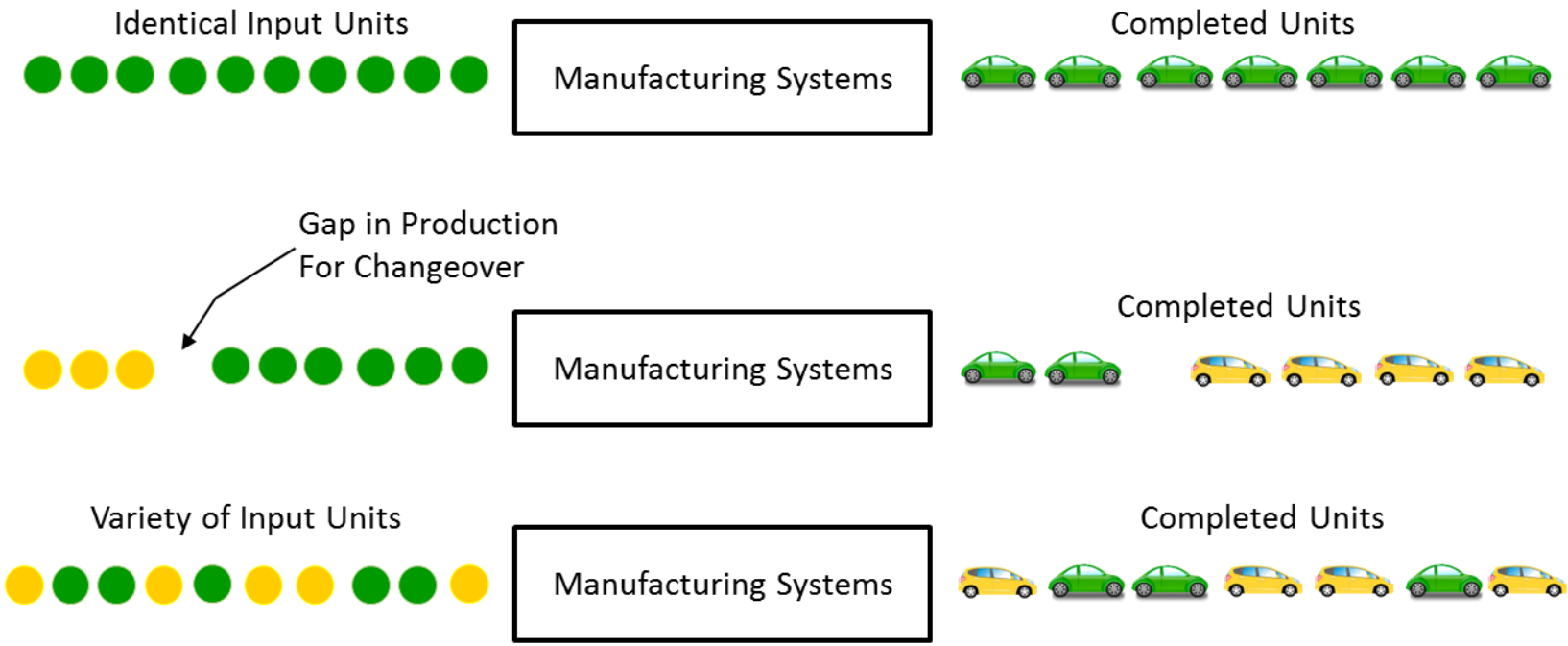
Discrete Manufacturing Vs. Continuous Process

Discrete Manufacturing	Continuous Processing
• Produce individual part/product that easily distinguishable • Example : Electronic Manufacturers, Automotive Manufacturers • Concerned with scheduling, material control and labor assignment	• Operate on product that continually flowing • Example : Chemical Industries, Oil Refineries • Capital intensive and concerned with capacity

Single Model Vs. Multi Model Manufacturing

- Capability of the system in producing variety of products or parts
- Two types:
  - Single-model type :
    - Identical parts or products
  - Multi-model type :
    - Batch-model: system produce different parts or products in batches therefore changeovers are required
    - Mixed-model: system produce different parts or products but no need changeover → Flexible Manufacturing System

Single Model Vs.
Multi Model Manufacturing



(a) Single-model type, (b) batch model type, and (c) mixed-model type

FLEXIBLE MANUFACTURING SYSTEM

- Enable flexibility in multi-model manufacturing system
- Need a set of computer numerical control (CNC) machine tools
- Need automated material handling system to connect workstations
- Called **FLEXIBLE** because it is able to process a variety of different parts/products at same time at the various workstation and the mix parts/products variety and quantities can be adjusted in response to changing demand pattern

What Make It FLEXIBLE?

