MSc Sustainable Engineering

The MSc in Sustainable Engineering at Loughborough University currently comprises of the following eight modules in addition to a major individual project:

Sustainable Development: The Engineering Context

This introductory module aims to provide students with an understanding of the principles and practices of sustainable development and to provide them with an understanding of how engineers can help manufacturing businesses develop into sustainable enterprises. Topics include: the economic and social dimensions of sustainable development; environmental legislation; resource conservation; financial costs/benefits of sustainability. A number of practical case studies (by external and internal guest speakers) are used to demonstrate the significant scientific and engineering challenges involved in establishing a sustainable approach for future manufacturing activities.

Life-Cycle Assessment (LCA)

The aim of this module is to define a methodology and introduce associated tools with which to conduct a life-cycle assessment. Topics within this module include an introduction to LCA, LCA based ISO standards, a framework for Goal and Scope, LCA analysis and impact. In addition, the methodology for conducting Life Cycle Assessment of products based on the international standard ISO14040 is introduced. Students are trained in using the leading commercial LCA software tool (SIMApro). This theory and practice is supported by developing an understanding of the scientific principles (Eutrophication, Greenhouse gases, Acidification, classification), mathematical and statistical methods (Characterisation, Normalisation, Aggregation, Weighting, Sensitivity analysis) and the engineering principles of how results can be interpreted and used to re-engineer and re-design products to reduce their environmental impacts (substitution, reduction, elimination, recovery).

Sustainable Energy Systems

The sustainable energy systems module involves an integrated approach to understanding energy management, energy utilisation and energy rationalisation. This module addresses several key issues related to energy including: renewable energy and alternative energy sources; policy, drivers and legislation; climate change and the global environment; energy usage trends; energy rationalisation and energy efficiency considerations; carbon sequestration and climate engineering, and the environmental economics of non-renewable energy sources. A number of methodologies are discussed which analyse energy consumption on the enterprise, plant, process and product manufacturing levels and which mathematically (based on empirical and theoretical data) determine the efficiencies of energy consumption across these levels. Statistical analysis enables the students to highlight areas of priority for energy efficiency improvements. Real industrial case studies are used to support this learning.

Waste Management and Product Recovery

The aim of this module is to introduce and explore factors influencing waste management, product recovery and the resultant management of resources. Topics addressed within this module include waste management and the waste hierarchy, controlled and uncontrolled waste, environmental laws and regulations associated with the production, treatment and disposal of waste, waste processing procedures, waste minimisation programmes, and alternative waste management processes and their procedures – such as reuse, remanufacturing and recycling. Underpinning each of these approaches are fundamental engineering principles such as thermodynamics, density separation, material identification (IR and NIR, MR, X-ray, spectroscopy, induction), separation based on material characteristics (density, magnetic, electromagnetic, terminal velocity, etc.) and chemistry (biological and chemical recycling methods).
Environmental Management Standards, Legislation and Directives

The Environmental Management Systems module involves an integrated approach to managing and monitoring a company’s environmental impact and complying with environmental regulations. The module content includes an introduction to Environmental management, environmental management standards including BS7750, ISO 14001 and EMAS. Students are trained to use the formal steps in ISO 14001 to develop an Environmental Management System (EMS) for an organisation. Further topics include environmental auditing, environmental regulation and legislation and the preparation, implementation and reviewing of environmental policy for manufacturing companies. The theory and practice is supported by developing an understanding of the scientific principles in identifying sources of pollution and emission (in solid, liquid and gas forms), mathematical and statistical methods for developing scoring models for prioritisation of environmental aspect and impact, and the engineering principles to develop a continuous improvement approach for systematic reduction of various environmental impact (solid waste, harmful emissions, elimination and safe use of chemical substances, wastewater management, etc.) by a manufacturing company.

Sustainable Product Design

The aim of this module is to provide an understanding of the tools and techniques available to facilitate sustainable product design and provide knowledge of the product design processes that can reduce environmental impacts and promote sustainable practices. Topics include: design for the environment; quantitative and qualitative design guides; Eco-design; life-cycle assessment; relevant legislation; design for disassembly/re-use/re-manufacture/recycling. A number of design methodologies based on use of solar-cyclic-safe principles and triple sustainability bottom lines to improve the environmental impact of products during the entire lifecycle are described. In addition students are trained in use commercial environmental analysis tool such as Eco-Indicator99 to evaluate the significance of the environmental impact during various stages of a product life cycle.

Sustainable Business Management

The module on sustainable business management explores how and why environmental impact can be attributed to manufacturing activities and thus provides an insight into how businesses can be better managed in the future to reduce these impacts. The module explains how to cost products over their entire life cycle, how to produce corporate social responsibility reports and how to avoid generating greenwash. It also takes a detailed look at product service systems, how these can improve environmental performance and details the corporate structure changes of a manufacturing organisation to be able to these product service systems. In addition, the engineering principles for developing flexible reconfigurable systems and distributed localised production processes are described. Students are also introduced to the principle of distributed production planning and control based on various networking theories. Finally the roles of both consumers and manufacturers are discussed and how both of these can play a part in reducing environmental impacts across all stages of the product lifecycle.

The Innovation Process and Project Management

This module provides an overview of project engineering and the innovation process. Process stages include the need, investigation and problem formulation, design specification, concept generation and evaluation, concept development, detail design, manufacture, sales, user feedback, and product life cycles. Project management methods, creativity and the relationship between innovation and company structure are considered. Principles covered can be applied in any field of engineering but are relevant to this course as the methodologies studied support the undertaking of the major individual project.