

THE PROFESSIONAL MECHANICAL ENGINEER IN THE BULK MATERIALS HANDLING INDUSTRY AND HOW TO BECOME ONE.

Institution of
**MECHANICAL
ENGINEERS**

This guide is designed to provide a source of information to help inspire student and graduate engineers to consider a career as an engineer in the bulk materials handling industry.



Improving the world through engineering

CONTENTS

INTRODUCTION	3
ENGINEERING IN THE BULK MATERIALS HANDLING	
THE UK BULK MATERIALS HANDLING INDUSTRY	4
BULK MATERIAL BEHAVIOUR - THE SCIENCE	
DIVISIONS AND SECTORS	6
SECTORS OF INDUSTRY WHERE BULK HANDLING IS IMPORTANT	
MECHANICAL ENGINEERING ROLES	7
SPECIALIST BULK HANDLING EQUIPMENT MANUFACTURER	
ROLES, ENGINEERING PROCUREMENT & CONSTRUCTION	
OPERATING COMPANY ROLES	
ACQUIRING THE SKILLS	9
INFORMATION SOURCES	10
MARKET TRENDS	11
WHO IS INVOLVED IN BULK HANDLING?	12
RELEVANT LEGISLATION	13
PROFESSIONAL DEVELOPMENT	14
STANDARDS	
PROFESSIONAL DEVELOPMENT	
TRAINING AND PROFESSIONAL DEVELOPMENT FOR YOUR CAREER	
ROUTES INTO ENGINEERING	15

This booklet has been prepared to explain the role of the engineer in this important industry sector. A career in the bulk handling industry can be rewarding, exciting and challenging, yet also offer opportunities in a huge range of seemingly unrelated industry sectors, each connected by a common need - to efficiently and reliably move and process bulk materials.

INTRODUCTION

‘Bulk Materials Handling’ or ‘Bulk Handling’ refers to the handling of any granular or powder material in bulk, eg the continuous movement of loose material in a conveyor or elevator. The most visible examples are dockside loaders and unloaders; open conveyors moving sand and other quarried materials; and the round, corrugated storage silos containing wheat and other grains, with their attached conveyors and elevators. However, most processing factories in almost every industry use smaller scale mechanical and pneumatic conveyors, elevators and other equipment to move and process bulk materials as an integral part of their manufacturing process. Industries as diverse as automotive, aerospace, mining, food, pharmaceutical and petro-chemicals rely on the skills and expertise of bulk materials handling engineers.

ENGINEERING IN THE BULK MATERIALS HANDLING INDUSTRY

Much of what is moved and processed throughout the world relies on effective and safe material handling technologies. Still, as we strive to improve our standards of living and take full advantage of ongoing technological developments, we create ever-increasing demands for further automation, processing efficiency, throughput and environmental safety. These demands fuel a constant pressure for refinement of our understanding of the behaviour of bulk materials, as well as innovation in the design of the equipment and the factories needed to process them.

The industries that the bulk handling engineer operates in are hugely varied and produce the elements of today’s life, whether it be food, transport, construction or power. The international nature of the industry means that there are many opportunities for bulk handling engineers to travel the world.

A bulk handling engineer has a valuable role to play in so many different industries that the skills s/he acquires could lead to a fulfilling career in design, manufacturing, project management, sales, consultancy, testing and certification or academic research, but with additional opportunities to move across industry sectors or into senior management - a unique career opportunity and one that fulfils a vital role in society.

THE UK BULK MATERIALS HANDLING INDUSTRY

An engineer in this sector may be dealing with any aspect of storage, transportation, processing, logistics, quality control and in some cases research & development and be required to have knowledge of all the associated compliance issues, as well as the environmental and legal aspects.

