

# **Unit 5015: Manufacturing Systems Engineering**

**Unit Code:** J/615/1516

**Level:** 5

**Credits:** 15

---

## **Introduction**

Manufacturing systems engineering is concerned with the design and on-going operation and enhancement of the integrated elements within a manufacturing system, which is a very complex activity, even for simple products. The art of manufacturing systems engineering is essentially designing systems that can cope with that complexity effectively.

The aim of this unit is to develop students' understanding of that complexity within a modern manufacturing environment. Among the topics covered in this unit are: elements that make up a manufacturing system, including production engineering, plant and maintenance engineering, product design, logistics, production planning and control, forecast quality assurance, accounting and purchasing, all of which work together within the manufacturing system to create products that meet customers' requirements.

On successful completion of this unit students will be able to explain the principles of a manufacturing system and consider how to design improvements. They will be introduced to all the elements that make up a modern manufacturing system, and they will learn how to optimise the operation of existing systems through discerning use of monitoring data. Some of the elements will be developed in greater depth; of particular importance will be looking at the systems of production planning and control, which are the day-to-day tools used to manage the manufacturing system effectively.

## Learning Outcomes

By the end of this unit a student will be able to:

- LO1 Illustrate the principles of manufacturing systems engineering and explain their relevance to the design and enhancement of manufacturing systems
- LO2 Use a range of analysis tools, including value stream mapping, to determine the effectiveness and efficiency of a manufacturing system, and then develop an appropriate future state for that system
- LO3 Outline the impact of different production planning approaches on the effectiveness of a manufacturing system
- LO4 Define the responsibilities of manufacturing systems engineering and review how they enable successful organisations to remain competitive.

## Essential Content

### **LO1 Illustrate the principles of manufacturing systems engineering and their relevance to the design and enhancement of manufacturing systems**

#### *Manufacturing systems elements:*

Elements to be considered include quality, cost, delivery performance and optimising output

Problem-solving and managing complexity, maintenance scheduling and planning, resource planning and productivity

Effect of testing and data analysis on performance.

### **LO2 Use a range of analysis tools, including value stream mapping, to determine the effectiveness and efficiency of a manufacturing system, and then develop an appropriate future state for that system**

#### *Analysis tools:*

Introduction to value stream mapping, and the value of both current state mapping and future state mapping

Bottle-neck analysis, by using process improvement tools and techniques e.g. value stream analysis, simulation, kanban

Using key performance indicators to understand the performance of a manufacturing system e.g. overall equipment effectiveness, lead-time, cycle time, waiting time, yield, delivery performance, safety metrics

Reviewing key performance indicators; methods for presenting metrics and performance e.g. balanced scorecards, performance dashboards, Andon boards, Gemba walks.

**LO3 Outline the impact of different production planning approaches on the effectiveness of a manufacturing system**

*Production planning approaches:*

Examples of production planning strategy: push vs pull factors, kanban systems, make to stock, make to order and engineer to order

Production planning approaches such as batch and queue, pull/kanban, just-in-time, modular design, configuration at the final point, and master scheduling.

*Production planning management tools:*

Enterprise Resource Mapping (ERP) systems, Material Resource Planning (MRP 2) and Manufacturing Execution systems, ability to managing complexity and resourcing through information technology

Industrial engineering issues: the importance of standard times and the impact on productivity and the costing of products. Standard work underpins the repeatability of process and quality control.

**LO4 Review the functions of manufacturing systems engineering and how they enable successful organisations to remain competitive.**

*Effectiveness of manufacturing systems:*

Plant layout design, planning and control, productivity and continuous improvement, quality control and equipment effectiveness

Return on investment and capital expenditure, control of the cost of planned maintenance

Manufacturing information technology: the supply of data from the process to decision-makers e.g. failure modes for both product and system, maintenance and down time data, standard times for production, material control, energy usage.

## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<b>LO1</b> Illustrate the principles of manufacturing systems engineering and their relevance to the design and enhancement of manufacturing systems		<b>D1</b> Apply value stream mapping to a production process to evaluate the efficiency of that process by using the current state map to suggest improvements.
<b>P1</b> Illustrate the principles of manufacturing engineering. <b>P2</b> Explain the relevance of manufacturing systems engineering to the design of a manufacturing system.	<b>M1</b> Evaluate the impact that manufacturing systems have on the success of a manufacturing organisation.	
<b>LO2</b> Use a range of analysis tools, including value stream mapping, to determine the effectiveness and efficiency of a manufacturing system, and then develop an appropriate future state for that system		<b>D2</b> Review value stream mapping against other production planning methodologies and justify its use as a production planning tool.
<b>P3</b> Apply value stream mapping to visualise a production process.	<b>M2</b> Identify optimisation opportunities through value stream mapping of a production process.	

Pass	Merit	Distinction
<b>L03</b> Outline the impact of different production planning approaches on the effectiveness of a manufacturing system		<b>D3</b> Justify the most appropriate production planning technique and its suitability for a particular manufacturing approach, such as make to stock, make to order, or engineer to order.
<b>P4</b> Identify the common production planning approaches and state their impact on manufacturing systems.  <b>P5</b> Define the types of manufacturing approach, such as make to stock, make to order and engineer to order.	<b>M3</b> Evaluate the effectiveness of production planning methods.  <b>M4</b> Explore the effectiveness of common production planning techniques to identify which production approach they complement.	
<b>L04</b> Review the functions of manufacturing systems engineering and how they enable successful organisations to remain competitive.		<b>D4</b> Critically consider the elements of an existing manufacturing system to appraise why this is successful.
<b>P6</b> Define the core responsibilities of a manufacturing systems engineer.  <b>P7</b> Identify the key contributing success factors of a manufacturing system.	<b>M5</b> Evaluate the impact that a manufacturing systems engineering has on successful manufacturing organisations.	

## Recommended Resources

*Note: See HN Global for guidance on additional resources.*

### Print Resources

Bicheno, J. and Holweg, M. (2009) *The Lean Toolbox*. 4th Ed. PICSIE Books.

Chopra, S. and Meindl, P. (2015) *Supply Chain Management: Strategy, Planning, and Operation (Global Edition)*. 6th Ed. Pearson.

Groover P. M. (2019) *Fundamentals of Modern Manufacturing: Materials, Processes, and Systems*. 7th Ed. Wiley.

Huang Y., Wang L., and Liang S. Y. (2019) *Handbook of Manufacturing*. World Scientific Publishing Company.

Kalpakjian S. and Schmid S. (2022) *Manufacturing Engineering and Technology*. 8th Ed. Pearson.

Slack, N. (2013) *Operations Management*. 7th Ed. Pearson.

Womack, J., Jones, D. and Roos, D. (1990) *The Machine That Changed the World*. Free Press.

### Websites

<http://www.industryweek.com/>

Industry Week

Five Benefits of an MES

(Article)

### Links

This unit links to the following related units:

Unit 5016: Lean Manufacturing

Unit 5017: Advanced Manufacturing Technology

Unit 5018: Sustainability.