Three capabilities that a manufacturing system must have to be FLEXIBLE :

- The ability to identify and distinguish among the different part/product configurations and processes
- Quick changeover of operating instruction
- Quick changeover of physical setup

Key Elements of an FMS

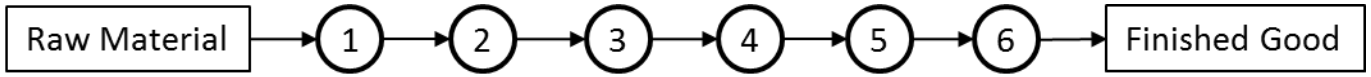
- Automatic programmable machines
- Automated tools for :
  - Delivering material or parts
  - Changing the process or route
  - Setup machines
- Automated material handling:
  - For transferring and
  - For loading and unloading
- Coordinated control

Make-to-Stock Vs. Make-to-Order

Make-to-Stock	Make-to-Order
• Produce according to a periodic forecasted demand and sell the product to any incoming customer who wants to buy them • Example : Consumer Product Production • Concerned with sales history, inventory level and supply chain management	• Specially produce and deliver a product for a customer's order • Example : Production of Designer Jewelry, Production of Aeroplanes, Production of Special type of steel, High end instruments and vehicles etc., • Concerned with product specification/configuration, project management and delivery date target

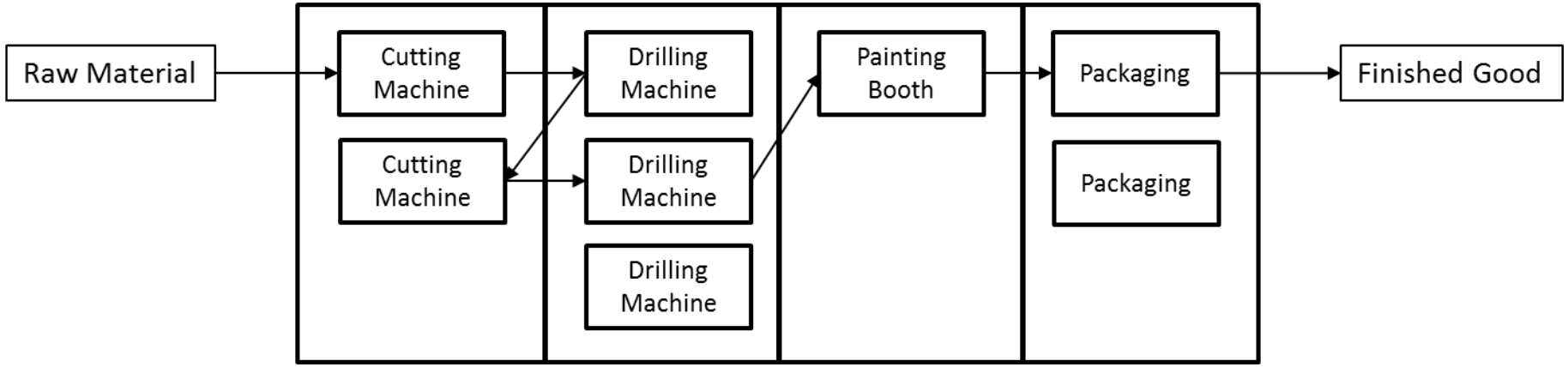
Product Layout

- Design for a specific product
- The product flow from first machine to the second, from second to third and so on
- Upon completing processing at the last machine, the raw material has been converted into a finished product



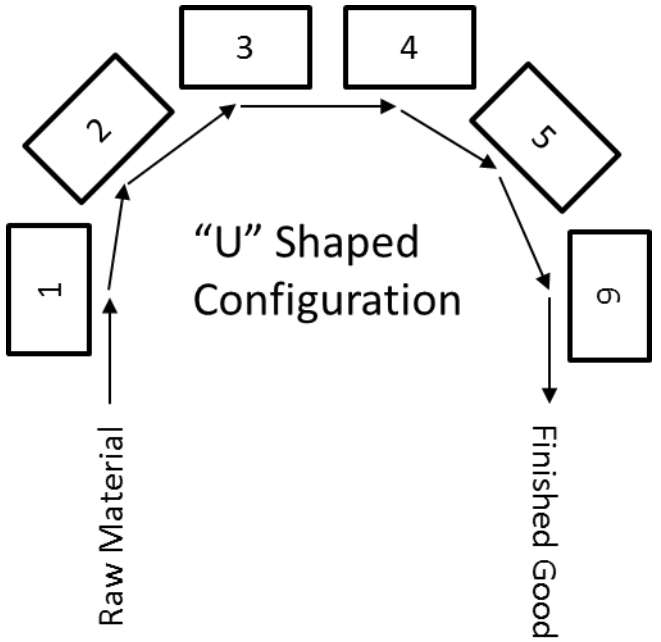
Process Layout

- Machines have similar capabilities and perform similar functions are grouped
- Product could follow various process routing
- Typical process is job order
- Configuration and specification of product could be vary from one to another