Bulk Handling systems may be composed from some of the following pieces of equipment:

- **conveyors:** belt, chain, screw and pneumatic
- **elevators:** bucket, chain, screw, belt and pneumatic
- **weighers, bagging and packaging equipment**
- **feeders and metering equipment**
- **dust extraction systems**
- **pneumatic equipment and systems**
- **screens, separating and sorting equipment**
- **grinders, granulators, driers, pelleting mills, mixers and other process equipment**
- **storage systems** including silos, hoppers, domes, flat stores
- **large machines** such as stackers, reclaimers, truck dumpers, railcar dumpers/wagon tipplers, ship loaders and unloaders
- **mobile equipment.**

Advanced bulk materials handling and processing facilities typically computerise all the elements to produce integrated bulk storage, discharge, conveying and processing systems.

Interestingly, different sectors have different priorities and approaches:

- in the pharmaceutical and food sectors, the emphasis is on hygiene and containment
- the cement industry has an environmental emphasis in terms of the production process and energy input
- in the extractive industries, the emphasis might be on equipment lifespan
- in some sectors, the need to handle extremely difficult materials means the engineer might be faced with materials that refuse to flow reliably
- some materials may have the potential to be explosive, flammable, toxic or have other undesirable traits. Engineering the handling of these hazardous materials may require imaginative techniques to properly protect plant and personnel.

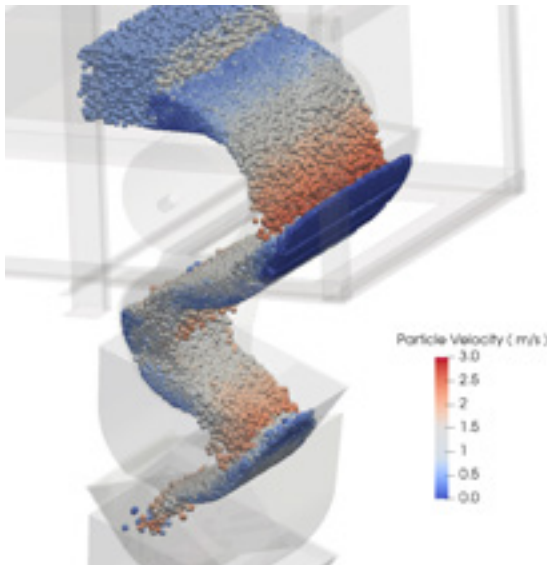
These all create challenges that will appear in some form in each case. It will be up to the engineer to prioritise and deal with the problems as they arise, whether in a new build or an existing installation.

As companies work towards reducing costs, in particular associated with energy and the impact of stricter environmental regulations and the reduction in carbon emissions targets, the skills of a mechanical engineer are an essential ingredient. Typical skill specialisations include design, research & development, sales, project management, operations or maintenance of handling and processing equipment.

In the early decades of the 20th Century, it was relatively easy to differentiate between a mechanical engineer and an engineer of other disciplines, such as electrical or civil engineering. Now in the 21st Century, engineers must acquire a broad range of skills that include aspects of many disciplines. Mechanical engineers will often diversify and acquire knowledge and experience, constantly learning and adding to their expertise.

BULK MATERIAL BEHAVIOUR - THE SCIENCE

One common thread running through a bulk-handling engineer's job is the need to understand how materials are likely to behave whilst in storage or flowing through a system. Getting this wrong can have costly consequences as experience shows. Unlike liquids, powders and bulk solids have strength and frictional characteristics: they can be compressible, sometimes unyielding and effectively possess a combination of the standard characteristics associated with solids, liquids and gases. This creates uncertainty that can affect the behaviour and performance of equipment and plant. There is some seriously interesting science in bulk material behaviour. Whilst our knowledge has moved on rapidly in the last 50 years, there is still much work to do.



Discrete element model of a granular material flowing down a controlled flow chute

DIVISIONS AND SECTORS

Bulk materials handling is not a division or a sector of industry itself. Instead, it is a fundamental constituent part of most industry sectors.

The range of products handled and processed can range from large rocks and ores, through granular materials such as sand and gravel, to wheat, barley, peas and beans, and on to powders that can fluidise and flow like water. Some materials are of a relatively low value (perhaps less than £100/tonne), ranging to high value chemicals (at more than £1,000/kg). Products handled can range from innocuous, easy flowing compounds or highly cohesive powders, to explosive and dangerous materials that pose significant health & safety risks.

