Unit 161: Condition Monitoring and Fault Diagnosis Within Large-Scale Vehicle Manufacturing

Unit code	**T/616/4522**
Unit level	4
Credit value	15

Aim

The successful completion of this unit will provide learners with an understanding of condition monitoring and the techniques employed in the process within large-scale vehicle manufacturing. This understanding will then be extended to enable location and diagnoses of faults in condition monitoring systems in a systematic and cost-effective way.

Unit abstract

Condition Monitoring (CM) is the process of determining the condition of machinery whilst in operation, often automatically, to ensure optimum performance. It is an essential element of the preventative maintenance programmes which support the smooth running of large engineering plants such as vehicle manufacturing. It can signal the need for intervention to avoid expensive failures and system shutdowns and provide data to aid the design of more effective preventative maintenance programmes.

This unit first examines the general concepts of condition monitoring, including the causes of failure, monitoring methods and the analysis of data supplied by monitoring systems. Learners will progress to examine a range of condition monitoring techniques relevant to vehicle manufacturing plants.

The checks, tests and other techniques used to diagnose, locate and identify system faults, accurately and systematically, will then be studied.

Finally, learners will investigate the more common causes and effects of failure and, using a range of techniques, analyse the effect of such failures on system performance and the planning of preventative maintenance programmes.

Learning outcomes

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

1. Explain the concepts of condition monitoring

2. Describe how condition monitoring techniques are used in large-scale vehicle manufacturing plant and equipment

3. Locate faults accurately and systematically in large-scale vehicle manufacturing systems

4. Recognise the causes and effects of faults in large-scale vehicle manufacturing systems and suggest ways of improving preventative maintenance programmes.

Unit content

1   **Explain the concepts of condition monitoring**

Failure and breakdown: degradation due to corrosion, cracking, fouling, wear, ageing, mal-operation, environmental effects, operational and maintenance considerations; statistical analysis of failure rates on plant and equipment

Monitoring: arrangements and measured parameters, 'online' and 'offline' monitoring, fixed and portable monitoring equipment, continuous and semi-continuous data recording, stress analysis, strain recording

Data acquisition and analysis: data acquisition techniques, data analysis methods, computerised systems, use of generic computer software (spreadsheets, databases etc.), bespoke computer analysis systems, fault analysis/diagnosis, plant down time analysis, data storage techniques, high-speed data capture, trend analysis, expert systems, condition monitoring integrated within 'normal' plant and machinery control and data acquisition systems

2   **Describe how condition monitoring techniques are used in large-scale vehicle manufacturing plant and equipment**

Vibration: broad band defect detection; frequency spectrum analysis; shock pulse method; high-frequency analysis techniques

Leak detection: acoustic emission and surveillance; moisture sensitive tapes; radiotracer/radio-chemical methods

Corrosion detection: chromatography; eddy currents; electrical resistance; tangential impedance meter; IR spectroscopy; potential monitoring; thermograph; lasers

Crack detection: ultrasonic methods; optical fibres; lasers; strain gauges; electrical potential method; eddy currents; acoustic emission; thermography

Temperature monitoring: thermography; thermometry; thermistors; thermocouple devices; RTDs; optical pyrometers; IR pyrometers; lasers

3   **Locate faults accurately and systematically in large-scale vehicle manufacturing systems**

Information and documentation: roles of plant personnel, national and international standards applicable to CM; alarm systems; component data sheets; block diagrams; flow charts; dependency charts; trouble shooting charts; wiring and schematic diagrams; circuit diagrams; system diagrams; operation and maintenance manuals; computerised records and data; use of internet. CAD systems, use and modification of CAD diagrams

Inspection and test: characteristics of system; online/offline testing; test equipment; electrical/electronic/software based; self-diagnostic techniques; expert systems; safety requirements; safety and damage limitation

Fault location techniques: appropriate sources of information identified and selected; analysis of evidence; systematic and logical approach to fault finding; evaluation and verification of faults

4 **Recognise the causes and effects of faults in large scale vehicle manufacturing systems and suggest ways of improving preventative maintenance programmes**

Causes of failure: mal-operation; environmental; poor/absence maintenance; operation outside design specifications; infrequent use, too frequent use; the 'bath tub' curve; reliability; common mode failure

Effects of failure: safety, economic, downtime, loss of production etc; failure states of components within a system

Analytical techniques: failure mode and effect analysis; fault tree analysis; cause and effect analysis, predictive maintenance

Preventative maintenance systems: function and operation of preventative maintenance systems and predictive maintenance, responsibility of the technician/engineer to reflect proactively on the cause and prevention of faults, use of a reflective log to note faults and action, feedback (need for and methods of) contributing to the effectiveness and redesign of preventative maintenance programmes

Learning outcomes and assessment criteria

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
LO1 Explain the concepts of condition monitoring	1.1 identify the need for, and general requirements of, an effective condition monitoring system for use in a large-scale vehicle manufacturing operation
	1.2 describe the main causes of failure and breakdown in vehicle manufacturing plant and equipment and explain the use of statistical data for analysing such failures or breakdowns
	1.3 explain how condition monitoring may be integrated within normal plant and machinery operation, control and data acquisition systems
LO2 Describe how condition monitoring techniques are used in large-scale vehicle manufacturing plant and equipment	2.1 detail the main types of the condition monitoring techniques used in vehicle manufacturing plant and equipment
	2.2 review given examples of condition monitoring systems used in large-scale vehicle manufacturing operations to highlight the relative merits of each arrangement
LO3 Locate faults accurately and systematically in large-scale vehicle manufacturing systems	3.1 investigate and identify sources of information and documentation used as an aid to fault finding and fault location and report on their relative usefulness
	3.2 select appropriate inspection and test equipment for given examples of fault location
	3.3 carry out appropriate fault-finding procedures to locate and verify faults in systems

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
LO4 Recognise the causes and effects of faults in large-scale vehicle manufacturing systems and suggest ways of improving preventative maintenance programmes	4.1 investigate and report on the causes of failure and identify the failure states of components within a given system 4.2 carry out failure mode and effect, fault tree and cause and effect analysis, reporting on the appropriateness of each process for different situations 4.3 describe how reflective practice by technicians and engineers can help the development of more effective preventative maintenance systems

Guidance

Links

This unit may be linked with other plant/process and engineering maintenance units, particularly *Unit 45: Plant Operation and Performance and new unit D/615/1490 Instrumentation and Control Systems*.

Successful completion of this unit will enable learners to meet, in part, the Engineering Council Standards for Professional Engineering Competence (UK-SPEC), detailed below:

- Engineering Technician (Eng Tech) B1 standard 'identify problems and apply diagnostic methods to identify causes and achieve satisfactory solutions'

- Incorporated Engineer (IEng) standard A2 sub-paragraph 4 'Apply knowledge and experience to investigate and solve problems arising during engineering tasks and implement corrective action'.

Essential requirements

Centres delivering this unit must be equipped with, or have access to, industrial-standard condition monitoring equipment, instrumentation and facilities/equipment suitable for testing/fault finding. The opportunity to see system monitoring equipment operating in a large scale vehicle manufacturing environment is also essential. A range of system components for demonstration purposes and hands-on familiarisation will also need to be available.

Employer engagement and vocational contexts

Liaison with employers would prove of benefit to centres, especially if they are able to offer help with the provision of suitable industrial condition monitoring and fault-finding facilities and equipment.