Group Technology Layout/ Cellular Manufacturing

- Can be used to convert otherwise process layout system to pseudo product layout environments
- Similar part are grouped together in sufficient quantity to justify their own machines
- A cell then laid out to produce just this set of parts
- Potentially as important a technological innovations as numerical control and robotic



Fixed Layout

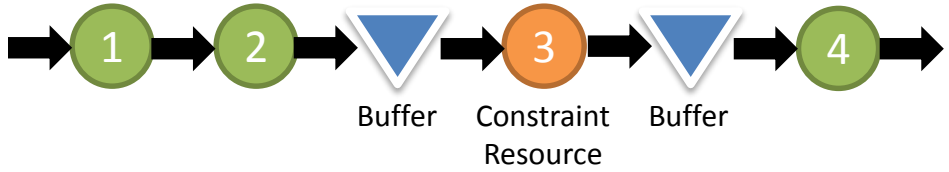
Assembly Line

- A set of sequential workstations, typically connected by a continuous material handling to transfer materials and parts
- The materials and parts are passed down the line, visiting each station in sequence to make a finished product
- The line is designed to assemble component parts and perform any related operations necessary to produce a finished product
- Upon completion of assigned tasks on an item/a part, the work station pass it to the next work station, obtain a new item/part from predecessor work station and repeat the tasks

Batches

- Products are produced in groups instead of in continuous streams as they are on assembly lines
- A specific process for each item takes place at the same time on a batch of items, and that group does not move onto the next stage of production or inspection until the whole batch is done.
- This type of production is necessary when a manufacturer is producing similar things, but with variants.
- Making in batches reduces unit costs, Use of specialist machinery & skills can increase output and productivity
- Time lost switching between batches – machinery may need to be reset, Need to keep stocks of raw materials. Cash also investment in work-in-progress

Buffers



- Provide or release materials before its schedule
- The purpose of buffer is to protect the system, meaning to ensure the system still running or operate when there is failure on one or more of its components/resources
- Buffer should be applied to constraint resources only
- Buffers are placed in front of the governing constraint, thus ensuring that the constraint is never starved.
- Buffers are also placed behind the constraint to prevent downstream failure from blocking the constraint's output
- Concern with buffer management – buffer quantity and buffer duration

*Tied in Theory of Constraint (ToC) and Drum-Buffer-Rope (DBR) methodology

JIT/KANBAN

- Also known as Pull System or Lean Manufacturing
- Produce only exactly what needed, when need it and in the needed quantity
- Producing based on customer's order in small lot size (Ideal Lot Size = 1)
- Parts and materials are requested and delivered as they are needed.
- Materials & parts are pulled into the production operation when needed.
- Use KANBAN to move material/parts and produce products

ANOTHER PERSPECTIVE

- Another classification of manufacturing system is from automation and manning level of the machines/equipment perspective
  - Manually operated machines are controlled or supervised by a human worker
  - Semi-automated machines perform a portion of the work cycle under some form of program control, and a worker tends the machine the rest of the cycle
  - Fully automated machines operate for extended periods of time with no human attention

This classification will lead to what we call Computerized Integrated Manufacturing (CIM) and Computerized-Aided Manufacturing (CAM)

Model of a System

- The representation of an system in some form other than the form of the system itself
- Modeling involves observing a system, noting the various components, then developing a representation of the system that will allow for further study of or experimentation on the system

Why Model?

- Training or instruction
- To aid thought
- To aid communication
- Prediction
- Experimentation
- To aid decision making process

Types of Models

- Physical: an actual representation
- Schematic: a pictorial representation
- Descriptive: a verbal description
- Mathematical: components are described mathematically, in the form of equations
- Heuristics: descriptive model based on rules; algorithmic; - computer based

To Study Manufacturing System, It Is Necessary to Develop Manufacturing Model Accordingly

References

- Gershwin, S. B. (1994). *Manufacturing System Engineering*. Prentice Hall.
- Askin, R.G. and Standridge, C. R. (1993). *Modeling and Analysis Manufacturing System*. John Wiley & Sons, Inc.
- Groover, M. P. (2008). *Automation, Production Systems, and Computer-Integrated Manufacturing, Third Edition*. Pearson Education.