SECTORS OF INDUSTRY WHERE BULK HANDLING IS IMPORTANT

Industry Sector	Relevant UK Annual Statistics
Additive manufacturing	A fast-expanding hi-tech sector requiring powder handling skills
Agricultural products and processing	25 m tonnes Cereals harvested ¹
Biomass processing and use	4.8 m tonnes Wood pellets (Imports + UK production) ¹
Building materials production	9 m tonnes Cement produced ²
Chemicals production and use	£8.8 billion Gross value added ⁴
Animal Feeds	14 m tonnes produced ¹
Food & drink manufacture	£28.86 bn Gross value added ¹
Maltings	1.8 m tonnes Malting barley purchased from 2017 crop (UK is the world's 3rd largest malts producer) ³
Mining and Minerals extraction and processing	127 m tonnes Primary aggregates consumed ²
Pharmaceuticals manufacture	£6.4 billion Gross value added ⁴
Tunnelling	Approx. 8 million m ³ of spoil was removed during the construction of the Channel Tunnel
Waste management	Many categories of waste combine to create large quantities of waste that is sorted and processed to help reduce landfill disposal

References:

1. 2017 UK National Statistics
2. 2014 UK National Statistics
3. Maltsters' Association of Great Britain
4. 2014 UK Chem & Pharma Ind. Report

MECHANICAL ENGINEERING ROLES

Mechanical Engineers, through their education and training, develop a wide range of skill sets, which allow them to diversify into a wide range of roles. The principal bulk materials handling areas in which they are employed are:

- equipment design
- equipment manufacture
- equipment sales & marketing
- plant layout design
- project engineering
- project management
- plant engineering
- testing, certification and approvals.

Few operating companies now employ in-house engineering teams. The engineering of new plant and plant upgrades is usually outsourced to engineering contractors. The mechanical engineers employed by operating companies therefore tend to be focussed on plant maintenance and the management and supervision of contractors for design, construction and maintenance.

Bulk handling within process plants is complex and the design requires co-ordination between different engineering disciplines within the engineering team. Mechanical engineers will therefore need to work closely with engineers of other disciplines. For example,

- Chemical engineers
- Control & Instrumentation engineers
- Electrical engineers
- Software engineers
- Civil engineers
- Structural engineers
- Construction engineers
- Commissioning engineers
- Metallurgists
- Acoustic engineers
- Health & safety engineers
- Compliance engineers.

All the following roles will assume knowledge, expertise and experience in bulk materials handling and in the associated engineering and relevant legislation.

SPECIALIST BULK HANDLING EQUIPMENT MANUFACTURER ROLES

Equipment Design Engineers

This role involves the design and possibly the specification of customised or standard modular pieces of equipment. The role will often include elements of product research and development, manufacturing and product testing.

Equipment Sales/Proposals Engineers

This role often combines bulk handling engineering knowledge and experience with commercial sales skills. It will usually involve initial equipment selection, followed by preparation of a suitable specification and quotation to suit the plant operating company's needs. The engineer will often advise EPC Contractors on the most suitable equipment and options for plant layout.

ENGINEERING PROCUREMENT & CONSTRUCTION ("EPC") CONTRACTOR ROLES

Plant Design Engineers

This is a role that is carried out by plant integrators and EPC engineers. As the name implies, it is primarily concerned with plant layout design and selection of appropriate equipment to handle the required material. Co-ordination and communication with sub-suppliers is an important and necessary skill.

Project Engineers

This role's primary function is in the co-ordination of the engineering aspects of a project from design, procurement and construction through to final commissioning. Particular skills include interpretation of drawings, scheduling, planning and supervision of engineering staff and site contractors.

Project Managers

This role is to ensure the smooth running of the project from conception to commissioning and client take-over. Particular skills include in-house staff management, client management and project planning, financial management, procurement and contract services.

OPERATING COMPANY ROLES

Plant Engineer

The Plant Engineer is responsible for the smooth and profitable running of the plant. The duties include managing site maintenance, preparation of equipment efficiency data, management of environmental issues, supervision of maintenance teams, development of work scopes, schedules and planning and managing site contractors, as well as advising on upgrade opportunities.

ACQUIRING THE SKILLS

A mechanical engineering degree is an important starting point or foundation, as it provides an advanced knowledge and understanding of the fundamental technical and academic tools a modern bulk handling engineer needs. However, it generally does not provide any bulk materials handling-specific training or knowledge. As with most other engineering disciplines, there has to be further learning post-degree to develop a successful career in bulk materials handling.

Engineers in this sector may typically be required to have knowledge of the individual elements of storage and handling equipment, such as silos, hoppers, conveyors and elevators, as well as an understanding of complete materials handling systems, where combinations of these elements are integrated into one operational system. Dealing with powders means that there are also associated health & safety and environmental issues, where the engineer will endeavour to balance production demands with stringent legislative standards. How can this knowledge and experience be gained?



Household waste being conveyed into a processing area



A Z-blade industrial mixer used for mixing, kneading and dispersion of very viscous doughs and pastes. This food quality machine is shown with the casing removed for cleaning.

Through Work Experience

Trainee roles are available in large and small companies, often with an element of management training included. Large companies typically offer structured training closely focussed on their particular business areas, and often linked to the IMechE Monitored Professional Development scheme. In contrast, smaller specialist companies often offer more varied work with more responsibility earlier, which can be very rewarding. In both cases, working alongside experienced engineers ensures continuous learning.

Through Academic Learning

There are specialist departments in some universities that offer an MSc or PhD in a materials handling subject. This route can be used to convert from many other technical degrees and opens up career opportunities in plant and equipment design, as well as in sales, research and consultancy roles.

INFORMATION SOURCES

IMechE - Institution of Mechanical Engineers Library offers a wealth of information, on all aspects of engineering. Members can access over 40,000 online titles from leading engineering publishers, wherever they are based. The IMechE Library team offer a free enquiry service supplying literature reviews, company data or materials properties info, e-mail library@imeche.org. Books and standards are also available via free postal loan from the library at IMechE Headquarters. www.imeche.org

IMechE Bulk Materials Handling Committee provides a focus for technology transfer, the exchange of information and ideas, and the dissemination of best engineering knowledge and practice in the bulk materials handling industry. www.imeche.org/get-involved/special-interest-groups/process-industries-division/bulk-materials-handling-committee

The Engineering Council is the UK regulatory body for the engineering profession. The national registers are held for the 222,000 Engineering Technicians (EngTech), Incorporated Engineers (IEng), Chartered Engineers (CEng) and Information & Communications Technology Technicians (ICTTech). www.engc.org.uk/

The Wolfson Centre for Bulk Solids Handling Technology, University of Greenwich offers consultancy, research and short courses for industries that handle powder or granular materials as part of their processes. www.gre.ac.uk/engsci/research/groups/wolfsoncentre/home

HSE - Health and Safety Executive is responsible for health and safety in the UK industry. www.hse.gov.uk

SHAPA - Solids Handling and Processing Association are the UK's leading specialist association for the solids handling and processing industry. www.shapa.co.uk

MHEA - Materials Handling Engineers Association supports the technical and commercial interests of engineers working for UK and overseas companies supplying and using bulk handling equipment. www.mhea.co.uk

BSI - British Standards Institute is the world's leading UK, European and International Business Standards publisher. BSI works with business experts and government bodies to formulate best practises and structures that give all organisations knowledge they need to succeed. www.standardsuk.com

MARKET TRENDS

The manufacturing and processing industry is constantly striving to improve efficiencies and control costs, whilst ensuring that its activities meet the challenges thrown up by environmental considerations on a global level. Also, demand for products and resources from developing countries such as China, Africa and India is creating further opportunities for engineers in all disciplines. All these challenges and demands will further drive the need for bulk materials handling engineers.

Currently, and in the short- and medium-term, there is significant scope for engineering development in the following:

- plant de-commissioning and re-use
- waste and recycling technology
- plant and process energy efficiency improvement
- plant and process environmental impact and emissions reduction
- novel energy generation, conversion processes and schemes (energy from waste, hydrogen schemes, energy storage systems, etc.).



A seed cleaning plant

WHO IS INVOLVED IN BULK HANDLING?

An internet search on the following descriptions will yield a list of relevant companies:

- bulk materials handling machinery manufacturers
- bulk solids handling machinery manufacturers
- pneumatic conveying systems
- storage silo and other bulk storage bin manufacturers
- grain storage and processing plant design and build
- bulk material storage plants
- bulk material processing plants.

Processing plants for whom bulk materials handling forms a major part of their activities:

- pharmaceuticals and chemicals manufacturers
- food and animal feed manufacturers
- waste and recycling processors
- maltings and distilleries
- power companies
- cement manufacturers
- quarries and mines.

Major engineering houses, Consultants, EPC Contractors, Architect Engineers and Facilities Managers all may have requirements for Bulk Handling Engineers.

Trade Associations that serve or have interests in bulk materials handling:

- Solids Handling and Processing Association (SHAPA)
- Materials Handling Engineers' Association (MHEA)
- Institute of Local Exhaust Ventilation Engineers (ILEVE)
- Processing and Packaging Machinery Association (PPMA)
- British Aggregates Association (BAA)
- Mineral Products Association (MPA)
- British Ports Association (BPA)
- Minerals Engineering Society (MES)
- Institute of Materials, Minerals and Mining (IOM3)




RELEVANT LEGISLATION

Once into the bulk handling sector there are several areas away from mainstream engineering that can also open up as a career path.

Bulk Handling Engineers must be aware of, and ensure that their work conforms to, a wide range of legislation and regulations. These include national (as well as regional and international) laws. Besides influencing many specifically technical aspects of a design or scheme, they also set out rules which will indirectly affect it, such as:

- the need to obtain development permits and consents, environmental protection considerations
- health and safety requirements
- restrictions on how a project can be financed and commercial activities that may be taxed and/or subsidised, and
- how goods and services may be procured and transported between jurisdictions.

Understanding this body of legislation is vital and can be a fascinating part of an engineer's role. The following list gives a basic overview of the breadth of laws that an engineer working in the UK may need to be aware of:

- The European CE Compliance directive 
- Construction Design and Management Regulations (CDM)
- Control of Major Accident Hazards Legislation (COMAH)
- Control of Substances Hazardous to Health Regulations (COSHH)
- European Emissions Trading Scheme Directive and associated legislation
- European Integrated Pollution Prevention and Control Directive
- European Industrial Emissions Directive
- International waste - disposal and dumping conventions (OSPAR and London Conventions)
- Health and Safety at Work Act and associated regulations and guidance.
- Town and Country Planning legislation
- Treaties of the European Union - setting out, amongst many other things, restrictions on state funding for projects.



Bulk Handling is a global business, as raw materials are often found in developing nations and not in the country of process and ultimate use. There is a global need for people who understand bulk handling, who also have knowledge of exporting legislation, shipping, logistics and financing requirements.

PROFESSIONAL DEVELOPMENT

To become a professional engineer in this field, you need the building blocks. It all starts at school when you acquire the basic skill sets and knowledge, pursuing subjects that might include mathematics, physics, chemistry, science and information & communication technology.

At the end of this booklet there is a diagram showing the different routes into engineering and the levels of registration available to those with varying academic backgrounds. The Information Sources section of this booklet might also be able to help.

STANDARDS

The Engineering Council oversees the standards of the engineering profession in the UK. Details about the organisation and affiliated Institutions can be viewed at www.engc.org.uk.

Students are encouraged to pursue courses accredited by the Institution of Mechanical Engineers, or any other engineering institution, to facilitate their journey towards the status of a professional engineer.

PROFESSIONAL DEVELOPMENT

Training and professional development builds upon academic skills and can enable developing engineers to work to and achieve registration as a Chartered Engineer (CEng) or Incorporated Engineer (IEng). It must be challenging and is based upon the level of educational achievement reached.

MENTORING

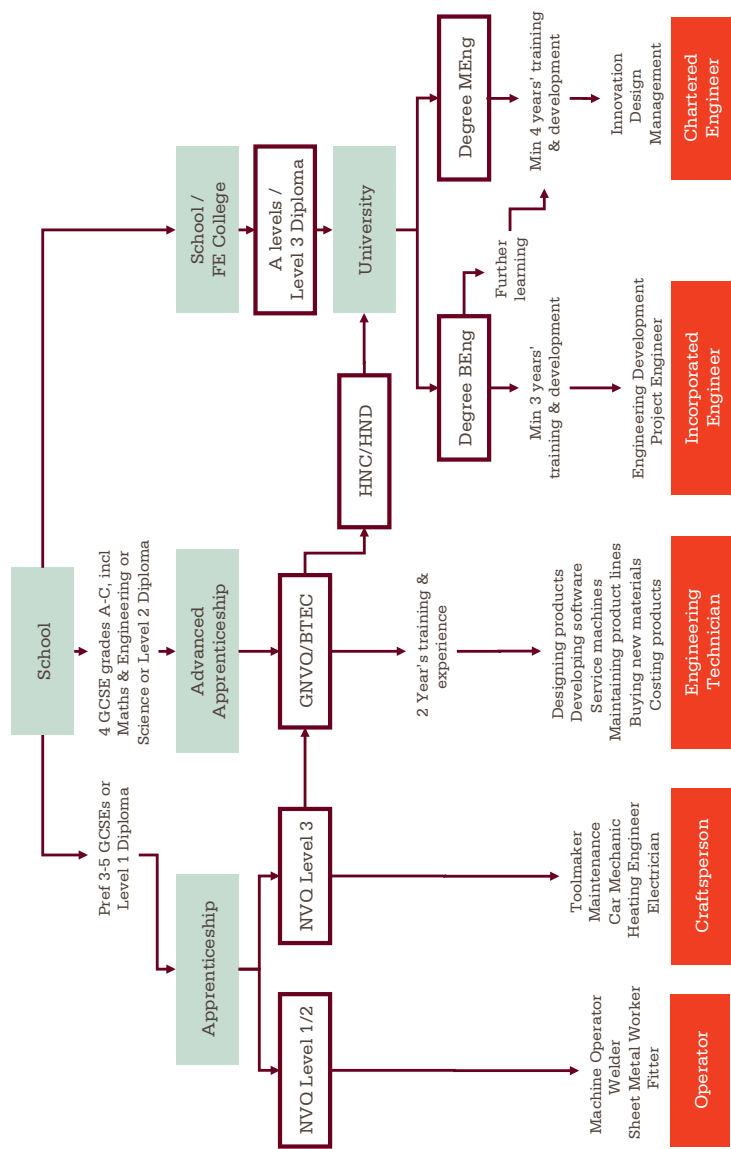
It is always useful to work with a mentor towards CEng or IEng. If you are working for a company with an accredited Monitored Professional Development Scheme (MPDS), an MPDS mentor will be allocated to you by your company. If you are not on an official scheme, you may work with any engineer who has experience of professional registration and UK-SPEC.

The IMechE, in association with other Institutions, has developed PD-HOW2 which can be viewed at www.pd-how2.org/. The website gives guidance on how to record your competences and evidence.

TRAINING AND PROFESSIONAL DEVELOPMENT FOR YOUR CAREER

The Institution of Mechanical Engineers now offers training and professional development short courses from a range of expert providers, enabling outstanding professional development opportunities for all engineers, technical professionals and scientists at all stages of their careers. Visit www.imeche.org/training-qualifications for more information.

ROUTES INTO ENGINEERING



For information on Bulk Materials Handling events, go to:

www.imeche.org/events

Please contact us with any comments, suggestions or questions at

ge@imeche.org

Cover image of Bulk Materials Handling Industry supplied and copyrighted to **Drax Power Station** (Selby) biomass domes and engineers

The logo for the Institution of Mechanical Engineers (IMECHE) is located in the bottom left corner. It consists of a red parallelogram with the text "Institution of MECHANICAL ENGINEERS" in white. "Institution of" is in a smaller font, while "MECHANICAL" and "ENGINEERS" are in a larger, bold, sans-serif font.

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